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Bryophyte flora of the "Góry Pieprzowe" Nature Reserve  
on Wyżyna Sandomierska, SE Poland

## SUMMARY

As a result of bryological investigation carried out in 2005 in the “Góry Pieprzowe” nature reserve near Sandomierz (Wyżyna Sandomierska, SE Poland), 7 species of liverwort and 67 species of moss have been discovered. Of these, 6 species of liverwort and 44 species of moss are new to the Góry Pieprzowe Hills. The flora is briefly assessed and an annotated list of species is given. Additionally, protected and endangered taxa are indicated. To the most interesting plants belong, first of all, small xeromorphic mosses growing on loess layer (*Acaulon muticum*, *Microbryum curvicolle*, *Pseudocrossidium hornsuschuchianum*, *Pterygoneurum ovatum*, *P. subsessile*) and the mosses growing on schist-waste covering slopes (*Atrichum angustatum*, *Rosulabryum elegans*, *Thuidium recognitum*). Additionally, two another remarkable species were found on rotten tree stump (*Aulacomnium androgynum*) and mineral soil (*Oxyrrhynchium schleicheri*).

## STRESZCZENIE

W wyniku badań terenowych przeprowadzonych w 2005 roku na obszarze rezerwatu „Góry Pieprzowe” koło Sandomierza stwierdzono występowanie 7 gatunków wątrobowców oraz 67 gatunków mchów. Wśród nich jest 6 gatunków wątrobowców i 44 gatunki mchów, nowych dla całego obszaru Gór Pieprzowych. Opracowanie zawiera krótką charakterystykę flory oraz systematyczny wykaz gatunków. Dodatkowo wyróżniono taksony chronione i zagrożone. Do najbardziej godnych uwagi należą przede wszystkim drobne kserotermiczne mchy rosnące na warstwie

lessu (*Acaulon muticum*, *Microbryum curvicolle*, *Pseudocrossidium hornschruchianum*, *Pterygoneurum ovatum*, *P. subsessile*) oraz mchy rosnące na zwietrzelinie łupków pokrywającej zbocza (*Atrichum angustatum*, *Rosulabryum elegans*, *Thuidium recognitum*). Dwa pozostałe interesujące gatunki zostały odnotowane na murszejącym pniu drzewa (*Aulacomnium androgynum*) i mineralnej glebie (*Oxyrrhynchium schleicheri*).

**Key words:** "Góry Pieprzowe" nature reserve, liverworts, mosses, ecology, protected and/or endangered species, Góry Pieprzowe Hills, Wyżyna Sandomierska, SE Poland.

## INTRODUCTION

The "Góry Pieprzowe" nature reserve forms an eastern part of the Góry Pieprzowe Hills (Wyżyna Sandomierska, SE Poland) (8), the region widely known by its unique geomorphology and a great biodiversity in both fauna and vegetation. Although the flora of the region is quite well documented due to many studies provided here by different botanists since the first half of the 19th century (4, and literature cited), most of these data refer to the group of vascular plants, whereas the information concerning liverwort and moss floras is much more restricted. As it has been referred by Głazek (3), 341 species of vascular plant, 42 species of moss as well as 3 species of liverwort grow in the area. Moreover, Kuc (9) and Ochrya (11) presented some moss records from this region (26 and 4 species, respectively). All of these data, however, are regarded to the Góry Pieprzowe Hills in general, and we can not be certain of its unquestionable affiliation to the reserve. Thus, the principal purpose of this study is to supplement our present knowledge of the region with a critical list of liverworts and mosses of the reserve.

## DESCRIPTION OF THE STUDY AREA

The "Góry Pieprzowe" nature reserve was established on 19th April 1979 (Monitor Polski No 13, clause 77, 1979) and encompasses an area of 18 hectares to protect natural xerothermic grassland, shrub communities, rich insect fauna and exposure of mid-Cambrian schist. The territory of the reserve, extending between the villages of Kamień Łukawski and Kamień Nowy (2–3 km north-east of Sandomierz town), is formed by steep slopes exposed to the south and cut by the numerous gorges (Fig. 1). Distinctive feature of these slopes, ascending maximum up to 199.4 m a. s. l. and creeping over the Wisła old river-bed, is the occurrence of mid-Cambrian schist. In the upper part of the reserve the schist is covered by the Quaternary deposits (boulder clay, loess, sandy loess) (1).

