

# Main features of the sandstone flora and plant communities of the North-Western part of Sudetes Foreland

Krzysztof ŚWIERKOSZ

Museum of Natural History, Wrocław University  
ul. Sienkiewicza 21, PL-50-335, Wrocław  
krissw@biol.uni.wroc.pl

Marek KRUKOWSKI

Institute of Environmental Management and Conservation, Agricultural University  
pl. Grunwaldzki 24, PL-50-363, Wrocław  
mkruk@miks.ar.wroc.pl

**Keywords:** flora; plant communities; *Trichomanes speciosum*; sandstones; North-Sudetic Depression; Cretaceous Basin; Sudetes Foreland; Poland

## Abstract:

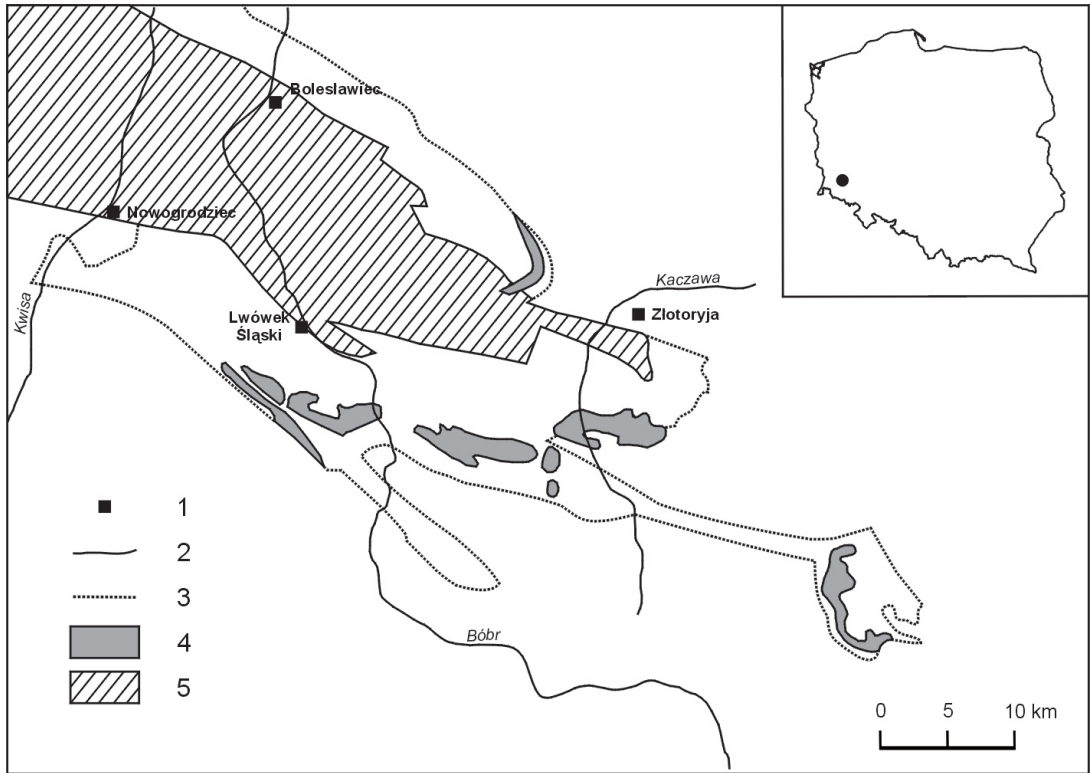
The north-western part of Sudetes Foreland encompasses North-Sudetic Depression filled up with cenoman-santon sandstones. It forms the northernmost part of Cretaceous Basin which flora and geobotany has not been studied in last decades. The whole area was heavily transformed by intensive agriculture and forestry, so nowadays only small remnants of natural habitats have been preserved. The most valuable are: oak-hornbeam forest *Galio sylvatici-Carpinetum betuli*, which remains mainly in sandstone ravines; ash-elm riparian forest *Ficario-Ulmetum minoris* along river valleys and ash-alder alluvial forest *Stellario nemorum-Alnetum glutinosae* occurring along smaller streams. Other natural plant communities include chasmophytic communities on rocks cliffs and in cervices (*Woodsio-Asplenietum septentrionalis* and *Hypno-Polypodietum*) or forest springs *Caricetum remotae*. Almost all communities has a lowland character without small admixture of montane species. Rare and endangered plant taxa cover: forest species (*Cephalanthera damasonium*, *Equisetum telmateia*, *Matteucia struthiopteris*, *Moneses uniflora*, *Orthilia*

