

Molluscs of the Skálí, Smradlavá and Vachalka Nature Monuments (Vsetínské vrchy Mts., Western Carpathians, Czechia)

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The mollusc fauna of three small forest Nature Monuments (Skálí, Smradlavá and Vachalka) in the Vsetínské vrchy Mts., Western Carpathians, was surveyed in 2021 using a comparable inventory approach. One sampling site in the protective zone of Skálí, outside the formal boundary of the Nature Monument, was excluded from the comparative dataset, leaving 42 sites within the three protected areas. In total, 46 mollusc species were recorded, comprising 43 terrestrial gastropods, two freshwater gastropods and one freshwater bivalve, represented by 1,287 individuals. Observed species richness was similar in Skálí (35 species) and Smradlavá (37) and lower in Vachalka (29). Twenty-one species occurred in all three Nature Monuments. Pairwise similarity was highest between Skálí and Smradlavá (Jaccard index 0.714), compared with Skálí–Vachalka (0.561) and Smradlavá–Vachalka (0.535). Five species classified as Critically Endangered, Endangered or Vulnerable in the Czech Red List were recorded in Smradlavá: *Macrogastra borealis*, *Bulgarica cana*, *Daudebardia brevipes*, *Eucobresia nivalis* and *Vitrea transsylvanica*. Forest-associated species formed the majority of the species pool in all three Nature Monuments. Despite documented differences in substrate, hydrology, relief and forest structure, the three Nature Monuments shared a core of forest-associated species, while differences were more apparent among low-abundance taxa.

Key words: forest malacofauna, small protected areas, faunistics, nature conservation

Introduction

Forest mollusc assemblages can vary with local soil conditions and forest structure, including the amount of coarse woody debris (CWD) (SVOBODOVÁ & HORSÁK 2025). Comparable inventories of neighbouring protected forest sites can document shared species pools and local differences in species composition.

The present study uses malacological inventories of three small forest Nature Monuments near Karolinka in the Vsetínské vrchy Mts.: Skálí, Smradlavá and Vachalka. Reviews of published sources, museum locality cards and the Nature Conservation Species Occurrence Database (NDOP) conducted for the 2021 inventories found no earlier systematic malacological survey focused directly on any of the three protected areas (KUPKA et al. 2021a–c). All three lie within the Beskydy Protected Landscape Area and are dominated by forest habitats on south- to south-east-facing mountain slopes, but they differ in area, relief, geological substrate, hydrology and forest structure. This study documents and compares the mollusc fauna of the

three Nature Monuments, identifies species shared among them and species recorded in only one Nature Monument, and summarises species of conservation concern using current nomenclature and Red List categories.

Study area

All three Nature Monuments are situated in the cadastral area of Karolinka (Vsetín District, Czechia), in the Vsetínské vrchy Mts. of the Western Carpathians and within the Beskydy Protected Landscape Area. The Nature Monuments are dominated by beech forest, with local admixture of sycamore maple, fir and other broadleaved trees (KUPKA et al. 2021a–c). The location of the three Nature Monuments and the distribution of sampling sites are shown in Fig. 1, and their basic characteristics are summarised in Table 1.

Skálí (19.87 ha) occupies a steep south-facing slope at 680–825 m a.s.l. Its substrate consists of flysch sandstones and claystones, partly calcareous, near the boundary of the Zlín and Solán layers. Sandstone outcrops, block

Table 1. Basic characteristics of the three studied Nature Monuments summarised from the 2021 inventory reports (KUPKA et al. 2021a–c). NM – Nature Monument.

Characteristic	Skálí NM	Smradlavá NM	Vachalka NM
Area	19.87 ha	9.28 ha	8.30 ha
Slope aspect	South	South-east	South to south-east
Relief	Steep slope; sandstone outcrops, block screes, pseudo-karst depressions	Steep slopes; incised stream channel	Mountain slopes descending to headwater areas
Substrate	Flysch sandstones and claystones, partly calcareous	Flysch dominated by calcareous claystones, with glauconitic sandstones	Relatively nutrient-poor flysch; grey claystones, partly calcareous, and glauconitic sandstones
Forest character	Near-natural uneven-aged beech and scree forests; managed spruce stands occurring locally	Mainly natural beech forest; locally old-growth-like stands	Well-preserved herb-rich beech forest with old-growth-like structure
Hydrological context	Springs and small watercourses; permanent seepages absent from the central pseudokarst sector	Springs and permanent slope/footslope forest seepages	Slopes descending towards the headwaters of the Kobylská and Račkov streams
Sampling sites analysed	14 (one protective-zone site excluded from analysis)	15	13

