OCCURRENCE OF DESMOULIN'S WHORL SNAIL *VERTIGO MOULINSIANA* (DUPUY 1849) IN THE NIDA WETLANDS (SOUTH POLAND): INTERACTIVE EFFECTS OF VEGETATION AND SOIL MOISTURE

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Abstract Vertigo moulinsiana *is a little known, but very rare, small land snail species, living in wet areas with high pH and calcium content. The paper presents research carried out in May 2008, on one of the few sites of this species in Poland: in wetlands located in the valley of the Nida river. Based on data collected in 60 randomly selected points, it was found that* Vertigo moulinsiana *occurred most often and in the highest densities in places overgrown with* Glyceria *and sedge* Carex. *The occurrence of the highest density in* Glyceria *was under "wet" conditions. In sedge, the highest density was noted in "dry" conditions. Also affecting the differences in the population density of snails are the interactions between the type of vegetation and dampness of the conditions, which probably provide suitable microclimatic conditions for snails. Most likely, the presence of Desmoulin's whorl snail is linked with the spatial structure of vegetation occurring under particular hydrological conditions, which allows for the development of a specific microclimate.*

Key words Vertigo moulinsiana, *Polish wetlands, occurrence, vegetation, soil moisture*

INTRODUCTION

Desmoulin's whorl snail remains one of the least studied and enigmatic molluscan species to date (Lipińska, 2010). It is a small land snail, living in wet areas with high pH and calcium content (Pokryszko, 1990). Most known populations of this species occur in western and central Europe (Killeen, 1996a) and the range of habitats there is well-known (Drake, 1997; Hornung *et al*., 2003; Killeen & Moorkens, 2003; Proschwitz, 2003; Myzyk, 2004; Książkiewicz, 2009). Little is known, however, of the ecology of this species outside this area as most of the research concerned mainly the dynamics of populations occurring in Great Britain (Killeen, 2002) and their hydrological requirements (McInnes & Tattersfield, 2003). In Poland, recent work has greatly increased the number of known populations (Pokryszko, 1990; Myzyk, 2004; Zając & Zając, 2006; Książkiewicz, 2009).

The species has been regarded as threatened on an international scale, and was included in the IUCN Red List (IUCN, 2004) with a LR/cd category, and included in Annex II of the EU Habitats Directive (Cameron *et al.*, 2003). In Poland, Desmoulin's whorl snail has been placed under the species protection regime and placed on the Red List of Endangered and Threatened Animal Species in the category CR (critically endangered species; Zając, 2004). Habitat loss is given as the main reason for the species becoming extinct (Zając, 2004), but there are many sites with apparently suitable habitats in which it has never been found (McInnes & Tattersfield, 2003). The occurrence of the snail within a given locality is also often uneven (Lipińska & Gołąb, unpubl.). These differences most likely correspond with the habitat properties that if studied in detail could enable more a effective protection of the species.

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MATERIALS AND METHODS

One of the localities of *Vertigo moulinsiana* in Poland is situated in the so-called Middle Nida River Delta (50°34'30" N, 20°31'27" E; Zając & Zając, 2006). It is an area where meanders and anastomoses of the Nida river, cause the valley to widen to 6 km, forming an inland delta. As a result, an extremely diversified natural environment has been created, with a large number of old river beds at various stages of succession.

Our 6.1 ha study area is situated in this delta. It is covered by a dense network of narrow and shallow (up to 1.5 m deep) erosion channels and old river beds (3% of the area), inhabited by

communities of macrophytes *Nupharo-Nymphaeetum*, pleustonic plants *Lemno-Spirodeletum polyrrhizae* and immersed communities such as *Elodeetum Canadensis* and *Ceratophylletum demersi*. Areas further from old river beds are covered by meadows with the *Arrhenatheretum medioeuropaeum* association (12%). The lowest and wettest places, overgrown by *Typhetum latifoliae* (8%) or *Phragmitetum communis* (6%), are surrounded by *Glycerietum maximae* (16%) and extensive patches of *Carex elata* (55%; Korzeniak *et al*., 1995; Fig. 1). There are no tree- or shrub-covered areas on the site.

