

IMPACT OF LAND USE ON POPULATIONS OF *VERTIGO MOULINSIANA* (DUPUY, 1849) AND *VERTIGO ANGUSTIOR* (JEFFREYS, 1830) (GASTROPODA: PULMONATA: VERTIGINIDAE): ILANKA RIVER VALLEY (W. POLAND)

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ABSTRACT: Many sedge meadows in western Poland provide suitable habitats for *Vertigo angustior* Jeffreys and *Vertigo moulinsiana* (Dupuy) which are regarded as threatened across Europe. Such habitats are often subject to conservation measures aimed at supporting wetland birds in accordance with the European Birds Directive. Such measures, usually involving extensive mowing, may not favour the vertiginids. Both species are protected by another European act – The Habitats Directive. The range of methods used for maintaining the bird habitats is wide: the sites are mowed manually or mechanically in different ways, and the mowing covers the entire site or just selected patches. The aim of this study was to check how the different maintenance methods influenced the vertiginid populations. The abundance of *V. angustior* and *V. moulinsiana* was studied at 17 sampling sites along the Ilanka river valley (Lubuskie Province, W. Poland). The sites differed in size, moisture level, vegetation, type of land use and shadiness. The results suggest that extensive land management can be advantageous for both species only when the site is divided in patches which are mowed alternately in consecutive years.

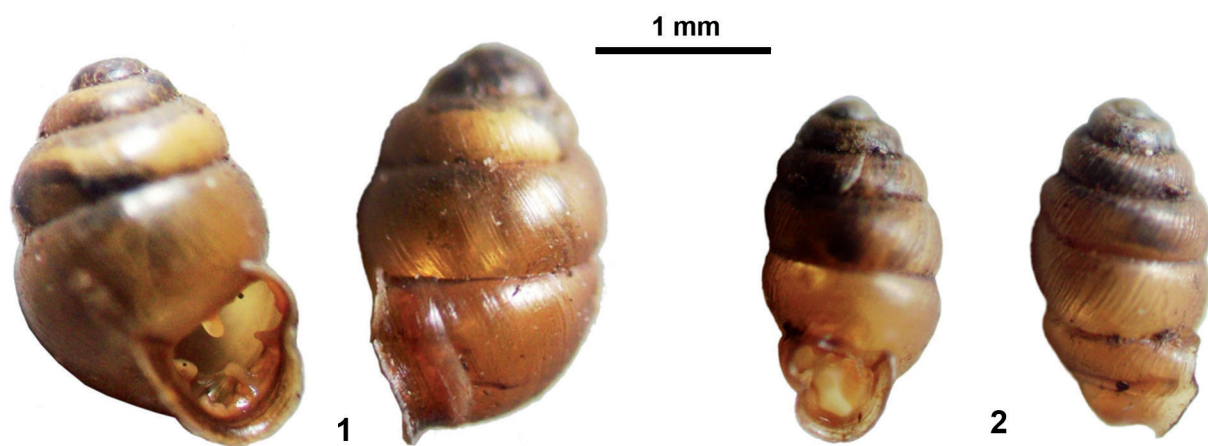
KEY WORDS: *Vertigo moulinsiana*, *Vertigo angustior*, active protection, extensive land management, sedge meadows, bird protection

INTRODUCTION

Vertigo moulinsiana (Dupuy, 1849) and *Vertigo angustior* Jeffreys, 1830 are minute terrestrial pulmonates (Figs 1–2), regarded as threatened across Europe and protected under the EU Habitats Directive. They live in wetland habitats, usually treeless, calcareous, sedge-covered sites (CAMERON et al. 2003, KILLEEN 2003, PROSCHWITZ 2003). *V. moulinsiana* is a climbing species; during hot days it climbs plants in search of the proper moisture level (POKRYSZKO 1990, KILLEEN 2003, TATTERSFIELD & MCINNES 2003). *V. angustior* is a typical litter-dweller (HORNUNG et al. 2003, MOORKENS & GAYNOR 2003). It spends its life among dead sedge leaves and only sporadically (wet and cool autumn days) can be found at the base of

plants (CAMERON et al. 2003, KSIĄŻKIEWICZ, unpublished). Thus, mowing should have a negative influence especially on *V. moulinsiana*, because it destroys individuals mechanically and devastates the suitable microhabitats. *V. angustior*, as a litter-dweller, is less sensitive to mowing because it can survive buried in the litter.