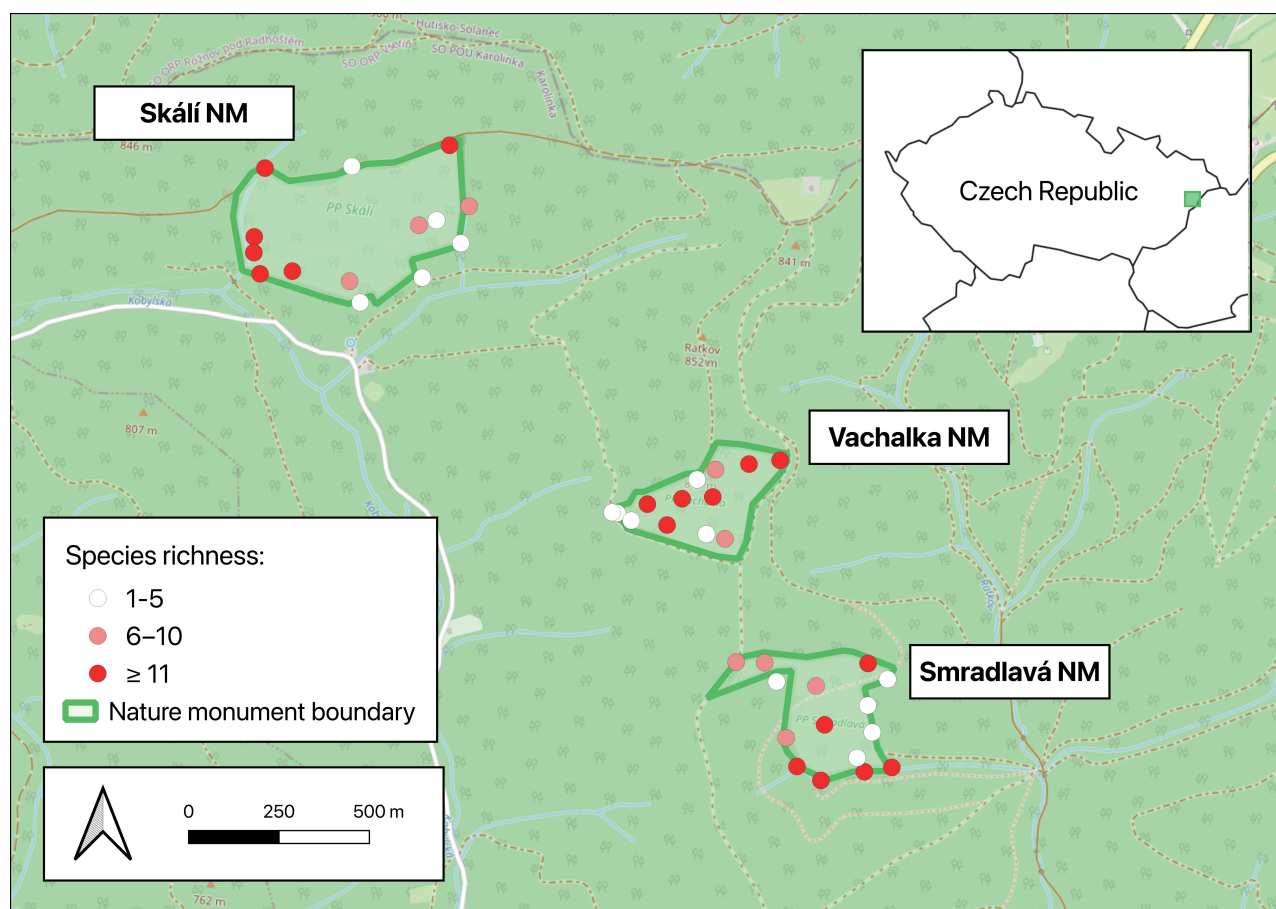


Fig. 1. Location of the study area in the Czech Republic (inset) and distribution of sampling sites in the Skálí, Smradlavá and Vachalka Nature Monuments. White points indicate sites with up to 5 recorded species, pink points sites with 6–10 species, and red points sites with 11 or more recorded species. Green lines indicate Nature Monument boundaries. Map data by OpenStreetMap under Open Database License (ODbL); Nature Monument boundaries © AOPK ČR, 2026, licensed under CC BY 4.0; Czechia outline by © EuroGeographics, Eurostat GISCO; modified by the authors.

scree and local pseudokarst depressions create marked geomorphological heterogeneity. Forest stands are mainly near-natural, uneven-aged beech and scree forests, with managed spruce stands occurring locally (Fig. 2). Springs and small streams are present, whereas permanent slope and footslope seepages are absent from the central pseudokarst sector (KUPKA et al. 2021a).

