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# NATURE RESERVES GRĄDY NAD MOSZCZENICĄ AND GRĄDY NAD LINDĄ – REFUGES OF FOREST MALACOFAUNA IN CENTRAL POLAND

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ABSTRACT: In 2007 and 2009 two forest nature reserves situated in the environs of Łódź, Central Poland, were sampled by visual search and sieving litter samples to produce complete lists of terrestrial gastropods. Four sites representing various plant communities were searched in each reserve (*Tilio-Carpinetum typicum*, *Tilio-Carpinetum stachyetosum*, *Fraxino-Alnetum*, *Ribeso nigri-Alnetum*). The resulting material included 3,217 specimens representing 44 species of gastropods (including 38 terrestrial) and bivalves (*Pisidium* sp.). Thirty eight gastropod species were recorded from Grądy nad Moszczenicą (among them five slugs and four freshwater snails); and 35 from Grądy nad Lindą (among them six slugs and four freshwater snails). The richest sites (*Fraxino-Alnetum* in Grądy nad Moszczenicą and *Ribeso nigri-Alnetum* in Grądy nad Lindą) harboured 27 and 26 terrestrial gastropod species, respectively. Some species were recorded for the first time in the region, namely: *Acicula polita* (Hartmann), *Vertigo alpestris* Alder and *Clausilia cruciata* (Studer). The rich malacofauna with three coexisting clausiliid species (*Alinda biplicata* (Montagu), *Ruthenica filograna* (Rossmässler) and *Clausilia cruciata* (Studer)) in Grądy nad Moszczenicą indicates a small degree of habitat destruction in the nature reserve.

KEY WORDS: Gastropoda, forest snail faunas, nature reserve, endangered species, Central Poland

## INTRODUCTION

The richness of forest snail faunas in Poland and their affinities to other European malacocoenoses have been recently described by POKRYSZKO & CAMERON (2005). It appears that snail faunas from lowland localities in Poland have more in common with the faunas of north-western Europe than with those of the Carpathians, despite the greater geographical distance. In the Polish lowlands the snail faunas are not very species-rich, with exception of a few localities such as Białowieża Forest or Kaszuby Uplands (CAMERON & POKRYSZKO 2004, 2006). There are also records of species-rich malacocoenoses from Wielkopolska (SZYBIAK 2008).

Little is known about forest snail faunas of Central Poland. Published data concern three nature reserves near Stryków (DZIĘCZKOWSKI 1988) and Polesie Konstantynowskie – another nature reserve, at present within the boundaries of the city of Łódź (PIECHOCKI 1963, SULIKOWSKA-DROZD 2007). In this project, two other nature reserves situated near Łódź and protecting deciduous forests, were investigated to check if they provided a refuge for forest malacofauna.

## STUDY AREA AND SAMPLING SITES

The nature reserve Grądy nad Moszczenicą (GM), 42.1 ha in area, established in 1994, is situated north of Łódź and Zgierz (51°55'N, 19°30'E), in a large forest called "Szczawin" (Fig. 1) on the left bank of the Moszczenica river – tributary of the Bzura river (KUROWSKI et al. 1996). Floristic information on the reserve has been provided by KUROWSKI et al. (1994). The flora consists of 172 species (among them 40

