

# Distribution and habitats of *Pulsatilla vernalis* (L.) Mill. in the Tatra Mountains

H. PIĘKOŚ-MIRKOWA<sup>1</sup>, Z. MIREK<sup>2</sup> and  
A. MIECHÓWKA<sup>3</sup>

<sup>1</sup>Institute of Nature Conservation, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland; <sup>2</sup>Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland; <sup>3</sup>Department of Soil Science, Agricultural University, Aleje Mickiewicza 21, 31-120 Kraków, Poland

**Abstract.** The distribution of a very rare species *Pulsatilla vernalis* (L.) Mill. is reviewed both in the Polish and Slovak Tatras, and presented on the map. The information on then orographic, edaphic and phytocoenotic factors is provided. The size of populations and the threat to their localities is assessed.

**Key-words:** *Pulsatilla vernalis*, distribution, habitats, Tatra Mtns, Poland, Slovakia

## Introduction

*Pulsatilla vernalis* is a rare species in Poland included in the Polish 'red data book' (Zarzycki and Kaźmierczakowa 1993) as well as in the 'red data list' for Poland (Zarzycki and Szelağ 1992) and the for Carpathians (Mirek and Piękoś-

Mirkowa 1992). This species is also very rare in Slovakia and included in the 'red data list' for this country (Maglocký and Feráková 1993).

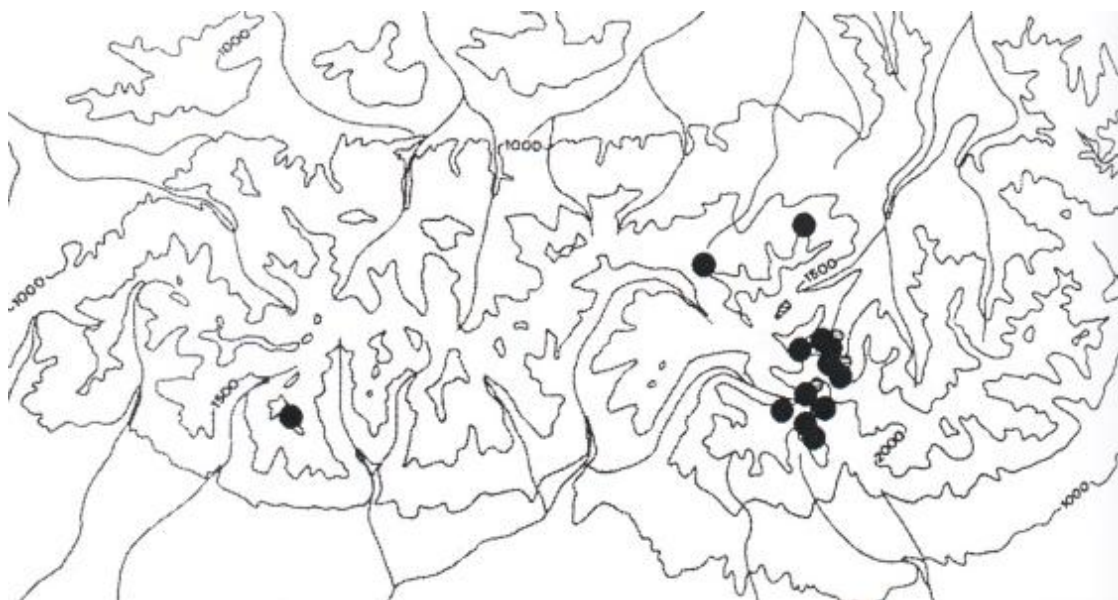
*P. vernalis* has been reported for the first time from the Tatra Mtns and from the Carpathians as a whole by Pawłowski in 1928 (Pawłowski et al 1928). Since that time it has been found in a few stations in the High Tatras and from one isolated station in the Western Tatras. Hitherto, there is insufficient information concerning ecological requirements and population size of *P. vernalis*. The studies carried out by the authors were aimed to recognize distribution, habitat conditions and phytocoenoses as well as a size of populations and threat to the species in the Tatra Mtns.