Investigated area is strongly influenced by two climatic regions, Kotlina Sandomierska and Wyżyna Małopolska. The mean annual temperature (8.2°C) and precipitation (575 mm), together with long lasting vegetative period (250 days, 163 days without ground frost), create a great opportunity for xerothermic plants to grow (2, 5).

Such environmental conditions play an important role in the plant cover formation and strongly determine the type of local flora. Thus, the considerable participation in vegetation layer show, first of all, the classes *Rhamno-Prunetia* Rivas Goday et Garb. 1961 and *Festuco-Brometia* Br.-Bl. et R.Tx. 1943. Particularly, of a great value for the reserve are two plant communities, namely *Sisymbrio-Stipetum capillatae* (Dziub. 1925) Medw.-Korn. 1959 and *Prunetum fruticosae* Dziub. 1925. This area is also distinguished by the remarkable collection of *Rosa* species, probably the richest one in the territory of Poland (13).

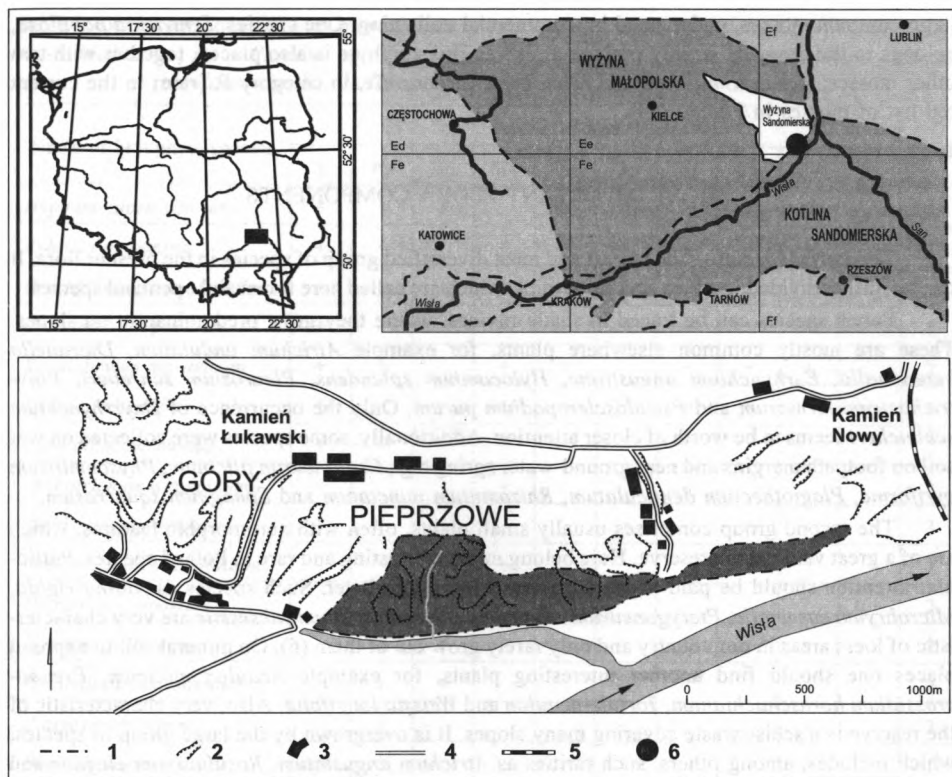


Fig. 1. Map of the "Góry Pieprzowe" Nature Reserve. 1 – border of the reserve, 2 – gorges, 3 – buildings, 4 – roads, 5 – railway, 6 – location of the reserve

## MATERIAL AND METHODS

The material presented was collected in 2005 growing season. Liverworts and mosses were sampled from all types of habitat. Also, the vegetative and generative structures were noted. Investigated area lies within Ef 92 square ( $10 \times 10$  km) of the ATMOS grid (10). The nomenclature and the systematic arrangement of mosses follow Ochrya et al. (12), while those of liverwort Klama (7). Specimens are housed in the Herbarium of the Department of Botany and Mycology UMCS (LBL B).