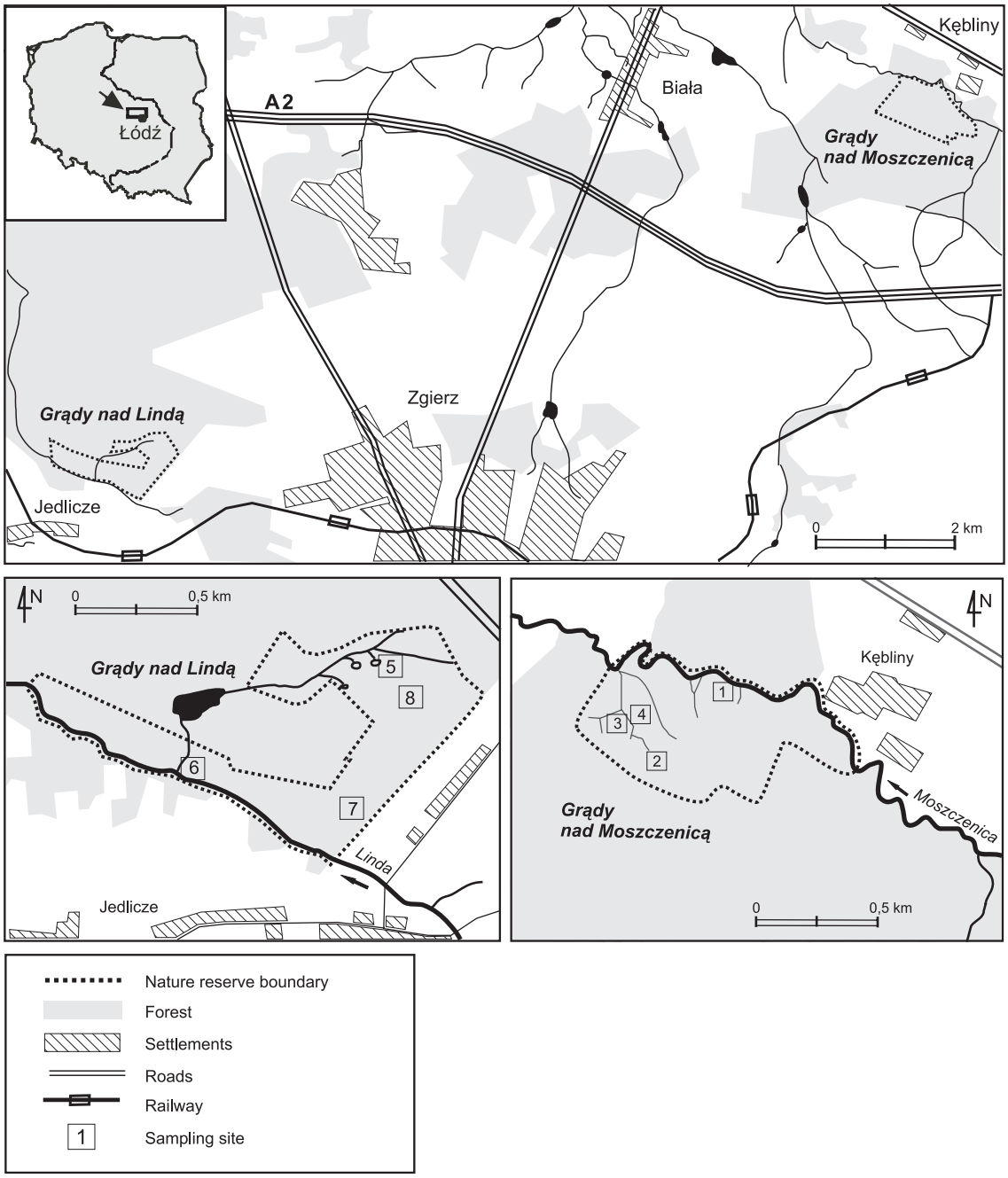


Fig. 1. Location of the studied nature reserves (top); sample sites in nature reserve Grądy nad Lindą (bottom left) and in nature reserve Grądy nad Moszczenicą (bottom right)

trees and shrubs). About 2/3 of the area is covered by oak-hornbeam forests (*Tilio-Carpinetum*). In the western part of the reserve, small brooks cut the moraine into deep gorges and the hornbeam forest is more humid with a lush herb layer (*Tilio-carpinetum stachyetosum*). Wet alder forest *Fraxino-Alnetum* adjoins the river and surrounds a spring area in the southern part of the reserve. The rest of the protected area is overgrown by mixed forest with pine and oak (*Querco roboris-Pinetum*).