## Material and Methods

A distribution map of *Pulsatilla vernalis* in the Tatras and a diagram of altitudinal range have been elaborated on the basis of literature and the authors' records. Soils on which *P. vernalis* occurs were characterized on the basis of soil samples taken from the upper genetic horizons in four localities in the Tatra Mtns. The type of soils was determined and their chemical properties were examined in the laboratory. The active ( $\text{pH}_{\text{H}_2\text{O}}$ ) and exchangeable ( $\text{pH}_{\text{KCl}}$ ) acidities

Localities	1	2	3	4
$\text{pH}_{\text{H}_2\text{O}}$	5.7	4.7	5.3	4.5
$\text{pH}_{\text{KCl}}$	4.5	4.0	4.0	3.7
% C org.	3.24	4.77	7.05	7.08
% N total	0.34	0.36	0.67	0.41
C/N	9.5	13.3	10.5	17.3
<b>Available nutrients [mg/100g]</b>				
$\text{P}_2\text{O}_5$	1.7	3.9	2.0	6.2
$\text{K}_2\text{O}$	19.0	24.5	10.2	8.0
MgO	10.1	11.9	2.2	0.1
S cmol(+)/kg	8.08	4.81	0.67	1.03
Hh cmol(+)/kg	9.09	13.83	19.07	16.22
CEC cmol(+)/kg	17.17	18.64	19.74	17.25
V [%]	47.1	25.8	3.4	6.0

**Table 1.** Some chemical properties of investigated soils in the patches with *Pulsatilla vernalis* in the Tatra Mtns S - sum of bases, Hh - hydrolitical acidity, CEC - cation exchange capacity, %V - degree of base saturation. Localities: 1 - Wrota Chałubińskiego 2,015 m, SE, 65°, 2 - Wrota Chałubińskiego 2,025 m, SSE, 55°, 3 - Wrota Chałubińskiego 2,025 m, NNW, 35°, 4 - Mała Koszysta 2,050 m, E, 60°



**Fig. 1.** Distribution of *Pulsatilla vernalis* (L.) Mill. in the Tatra Mtns.

were determined potentiometrically, hydrolytical acidity after Kappen's method, organic carbon content using Tiurin's method, total nitrogen using Kjedahl's method, total exchangeable bases (in  $\text{NH}_4\text{Cl}$ ), available nutrients  $\text{K}_2\text{O}$  and  $\text{P}_2\text{O}_5$  using Egner-Riehm's method and  $\text{MgO}$  using Schachtschabel's method. Results are presented in Table 1 and Figure 3.

#### General distribution

*Pulsatilla vernalis* belongs to the Central-European subelement. This species represents a distinct, 'Pulsatilla distributional type' (Pawłowski 1929; Pawłowska 1951, 1966) having two centres of occurrence: in the lowlands and in the mountains (the Pyrenees, the Massif Central of France, the Alps, the Sudets, the Carpathians, the Rila and Pirin mountains). In Poland *P. vernalis* occurs both in the lowlands and in the Tatra Mtns (Pawłowska 1951, 1966; Wójtowicz 1993). In Slovakia it is restricted exclusively to the Tatra Mtns (Futák 1982). The high mountain taxon occurring in the Alps and Tatra Mtns is regarded as var. *alpestris* Aichele et Schwegler (Aichele and Schwegler 1957; Paclová 1960; Futák 1982).

#### Distribution in the Tatra Mountains

*Pulsatilla vernalis* belongs to the rarest species in the Tatra Mountains, both in the Polish part and in the Slovak one (Fig.1). It is to be found in scattered stations from subalpine to subnival belt having its maximum occurrence in the alpine belt (Fig. 2). The lowest localities have been found on Mt Mięguszowiecki Szczyt Wielki 1,650 m, in the Polish Tatras (Pawłowski 1956), and in Mengusovska dolina valley 1,835 m in the Slovak Tatras (Paclová 1960). The highest stations have been recorded from Mt Mięguszowiecki nad Czarnym 2,170 m, in the Polish Tatras (Pawłowski *et al.* 1928), and Mt Satan 2,352 m (formerly 2,360 m), on the Slovak Tatras (Pawłowski 1956; Paclová 1971). A full list of localities included in the map (Fig.1) is provided as follows:

#### The Polish Tatra Mountains:

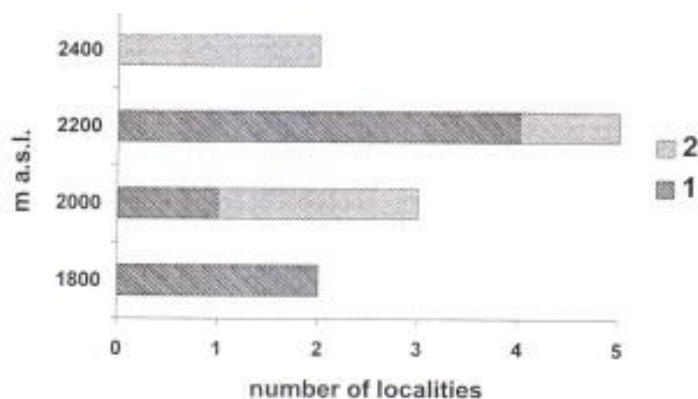
High Tatras: Mt Skrajna Turnia below Liliowe Pass 1,890-1,900 m (Pawłowski 1930), Mt Mała Koszysta 2,050 m (Piękoś-Mirkowa and Miechówka 1999), Wrota Chałubińskiego Pass 2,015 m and 2,025 m (Piękoś-Mirkowa *et al.* 1996), Mt Cubryna 1,670-1,800, Mt Mięguszowiecki Szczyt Wielki 1,650-1,700 m, Mt Mięguszowiecki Środkowy 2,060 m and Mt Mięguszowiecki nad Czarnym 2,130-2,170 m (Pawłowski *et al.* 1928).

#### The Slovak Tatra Mtns:

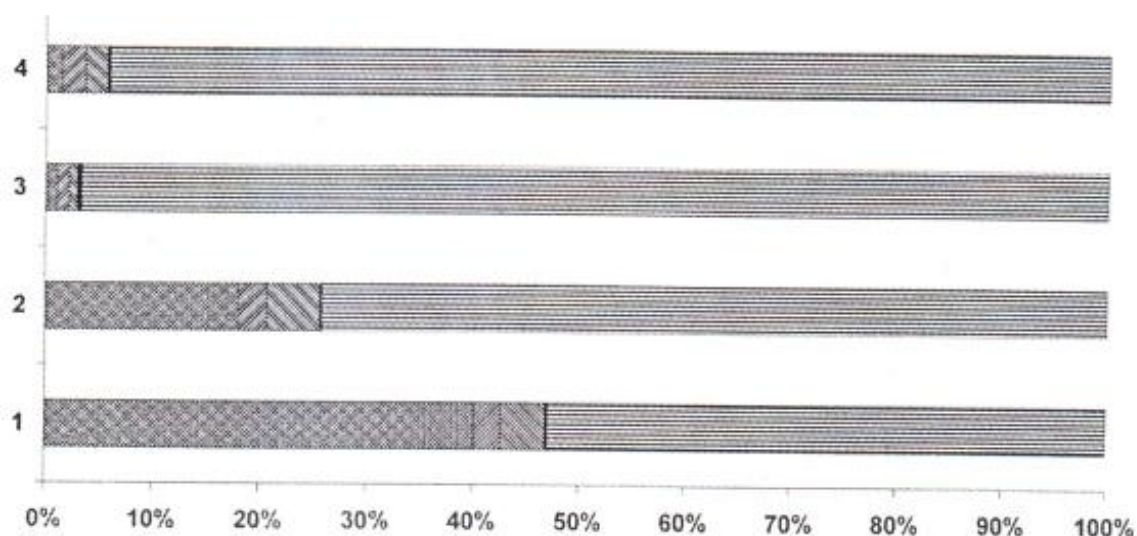
Western Tatras: Baranec-Hrubý 1,980 m (Suza 1936); High Tatras: Furkotská dolina valley (Paclová in Futák 1982), Satan 2,352 m (Pawłowski 1931; Paclová 1960, 1971, 1977), below Vyšné Kôprovské sedlo Pass 2,035-2,060 m (Paclová 1960, 1977), Predná Bašta 2,310 m (Krajina 1933), and 2,325 m (Paclová 1960), Mengusovská dolina valley below Satanove sedlo pass 1,835 m (Paclová 1960).

