

Zeitschrift: Veröffentlichungen des Geobotanischen Institutes der Eidg. Tech. Hochschule, Stiftung Rübel, in Zürich
Herausgeber: Geobotanisches Institut, Stiftung Rübel (Zürich)
Band: 107 (1992)

Artikel: Vegetation of the Orawa-Nowy Tarf Basin peat bogs (S. Poland)
Autor: Staszkiewicz, Jerzy
DOI: <https://doi.org/10.5169/seals-308949>

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Vegetation of the Orawa-Nowy Targ Basin peat bogs (S. Poland)

Jerzy STASZKIEWICZ

1. GENERAL CHARACTERIZATION OF THE REGION AND PLANT COVER

The Orawa-Nowy Targ Basin is located north of the Tatra Mts. and south of the main range of the Beskidy Mts., both on the territory of Slovakia and Poland, at the altitude of 585-686 m a.s.l. Its W-E length is 60-65 km and width about 10-12 km. The European watershed runs across the basin. About 1/4 of the western part of the area belongs to the Black Sea catchment and 3/4 in the eastern part to the Baltic Sea catchment. It is drained by the Orawa, Czarny and Bialy Dunajec rivers, which flow together in Nowy Targ forming hence the Dunajec river. The Orawa-Nowy Targ Basin is in the Polish and Slovak Carpathian system, and contains the largest high peat bogs. Their ages differ but the oldest are of the Late Glacial period (KOPEROWA 1962, OBIDOWICZ 1992). As a result of settlement beginning in the 13th century, degradation of the peat bogs began when local communities started intensively exploiting them. After the Second World War, the exploitation of some peat bogs followed even an industrial scale. Lately some of the Slovak high peat bogs have been flooded as a result of damming the Orawa River. The disturbance of the natural water level and plant relations on the peat bogs caused a natural import of *Pinus mugo* from nearby localities in the Tatra Mts. about 400 years ago. Apparently, the first generation of *Pinus mugo* ready for reproduction was fertilized by the abundant *Pinus sylvestris*. At present, the proportion of

"pure" *Pinus mugo* does not exceed 3-5% on the peat bogs, which are dominated by hybrid individuals of *Pinus mugo* x *Pinus sylvestris* (= *Pinus x rhaetica* Bruggen) with a various contribution of *Pinus mugo* and *Pinus sylvestris* genes (STASZKIEWICZ and TYSZKIEWICZ 1969). *Pinus sylvestris*, forming large forest complexes in the closest neighbourhood, has also changed its genotype as a result of the introduction of *Pinus mugo* genes (BOBOWICZ 1990). It is thought that this pine forms a separate variety called "Podhalanska". The polygonal graph in Fig. 1 shows differences between poor *Pinus mugo* and *Pinus sylvestris* from Poland regarding six main estimated features. The *Pinus* population at "Bor na Czerwone" reserve, presented in Fig. 2 clearly manifests a hybridogenous character.

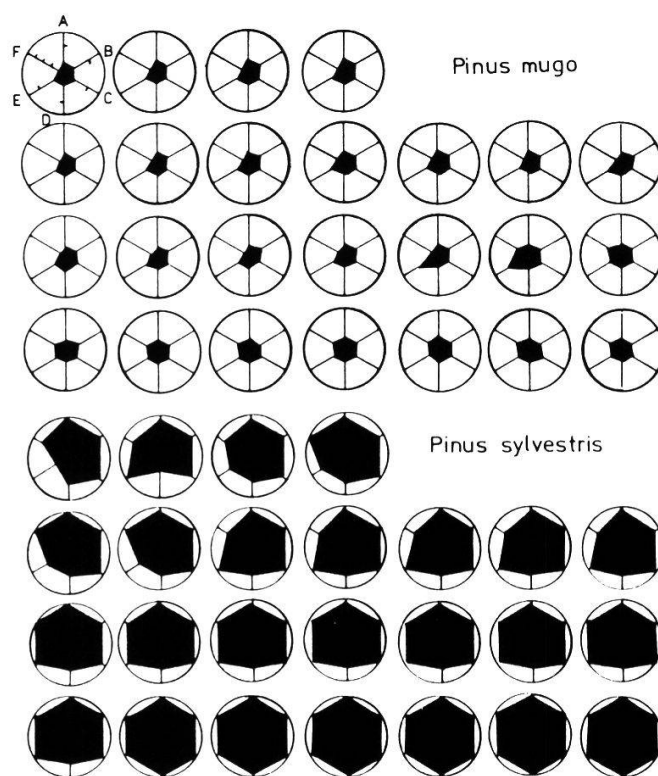


Fig. 1. Polygonal graphs of six main features (A-F) for *Pinus mugo* and *Pinus sylvestris* specimens from Poland.