*secunda*); bog species which could be found in secondary peat-bogs (*Drosera rotundifolia*, *Equisetum variegatum*, *Juncus tenageia*, *Ledum palustre*, *Lycopodiella inundata*); thermophilous taxa which are common in the whole area but mostly occurring on non-sandstone bedrock like basalt (*Alyssum alyssoides*, *Stachys germanica*, *Viola rupestris*); the outposts of montane species migrating along Bóbr river valley (*Aconitum variegatum*, *Allium ursinum*, *Aruncus sylvestris*, *Cardaminopsis halleri*, *Carduus personata*, *Leucoium vernum* ssp. *vernum*, *Lunaria rediviva*). Also a significant representation of the sub-Atlantic phytoelement (*Aira caryophyllea*, *Blechnum spicant*, *Chrysosplenium oppositifolium*, *Corynephorus canescens*, *Juncus tenageia*, *Lonicera periclymenum*, *Spergula morisonii*) was found on this area. But the most curious and interesting groups are pteridophytes with extinct locality of *Asplenium adiantum-nigrum* var. *melanea* and two present localities of *Trichomanes speciosum* gametophytes on the sandstone bedrock discovered in 2002, the new taxon for Polish flora.

## Introduction

The north-western part of the Sudetes Foreland, stretching between the towns of Bolesławiec, Nowogrodziec and Złotoryja constitutes a small sandstone area. The area is divided by Bóbr River

in two separate geographical mesoregions: Izerskie Piedmont in the west, and Kaczawskie Piedmont in the eastern part. The altitude ranges from ca 180 up to around 390 m a.s.l. on Grodziec basalt hill. The whole area forms a North-Sudetic Depression filled up with cenoman-santon sandstones with numerous basaltic intrusions (Fig. 1). The local



**Fig. 1:** Main geological units of North Sudetic Depression. Source: adapted from Stupnicka (1997). 1. Main cities. 2. Rivers. 3. Range of sedimentary rocks of North Sudetic Depression. 4. Upper Cretaceous sedimentary rocks. 5. Lower Permian volcanic rocks.

geomorphology is dominated by wide, not high ridges and hills (cuesta) accompanied with some pseudo-karst caves in the vicinity of Złotoryja (Maciejak & Migoń 1990). Majority of the area cover arable fields and pastures whereas forests are covering mostly top of the ridges (Figs 2; 3). The whole area is strongly modified by long history of human settlement and intensive agriculture. Thus the most of the plant communities are semi-natural and of anthropogenic origin.

The geological history of this sandstone area is strictly connected with the whole Cretaceous Basin. However, this interesting area was frequently omitted both in geological and geobotanical analyses.

The climatic conditions are relatively mild but differ from neighbouring Saxonian-Bohemian Switzerland massif in greater continentality marked by lower mean air temperature – ca. +7 °C to +8 °C, and rainfall – ca. 650 mm to 720 mm respectively (Wiszniewski 1973; Vogel *et al.* 1993).

## Material and methods

The paper summarizes botanical and phytogeographical investigations of this area carried out between 2000 and 2004. During the field investigation some interesting higher plant species and plant communities were documented.

The classification of plant communities follows Matuszkiewicz (2005) and Pott (1995). The Latin nomenclature of plant species follows Mirek *et al.* (2002).