The nature reserve Grądy nad Lindą (GL) (coordinates: 51°53'N, 019°21'E; area: 55.85 ha, established in 1997) is situated to the northwest of Łódź and Zgierz at the edge of the large forest area "Las Grotnicki". The southern boundary of the reserve goes along the Linda river (tributary of the Bzura river). The highest elevation is situated in the eastern part of the reserve (196 m a.s.l.). In the northern part there is a spring area with a peatbog and three springs creating small pools with a stony bottom (KUROWSKI et al. 1996). A brook, tributary of Linda, originates there. According to KUROWSKI (2006) the flora of the reserve consists of 288 species (among them 59 species of trees and shrubs). The dominant plant community – oak-hornbeam forest (*Tilio-Carpinetum*) – develops here in three variants, depending on the soil humid-

ity. Along the river and its tributary there is a narrow belt of wet alder forest (*Fraxino-Alnetum).* Small patches of alder swamp (*Ribeso nigri–Alnetum*) surround the spring area in the northern part of the reserve. Mixed forest (*Querco-Pinetum*) covers small patches in the north-western part.

Four study sites were chosen in each of the reserves:

Grądy nad Moszczenicą

1. **wet alder forest on the bank of the Moszczenica river;** *Fraxino-Alnetum*; canopy cover 55%; main trees: *Alnus glutinosa, Carpinus betulus, Acer platanoides, Tilia cordata, Acer pseudoplatanus*; herb layer 60%: *Aegopodium podagraria, Chrysosplenium alternifolium, Impatiens noli-tangere* (Fig. 2).
2. **alder forest in the southern part of the reserve**; drying out patches of *Fraxino-Alnetum*; canopy cover 65%; main trees: *Alnus glutinosa, Betula verrucosa, Acer platanoides*, herb layer 90%: *Deschampsia caespitosa, Milium effusum, Chrysosplenium alternifolium.*
3. **humid oak-hornbeam forest along the spring area and gorges, western part of the reserve**; *Tilio-Carpinetum stachyetosum*; canopy cover 50%, mainly *Alnus glutinosa, Acer pseudoplatanus* and *Carpinus betulus*; herb layer 80%: *Galeobdolon luteum, Stellaria holostea, Anemone nemorosa, Aegopodium podagraria, Urtica dioica* (Fig. 3).
4. **oak-hornbeam forest in the western part of the reserve;** *Tilio-Carpinetum typicum*; canopy cover 50%; herb layer 40%, *Milium effusum, Trientalis europaea, Oxalis acetosella, Majanthemum bifolium* (Fig. 4).

Grądy nad Lindą

5. **swamp alder forest surrounding the spring area in the northern part of the reserve**; *Ribeso nigri-Alnetum*; canopy cover 60%; main trees: *Alnus glutinosa, Acer pseudoplatanus*; variation in microhabitat: spring pools flooded by groundwater and much drier hummocks (Fig. 5).
6. **wet alder forest on the bank of the Linda river**; *Fraxino-Alnetum*; canopy cover 60%; main tree: *Alnus glutinosa*, admixture of *Acer pseudoplatanus, Ulmus glabra, Tilia cordata* (Fig. 6).
7. **humid oak-hornbeam forest in the south-eastern part of the reserve;** *Tilio-Carpinetum stachyetosum*; canopy cover 60%; main trees *Carpinus betulus, Ulmus glabra, Betula verrucosa*; herb layer 40%: *Asarum europaeum, Stachys sylvatica, Hepatica nobilis* (Fig. 7).
8. **oak-hornbeam forest in the eastern part of the reserve;** *Tilio carpinetum typicum;* canopy cover 50%; main trees *Carpinus betulus, Quercus petraea;* herb layer 10%.