Both species are endangered across Europe and listed in Annex II of the European Union Habitats Directive (SPEIGHT et al. 2003), the main threats to them being the disappearance of their habitats caused by human activities (melioration mainly) as well as natural succession (POKRYSZKO 2003, ANDERSON 2004). Particular threats include increasing shadi-



Figs 1–2. Shells: 1 – *Vertigo moulinsiana*, 2 – *Vertigo angustior*. Photo: ZOFIA KSIĄŻKIEWICZ

ness, altering of microhabitat conditions just above the ground level, reduction of litter humidity and changes in plant species composition.

The sites where *V. moulinsiana* and *V. angustior* occur are often important for the conservation of wetland birds. Since the implementation of the environmental management scheme financed by the European Union in Poland in 2004, many farmers decided to use wet sedge meadows to support the so called Birds Directive (Council Directive 2009/147/EC on the conservation of wild birds). Agricultural subsidies were offered to farmers to encourage them to keep meadows in an appropriate condition for wetland birds, and thus extensive mowing started to be commonly applied. The range of methods used for maintaining the bird habitats is wide. The sites are

mowed manually or mechanically in different ways, and the mowing covers the entire site or just selected patches of the habitat. Such a form of management favours conservation of rare bird species but its effect on snail populations is questionable; this pertains especially to *V. moulinsiana*.

To compare the condition of populations of *V. angustior* and *V. moulinsiana* in non-managed sites and in the sites where the land had been managed in various ways for a few years, research was undertaken in the Ilanka river valley where the species often co-occur (KSIĄŻKIEWICZ 2009, 2010). The main aim of the survey was to answer the question if active protection of wetland sedge habitats of birds was possible without destroying or impairing populations of the endangered snail species.

MATERIAL AND METHODS

The field studies were conducted in July 2012 within the Natura 2000 area "Ilanka River Valley" (Lubuskie Province, W. Poland) (Fig. 3). Seventeen sampling sites (Table 1) were examined for the occurrence of *V. angustior* and *V. moulinsiana* in situ for maximum 30 minutes per site. Where their occurrence was confirmed, their densities were assessed. Individuals were counted within three randomly selected squares (Økland frame 0.25×0.25 m) in each site for 15 minutes per square (total: 45 minutes per site). Three abundance categories were distinguished based on the average densities per square metre: (A) 30 and more; (B) 10–29; (C) less than 10.

The studied sites differed in their size: the smallest one was 0.3 ha and the largest 7.0 ha. Thirteen were non-managed but in the remaining four sites different forms of management had been applied since 2009. One site (4) was divided into patches mowed manually, alternately in consecutive years, another (6) was mowed completely with machines,

and yet another (7) was mowed manually almost completely, excluding clumps of *Carex paniculata*. Site 12 was mowed with machines only on its edges. In each case the site was mowed once a year and the hay was collected and removed.

The sites differed also in their vegetation. They were mostly sedge-covered (mainly *Carex acutiformis*) but within some of them reed (*Phragmites communis*) predominated. The moisture level varied. Some of the sites were notably homogenous: entirely flooded or tending to dry out. Most of the sites constituted a mosaic of patches of different moisture level: from dry through moderately damp to flooded. Within the dry patches, the top litter layer was dry, and the soil was wet but not saturated with water. Within the moderately wet plots the litter was wet and the soil was water-saturated. The habitat in each site was described with respect to its surface area, moisture level, vegetation, type of land use and shadiness (Table 1).