## Results

### Plant communities

The majority of the forest communities, heavily transformed by forestry management, are composed



Fig. 2: The characteristic landscape of North-Western part of Sudetes Foreland.

of spruce, pine or oak plantations with significant admixture of birch and larch. The small patches of oak-hornbeam forest *Galio sylvatici-Carpinetum betuli* Oberd. 1957 remain mainly in ravines. Along Bóbr and Kwisa river valleys ash-elm riparian forest *Ficario-Ulmetum minoris* Knapp 1942 em. J. Mat. 1976 could be found. Ash-alder alluvial forest *Stellario nemorum-Alnetum glutinosae* Lohm. 1957 occur often along smaller streams. Distribution of forest patches, especially of *Galio-Carpinetum*, is linked with the occurrence of sandstone rocks and ravines. In such places forestry management is still more difficult and limited, so it is the main factor for the preservation of these valuable forest habitats till now.

Semi natural hay meadows and tall herb communities (*Arrhenatheretum elatioris* Br.-Bl. ex Scherr. 1925, *Angelico-Cirsietum oleracei* R. Tx. 1937 em. Oberd. 1967, *Filipendulo-Geranietum* W. Koch 1926, *Scirpetum silvatici* Ralski 1931) or pastures (*Lolio-Cynosuretum* R. Tx. 1937, *Festuco-Cynosuretum* Büker 1941) are prevailing among non-forest communities. Only few of them are of natural origin e.g. chasmophytic communities of *Woodsio-Asplenietum septentrionalis* R. Tx. 1937 and *Hypno-Polypodietum* Jurko et Pecir 1963 occurring on rocks cliffs and in crevices or spring forest *Caricetum*

*remotae* (Kastner 1941) *Schwickerath* 1944, which occurs around the sources of streams and brooks.

The most interesting anthropogenic vegetation are sparse fissure communities of old walls *Cymbalariaietum muralis* Görs 1966 and *Asplenietum rutae-murariae-trichomanis* Kuhn 1937, colourful communities of segetal weeds with *Agrostemma githago*, *Centaurea jacea* and *Papaver rhoeas*.

Almost all communities has a lowland character without small admixture of montane species.

#### Vascular plants

Some interesting plant species e.g. *Cephalanthera damasonium* (Mill.) Druce, *Equisetum telmateia* Ehrh., *Matteucia struthiopteris* (L.) Tod., *Moneses uniflora* (L.) A.Gray or *Orthilia secunda* (L.) House still occur in the forest communities. These rare species are endangered or vulnerable to extinction in the Polish part of the Sudetes massif (Fabiszewski & Kwiatkowski 2002). In some of the old kaolin quarries secondary curious peat-bogs gathering numerous rare plant taxa have developed like *Drosera rotundifolia* L., *Equisetum variegatum* Schleich., *Juncus tenageia* Ehrh., *Ledum palustre* L. and *Lycopodiella inundata* (L.) Houlb. The prevailing part of rare and interesting plant species and communities have a mainly





Fig. 3: The sandstone cliffs near the village of Skalka.

lowland character (Kwiatkowski 2000; Świerkosz & Narkiewicz 2004). Thermophilous taxa are common in the whole area, but in the most cases they are growing on non-sandstone bedrock like basalt. The most interesting and one of the best preserved basalt intrusions in this area is nature reserve "Wilcza Góra", where *Alyssum alyssoides* (L.) L., *Stachys germanica* L. and *Viola rupestris* F. W. Schmidt were found (Kwiatkowski 2001).

Montane species such as *Aconitum variegatum* L., *Allium ursinum* L., *Aruncus sylvestris* Kostel., *Cardaminopsis halleri* (L.) Hayek, *Carduus personata* (L.) Jacq., *Leucoium vernum* ssp. *vernum* L. and *Lunaria rediviva* L. were found only at single localities. Most of them occur along deep valley of Bóbr River near Lwówek Śląski and for some taxa there are the lowest localities in the whole Sudetes massif (Kwiatkowski 2000, 2001).