A - habit character (dwarf = 1, intermediate = 2, tree = 3); B - cone character (*Pinus mugo* type = 1, *Pinus uliginosa* type = 2, *Pinus sylvestris* type = 3), C - epidermal cell shape (orthogonal = 1, square to orthogonal = 2, square = 3); D - number of resin canals (<5.5 = 1, 5.6-9.5 = 2, >9.6 = 3); E - number of stomata per 5 mm row (<49.9 = 1, 50-54.9 = 2, >55.0 = 3); F - cross-section index (Mercet's coefficient = needle width x vascular bundle distance/needle thickness) (<12.4 = 1, 12.5-24.9 = 2, 25.0-37.4 = 3, 37.5-49.9 = 4, >50.05 = 5). 1-5 feature estimates.

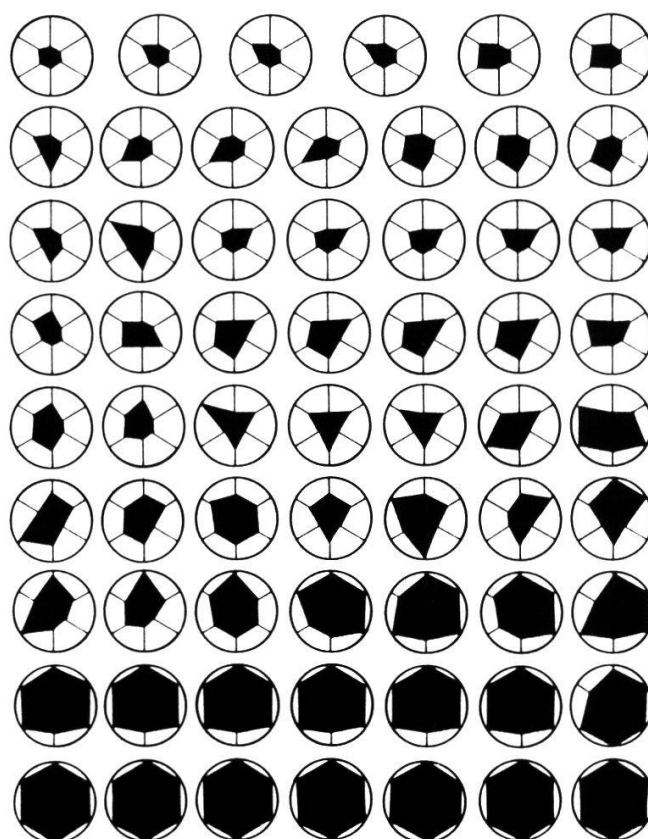


Fig. 2. Polygonal graph of six main features for the *Pinus* specimens from "Bor na Czerwonym" peat bog. For details see Fig. 1.

2. THE MOST IMPORTANT PLANT COMMUNITIES ON PEAT BOGS

The most important community of the high peat bogs, overgrown with shrubs and sometimes also with single trees, is the *Pino x rhaeticae-Sphagnetum* Staszk. (prov.) association with only one characteristic species, *Pinus x rhaetica* (Table 1). It is an equivalent association of *Pino rotundatae-Sphagnetum* Kast. et Flos. 1933 em. Neuhausl 1969, of high peat bogs distributed in Moravia and especially in Bohemia. Besides *Pinus x rhaetica*, *Pinus mugo* also occurs in the shrub layer, but rarely. The constant elements of the association are: *Vaccinium uliginosum*, *Ledum palustre*, *Eriophorum vaginatum*, *Empetrum nigrum*, *Oxycoccus quadripetalus*, *Oxycoccus microcarpus*, *Andromeda polifolia*, *Carex nigra*, *Drosera rotundifolia*, *Sphagnum nemoreum*, *Sphagnum recurvum*, *Polytrichum strictum*, *Dicranum bergeri*, *Pleurozium schreberi* and others. The second most important association is *Sphagne-*

Table 1. *Pino x rhaeticae-Sphagnetum* Stasz. 1989 in the Bor na Czerwone complex.