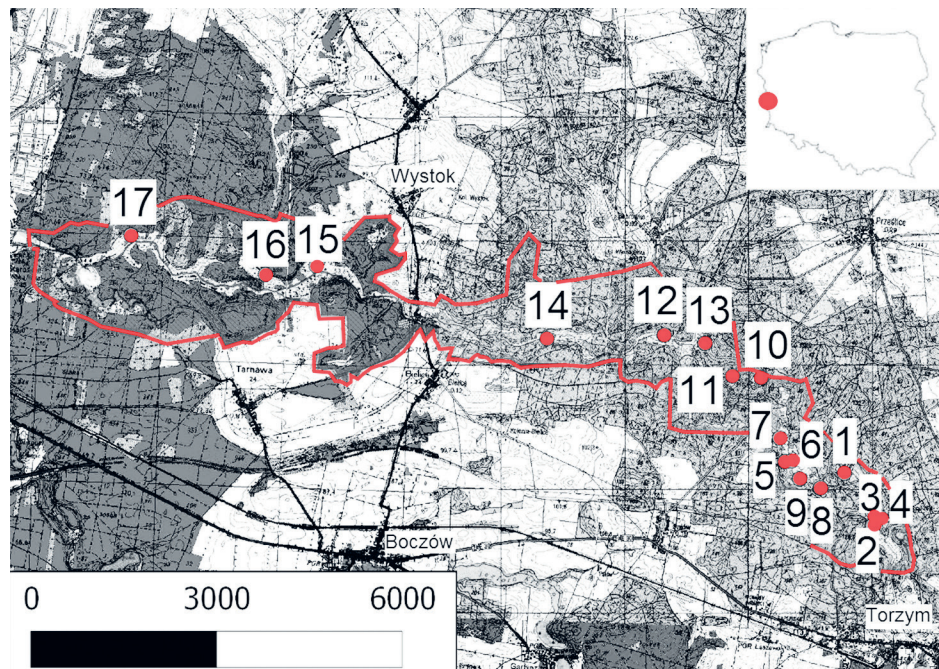


Fig. 3. Location of the studied sites in the Natura 2000 area “Ilanka River Valley” in 2012 (shape of the area marked by a red line)

Table 1. Condition of *Vertigo moulinsiana* and *Vertigo angustior* populations (abundance) in the studied sites in the Ilanka river valley in 2012. Abundance: A – ≥ 30 , B – 10–29, C – < 10 ; Site description: moisture level: 1 – drying out, 2 – mosaic of drying out and moderately moist patches, 3 – mosaic of flooded and moderately moist patches, 4 – flooded; vegetation (Veg., according to dominant plants) – areas covered with: 1 – sedges, 2 – sedges with admixture of reed, 3 – reed with admixture of sedges; land management: NON – non-managed, LU1 – extensively managed area divided into patches mowed manually, alternately in consecutive years, LU2 – area mowed completely with machines, LU3 – area mowed with machines only on edges, LU4 – area mowed manually almost completely, excluding clumps of *Carex paniculata*; shadiness: 0 – non-shaded, 1 – partly shaded

Site no.	Abundance		Site description				
	<i>V. moulinsiana</i>	<i>V. angustior</i>	Area [ha]	Moisture level	Veg.	Land management	Shadiness
1	B	×	0.8	4	3	NON	1
2	B	×	4.5	2	3	NON	0
3	B	B	1.7	1	2	NON	0
4	A	A	2.5	3	1	LU1	0
5	B	B	3.6	2	1	NON	1
6	C	B	1.5	3	3	LU2	0
7	B	×	1.3	2	3	LU3	1
8	C	B	0.3	2	1	NON	1
9	B	C	0.4	2	2	NON	0
10	B	B	1.0	2	2	NON	0
11	C	×	0.9	1	3	NON	1
12	B	B	1.3	3	1	LU4	0
13	A	A	2.8	3	2	NON	0
14	B	×	1.1	2	2	NON	1
15	B	B	6.0	3	2	NON	1
16	A	A	5.0	3	2	NON	0
17	A	B	7.0	2	2	NON	1



RESULTS

V. moulinsiana was present in all of the 17 studied sites while *V. angustior* was found in 12 sites (Table 1). The densities of both species exceeded 30 individuals per square metre in three sites: 4, 13 and 16. Besides, *V. moulinsiana* reached high density in site 17. Low densities of *V. moulinsiana* (<10 individuals per square metre) were recorded in three sites (6, 8, 11) and *V. angustior* in one site (9) (Table 1). The densities of the species varied among the sites of different conservation regime. In the extensively managed site 4 (Fig. 4) the densities of both species were high (30 or more individuals per square metre). The site (total area 2.5 ha) was divided into five patches of ca. 0.5 ha each which were mowed alternately in con-

secutive years (each year about 20% of the area was mowed) to support The Birds Directive. In another two mowed sites (7 with *V. moulinsiana* and 12 with *V. angustior* and *V. moulinsiana*), medium sized populations of both vertiginids were found. Site 7 (Fig. 5) was machine-mowed in its edges and site 12 (Fig. 6) was mowed manually almost completely. However, within this site clumps of *Carex paniculata* were left intact. Site 6 (Fig. 7) which was mowed completely with machines was hostile for *V. moulinsiana*. The density of the species was lower than 10 individuals per square metre. The population of *V. angustior* in that site was classified as medium sized (10–29 individuals per square metre).