The westernmost location of this part of Sudetes Foreland in Poland is also pronounced by the significant representation of the sub-Atlantic phytoelement e.g. *Aira caryophyllea* L., *Blechnum spicant* (L.) Roth, *Chrysosplenium oppositifolium* L., *Corynephorus canescens* (L.) P. Beauv., *Juncus tenageia* Ehrh., *Lonicera peiclymenum* L., *Spergula morisonii* Boreau.

Pteridophytes are one of the most interesting group among vascular plants of this area. Locality of *Asplenium adiantum-nigrum* L. var. *melanea* near Złotoryja became extinct in the beginning of XXth century (Świerkosz & Szcześniak 2003), but not only the impoverishment of local flora was observed. Last discovery of two localities of *Trichomanes speciosum* Willd. gametophytes on the sandstone bedrock (Krukowski & Świerkosz 2004) was one of the most surprising inputs of this area into the biodiversity of Poland (Zajac & Zajac 2003).

## Discussion

The described northern-easternmost location within the Central European sandstone areas influences its community diversity and richness of local flora. The highest proportion have got there Atlantic and sub-Atlantic phytoelements.

Geobotanical analysis of plant taxa and plant communities show their general lowland character, with almost any montane element, except single localities of some mountain species along the Bóbr River.

The first discovery of *Trichomanes speciosum* gametophytes in Poland, extended the north-eastern border of the distributional range of this species in Europe in fact emphasize the importance of this area for protecting biodiversity. These studies helped also in designation of new protected areas as a part of Natura 2000 network.

## References

- Fabiszewski J. & Kwiatkowski P. 2002. - Threatened Vascular Plants of the Sudeten Mountains. *Acta Societatis Botanicorum Poloniae* 71(4): 339-350.
- Härtel H., Sádlo J., Świerkosz K. & Marková I. (in press). - Phytogeography of sandstone areas of the Bohemian Cretaceous Basin, in Härtel H., Cilek V., Herben T., Jackson A. & Williams R. B. G. (eds.), *Sandstone Landscapes*. Academia Press, Praha.
- Krukowski M. & Świerkosz K. 2004. - Discovery of the gametophytes of *Trichomanes speciosum* Willd. (Hymenophyllaceae: Pteridophyta) in Poland and their biogeographical importance. *Fern Gazette* 17(2): 79-85.
- Kwiatkowski P. 2000. - Floristic notes from Kaczawskie Mountains and their Foreland (Western Sudetes). Part I. *Fragmenta Floristica et Geobotanica Polonica* 7: 105-116. (in Polish with English summary).
- Kwiatkowski P. 2001. - The project of plant conservation of Kaczawskie Mountains and their Foreland. *Annales Silesiae* 31: 5-26. (in Polish).
- Maciejak K. & Migoń P. 1990. - The geomorphology of the cuestas of Izerskie and Kaczawskie Piedmonts. *Chrońmy Przyrodę Ojczystą*. 46: 73-81 (in Polish).
- Matuszkiewicz W. 2005. - A guide to determination of the plant communities of Poland. PWN, Warszawa, 537 p. (in Polish).
- Mirek Z., Piękoś-Mirkowa H., Zajac A. & Zajac M. (eds.) 2002. - Flowering plants and pteridophytes of Poland. A checklist. W. Szafer Institute of Botany PAS, Kraków, 442 p.
- Pott R. 1995. - Die Pflanzengesellschaften Deutschlands 2. Auflage. Verlag Eugen Ulmer, Stuttgart, 622 p.
- Stupnicka E. 1997. - Regional geology of Poland. Warsaw University, Warszawa, 348 p. (in Polish).
- Świerkosz K. & Narkiewicz C. 2004. - Flora and the plant communities of Izerskie Piedmont and the Żytawa-Zgorzelec Depression. *Prace Wrocławskiego Towarzystwa Naukowego* 213: 45-58 (in Polish with English summary).
- Świerkosz K. & Szcześniak E. 2003. - The state of populations and threats to chosen petricolous plant species in Lower Silesia: 69-83, in Kački Z. (ed.), *Endangered vascular plants of Lower Silesia*. University of Wrocław & PTPP «pro Natura», Wrocław (in Polish with English summary).
- Vogel J. C., Jessen S., Gibby M., Jermy A. C. & Ellis L. 1993. - Gametophytes of *Trichomanes speciosum* (Hymenophyllaceae: Pteridophyta) in Central Europe. *Fern Gazette* 14: 227-232.
- Wiszniewski W. (ed.) 1973. - Climatic atlas of Poland. PPWK. Warszawa (in Polish).
- Zajac M. & Zajac A. 2003. - Biodiversity - vascular plants and others, in Andrzejewski R. & Weigle A. (eds.), *Biodiversity of Poland*: 67-82. National Foundation of Environment Protection, Warszawa (in Polish).