Smradlavá (9.28 ha) lies on south-east-facing slopes at 610–790 m a.s.l. The substrate belongs to the Vsetín layers of the Magura Flysch and is dominated by grey and greenish-grey calcareous claystones, with glauconitic sandstones. Smradlavá is covered mainly by natural beech forest. A distinctive habitat feature is the presence of springs and permanent slope and footslope seepages along an incised stream channel, locally combined with old-growth-like forest structure, natural herb vegetation and abundant CWD (Fig. 3) (KUPKA et al. 2021b).

Vachalka (8.30 ha) occupies south- to south-east-facing slopes descending towards the headwaters of the Kobylská and Raťkov streams. Vachalka contains a well-preserved herb-rich beech forest with old-growth-like structure, including sycamore-rich and rich fir-beech stands. The substrate is comparatively nutrient-poor flysch composed mainly of grey claystones, partly calcareous, and glauconitic sandstones. During the inventory, the more spe-

cies-rich forest patches were associated with old-growth-like stands containing sycamore maple and fallen wood (Fig. 4) (KUPKA et al. 2021c).

Material and methods

The malacological surveys were conducted from May to October 2021 as inventory surveys for the Nature Conservation Agency of the Czech Republic (KUPKA et al. 2021a–c). Terrestrial molluscs were collected primarily by hand searching, supplemented where appropriate by sweeping vegetation and sieving or washing substrate. Spring and aquatic habitats were additionally sampled by wet sieving of substrate (HORSÁK 2003).

Sampling sites were selected to cover habitat heterogeneity, including habitats expected to be species-poor, rather than in proportion to the area of individual habitat types. The field records distinguished sampling points with 1–5 species from more intensively searched plots with more than five species. Sampling plots measured approximately 20 × 20 m. At species-rich plots, hand searching often continued for 30 minutes or longer. The original Skálí inventory contained 15 sampling sites, but one site lay in the protective zone outside the formal boundary of the Nature Monument. It was excluded here to keep the spatial



Fig. 2. Skálí Nature Monument: forest stand with sandstone scree and coarse woody debris in the western part of the site. Photo by the authors.

delimitation consistent among the three protected areas. The comparative dataset therefore contains 14 sites in Skálí, 15 in Smradlavá and 13 in Vachalka, 42 sites in total (KUPKA et al. 2021a–c).

Abundance is reported as the absolute number of recorded individuals. Because sampling effort was neither fully standardised nor weighted by habitat area, differences in richness and abundance, as well as Jaccard similarity values, were interpreted descriptively. No inferential statistical tests were applied. Nomenclature follows HORSÁK et al. (2026), and conservation status follows BERAN et al. (2017). Ecological groups follow LOŽEK (1964), with the numerical woodland and moisture categories adjusted according to JUŘIČKOVÁ et al. (2014). Aquatic taxa were retained in group 10. Ecological groups were used for broad comparison among the three Nature Monuments.

Results

A total of 46 mollusc species were recorded within the three Nature Monuments, comprising 43 terrestrial gastropods, two freshwater gastropods and one freshwater bivalve. The combined dataset contains 1,287 individuals. The highest observed species richness was in Smradlavá (37 species, 468 individuals), followed closely by Skálí

(35 species, 487 individuals). Vachalka yielded 29 species and 332 individuals (Tab. 2). Twenty-one species occurred in all three Nature Monuments. Skálí and Smradlavá shared 30 species and had the highest pairwise similarity (Jaccard = 0.714). Skálí and Vachalka shared 23 species (Jaccard = 0.561), as did Smradlavá and Vachalka (Jaccard = 0.535).

Three species were recorded only at Skálí in the present dataset: *Ena montana* (16 individuals), *Euglesa casertana* (13) and *Vitrina pellucida* (1). Five were recorded only at Smradlavá: *Acanthinula aculeata* (3), *Retinella pura* (1), *Eucobresia nivalis* (1), *Galba truncatula* (1) and *Vitrea transsylvanica* (1). Four were recorded only at Vachalka: *Daudebardia rufa*, *Petasina unidentata*, *Vertigo substriata* and *Vitrea contracta*, each represented by a single individual. Nine of the twelve species recorded in only one Nature Monument were represented by single individuals. Five species in the combined dataset are classified as Critically Endangered, Endangered or Vulnerable in the Czech Red List. *Macrogaster borealis* is Critically Endangered, *Bulgarica cana* is Endangered, and *Daudebardia brevipes*, *Eucobresia nivalis* and *Vitrea transsylvanica* are Vulnerable. Smradlavá contained all five taxa, Skálí three and Vachalka two. Three additional species are classified as Near Threatened: *Bielzia coerulans*, *Vestia turgida* and



Fig. 3. Smradlavá Nature Monument: slopes of an incised stream channel with permanent slope and footslope seepages and coarse woody debris. Photo by the authors.