Fig. 4. Site 4, mowed patchily. Photo: ZOFIA KSIĄŻKIEWICZ



Fig. 6. Site 12 mowed manually, clumps of *Carex paniculata* left intact. Photo: ZOFIA KSIĄŻKIEWICZ



Fig. 5. Site 7 with machine-mowed edges. Photo: ZOFIA KSIĄŻKIEWICZ



Fig. 7. Site 6, almost completely machine-mowed. Photo: ZOFIA KSIĄŻKIEWICZ

DISCUSSION

In north-western and western Poland *V. angustior* and *V. moulinsiana* often co-occur in the same areas, occupying habitat patches which differ in microclimatic conditions (KSIĄŻKIEWICZ 2010, JANKOWIAK & BERNARD 2013, KSIĄŻKIEWICZ et al. 2013). The two vertiginids are actually neighbours, not room-mates, as they inhabit micro-climatically different fragments of the same sedge meadow. Therefore, mosaic sites, with many micro-climatically different patches, such as sites 4, 13 and 16, are crucial for the species coexistence. These sites included flooded and moderately wet plots but only in one of them such mosaic structure was a result of human activity. This site (4) was extensively used for The Birds Directive since 2009, and its area was divided into five plots only one of which was mowed each year. As a result, about 80% of the area remained intact after each mowing procedure. This kind of land use provides refugia for the two snail species and enables them to disperse quickly into adjacent, freshly mowed plots. Besides, the procedure can increase the soil moisture by reducing evapotranspiration which can be advantageous especially for *V. moulinsiana*. Mowing also removes shrubs, expanding the area available to the species. This observation suggests that the appropriate extensive land management may actually have a positive effect on both species. The finding is further supported by the fact that both vertiginids had lower densities in non-managed and less moist areas adjacent to this site (sites 2 and 3).

Within the other two extensively managed sites (7 and 12) populations of the species were moderately abundant (10–29 individuals per square metre). In the reed-dominated site 7 where only *V. moulinsiana* was found, the species was absent in the mowed patches. Thus, repeated machine mowing of the same habitat patches probably had a negative effect on *V. moulinsiana*. The snails could not survive in the constantly disturbed plots, although such management prevented shrub expansion, reduced shadiness and unfavourable changes in the plant communities.

Within site 12 almost all *Carex acutiformis* was mowed manually, and only *C. paniculata* clumps were left intact. Nevertheless, the habitat offered diverse moisture conditions suitable for both vertiginids: the central part of the site was waterlogged and its edges were moderately moist. *V. moulinsiana* survived abundantly within *C. paniculata*, and *V. angustior* was present on the fringes of the site. Mowing the substantial part of the habitat had most likely a negative impact on the vertiginid densities, especially in the case of *V. moulinsiana*. However, probably as long as the clumps of *Carex paniculata* remain intact, the snails can survive in the habitat and spread out from the clumps when the mowing is suspended and the vegetation grows back.

The kind of land use applied in site 6 had a distinctly negative impact on both *V. moulinsiana* and *V. angustior*. The site had been mowed completely with machines for a few years. The vertiginids were found only in small patches omitted during the mowing. Although the soil was saturated with water in the mowed area, the litter was destroyed by the heavy equipment. Also the vegetation was trimmed heavily, almost to the ground surface.

Within the non-managed sites usually the smallest ones (e.g. sites 8, 9 and 11) offered less suitable conditions for the studied species. This was probably caused by the fact that such sites are more prone to natural succession (shrub and herb expansion) resulting in increased shadiness and decreased soil and litter moisture. Moreover, smaller areas hold fewer microhabitats. Larger areas are usually micro-climatically more diverse which makes them more suitable for the co-existence of *V. angustior* and *V. moulinsiana* (e.g. in sites 13 and 16). On the other hand, the great advantage of the studied Ilanka valley is the connective force of the river which provides a dispersal corridor for *V. moulinsiana* and *V. angustior* (FALKNER 2003, HORNING et al. 2003, MYZYK 2005), and the impoverished populations can be reinforced by individuals from sites located in the same wetland system.

The observations presented here need to be supported by more detailed and long-lasting research, however it seems that conservation of wetland birds could be successfully combined with snail protection. Extensive land management, aimed at restoring the habitat, should be however scheduled in a way that is advantageous for both *V. moulinsiana* and *V. angustior*. The best option for these species seems to be the patchy mowing. Dividing the site into a few plots mowed alternately in consecutive years improves moisture conditions, reduces shadiness and contributes to restoring the vertiginid populations within patches moved in the previous years. The presence of *V. moulinsiana* in patches mowed a few years before indicates that the species can disperse from the refugia to adjacent, freshly mowed patches. Such land management is probably the most advisable in areas connected with other sites within the same river valley: individuals can be transported via the river corridor into disturbed (mowed) areas.