Number of record	1	2	3	4
Height of shrub layer (max., cm)	120	180	180	220
Cover of shrub layer (%)	50	50	75	90
Cover of herb layer (%)	75	75	95	95
Cover of moss layer (%)	100	100	100	95
Surface of trial plot (m ²)	100	100	100	100
Char. ass.				
<i>Pinus x rhaetica</i>	3.2	3.2	4.2	5.5
Ch. <i>Oxycocco-Sphagnetum</i>				
<i>Eriophorum vaginatum</i>	1.1	2.2	1.2	+
<i>Oxycoccus microcarpus</i>	2.2	1.2	+2	.
<i>Oxycoccus quadripetalus</i>	+	+	.	+2
<i>Andromeda polifolia</i>	1.1	1.1	+	.
<i>Polytrichum strictum</i>	3.2	3.3	2.2	1.2
<i>Ledum palustre</i>	1.2	2.2	2.2	2.2
<i>Vaccinium uliginosum</i>	+	+2	1.2	1.3
<i>Sphagnum magellanicum</i>	+2	+2	1.2	.
<i>Aulacomium palustre</i>	.	.	.	+
Others				
<i>Pinus mugo</i>	+?	+?	.	.
<i>Sphagnum recurvum</i>	4.4	4.4	4.3	2.2
<i>Calluna vulgaris</i>	1.1	1.1	1.1	1.1
<i>Pleurozium schreberi</i>	.	.	1.2	2.2
<i>Empetrum nigrum</i>	.	.	.	+
<i>Vaccinium vitis-idaea</i>	.	.	.	+2
<i>Vaccinium myrtillus</i>	.	.	.	+2
<i>Dicranum bonjeanii</i>	.	.	.	+2
<i>Cladonia rangiferina</i>	.	.	+2	.
<i>Carex nigra</i>	.	+	.	.

tum magellanicum (Malc. 1929) Kast. et Flos 1933, growing on peat bogs in places without shrubs. *Andromeda polifolia*, *Drosera rotundifolia* and *Oxycoccus quadripetalus* always occur in the herb layer. The moss layer consists of *Polytrichum strictum*, *Sphagnum magellanicum*, *Sphagnum rubellum*, *Sphagnum nemoreum*, *Sphagnum fuscum*, *Sphagnum recurvum*, *Sphagnum capillifolium*, *Aulacomnium palustre*. The association *Eriophoro vaginati-Sphagnetum recurvi* Hueck 1925 occurs at the base of banks or on exploited peat bogs. In some places, patches of the *Eriophorum vaginatum-Pinus sylvestris* community occur on peat bogs overgrown with scattered specimens of *Pinus sylvestris*. The edges of peat bogs, often extensively flooded, are occupied by the *Scheuchzerio-Sphagnetum cuspidati* Osvald 1923 and *Caricetum limosae* Br.-Bl. 1921 communities. On the margin between peat bog and forest, the following vegetation communities develop: *Nardo-Juncetum*

Table 2. *Vaccinio uliginosi-Pinetum* Kleist 1929 in the Bor na Czerwonym complex.