Bythinella austriaca. Species in ecological groups 1 and 2 together accounted for 62.9% of the recorded species in Skáli, 67.6% in Smradlavá and 69.0% in Vachalka. Moisture-associated groups were represented in all three Nature Monuments, whereas aquatic taxa were recorded only at Skáli and Smradlavá.

Discussion

The three Nature Monuments shared a core of forest mollusc species, with 21 of the 46 recorded species occurring in all three. Ecological-group composition was also similar, with forest-related groups predominating in all three Nature Monuments. Differences were more apparent among individual taxa, particularly low-abundance species. However, species recorded in only one Nature Monument should not necessarily be regarded as absent from the other two, especially where they were represented by only one or a few individuals.

Smradlavá had the highest observed richness and was the only Nature Monument in which all five species classified as CR, EN or VU in the combined dataset were recorded. Its higher observed richness may partly reflect the presence of permanent springs and slope and footslope seepages, which increase local habitat heterogeneity and provide

additional moisture-rich habitats for molluscs. Smradlavá is also characterised by a predominance of calcareous claystones, locally old-growth-like beech forest and abundant CWD (KUPKA et al. 2021b). *Eucobresia nivalis* and *Vitrea transsylvanica* were, however, each represented by a single individual.

Skáli was roughly twice as large as either Smradlavá or Vachalka and showed pronounced geomorphological heterogeneity, including rock outcrops, screes and pseudokarst depressions, yet its observed species richness was slightly lower than that of Smradlavá. Skáli contains spring and scree habitats as well as locally managed spruce stands, while permanent slope seepages are absent from parts of the central pseudokarst sector (KUPKA et al. 2021a).

Vachalka had the lowest observed richness (29 species) despite its well-preserved beech forest and old-growth-like structure (KUPKA et al. 2021c). Vachalka nevertheless provided moist forest conditions, but, unlike Smradlavá, permanent springs and slope seepages were not a prominent habitat component, and no aquatic taxa were recorded. Differences in hydrological context may therefore contribute to the lower observed richness.

When aquatic taxa are excluded, the observed richness of terrestrial molluscs is 33 species in Skáli, 35 in Smradlavá



Fig. 4. Vachalka Nature Monument: well-preserved beech forest with coarse woody debris. Photo by the authors.

and 29 in Vachalka. Thus, the ranking of the three Nature Monuments remains unchanged, although the differences in richness are slightly reduced. Aquatic taxa therefore contribute to, but do not fully account for, the observed differences in total species richness.

Excluding the single protective-zone site from Skálí removed 36 individuals and four species that were recorded only at this excluded site and nowhere else in the three surveys; these four species are therefore absent from the present comparative dataset. Its inclusion was appropriate in the original management inventory, which also considered the protective zone, but retaining it here would make the spatial delimitation inconsistent among the three Nature Monuments (KUPKA et al. 2021a).

The original inventories recommended protection of springs and seepages, retention of fallen coarse woody debris, and maintenance of natural broadleaved forest structure (KUPKA et al. 2021a–c). Evidence from managed spruce forests also supports the role of CWD (SVOBODOVÁ & HORSÁK 2025).

Conclusion

The three small forest Nature Monuments Skálí, Smradlavá and Vachalka shared a core of forest mollusc species within the Western Carpathians, with 21 species recorded in all three Nature Monuments. Smradlavá yielded the highest observed richness and all five species classified as CR, EN or VU in the combined dataset, whereas Vachalka yielded fewer species despite its well-preserved forest character. Differences in species composition were more apparent among low-abundance taxa. Their malacological significance therefore lies chiefly in the occurrence of threatened species within this shared forest fauna.

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Table 2. Mollusc species recorded in the Skáli, Smradlavá and Vachalka Nature Monuments in 2021. Values are numbers of recorded live individuals. Conservation status follows BERAN et al. (2017): CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, NE – Not Evaluated. Ecological groups follow LOŽEK (1964), adjusted according to JUŘIČKOVÁ et al. (2014): 1 – strictly forest species; 2 – woodland species; 3 – hygrophilous woodland species; 7 – euryvalent species; 8 – predominantly hygrophilous species; 10 – aquatic species. ~ = not recorded.