Extensive land management needs to be carried out only when necessary, for example when the habitat tends to dry out and/or become shaded, and the plant assemblages become significantly altered. Considering that the habitats adjacent to rivers change dynamically, they have a chance to evolve into suitable habitats under appropriate weather conditions.



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REFERENCES

- ANDERSON T. 2004. Mystery *Vertigo* (*Vertigo paradoxa*): a technical conservation assessment [Online]. USDA Forest Service, Rocky Mountain Region. Available: <http://www.fs.fed.us/r2/projects/scp/assessments/mysteryvertigo.pdf>
- CAMERON R. A. D., COLVILLE B., FALKNER G., HOLYOAK G. A., HORNUNG E., KILLEEN I. J., MOORKENS E. A., POKRYSZKO B. M., PROSCHWITZ T. VON, TATTERSFIELD P., VALOVIRTA I. 2003. Species accounts for snails of the genus *Vertigo* listed in Annex II of the Habitats Directive: *V. angustior*, *V. genesii*, *V. geyeri* and *V. moulinsiana*. *Heldia* 5: 151–170.
- FALKNER G. 2003. The status of the four Annex II species of *Vertigo* in Bavaria. *Heldia* 5: 59–72.
- HORNUNG E., MAJOROS G., FEHÉR Z., VARGA A. 2003. An overview of the *Vertigo* species in Hungary: their distribution and habitat preferences. *Heldia* 5: 51–57.
- JANKOWIAK A., BERNARD R. 2013. Coexistence or spatial segregation of some *Vertigo* species (Gastropoda: Vertiginidae) in a *Carex* rich fen in central Poland. *J. Conch.* 41: 399–406.
- KILLEEN I. J. 2003. Ecology of Desmoulin's Whorl Snail *Vertigo moulinsiana*. *Conserving Natura 2000 Rivers*. Ecology Series No. 6. English Nature, Peterborough.
- KSIAŻKIEWICZ Z. 2009. New localities of *Vertigo moulinsiana* (Dupuy, 1849) in north-western Poland. *Folia Malacol.* 17: 219–222. <http://dx.doi.org/10.2478/v10125-009-0018-8>
- KSIAŻKIEWICZ Z. 2010. Higrofilne gatunki poczwarówek północno-zachodniej Polski. Poradnik ochrony siedlisk poczwarówki zwężonej *Vertigo angustior* Jeffreys 1830 i poczwarówki jajowatej *Vertigo moulinsiana* (Dupuy 1849). Wydawnictwo Klubu Przyrodników, Świebodzin.
- KSIAŻKIEWICZ Z., KIASZEWICZ K., GOŁDYN B. 2013. Microhabitat requirements of five rare vertiginid species (Gastropoda, Pulmonata: Vertiginidae) in wetlands of Western Poland. *Malacologia* 56: 95–106. <http://dx.doi.org/10.4002/040.056.0207>
- MOORKENS E. A., GAYNOR K. 2003. Studies on *Vertigo angustior* at a coastal site in western Ireland. *Heldia* 5: 125–134.
- MYZYK S. 2005. On the biology of *Vertigo moulinsiana* (Dupuy, 184) (Gastropoda: Pulmonata: Vertiginidae). In: POKRYSZKO B. M. The 21st Polish Malacological Seminar. *Folia Malacol.* 13: 128.
- POKRYSZKO B. M. 1990. The Vertiginidae of Poland (Gastropoda: Pulmonata: Vertiginidae) – a systematic monograph. *Ann. Zool.* 43: 133–257.
- POKRYSZKO B. M. 2003. *Vertigo* in Continental Europe – autecology, threats and conservation status (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 13–25.
- 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). *Heldia* 5: 27–50.
- SPEIGHT M. C. D., MOORKENS E. A., FALKNER G. (eds) 2003. Proceedings of the workshop on conservation biology of European *Vertigo* species. *Heldia* 5: 1–183.
- TATTERSFIELD P., MCINNES R. 2003. Hydrological requirements of *Vertigo moulinsiana* on three candidate Special Areas of Conservation in England (Gastropoda, Pulmonata: Vertiginidae). *Heldia* 5: 135–147.

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