Fig. 2. Alder forest on the bank of the Moszczenica river (site 1)

Fig. 3. Grądy nad Moszczenicą nature reserve – spring area (site 3)

Fig. 4. Oak-hornbeam forest in Grądy nad Moszczenica nature reserve (site 4)

Fig. 5. Grądy nad Lindą nature reserve – spring area (site 5)

Fig. 6. Alder forest on the bank of the Linda river (site 6)

Fig. 7. Oak-hornbeam forest in Grądy nad Lindą nature reserve (site 7)

## MATERIAL AND METHODS

Sampling of snails and slugs was carried out in 2007 and 2009 at eight forest sites (each ca. 400 $m^2$ in area) within the reserves. Samples were made by a combination of litter collection and visual search according to procedure recommended by CAMERON & POKRYSZKO (2005). At first (spring 2007), forest floor, bark of logs, and vegetation were searched for gastropods with a constant effort (two person-hours). Individuals of large, easily identified species were counted and released. Also 10 l of litter were collected in each site, taken to the laboratory, air-dried, sieved and sorted down to 0.5 mm mesh to find the smallest individuals. In the autumn 2007 all the localities were once more searched for slugs. The Chao index was calculated to estimate the completeness of the sampling. It showed that the number of species was underestimated; consequently, the sites were re-sampled in the summer 2009 – additional 10 l of litter were taken from each locality.

The differentiation of the fauna was measured by Whittaker's index ($I_w = S/\alpha$, where S – number of species in the locality, and $\alpha$ – mean number of species per site), and $I_{max}$, ($I_{max} = S/\alpha_{max}$). Faunal similarity among the studied sites was estimated with the Nei index: $I_N$ = number of species in common/geometric mean of species present at each site (CAMERON & POKRYSZKO 2005, POKRYSZKO & CAMERON 2005).

The collected material (Gastropoda), including 3,202 specimens, is kept in the author's collection.

Nomenclature of terrestrial gastropods throughout follows WIKTOR (2004), and aquatic forms – PIECHOCKI (1979).

## RESULTS

### COMPLETENESS OF DATA SET

The Chao index calculated for the whole GM nature reserve equalled 1.0, and for the whole GL nature reserve – 0. It is possible that one more species was present in GM but remained undetected; the species list for GL seems to be complete. However, in individual sites in both reserves there are a few singletons. In spite of the repeated sampling, the number of species per site could be underestimated.

SPECIES LIST

Forty four species of gastropods were recorded, 38 in GM, and 35 in GL. In each reserve four freshwater snail species and clams (*Pisidium* sp.) were found in litter samples. Table 1 shows the numbers of each species found at each site and at each locality. The total number of snail specimens recorded

Table 1. Species composition of sites in Grądy nad Moszczenicą and Grądy nad Lindą nature reserves