The studies were conducted in May of 2008. The vegetation cover was precisely mapped (1 m accuracy) by means of a GPS receiver (Geoexplorer II), and categorized according to distinguished land cover types. After mapping, the demarcations and land cover attributes of the subdivisions were imported to GIS (ArcInfo), enabling a detailed digital map of the study area to be developed (Zając *et al*., 2006). Based on this map, 60 measurement plots (each of 1 m^2 surface area; Fig. 1) were randomly drawn, using ArcGIS software. The positions of the measurement plots were determined to an accuracy of one metre. The plots so drawn were then checked for the presence of Desmoulin's whorl snail. Two persons searched for the snails in a circle of 1 m radius around a set point. The number of snails were recorded, together with the level of soil moisture in three arbitrarily applied categories (patterned after the dampness index of Stebbings & Killeen (1998): namely: very wet – stagnant water could be seen on the ground, wet – water appeared after stepping on the ground, or dry – water did not appear after stepping on the ground). In addition the type of vegetation on which the snails were found (5 types: sedge – *Carex* sp., sweetgrass, or flote grass – *Glyceria* sp., reed – *Phragmites* sp., cattail, or reedmace – *Typha* sp., and meadow; Fig. 1) was also noted.

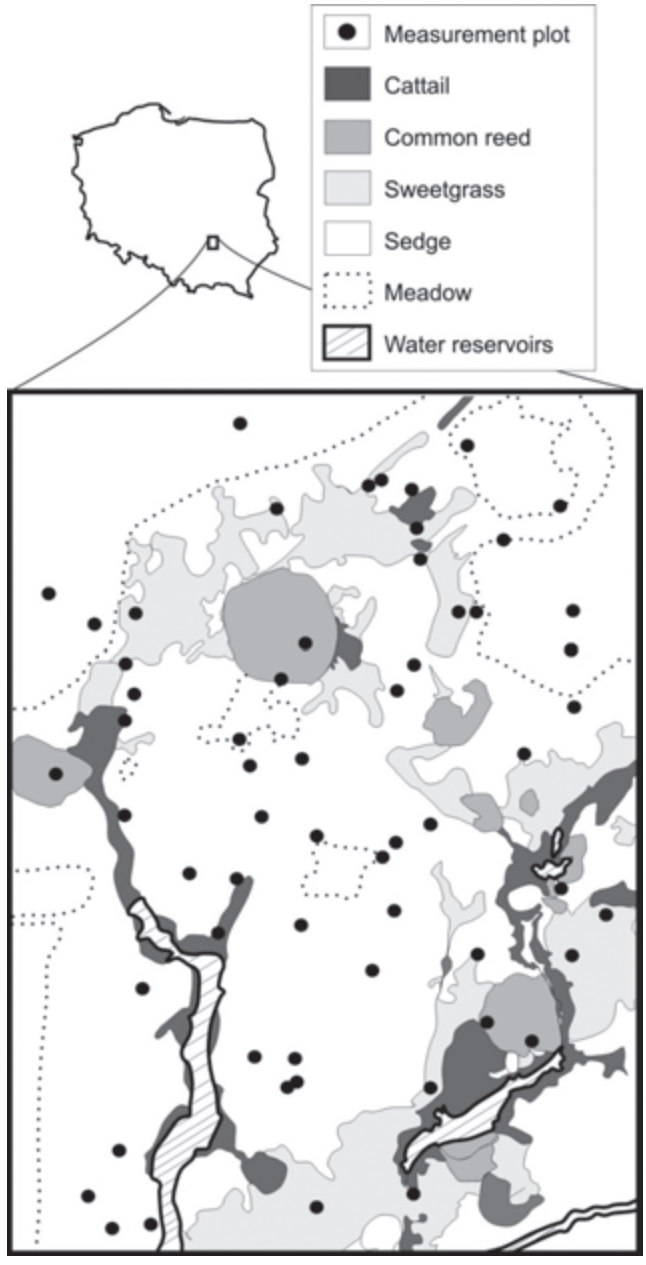

Figure 1 Main types of vegetation and locations of 60 randomly chosen measurement plots on the study area in the Nida River valley near Umianowice.