## PROTECTED AND ENDANGERED SPECIES

During the field study, 11 mosses that are considered partly protected in Poland (The Regulation of the Minister of Environment from 9th July 2004), were noted. This group comprises *Abietinella abietina*, *Calliergonella cuspidata*, *Dicranum scoparium*, *Eurhynchium angustirete*, *Hylocomium splendens*, *Pleurozium schreberi*, *Pseudoscleropodium purum*, *Rhytidiadelphus squarrosus*, *Sphagnum squarrosum*, *Thuidium delicatulum* and *T. recognitum*. These are mostly

large common mosses, endangered by commercial collecting. One species, *Syntrichia papillosa*, belongs to the group of strictly protected plants. This epiphyte is also placed, together with two other mosses, *Acaulon muticum* and *Microbryum curvicolle*, in category R (rare) in the current red-list of mosses in Poland (14).

## MOST IMPORTANT FLORA COMPONENTS

**Terrestrial species** – The largest and most diversified group of species in the present flora. It can be further divided into two smaller groups, which are called here forest and openland species.

Forest species can be traced in shady ravines, where they grow predominantly on slopes. These are mostly common elsewhere plants, for example *Atrichum undulatum*, *Dicranella heteromalla*, *Eurhynchium angustirete*, *Hylocomium splendens*, *Pleurozium schreberi*, *Polyptrichastrum formosum* and *Pseudoscleropodium purum*. Only the occurrence of *Oxyrrhynchium schleicheri* seems to be worth of closer attention. Additionally, some species were collected on wet soil on footpath margins and near ground-water spring e.g., *Cratoneuron filicinum*, *Physcomitrium pyriforme*, *Plagiothecium denticulatum*, *Rhizomnium punctatum* and *Sphagnum squarrosum*.

The second group comprises usually small plants, often with xeromorphic features, which are of a great value to the reserve. Here belong many interesting and rare in Poland species. Particular attention should be paid to mosses growing on loess layer. Such species as *Aloina rigida*, *Microbryum curvicolle*, *Pterygoneurum ovatum* and *Pterygoneurum subsessile* are very characteristic of loess areas in our country and only rarely grow out of them (6). On mineral soil in exposed places one should find another interesting plants, for example *Acaulon muticum*, *Pseudocrossidium hornschuchianum*, *Tortula acaulon* and *Weissia longifolia*. Also, very characteristic of the reserve is a schist-waste covering many slopes. It is overgrown by the large group of species, which includes, among others, such rarities as *Atrichum angustatum*, *Rosulabryum elegans* and *Thuidium recognitum*. It is, however, very significant that none of the large handsome mosses growing locally *en masse* in grasslands, i.e. *Brachythecium salebrosum*, *Homalothecium lutescens*, *Hypnum cupressiforme* var. *lacunosum* and *Rhytidiadelphus triquetrus*, was discovered in the reserve, which is probably the case of low content of lime in the basis.

**Epiphytic species** – Bryophytes growing on the bark of trees constitute a large group of 24 species. Six mosses, i.e. *Brachytheciastrum velutinum*, *Hypnum cupressiforme*, *Leskea polycarpa*, *Orthotrichum pumilum*, *Pylaisia polyantha* and *Rosulabryum moravicum*, were collected on nearly all species of trees. These plants are widespread throughout the country and grow also frequently on the other types of habitat, so it was noted in the reserve too. Seven mosses were noted only on single tree species and this group comprises mainly terrestrial plants, which only occasionally grow on the bark of living trees. Liverworts are exceedingly rare components of analysed flora and are represented only by three species, namely *Frullania dilatata*, *Ptilidium pulcherrimum* and *Radula complanata*. Further details are presented in Table 1.

**Epixylic species** – Bryophytes associated with rotten wood were collected on logs and stumps in shady ravine. They belong mainly to the group of common species, for example *Amblystegium serpens*, *Brachytheciastrum velutinum*, *Herzogiella seligeri* and *Rhizomnium punctatum*. This group includes also two rare plants in the reserve – *Chiloscyphus pallescens* and *Aulacomnium androgynum*. The second species is a rare lowland plant and its occurrence in the reserve is particularly important.