| Species | Grądy nad Moszczenicą | | | | | Grądy nad Lindą | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Total | 5 | 6 | 7 | 8 | Total |
| *Acicula polita* (Hartmann, 1840) | | | 1 | | 1 | 3 | | | | 3 |
| *Carychium minimum* (O.F. Müller, 1774) | 1 | 53 | 16 | | 70 | | 55 | | | 55 |
| *Carychium tridentatum* (Risso, 1826) | 1 | 57 | 16 | | 74 | 85 | 41 | 52 | | 178 |
| *Succinea putris* (Linnaeus, 1758) | 15 | | | | 15 | 2 | 1 | | | 3 |
| *Cochlicopa lubrica* (O.F. Müller, 1774) | 11 | 44 | 15 | 1 | 71 | 60 | 30 | 18 | | 108 |
| *Cochlicopa lubricella* (Porro, 1838) | | | | | | 65 | | 1 | | 66 |
| *Columella edentula* (Draparnaud, 1805) | | | | | | 7 | | 12 | | 19 |
| *Vertigo alpestris* Alder, 1837 | 13 | | | | 13 | | | | | |
| *Vertigo antivertigo* (Draparnaud, 1801) | | | 16 | | 16 | | | | | |
| *Vertigo pusilla* O.F. Müller, 1774 | 2 | | 4 | 1 | 7 | 46 | 3 | | | 49 |
| *Vertigo substriata* (Jeffreys, 1833) | | 2 | | | 2 | 12 | 8 | 1 | | 21 |
| *Acanthinula aculeata* (O.F. Müller, 1774) | | 2 | 5 | | 7 | 82 | | 3 | | 85 |
| *Punctum pygmaeum* (Draparnaud, 1801) | 2 | 4 | 5 | 3 | 14 | 46 | 17 | 56 | | 119 |
| *Discus ruderatus* (Férussac, 1821) | 4 | | 2 | 51 | 57 | 3 | | 33 | | 36 |
| *Discus rotundatus* (O.F. Müller, 1774) | | 18 | | | 18 | | 100 | 10 | 11 | 121 |
| *Arion rufus* (Linnaeus, 1758) | | | | | | | | + | | + |
| *Arion subfuscus* (Draparnaud, 1805) | + | + | + | + | + | + | + | | | + |
| *Arion circumscriptus* Johnston, 1828 | + | + | | | + | + | + | + | | + |
| *Vitrina pellucida* (O.F. Müller, 1774) | 23 | 3 | 22 | 4 | 52 | 19 | | 2 | | 21 |
| *Vitrea crystallina* (O.F. Müller, 1774) | 25 | 54 | 31 | | 110 | 17 | | | | 17 |
| *Aegopinella pura* (Alder, 1830) | 17 | 47 | 6 | 2 | 72 | 42 | | 1 | | 43 |
| *Nesovitrea hammonis* (Ström, 1765) | 11 | 108 | 27 | 11 | 157 | 81 | 64 | 57 | 1 | 203 |
| *Nesovitrea petronella* (L. Pfeiffer, 1853) | | 1 | | | 1 | 12 | 31 | 1 | | 44 |
| *Oxychilus alliarius* (Miller, 1822) | 1 | | 1 | 4 | 6 | 25 | 16 | | 1 | 42 |
| *Zonitoides nitidus* (O.F. Müller, 1774) | 17 | 51 | 91 | | 159 | 73 | 28 | 7 | | 108 |
| *Limax cinereoniger* Wolf, 1803 | + | + | + | + | + | + | + | + | + | + |
| *Malacolimax tenellus* (O.F. Müller, 1774) | + | | | + | + | + | + | + | + | + |
| *Deroceras laeve* (O.F. Müller, 1774) | + | | | | + | | + | | | + |
| *Euconulus fulvus* (O.F. Müller, 1774) | 1 | 30 | 9 | | 40 | 28 | 5 | 22 | | 55 |
| *Ruthenica filograna* (Rossmässler, 1836) | 6 | 56 | 23 | | 85 | 5 | | | | 5 |
| *Clausilia cruciata* (Studer, 1820) | | | 27 | 1 | 28 | | | | | |
| *Alinda biplicata* (Montagu, 1803) | 50 | 21 | 81 | 28 | 180 | | | | | |
| *Bradybaena fruticum* (O.F. Müller, 1774) | 17 | 6 | | | 23 | | | | | |
| *Perforatella bidentata* (Gmelin, 1791) | 4 | 50 | 10 | | 64 | 12 | 15 | 2 | | 29 |
| *Perforatella incarnata* (O.F. Müller, 1774) | 57 | 10 | 12 | 12 | 91 | 25 | 11 | 46 | 3 | 85 |
| *Perforatella rubiginosa* (A. Schmidt, 1853) | 2 | | | | 2 | | | | | |
| *Cepaea nemoralis* (Linnaeus, 1758) | | | | | | | | 4 | 6 | 10 |
| *Helix pomatia* Linnaeus, 1758 | 1 | 5 | 1 | 1 | 8 | | | | | |
| Total individuals (Gastropoda terrestria) | 281 | 622 | 421 | 119 | 1443 | 750 | 425 | 328 | 22 | 1525 |
| Total species (Gastropoda terrestria) | 27 | 23 | 24 | 15 | 34 | 26 | 20 | 22 | 7 | 31 |
| *Anisus spirorbis* (Linnaeus, 1758) | | | 3 | | 3 | | | | | |
| *Anisus leucostomus* (Millet, 1813) | 3 | | | | 3 | 1 | | | | 1 |
| *Lymneaa truncatula* (O.F. Müller, 1774) | 2 | 6 | 7 | | 15 | 4 | | | | 4 |
| *Lymnaea turricula* (Held, 1836) | | | | | | 2 | | | | 2 |
| *Lymnaea peregra* (O.F. Müller, 1774) | | | | | | 2 | | | | 2 |
| *Aplexa hypnorum* (Linnaeus, 1758) | 2 | | | | 2 | | | | | |
| *Pisidium* sp. | | 4 | 1 | | 5 | 5 | 5 | | | 10 |
| Total individuals (Mollusca aquatica) | 7 | 10 | 11 | 0 | 28 | 14 | 5 | 0 | 0 | 19 |
| Total species (Mollusca aquatica) | 3 | 2 | 3 | 0 | 5 | 5 | 1 | 0 | 0 | 5 |