Results

It was found that among all the types of vegetation compared, the individuals of Desmoulin's whorl snail occur most often and in the highest densities in places overgrown with sweetgrass and sedge (Kruskal Wallis test; H=25.82; p<0.0001; Table 1; Fig. 2). The analysis of data conducted within these two types of vegetation, showed the occurrence of the highest density in sweetgrass was under "wet" conditions. In sedge, the highest density was noted in "dry" conditions (GLZ; W=9.98; p<0.0067; Fig. 3). Also affecting the differences in the population density of snails are the interactions between the type of vegetation and dampness of the conditions (GLZ; W=31.39; p<0.0001), which probably provide suitable microclimatic conditions for snails.

Table 1 Parameters of *Vertigo moulinsiana* occurrence in different vegetation types. Abbreviations: N_0 – number of studied plots in each vegetation type (total n=60), N_1 – number of plots in which individuals were found (n=30), F – frequency of plots in which individuals were found (%), Σ – sum of individuals (total n=284) in each vegetation type, P – total area of each vegetation type on a study plot, Md – median number of individuals on a study plot in each vegetation type, N_{max} – maximum number of individuals on a study plot in each vegetation type, $\bar{D}$ – mean density of individuals on a study plot in each vegetation type, $SD_{\bar{D}}$ – standard deviation of mean density ($\bar{D}$).

Vegetation type	∑	Plots per area				Individuals per plot			
		N_0	N_1	F [%]	P [ha]	Md	N_{max}	$\bar{D}$ [ind/m^2]	$SD_{\bar{D}}$
cattail	0	3	0	0	0.9	0	0	0	0
common reed	7	5	3	60	3.4	1.0	4	0.4	0.5
meadow	0	10	0	0	0.5	0	0	0	0
sedge	74	27	14	51.9	0.7	1.0	23	0.9	1.6
sweetgrass	203	15	13	86.7	0.2	12.0	29	4.3	3.2

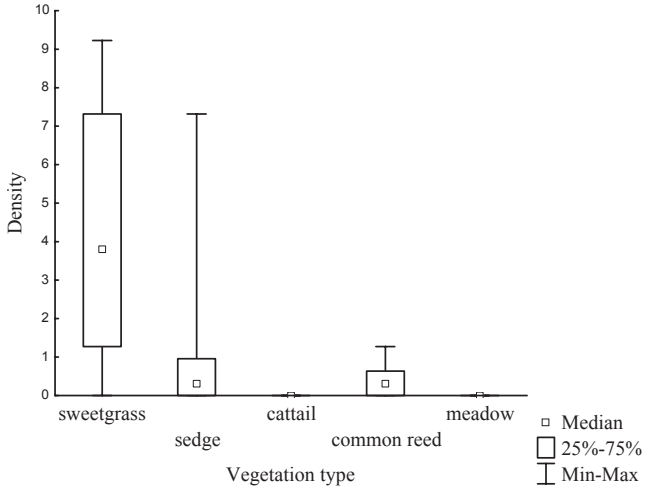

Figure 2 Box-Whiskers plot of differences in density of *Vertigo moulinsiana* between vegetation types, tested with Kruskal-Wallis test.

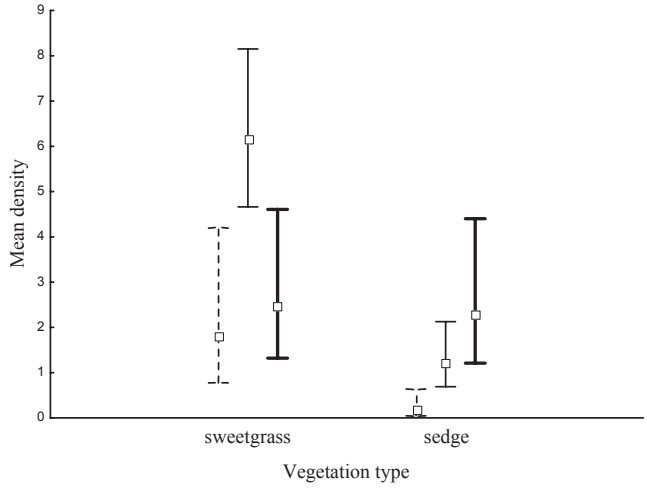

Figure 3 Influence of vegetation type on mean density of *Vertigo moulinsiana* snails grouped according to humidity conditions (GLZ model). Dashed line – dry conditions, solid line – wet conditions, bold line – very wet conditions, squares – mean density, whiskers –95% confidence interval.