**Epilithic species** – Epilithic flora of the reserve is very poor due to the lack of suitable habitats. Eight mosses were noted on two stones of anthropogenic origin and only two of them, *Dryptodon pulvinatus* and *Tortula muralis*, are exclusive species.

Table 1. Occurrence of epiphytes on various tree species. Be – *Betula pendula*, Cr – *Crataegus* sp., Ma – *Malus* sp., Po – *Populus* sp., Pr – *Prunus spinosa*, Py – *Pyrus pyraister*, Ro – *Robinia pseudoacacia*, S – *Salix* sp., Sa – *Sambucus nigra*, Ul – *Ulmus* sp.

Name of bryophyte species	Name of tree species										Total
	S	Py	Be	Ma	Po	Sa	Ul	Cr	Ro	Pr	
<i>Hypnum cupressiforme</i>	+	+	+		+	+	+	+	+		8
<i>Pylaisia polyantha</i>	+	+		+	+	+	+	+	+		8
<i>Brachytheciastrum velutinum</i>	+	+	+	+	+	+		+			7
<i>Orthotrichum pumilum</i>	+	+		+	+	+	+		+		7
<i>Rosulabryum moravicum</i>	+	+		+	+		+	+	+		7
<i>Leskea polycarpa</i>	+			+	+	+	+			+	6
<i>Ceratodon purpureus</i>	+	+	+								3
<i>Orthotrichum diaphanum</i>	+			+			+				3
<i>Amblystegium serpens</i>	+					+		+			3
<i>Orthotrichum obtusifolium</i>	+			+							2
<i>Dicranum scoparium</i>		+	+								2
<i>Hypnum pallescens</i>		+	+								2
<i>Orthodicranum montanum</i>		+	+								2
<i>Platygyrium repens</i>		+							+		2
<i>Barbula unguiculata</i>	+										1
<i>Calliergonella cuspidata</i>	+										1
<i>Fissidens taxifolius</i>	+										1
<i>Leptodictyum riparium</i>	+										1
<i>Syntrichia papillosa</i>	+										1
<i>Plagiomnium cuspidatum</i>		+									1
<i>Frullania dilatata</i>		+									1
<i>Radula complanata</i>		+									1
<i>Ptilidium pulcherrimum</i>			+								1
<i>Pohlia nutans</i>			+								1
Total	15	13	8	7	6	6	6	5	5	1	

### LIST OF SPECIES

The species are listed in the systematic order. Total number of taxa is 7 species for liverworts and 67 species for mosses. The information about habitat type and occurrence of sporophytes and gemmae, is also given. The taxa new to the



Góry Pieprzowe Hills (6 species of liverwort and 44 species of moss) are marked with an asterisk (\*).

Abbreviations: *c. gem.* – with gemmae, *c. spor.* – with sporophytes

#### MARCHANTIOPHYTA (Stotler & Crand.-Stotl.) Stotler

##### **Pelliaceae** H. Klinggr.

\**Pellia endiviifolia* (Dicks.) Dumort. – on mineral soil in shady ravine, sterile

##### **Ptilidiaceae** H. Klinggr.

\**Ptilidium pulcherrimum* (Weber) Vain. – on the bark of birch tree

##### **Geocalyceae** H. Klinggr.

*Lophocolea bidentata* (L.) Dumort. – on schist-waste and mineral soil on slopes and near paths

\**Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dumort. – very rare, on rotten wood in shady ravine, *c. spor.*

##### **Cephaloziellaceae** Douin

\**Cephaloziella divaricata* (Sm.) Schiffn. – on mineral soil in exposed places

##### **Jubulaceae** H. Klinggr.

\**Frullania dilatata* (L.) Dumort. – in small amount on the bark of *Pyrus pyraster*

##### **Radulaceae** (Dumort.) Müll. Frib.

\**Radula complanata* (L.) Dumort. – several stems creeping over the bark of *Pyrus pyraster* tree, *c. gem.*