Table 2. Terrestrial species richness, abundance and degree of differentiation of malacocoenoses ($I_W$, $I_{max}$) in the studied nature reserves

| | Grądy nad Moszczenicą | Grądy nad Lindą | Total |
|---|---|---|---|
| Samples | 4 | 4 | 8 |
| Species | 34 | 31 | 38 |
| mean/sample | 22.3 | 18.8 | |
| range | 15–27 | 7–26 | |
| $I_W$ | 1.53 | 1.65 | |
| $I_{max}$ | 1.26 | 1.19 | |
| Shells | 1,443 | 1,525 | 2,968 |
| mean/sample | 361 | 381 | |
| range | 119–622 | 22–750 | |

was 3,000 (2,968 terrestrial); additionally 202 slugs were collected: 75 specimens of Arionidae; 118 – of Limacidae and 9 – of Agriolimacidae. The data on species richness and the values of Whittaker's index are presented in Table 2. The richest sites (*Fraxino-Alnetum* in GM and *Ribeso nigri-Alnetum* in GL) harboured 27 and 26 terrestrial gastropod species, respectively. Each malacocoenosis held more than 80% species found in the reserve. Only two species were universal, recorded from all sites in both reserves (*Nesovitrea hammonis* and *Perforatella incarnata*). Four species were only recorded in single sites (GM: *Vertigo alpestris*, *Vertigo antivertigo*, *Perforatella rubiginosa*; GL: *Arion rufus*).

Table 3. Dominant snail species in malacocoenoses of Grądy nad Moszczenicą and Grądy nad Lindą nature reserves

| Sample site | Eudominants (abundance >20.01 %) | Dominants (abundance >10.01%) | Subdominants (abundance >5.01 %) |
|---|---|---|---|
| 1 | | *Alinda biplicata*<br>*Perforatella incarnata* | *Aegopinella pura*<br>*Arion circumscriptus*<br>*Bradybaena fruticum*<br>*Vitrina pellucida*<br>*Zonitoides nitidus* |
| 2 | | *Nesovitrea hammonis* | *Aegopinella pura*<br>*Carychium minimum*<br>*Carychium tridentatum*<br>*Cochlicopa lubrica*<br>*Perforatella bidentata*<br>*Ruthenica filograna*<br>*Vitrea crystallina*<br>*Zonitoides nitidus* |
| 3 | *Zonitoides nitidus* | *Alinda biplicata* | *Clausilia cruciata*<br>*Nesovitrea hammonis*<br>*Ruthenica filograna*<br>*Vitrina crystallina*<br>*Vitrina pellucida* |
| 4 | *Discus ruderatus* | *Alinda biplicata* | *Limax cinereoniger*<br>*Nesovitrea hammonis*<br>*Perforatella incarnata* |
| 5 | | *Acanthinula aculeata*<br>*Carychium tridentatum*<br>*Nesovitrea hammonis* | *Aegopinella pura*<br>*Cochlicopa lubrica*<br>*Cochlicopa lubricella*<br>*Punctum pygmaeum*<br>*Vertigo pusilla*<br>*Zonitoides nitidus* |
| 6 | *Discus rotundatus* | *Carychium minimum*<br>*Nesovitrea hammonis* | *Carychium tridentatum*<br>*Cochlicopa lubrica*<br>*Nesovitrea petronella*<br>*Zonitoides nitidus* |
| 7 | | *Carychium tridentatum*<br>*Nesovitrea hammonis*<br>*Perforatella incarnata*<br>*Punctum pygmaeum* | *Discus ruderatus*<br>*Euconulus fulvus*<br>*Malacolimax tenellus* |
| 8 | *Cepaea nemoralis*<br>*Discus rotundatus*<br>*Limax cinereoniger* | *Perforatella incarnata* | |