DISCUSSION

In the majority of papers on the occurrence of this snail, the level of moisture in the habitat is not defined, although seasonal variation can make estimates incommensurate. The optimum soil moisture level is usually described as "permanently wet" (Killeen, 1996a; Killeen, 1996b; Seddon, 1996; Hornung *et al*., 2003; Książkiewicz, 2009; Lipińska, 2010). Only McInnes & Tattersfield (2003), using the Stebbings & Killeen (1998) dampness index, found in areas in Great Britain overgrown with *Glyceria maxima*, *Cladium mariscus*, *Phragmites australis,* and *Carex elata*, that the hydrological optimum for this species occurred in "wet" and "very wet" places. This coincides with the results of our studies.

To-date, no relation of the Desmoulin's whorl snail with any particular plant species has been found (Horsák *et al*., 2007). Myzyk (2004) observed the individuals of *Vertigo moulinsiana* in northern Poland on *Phragmites australis*, *Glyceria sp*., *Carex sp*., as well as on *Leonurus cardiaca, Polygonum persicaria, Rumex sp., Urtica dioica, Equisetum sp*., and on the leaves of trees. However, Książkiewicz (2009) in her studies of localities in western Poland (surroundings of Torun town), found snails in tussocks of miliary sedge *Carex paniculata.* In Great Britain, these snails occur in their highest numbers on sweetgrass (mean number of individuals per sample = 201.2) and sedges

(*Carex riparia*, *C. acutiformis*, *C. paniculata*, *C. elata;* mean number of individuals per sample = 120.4; Killeen, 2002), whereas the lowest number was found on reeds. On the other hand, in southern Scandinavia, Desmoulin's whorl snail is invariably bound to alder swamps (Proschwitz, 2003).

Such an enormous diversity of plants coupled with a fairly narrow range of the required level of dampness, may testify to the decisive role of interaction between vegetation and dampness in the occurrence of this snail. Most likely, the presence of Desmoulin's whorl snail is linked with the spatial structure of vegetation occurring under particular hydrological conditions, which allows for the development of a specific microclimate.

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References

Cameron RAD, Colville B, Falkner G, Holyoak GA, Hornung E, Killeen IJ, Moorkens EA, Pokryszko BM, Proschwitz T von, Tattersfield P & Valovirta I 2003 Species Accounts for snails of genus Vertigo listed in Annex II of the Habitat Directive: *V angustior, V genesii, V geyeri* and *V moulinsiana* (Gastropoda: Pulmonata: Vertiginidae). *Heldia* **5**: 151–170.

Drake MC (ed.) 1997 *Vertigo moulinsiana* – surveys and studies commissioned in 1995–6. *English Nature Research Report* **217**. Northminster House, Peterborough.

Hornung E, Majaros G, Fehér Z & Varga A 2003 An overview of the *Vertigo* species in Hungary: their distribution and habitat preferences (Gastropoda, Pulmonata: Vertiginidae). *In* Speight MCD, Moorkens EA & Falkner G (eds) *Proceedings of the Workshop on Conservation Biology of European Vertigo species*. *Heldia* **5**: 51–57.

Horsák M, Hájek M, Díte D & Tichý L 2007 Modern distribution patterns of snails and plants in the Western Carpathian spring fens: is it a result of historical development? *Journal of Molluscan Studies* **73**: 53–60.

Iucn 2004 The IUCN Red List of Threatened Species, http://www.iucnredlist.org/. Accessed March 2011.

Killeen IJ 1996a An assessment of the status and distribution of the terrestrial pulmonate snail *Vertigo moulinsiana* (Dupuy) in the Kennet and Lambourn Valleys, Berkshire. *In* Drake CM (ed.) *Vertigo moulinsiana – surveys and studies commissioned in 1995–6*. English Nature Research Report **217**: 9–24. Northminster House, Peterborough.