#### Characteristics of habitats

*Pulsatilla vernalis* grows on steep rocky slopes and ledges, with inclination ranging from  $35^\circ$  to  $70^\circ$ . It appears to prefer northern and eastern aspects. Based on four examined localities in the Polish Tatras it has been found that *Pulsatilla vernalis* grows on lithosols, which are very shallow soils (with the thickness smaller than 10 cm), derived from granodiorites, chloritized granodiorites and chlorite slates. These soils are characterized by medium or large contents of skeletal parts, in the fine earth parts predominates sand fraction, while the fraction with the diameter below 0.02 mm amounts to 15%. The soils show acid or strongly acid reaction - pH in  $\text{H}_2\text{O}$  varies from 4.5 to 5.7, and pH in KCl from 3.7 to 4.5 (Table 1). The soils contain 3.27-7.08% of organic carbon, in the organic matter with C/N ratio 9.5-17.3. These soils are poor or medium rich in available phosphorus (1.7-6.2 mg  $\text{P}_2\text{O}_5/100$  g soil) and magnesium (0.1-11.9 mg  $\text{MgO}/100$  g soil), but they are rich or medium



**Fig. 2.** Altitudinal distribution of *Pulsatilla vernalis* (L.) Mill. localities in the Polish Tatras (1) and in the Slovak Tatras (2).



**Fig. 3.** Percentage of exchange cations in the cation exchange capacity of soil from the examined stands of *Pulsatilla vernalis* (L.) Mill. in the Tatras. Localities 1-4 as in the Table 1.

rich in available potassium (8.0-24.5 mg  $K_2O/100$  g soil). They show large CEC (cation exchange capacity) ranging from 17.17 to 19.74 cmol(+)/kg soil (Table 1), but in the absorbing complex predominate acid cations - hydrolitic acidity varies from 9.09 to 19.07 cmol(+)/kg soil. The degree of base saturation varies and depends on the parent rock, in the soils derived from chlorite slates is 47.1%, chloritized granodiorites 25.8% and from granodiorites 3.4-6.0% (Fig.3). According to Slovak authors, *P. vernalis* is confined to mylonites (Pačlová 1960, 1977; Futák 1982).

*Pulsatilla vernalis* is regarded as a characteristic species of the high mountain grasslands representing *Festuco versicoloris-Agrostietum alpinae* (*Versicoloreto-Agrostidetum alpinae*) association of the order *Seslerietalia varia* (Pawłowski 1956). There is a mosaic of intermixed calciphilous and calcifuge species. Floristic composition of phytocoenoses with *P. vernalis* in the eleven stations in the Polish and Slovak Tatras is shown in Table 2. Species names were adopted, in general, after Mirek *et al* (1995).

#### Population characteristics

*Pulsatilla vernalis* is represented in the Tatra

Mtns by small populations usually consisting of a few or several dozen individuals (Pawłowski 1930, 1931; Pačlová 1960, 1977; Piękoś-Mirkowa *et al* 1996; Piękoś-Mirkowa and Miechówka 1999). So far, the largest population was observed in 1995 in Mt Mała Koszysta, 2,050 m a.s.l. It consisted of 13 flowering plants and 78 sterile ones (Piękoś-Mirkowa and Miechówka 1999). In the subniveal belt (above 2,250 m a.s.l.) the species appears to be sterile. For instance, Pačlová (1960, 1977) observed in Predná Bašta at an altitude of 2,325 m the population which contained five sterile individuals, and in Satan 2,360 m - seven sterile individuals and one fruiting plant.