## STRUCTURE AND SIMILARITY OF MALACOENOSES

The structure of the malacocoenoses was analysed only for land snail species (slugs excluded). The list of dominant species at each site is shown in Table 3. In both reserves the dominant group consisted mainly of typical forest dwellers, such as *Discus ruderatus, D. rotundatus*, *Punctum pygmaeum*, *Acanthinula aculeata*, *Vertigo pusilla*, *Aegopinella pura*, *Alinda biplicata*, *Ruthenica filograna*, *Clausilia cruciata*, *Bradybaena fruticum*, *Perforatella incarnata*, *P. bidentata*; also hygrophilous snails were abundant: *Zonitoides nitidus, Nesovitrea petronella, Carychium minimum* and *Succinea putris*. Similarity of malacocoenoses estimated with the Nei index is presented in Table 4.

Table 4. Nei similarity values for sample sites. The highest values indicated in bold

| Studied sites | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 2 | **0.762** | | | | | | |
| 3 | **0.786** | **0.766** | | | | | |
| 4 | 0.696 | 0.538 | 0.738 | | | | |
| 5 | 0.755 | 0.736 | **0.761** | 0.608 | | | |
| 6 | 0.732 | 0.699 | 0.593 | 0.520 | 0.745 | | |
| 7 | 0.574 | 0.711 | 0.566 | 0.495 | **0.794** | 0.667 | |
| 8 | 0.364 | 0.315 | 0.307 | 0.488 | 0.371 | 0.507 | 0.483 |

## DISCUSSION

The species inventory on the scale of the whole nature reserve seems to be almost complete (see Chao index), while in individual sites some species remain undetected. This can be at least partly explained by the patchiness of habitats/plant communities that adjoin the small brooks, spring areas or places with high level of ground water (plant communities: *Fraxino-Alnetum*, *Ribeso nigri-Alnetum, Tilio-Carpinetum stachyetosum*). In many places these eutrophic communities form very narrow strips which results from the sharp soil humidity gradient. Consequently it was impossible to avoid sampling some accidental species penetrating the ecotone zone. Within GM the greatest similarity was that between sites 1 and 3 (wet alder forest and humid oak-hornbeam forest); within GL – between sites 5 and 7 (alder swamp and humid oak-hornbeam forest). The similarity between rich, eutrophic sites located in different reserves was also high. These sites harboured almost all fauna (see $I_{max}$, Table 2). Drier sites (typical oak-hornbeam forest) showed a lower level of similarity. A similar uniformity of faunas of different habitats was also recorded in Białowieża forest, with no species unique to the poorest habitats (CAMERON & POKRYSZKO 2004).

Some locally rare species were recorded in the reserves. The first localities of *Clausilia cruciata* and *Vertigo alpestris* in the region were found in GM. The two species are boreo-montane, with some scattered localities in the lowlands of Poland (WIKTOR 2004). Their occurrence shows that the forest stands in the reserve did not undergo any major disturbance by human activity. *Acicula polita*, which occurs in both studied reserves, was not previously recorded in the environs of Łódź. According to RIEDEL (1988) the range of the species covers the whole of Poland, but the small size of the snail makes it easy to overlook. Two of the recorded species are red-listed – *Nesovitrea petronella* and *Clausilia cruciata* (WIKTOR & RIEDEL 2002). Also *Ruthenica filograna* and *Discus ruderatus* may be regarded as endangered – it was noticed that they had retreated from some localities in Poland (RIEDEL 1988). For example, in the 1960s they were recorded from Polesie Konstantynowskie nature reserve, but were not found there during the 2002-2005 search (PIECHOCKI 1963, SULIKOWSKA-DROZD 2007). Co-occurrence of three clausiliid species in GM is unique in Central Poland. An extensive survey of forest fauna from the Polish lowlands showed that the small number of clausiliids per site or even their absence was typical there (CAMERON & POKRYSZKO 2006). It was suggested that the paucity of clausiliid fauna was the most evident sign of disturbance of habitats resulting from human activities (forest fragmentation, removal of timber or air pollution).