#### BRYOPHYTA Schimp.

##### **Sphagnaceae** Dumort.

\**Sphagnum squarrosum* Crome – on wet ground in shady ravine

##### **Polytrichaceae** Schwägr.

\**Atrichum angustatum* (Brid.) Bruch & Schimp. – very rare, on schist-waste on insolated slope, together with *Rosulabryum elegans*

\**A. undulatum* (Hedw.) P. Beauv. – on mineral soil and schist-waste, most frequently in sheltered places, *c. spor.*

\**Polytrichastrum formosum* (Hedw.) G. L. Sm. – on mineral soil in shady situations

*Polytrichum piliferum* Hedw. – on mineral soil and schist-waste in exposed places, *c. spor.*

**Funariaceae** Schwägr.

\**Physcomitrium pyriforme* (Hedw.) Bruch & Schimp. – on wet soil near ground-water spring, *c. spor.*

**Fissidentaceae** Schimp.

*Fissidens bryoides* Hedw. – on mineral soil and schist-waste near paths, *c. spor.*

\**F. taxifolius* Hedw. – on mineral soil and the bark of willow tree

**Ditrichaceae** Limpr.

\**Pleuridium subulatum* (Hedw.) Rabenh. – on mineral soil in open places, *c. spor.*

*Ceratodon purpureus* (Hedw.) Brid. – on loess, mineral soil and bark of trees, *c. spor.*

**Dicranaceae** Schimp.

\**Dicranum scoparium* Hedw. – on soil and bark of trees, very rarely with sporophytes

\**Orthodicranum montanum* (Hedw.) Loeske – on the bark of trees

\**Dicranella heteromalla* (Hedw.) Schimp. – on mineral soil and schist-waste, *c. spor.*

**Grimmiaceae** Arn.

\**Dryptodon pulvinatus* (Hedw.) Brid. – on stone by footpath, sterile

*Niphotrichum canescens* (Hedw.) Bednarek-Ochyra & Ochyra – on mineral soil and schist-waste in insolated places

**Pottiaceae** Schimp.

\**Pseudocrossidium hornschuchianum* (Schultz) R. H. Zander – on mineral soil in exposed place and on loess slope

*Barbula unguiculata* Hedw. – on loess, mineral soil, stones and the bark of willow tree

*Didymodon rigidulus* Hedw. – on loess slope, *c. gem.*

*Weissia longifolia* Mitt. – on mineral soil in open places, *c. spor.*

\**W. brachycarpa* (Nees & Hornsch.) Jur. – on mineral soil in insolated places, *c. spor.*

\**Pterygoneurum ovatum* (Hedw.) Dixon – on loess slope, *c. spor.*

*P. subsessile* (Brid.) Jur. – on loess slope, together with another xeromorphic mosses, e.g., *Microbryum curvicolle* and *Pterygoneurum ovatum*, *c. spor.*

*Aloina rigida* (Hedw.) Limpr. – on loess slope, *c. spor.*

\**Tortula muralis* Hedw. – on stones near paths, *c. spor.*

\**Tortula acaulon* (With.) R. H. Zander – on mineral soil in insolated places, *c. spor.*

\**T. truncata* (Hedw.) Mitt. – on mineral soil in open places and on loess slope, *c. spor.*

\**Microbryum curvicolle* (Hedw.) R. H. Zander – on loess slope and on mineral soil in exposed place, *c. spor.*

\**Acaulon muticum* (Schreb. ex Hedw.) Müll. Hal. – on mineral soil in open place and on loess slope, *c. spor.*

*Syntrichia ruralis* (Hedw.) F. Weber & D. Mohr – on schist-waste and mineral soil in exposed places

\**S. papillosa* (Wilson) Jur. – on the bark of willow tree, *c. gem.*

#### **Orthotrichaceae Arn.**

\**Orthotrichum pumilum* Sw. ex anon. – on the bark of various trees, *c. spor.*

\**O. diaphanum* Schrad. ex Brid. – on bark of trees and on stones, *c. spor.*

\**O. obtusifolium* Brid. – on the bark of trees, *c. gem.*

#### **Bryaceae Schwägr.**

\**Pohlia nutans* (Hedw.) Lindb. – on soil, schist-waste and the basal part of birch tree, *c. spor.*