Killeen IJ 1996b A survey of the River Avon and tributaries (Wiltshire/Hampshire) and associated wetland habitats to assess their importance for the snail *Vertigo moulinsiana*. *In* Drake CM (ed.) *Vertigo moulinsiana – surveys and studies commissioned in 1995–6*. English Nature Research Report **217**: 25–41. Northminster House, Peterborough.

Killeen IJ 2002 *Surveys of EU Habitats Directive Vertigo species in England: 3. Vertigo moulinsiana Part 1: Summary and monitoring protocol*. English Nature Research Report **450**: 7–24. Northminster House, Peterborough.

Killeen IJ & Moorkens EA 2003 *Monitoring Desmoulin's Whorl Snail*. Conserving Natura 2000 Rivers Monitoring Series **6**: 1–33. Northminster House, Peterborough.

Korzeniak J, Zając K & Zając T 1995 Delta środkowej Nidy – stan aktualny i perspektywy Ochrony. *Chrońmy Przyrodę Ojczystą* **51**: 27–46.

Książkiewicz Z 2009 New localities of *Vertigo moulinsiana* (Dupuy, 1849) (Gastropoda: Pulmonata: Vertiginidae) in Northwestern Poland. *Folia Malacologica* **17**: 219–222.

Lipińska AM 2010 Poczwarówka jajowata *Vertigo moulinsiana* – rzadki gatunek ślimaka chroniony Dyrektywą Siedliskową – Desmoulin's whorl snail *Vertigo moulinsiana* – rare species of snail protected by Habitat Directive. *Chrońmy Przyrodę Ojczystą* **66**: 482–490.

McInnes RJ & Tattersfield P 2003 Hydrological requirements of *Vertigo moulinsiana*. *Heldia* **5**: 135–147.

Myzyk S 2004 A new locality of two rare Vertiginid speces (Gastropoda: Pulmonata: Vertiginidae) in NW Poland. *Folia Malacologica* **12**: 57–61.

Pokryszko BM 1990 The Vertiginidae of Poland (Gastropoda: Pulmonata: Pupilloidea)–a systematic monograph. *Annales Zoologici* **43**: 133–257.

Proschwitz T von 2003 A review of the distribution, habitat selection and conservation status of the species of the genus *Vertigo* in Scandinavia (Denmark, Norway and Sweden) (Gastropoda, Pulmonata: Vertiginidae). *In* Speight MCD, Moorkens EA & Falkner G (eds) *Proceedings of the Workshop on Conservation Biology of European Vertigo species*. *Heldia* **5**: 27–50.

Seddon MB 1996 Distribution of *Vertigo moulinsiana* (Dupuy, 1849) in Europe. *In* Drake CM (ed.) *Vertigo moulinsiana – surveys and studies commissioned in 1995–6.* English Nature Research Report **217**: 56–68. Northminster House, Peterborough.

Stebbings RE & Killeen IJ 1998 Translocation of the habitat for the snail *Vertigo moulinsiana* in England. *In* Killeen IJ, Seddon MB & Holmes AM *Molluscan conservation: a strategy for the 21st century*. Journal of Conchology Special Publication **2**: 191–204.

Zając K 2004 *Vertigo (Vertigo) moulinsiana* (Dupuy, 1849) poczwarówka jajowata. *In* Adamski P, Bartel

R, BERESZYŃSKI A, KEPEL A & WITKOWSKI Z (eds) Gatunki Zwierząt (z wyj. ptaków). *Poradniki ochrony siedlisk i gatunków Natura 2000 – podręcznik metodyczny*: 158–161. Warszawa.

ZAJĄC A & ZAJĄC K 2006 Nowe stanowisko poczwarówki jajowatej *Vertigo moulinsiana* (Dupuy, 1849) w dolinie Nidy. *Chrońmy Przyrodę Ojczystą* **62**: 105–107.

ZAJĄC T, SOLARZ W & BIELAŃSKI W 2006 Adaptive settlement in sedge warblers *Acrocephalus schoenobaenus* – focus on the scale of individuals. *Acta Oecologica* **29**: 123–134.