In spite of the fact that *Pulsatilla vernalis* occupies the places which are usually difficult for tourists to access, some stands can be potentially threatened. For example, extremely small populations in Wrota Chałubińskiego pass appear to be in danger.

#### Acknowledgements

The authors wish to express their gratitude to H. Kuciel M.Sc. for her technical assistance and making the map of distribution.

Species	1	2	3	4	5	6	7	8	9	10	11
<i>Pulsatilla vernalis</i>	+	+	+	+	+	+	+	+	+	+	+
<i>Agrostis alpina</i>											
<i>Agrostis rupestris</i>	+		+	+	+				+		
<i>Alchemilla flabellata</i>			+	+	+	+			+		
<i>Androsace obtusifolia</i>									+		+
<i>Anemone narcissifolia</i>				+	+	+					+
<i>Antennaria carpatica</i>	+			+	+	+	+	+		+	
<i>Anthoxanthum alpinum</i>				+	+		+			+	+
<i>Arabis alpina</i>					+	+					
<i>Artemisia eriantha</i>			+					+			
<i>Asplenium viride</i>			+			+		+			
<i>Avenula versicolor</i>	+		+	+	+	+			+		
<i>Bartsia alpina</i>	+		+	+	+	+			+	+	
<i>Bellidiastrum michelii</i>				+	+		+		+		
<i>Callianthemum coriandrifolium</i>					+		+		+		
<i>Campanula alpina</i>	+	+		+	+	+			+		
<i>Campanula polymorpha</i>				+	+	+	+				+
<i>Carex fuliginosa</i>			+		+	+					
<i>Carex sempervirens</i>	+		+	+	+	+			+	+	
<i>Cerastium lanatum</i>					+	+			+	+	
<i>Cerastium tatrae</i>			+		+						
<i>Coeloglossum viride</i>	+		+	+							
<i>Deschampsia flexuosa</i>		+									
<i>Dianthus glacialis</i>				+	+	+					
<i>Doronicum clusii</i>	+	+		+	+	+					
<i>Dryas octopetala</i>				+		+	+				
<i>Empetrum hermaphroditum</i>				+	+		+				
<i>Erigeron uniflorus</i>				+	+	+		+	+	+	
<i>Euphrasia tatrae</i>			+	+		+					
<i>Festuca airoides</i>	+	+	+	+	+	+			+	+	
<i>Festuca picta</i>			+	+		+					
<i>Festuca versicolor</i>			+	+	+	+	+				
<i>Galium anisophyllum</i>			+	+	+	+	+	+			
<i>Gentiana frigida</i>		+			+						
<i>Geum montanum</i>										+	
<i>Geum reptans</i>					+	+					
<i>Hieracium alpicola</i> ssp. <i>ullepitschii</i>						+	+	+	+		
<i>Hieracium alpinum</i>					+						
<i>Huperzia selago</i>	+	+	+		+						
<i>Juncus trifidus</i>				+	+	+					
<i>Juniperus communis</i> ssp. <i>nana</i>			+		+						
<i>Leontodon pseudotaraxaci</i>				+	+	+	+				
<i>Lloydia serotina</i>			+		+	+	+	+	+		
<i>Luzula alpino-pilosa</i>					+	+					
<i>Luzula spicata</i>					+	+			+		
<i>Minuartia sedoides</i>	+						+			+	
<i>Minuartia verna</i>	+					+		+	+		
<i>Myosotis alpestris</i>				+	+	+					
<i>Oreochloa disticha</i>	+	+			+						
<i>Pachypleurum simplex</i>				+	+	+	+	+	+	+	
<i>Parnassia palustris</i>			+	+	+	+					
<i>Pedicularis oederi</i>		+	+	+	+	+	+		+		
<i>Pedicularis verticillata</i>					+	+	+	+		+	
<i>Phyteuma orbiculare</i>			+	+	+	+		+	+	+	
<i>Pinguicula alpina</i>								+			
<i>Poa alpina</i>					+	+					
<i>Polygonum viviparum</i>		+	+	+	+	+					
<i>Polystichum lonchitis</i>								+			
<i>Potentilla aurea</i>			+	+					+	+	
<i>Potentilla crantzii</i>	+			+		+	+	+			
<i>Primula minima</i>	+		+		+						
<i>Pulsatilla alba</i>	+		+	+	+	+				+	
<i>Ranunculus alpestris</i>			+		+	+		+			
<i>Ranunculus oreophilus</i>								+			
<i>Ranunculus pseudomontanus</i>					+	+	+	+			
<i>Rhodiola rosea</i>				+	+	+			+		
<i>Salix herbacea</i>					+	+					
<i>Salix kitaibeliana</i>	+	+	+	+	+	+					
<i>Salix reticulata</i>					+	+	+	+			
<i>Saxifraga aizoides</i>			+		+	+					
<i>Saxifraga androsacea</i>									+		
<i>Saxifraga bryoides</i>				+	+	+					
<i>Saxifraga hieracifolia</i>	+										