Number of record		1	2	3	4	5	6	7
Height of trees (max., m)		12	15	8	7	12	18	12
Diameter of tress (cm)		?	20	35	?	19	?	20
Cover of tree layer (a) (%)		75	80	70	50	70	60	70
Cover of shrub layer (b) (%)		20	2	40	40	-	10	-
Cover of herb layer (%)		70	90	85	100	80	80	90
Cover of moss layer (c) (%)		50	5	60	35	-	-	-
Surface of record (m ²)		100	100	100	200	200	100	100
Trees								
<i>Pinus sylvestris</i>	a	4.2	4.3	4.3	3.2	4.2	3.3	4.3
<i>Pinus sylvestris</i>	b	.	.	+	+	.	.	.
<i>Pinus sylvestris</i>	c	.	.	+	.	.	.	.
<i>Pinus x rhaetica</i>		.	.	1.1	.	.	.	.
<i>Picea abies</i>	b	1.1	.	.	.	.	.	.
<i>Picea abies</i>	c	.	.	.	+	.	.	.
<i>Betula pubescens</i>	a	.	.	+	.	+	.	.
<i>Betula pendula</i>	a	.	.	.	.	+	.	.
<i>Sorbus aucuparia</i>	b	+	.	.	.	+	.	.
<i>Salix aurita x cinerea</i>	b	+	.	.	.	.	.	.
<i>Salix aurita x silesiaca</i>	b	+	.	.	.	.	.	.
<i>Juniperus communis</i>	b	.	.	.	+	.	+	+
Ch. assoc.								
<i>Vaccinium uliginosum</i>		2.2	.	2.3	2.2	+2	+	1.1
<i>Ledum palustre</i>		+	+2	4.3	4.3	2.2	3.3	1.1
Ch. <i>Vaccinio-Piceetea</i>								
<i>Vaccinium myrtillus</i>		3.2	3.2	3.3	2.2	5.5	4.3	+
<i>Vaccinium vitis-idaea</i>		+	2.2	2.2	1.2	2.2	+	+
<i>Pleurozium schreberi</i>		+	+	4.4	2.3	3.4	4.4	+2
<i>Sphagnum girgensohnii</i>		1.2	+	.	.	2.3	.	3.4
Ch. <i>Oxycocco-Sphagnetes</i>								
<i>Eriophorum vaginatum</i>		.	+	.	.	+	+	+2
<i>Oxycoccus quadripetalus</i>		.	.	+	.	.	.	+
<i>Polytrichum strictum</i>		.	.	.	.	+	.	+
<i>Sphagnum magellanicum</i>		+	.	.	.	.	.	.
<i>Sphagnum recurvum</i>		+	.	.	.	.	.	.
Others								
<i>Polytrichum commune</i>		3.2	+	+	.	2.3	.	4.5
<i>Calluna vulgaris</i>		+	+	+	1.2	+	+	+
<i>Carex nigra</i>		.	+	.	1.2	+	.	2.2
<i>Sphagnum nemoreum</i>		.	.	.	.	.	.	+
<i>Sphagnum compactum</i>		.	.	.	.	+2	.	.
<i>Calamagrostis villosa</i>		.	+	.	.	.	.	.
<i>Molinia arundinacea</i>		.	.	+	.	.	+2	.
<i>Carex stellulata</i>		.	.	.	.	+2	.	2.2
<i>Juncus effusus</i>		.	.	.	.	.	.	+
<i>Juncus squarrosus</i>		.	.	.	+	+	.	.
<i>Nardus stricta</i>		.	.	.	.	2.3	.	.
<i>Deschampsia flexuosa</i>		.	.	+	.	.	.	.
<i>Dryopteris spinulosa</i>		.	.	.	.	.	1.1	.
<i>Potentilla erecta</i>		.	.	.	+	.	.	.
<i>Sieglingia decumbens</i>		.	.	.	+	.	.	.
<i>Leucobryum glaucum</i>		.	.	+	.	.	.	.

squarrosi Nordh. 1920, Buk 1942 with prevailing *Nardus stricta* and *Juncus squarrosus*, and *Carici canescentis*-*Agrostietum caninae* R.Tx. 1937 with *Carex canescens*, *Carex nigra*, *Carex stellulata*, *Agrostis canina*, *Pedicularis sylvatica*, *Ranunculus flammula*, *Galium palustre*, *Equisetum palustre*, *Potentilla erecta*, *Prunella vulgaris* and *Anthoxanthum odoratum*. Among the mosses, *Bryum ventricosum* frequently occurs.

Forests composed of *Pinus sylvestris* occur on peaty soils or in shallow peat bogs, sometimes also with a considerable proportion of *Picea abies*.