Group	Species	Status	Skáli	Smradlavá	Vachalka	Total
1	<i>Acanthinula aculeata</i> (O. F. Müller, 1774)	LC	~	3	~	3
	<i>Retinella iuncta</i> (Hudec, 1964)	LC	~	4	11	15
	<i>Retinella nitens</i> (Michaud, 1831)	LC	23	13	20	56
	<i>Retinella pura</i> (Alder, 1830)	LC	~	1	~	1
	<i>Arion silvaticus</i> Lohmander, 1937	LC	13	14	18	45
	<i>Bielzia coerulans</i> (M. Bielz, 1851)	NT	7	17	5	29
	<i>Bulgarica cana</i> (Held, 1836)	EN	28	20	25	73
	<i>Cochlodina laminata</i> (Montagu, 1803)	LC	56	26	15	97
	<i>Daudebardia brevipes</i> (Draparnaud, 1805)	VU	11	8	8	27
	<i>Daudebardia rufa</i> (Draparnaud, 1805)	LC	~	~	1	1
	<i>Discus ruderratus</i> (Hartmann, 1821)	LC	3	1	2	6
	<i>Ena montana</i> (Draparnaud, 1801)	LC	16	~	~	16
	<i>Eucobresia nivalis</i> (Dumont & Mortillet, 1854)	VU	~	1	~	1
	<i>Faustina faustina</i> (Rossmässler, 1835)	LC	7	23	44	74
	<i>Isognomostoma isognomostomos</i> (Schröter, 1784)	LC	7	5	6	18
	<i>Macrogastra borealis</i> (Boettger, 1878)	CR	12	22	~	34
	<i>Macrogastra plicatula</i> (Draparnaud, 1801)	LC	50	61	41	152
	<i>Malacolimax tenellus</i> (O. F. Müller, 1774)	LC	3	3	~	6
	<i>Petasina unidentata</i> (Draparnaud, 1805)	LC	~	~	1	1
	<i>Vitrea transsylvanica</i> (Clessin, 1877)	VU	~	1	~	1
	<i>Lehmannia marginata</i> (O. F. Müller, 1774)	LC	10	7	8	25
2	<i>Alinda biplicata</i> (Montagu, 1803)	LC	28	20	8	56
	<i>Arion fuscus</i> (O. F. Müller, 1774)	LC	13	10	2	25
	<i>Gonyodiscus rotundatus</i> (O. F. Müller, 1774)	LC	12	15	2	29
	<i>Limax cinereoniger</i> Wolf, 1803	LC	18	17	12	47
	<i>Perforatella incarnata</i> (O. F. Müller, 1774)	LC	10	17	25	52
	<i>Oxychilus glaber</i> (Rossmässler, 1835)	LC	1	1	~	2
	<i>Semilimax kotulae</i> (Westerlund, 1883)	LC	1	2	~	3
	<i>Helix pomatia</i> Linnaeus, 1758	LC	8	~	1	9
3	<i>Deroceras praecox</i> Wiktor, 1966	LC	4	10	10	24
	<i>Macrogastra tumida</i> (Rossmässler, 1835)	LC	11	1	2	14
	<i>Macrogastra ventricosa</i> (Draparnaud, 1801)	LC	52	38	20	110
	<i>Perforatella vicina</i> (Rossmässler, 1842)	LC	5	~	14	19
	<i>Vestia turgida</i> (Rossmässler, 1836)	NT	~	2	8	10
7	<i>Boettgerilla pallens</i> Simroth, 1912	NE	2	1	~	3
	<i>Euconulus fulvus</i> (O. F. Müller, 1774)	LC	7	8	~	15
	<i>Punctum pygmaeum</i> (Draparnaud, 1801)	LC	1	4	~	5
	<i>Vitrina pellucida</i> (O. F. Müller, 1774)	LC	1	~	~	1
	<i>Vitrea contracta</i> (Westerlund, 1871)	LC	~	~	1	1
8	<i>Vitrea crystallina</i> (O. F. Müller, 1774)	LC	1	1	2	4
	<i>Arianta arbustorum</i> (Linnaeus, 1758)	LC	14	14	19	47
	<i>Carychium tridentatum</i> (Risso, 1826)	LC	2	65	~	67
	<i>Vertigo substriata</i> (Jeffreys, 1833)	LC	~	~	1	1
10	<i>Bythinella austriaca</i> (von Frauenfeld, 1857)	NT	37	11	~	48
	<i>Galba truncatula</i> (O. F. Müller, 1774)	LC	~	1	~	1
	<i>Euglesa casertana</i> (Poli, 1791)	LC	13	~	~	13