The occurrence of synanthropic species in GL should be noted. *Cepaea nemoralis* and *Arion rufus* recorded there occur only in anthropogenic habitats in Central Poland. The irregular shape of the protected area and its location on the edge of the forest probably increase the rate of anthropogenic changes, such as introduction of pest species.

The recent inventory of the snail fauna in Polesie Konstantynowskie nature reserve, located within the boundaries of the city of Łódź, revealed 26 terrestrial

Table 5. Differences in the species lists from Grądy nad Moszczenicą, Grądy nad Lindą, Białowieża (data from CAMERON & POKRYSZKO 2004) and Kaszuby (CAMERON & POKRYSZKO 2006)

| Species present in GM but absent from Białowieża | Species present in GL but absent from Białowieża | Species present in GM but absent from Kaszuby | Species present in GL but absent from Kaszuby |
|---|---|---|---|
| *Vertigo antivertigo* | *Oxychilus alliarius* | *Vertigo antivertigo* | *Discus ruderatus* |
| *Oxychilus alliarius* | *Perforatella incarnata* | *Discus ruderatus* | *Zonitoides nitidus* |
| *Clausilia cruciata* | *Cepaea nemoralis* | *Zonitoides nitidus* | *Perforatella incarnata* |
| *Alinda biplicata* | | *Clausilia cruciata* | *Cepaea nemoralis* |
| *Perforatella incarnata* | | *Perforatella incarnata* | |
| | | *Perforatella rubiginosa* | |
| Nei index 0.66 | Nei index 0.66 | Nei index 0.65 | Nei index 0.64 |

gastropods, among them *Arianta arbustorum*, *Trichia hispida* and *Cepaea hortensis* which were absent in GM and GL (SULIKOWSKA-DROZD 2007, and unpublished). The similarity among the malacofaunas of these reserves in Central Poland is high (Polesie Konstantynowskie and GM – Nei index 0.70; Polesie Konstantynowskie and GL – 0.71; GM and GL – 0.82).

SZYBIAK (2008) presented a list of typical components of alder-carr malacocoenoses in central Wielkopolska. In GL (site 5) the malacocoenosis of *Ribeso nigri-Alnetum* includes a similar set of species, and, additionally, *Discus ruderatus* and *Oxychilus alliarius*. In the humid alder forest in Wielkopolska the richest site harboured 34 species of terrestrial gastropods (including six clausiliids) (SZYBIAK 2008). The comparison of the snail faunas of the studied reserves in Central Poland and Kaszuby or Białowieża refuges (data from CAMERON & POKRYSZKO 2004, 2006) indicates a slightly greater similarity to the latter area. Białowieża and the reserves in Central Poland together share 27 snail species (Nei index 0.71); Kaszuby and the reserves – 25 species (Nei index 0.67). Lower similarities with sites in the Kaszuby Upland may be associated with the humidity of those sites (absence of *Vertigo antivertigo*, *Zonitoides nitidus* and *Perforatella rubiginosa*). It differs from the Białowieża malacocoenoses also in the presence of western species (*Oxychilus alliarius*). The differences in the recorded faunas are presented in Table 5.

Comparatively small remnants of natural deciduous forests in GM and GL, with their range of eutrophic habitats, harbour a rich malacofauna even though it is much poorer compared to the renown Białowieża forest. It is noteworthy that the richest sites in both reserves were situated close to springs – the area with pronounced relief which probably discourages people from forestry or trespassing. Locating similar habitats in the lowlands may reveal more malacofauna refuges.

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