On deep peat bogs with an average groundwater level of about 30 cm, patches of the association, *Vaccinio uliginosi*-*Pinetum* Kleist 1929, develop (Table 2). The tree layer is formed of relatively low *Pinus sylvestris* and occasionally, *Picea abies* and *Betula pubescens* occur. The shrub layer is poor, *Juniperus communis*, *Sorbus aucuparia* and *Frangula alnus* occur sporadically and very rarely *Pinus x rhaetica*. In the undergrowth, *Ledum palustre*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea* and *Vaccinium myrtillus* play the main role. Other species frequently present are: *Oxycoccus quadripetalus* and *Calluna vulgaris*. The moss layer in dry patches is composed of *Pleurozium schreberi* and, only in depressions of *Polytrichum commune* and *Sphagnum girgensohnii*.

One of the most interesting forest associations is *Calamagrostio villosae*-*Pinetum* Stasz. 1958 (Table 3), described for the first time from the Orawa-Nowy Targ Basin, later found in many regions of S. Poland (STASZKIEWICZ 1958). The tree layer is formed mainly by *Pinus sylvestris*, sometimes however, with a large proportion of *Picea abies*. It is a very poor association with one characteristic species, *Calamagrostis villosa*. *Vaccinium myrtillus* and *Vaccinium vitis-idaea* frequently occur in the undergrowth. The very richly developed moss layer is mainly composed of *Sphagnum girgensohnii*, *Polytrichum commune*, *Pleurozium schreberi*, *Sphagnum recurvum*, *Plagiomnium elatum*, *Pohlia nutans*, *Polytrichum formosum* and others. Within the Polish range of the association, 99 moss species have been found, 14 of them indicate a high degree of stability (JEDRZEJKO and CABALA 1983). Patches of the association develop on loamy soils with a thin peaty upper layer, very strongly acidic both in the upper and lower layers (pH 3.1 and pH 3.7-3.9, respectively).

The only community in the Orawa-Nowy Targ Basin representing meso- and eutrophic deciduous forests is the *Alnetum incanae* Aich. et Siegr. 1930. The tree layer is formed by *Alnus incana* with admixture of *Picea abies*, *Fraxinus excelsior* and *Acer pseudoplatanus*. The shrubs include *Lonicera xylos-*

teum and *Ribes grossularia*. The very rich herb layer is composed of *Petasites kablikianus*, *Petasites officinalis*, *Chaerophyllum hirsutum*, *Geum urbanum*, *Geum rivale*, *Geranium robertianum*, *Stellaria nemorum*, *Carex sil-*

Table 3. *Calamagrosti villosae*-*Pinetum* Staszk. in the Bor na Czerwonem complex.

Number of record		1	2	3	4
Height of trees (max., m)		18	20	17	22
Diameter of trees (cm)		25	30	-	32
Cover of tree layer (a) (%)		75	75	40	90
Cover of shrub layer (b) (%)		-	5	25	15
Cover of herb layer (c) (%)		80	95	80	100
Cover of moss layer (%)		75	70	50	80
Surface of record (m ²)		600	500	400	400
Trees and shrubs					
<i>Pinus sylvestris</i>	a	3.2	4.2	3.2	3.1
<i>Pinus sylvestris</i>	b	.	.	.	+
<i>Pinus sylvestris</i>	c	+	.	.	.
<i>Picea abies</i>	a	1.1	.	.	2.2
<i>Picea abies</i>	b	.	1.2	+	1.1
<i>Picea abies</i>	c	+	+2	.	+2
<i>Betula pubescens</i>	b	.	+	2.2	.
<i>Betula pendula</i>	b	+	+	2.2	.
<i>Frangula alnus</i>	b	+	+	+	+
<i>Sorbus aucuparia</i>	b	+	.	.	+
<i>Juniperus communis</i>		.	.	.	+
Herbs					
<i>Calamagrostis villosa</i>		4.5	+2	.	4.4
<i>Vaccinium myrtillus</i>		1.2	3.3	5.4	5.4
<i>Vaccinium vitis-idaea</i>		+	3.2	+2	+
<i>Polytrichum commune</i>		1.2	2.2	2.2	2.2
<i>Sphagnum girgensohnii</i>		3.3	2.2	2.2	2.2
<i>Carex nigra</i>		+	+2	+	+
<i>Pleurozium schreberi</i>		.	3.3	2.2	2.2
<i>Calluna vulgaris</i>		.	+	+	+
<i>Dicranum scoparium</i>		+	.	+	+
<i>Carex stellulata</i>		+	.	.	+
<i>Luzula pilosa</i>		+	.	.	+
<i>Nardus stricta</i>		.	.	+	+
<i>Agrostis alba</i>		+	.	+	.
<i>Juncus effusus</i>		+	.	.	+
<i>Deschampsia caespitosa</i>		+	.	.	+
<i>Dryopteris spinulosa</i>		.	+	.	+
<i>Eriophorum vaginatum</i>		.	.	.	+
<i>Equisetum silvaticum</i>		+	.	.	.
<i>Potentilla erecta</i>		.	.	.	+
<i>Hylocomium splendens</i>		.	.	.	+2
<i>Leucobryum glaucum</i>		.	.	+	.
<i>Polytrichum strictum</i>		+	.	.	.