## Résumé de la présentation

### Caractéristiques principales de la flore des collines de grès de la partie nord des Sudètes

**Mots-clés:** flore gréseuse; communautés végétales; *Trichomanes speciosum*; Monts Sudètes; Pologne

La partie occidentale des Sudètes, s'étendant entre les villes de Bolesławiec, Nowogrodziec et Złotoryja entre 200 et 350 m d'altitude, constitue un petit paysage gréseux peu connu. Elle est composée de grès d'âge cénoomanien à santonian, formant des collines hautes et larges couvertes de forêts, de champs et de pâturages. Le secteur entier est sous forte pression humaine, c'est pourquoi la plupart des communautés végétales sont semi naturelles et d'origine anthropique. La majorité des communautés forestières sont transformées par la sylviculture et dominées par des plantations d'épicéa, de pin et de chêne, fortement imprégnées de bouleau et de mélèze. Il subsiste uniquement de petites aires isolées de chênaies charmaies *Galio sylvatici-Carpinetum* (principalement dans de profonds ravins gréseux), d'ormaises frênaies ripicoles *Ficario-Ulmetum* (dans les vallées des fleuves Bóbr et Kwisa) et d'aulnaies frênaies alluviales *Stellario-Alnetum* (en bordure de ruisseaux). Cependant, quelques espèces intéressantes sont toujours présentes, par exemple *Cephalanthera damasonium*, *Moneses uniflora*, *Orthilia secunda*, *Equisetum telmateia*, *Matteucia struthiopteris*. Dans quelques anciennes carrières de kaolin se sont développées des marais tourbeux avec *Lycopodiella*

*inundata*, *Drosera rotundifolia* et *Ledum palustre*. Toutes les espèces mentionnées sont menacées ou vulnérables dans la partie polonaise des Sudètes (Fabiszewski & Kwiatkowski 2002).

Beaucoup d'éléments intéressants de la flore et des communautés végétales sont typiques pour les plaines (Świerkosz & Narkiewicz 2004). Les taxons thermophiles sont très communs dans toute cette région, par contre certaines espèces montagnardes n'occupent que quelques stations isolées, p.ex. *Aconitum variegatum*, *Aruncus dioicus*, *Leucoium vernum* ssp. *vernum*.

Cette partie des Sudètes est située à l'extrême ouest de la Pologne, ce qui explique la représentation significative d'espèces sub-atlantiques, par exemple *Blechnum spicant*, *Juncus tenageia*, *Lonicera periclymenum*, *Corynephorus canescens*, *Spergula morisonii*, *Aira caryophylla*.

Deux stations à gamétophytes de *Trichomanes speciosum*, découvertes en 2002, sont de la plus grande importance pour la biodiversité de la région. Ces localités marquent la frontière nord-est de l'aire de distribution de cette espèce en Europe (Krukowski & Świerkosz 2004).