*Bryum argenteum* Hedw. – on loess, mineral soil and stones near paths

*B. caespiticium* Hedw. – on mineral soil in open places, on loess and on stones near paths

\**Rosulabryum elegans* (Nees) Ochrya – very rare, on schist-waste on insolated slope

*R. moravicum* (Podp.) Ochrya & Stebel – on bark of trees, mineral soil and rotten wood, frequently with gemmae

#### **Aulacomniaceae Schimp.**

\**Aulacomnium androgynum* (Hedw.) Schwägr. – very rare, on rotten stump in a ravine, *c. gem.*

#### **Cinclidiaceae Kindb.**

\**Rhizomnium punctatum* (Hedw.) T. J. Kop. – on rotten wood and wet ground in a ravine, *c. spor.*

#### **Plagiomniaceae T. J. Kop.**

*Plagiomnium cuspidatum* (Hedw.) T. J. Kop. – on mineral soil, schist-waste and rotten wood, *c. spor.*

*P. undulatum* (Hedw.) T. J. Kop. – on rotten wood and wet soil near ground-water spring, *c. spor.*

*P. rostratum* (Schrad.) T. J. Kop. – on schist-waste in exposed place, *c. spor.*

#### **Leskeaceae Schimp.**

\**Leskea polycarpa* Hedw. – on the bark of trees, rarely on stones, *c. spor.*

#### **Thuidiaceae Schimp.**

*Thuidium delicatulum* (Hedw.) Schimp. – on mineral soil in open places



\**T. recognitum* (Hedw.) Lindb. – very rare, on schist-waste on insolated slope

*Abietinella abietina* (Hedw.) M. Fleisch. – on mineral soil in exposed places

**Hylocomiaceae** (Broth.) M. Fleisch.

\**Hylocomium splendens* (Hedw.) Schimp. – on mineral soil on semi-shaded slope

\**Pleurozium schreberi* (Willd. ex Brid.) Mitt. – on mineral soil on slopes

**Cratoneuraceae** Mönk.

\**Cratoneuron filicinum* (Hedw.) Spruce – on wet ground and rotten wood in a ravine

**Brachytheciaceae** Schimp.

*Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen – on many substrates, most frequently on bark of trees, rotten wood, mineral soil and stones, *c. spor.*

\**Cirriphyllum piliferum* (Hedw.) Grout – on mineral soil on slopes and scarps

\**Oxyrrhynchium hians* (Hedw.) Loeske – on mineral soil near paths and on slopes

\**O. schleicheri* (R. Hedw.) Röhl – very rare, on mineral soil, collected as a single stem with sporophytes, mixed with other pleurocarpous mosses

\**Pseudoscleropodium purum* (Hedw.) M. Fleisch. – on mineral soil in semi-shaded places

*Eurhynchium angustirete* (Broth.) T. J. Kop. – on mineral soil in a ravine

**Plagiotheciaceae** (Broth.) M. Fleisch.

\**Plagiothecium denticulatum* (Hedw.) Schimp. – on wet soil near ground-water spring

**Amblystegiaceae** Kindb.

\**Amblystegium serpens* (Hedw.) Schimp. – on bark of trees, mineral soil and rotten wood, *c. spor.*

\**Leptodictyum riparium* (Hedw.) Warnst. – on the basal part of willow tree

*Campyliadelphus chrysophyllus* (Brid.) R. S. Chopra – on mineral soil in open places

\**Campylidium calcareum* (Crundwell & Nyholm) Ochyra – on mineral soil near footpath, *c. spor.*

**Hypnaceae** Schimp.

\**Pylaisia polyantha* (Hedw.) Schimp. – on the bark of trees, *c. spor.*

\**Platygyrium repens* (Brid.) Schimp. – on the bark of trees, *c. gem.*

*Hypnum cupressiforme* Hedw. – on mineral soil, schist-waste and also frequently on the bark of trees, *c. spor.*

\**H. pallescens* (Hedw.) P. Beauv. – on the bark of trees, *c. spor.*

*Calliergonella cuspidata* (Hedw.) Loeske – on soil, rotten wood and the basal part of willow tree

\**Herzogiella seligeri* (Brid.) Z. Iwats. – on rotten wood and mineral soil, *c. spor.*

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