vatica, *Glechoma hederacea*, *Poa nemoralis* and others. The association is distributed solely along the rivers Bialy Dunajec, Czarny Dunajec and a few major streams. Almost all of the characteristic plant associations and communities of the Orawa-Nowy Targ Basin occur on the Bor na Czerwonym complex.

3. THE BOR NA CZERWONEM COMPLEX

The Bor na Czerwonym is situated on the right bank of the Bialy Dunajec river at an altitude of about 620 m a.s.l. on fluvioglacial talus of Tatra origin, formed by gravel of differing ages. Under the gravel layer of Tertiary marl, almost impenetrable loam can be found. A part of the complex "Bor na Czerwonym" is a high peat bog. It is a natural reserve surrounded by pine or pine-spruce tree stands. The high peat bog started forming at the onset of the Atlantic period, i.e 4000-5000 years ago, as a result of the transformation of forests into a marsh. Maximum thickness of the peat is 4.76 m (OBIDOWICZ 1988). The Bor na Czerwonym Reserve was established in 1925, but only 2 ha were under protection. In 1956 the protected area was enlarged to 49.7 ha.

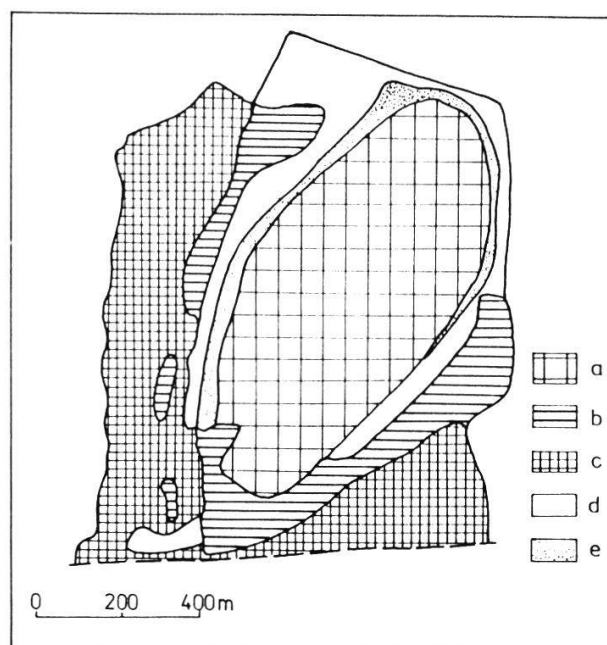


Fig. 3. Distribution of main plant communities in "Bor na Czerwonym" peat bog reserve and its surroundings.

a - complex of the communities with *Pinus x rhaetica* and *Pinus mugo* (mainly *Pino rhaeticae-Sphagnetum*), b - *Vaccinio uliginosi-Pinetum*, c - *Calamagrostio villosae-Pinetum*, d - complex of *Nardo-Juncetum squarrosi* and *Carici canescentis-Agrostietum caninae*, e - complex of *Scheuchzerio-Sphagnetum cuspidati* and *Caricetum limosae*.

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Address of the author: Prof. Dr. hab. Jerzy STASZKIEWICZ
W. Szafer Institute of Botany
Polish Academy of Sciences
Lubicz 46
31-512 Krakow, Poland