...continued

<i>Saxifraga moschata</i>	+				+	+	+			+
<i>Saxifraga oppositifolia</i>	+					+	+	+	+	
<i>Saxifraga paniculata</i>			+	+	+	+	+	+	+	+
<i>Saxifraga retusa ssp. retusa</i>						+	+	+		
<i>Saussurea pygmaea</i>	+							+		+
<i>Sedum alpestre</i>					+	+				+
<i>Selaginella selaginoides</i>				+		+				
<i>Sempervivum montanum</i>										+
<i>Silene acaulis</i>	+		+	+	+	+				+
<i>Soldanella carpatica</i>			+	+	+	+				+
<i>Solidago alpestris</i>	+		+	+						
<i>Swertia alpestris</i>			+			+				
<i>Tanacetum alpinum</i>	+	+			+					
<i>Thymus alpestris</i>			+	+	+	+				+
<i>Vaccinium gaultherioides</i>			+		+	+				
<i>Vaccinium myrtillus</i>	+		+	+	+				+	+
<i>Vaccinium vitis-idaea</i>		+		+	+	+	+		+	+
<i>Veronica aphylla</i>					+	+				

**Table 2.** Species accompanying *Pulsatilla vernalis* in its localities in the Tatra Mtns.

## Localities:

- 1- The Western Tatras: Baranec 1,980 m, N (Suza 1936)
- 2 - The High Tatras: Mała Koszysta 2,050 m, E, 60° (Piękoś-Mirkowa, and Miechówka 1999)
- 3 - Wrota Chałubińskiego 2,025 m, NNW, 35° (Piękoś-Mirkowa *et al* 1996)
- 4 - Cubryna 1,710 m, E - ENE, 70° (Pawłowski *et al* 1928)
- 5 - Mięguszowiecki Wielki 1,680 m, E, 45° (Pawłowski, *et al* 1928)
- 6 - Mięguszowiecki Środkowy 2,060 m, NE, 50° (Pawłowski *et al* 1928)
- 7 - Mięguszowiecki nad Czarnym 2,140 m, E, 50° (Pawłowski *et al* 1928)
- 8 - Vyšné Kôprovské sedlo 2,035-2,060 m, E (Paclová 1960)
- 9 - Satanove sedlo 1,835 m, NE (Paclová 1960)
- 10 - Predné Bašty 2,310 m, E (Krajina 1933)
- 11 - Predné Bašty 2,325 m, SE (Paclová 1960)

**References**

- Aichele, D. and Schwegler, H.W. 1957: Die Taxonomie der Gattung *Pulsatilla*. *Feddes Repertor.*, **60**(1-3): 1-230.
- Futák, J. 1982: *Pulsatilla* Mill. In: *Flora Slovenska*. (eds. Futák J. and Bertová L.) **3**: 110-138. Veda, Vyd. SAV.
- Krajina, V. 1933: *Pulsatilla vernalis* (L.) Mill., nová roślina pro československou část Vysokých Tater. *Veda prírody*, **14**: 184
- Maglocký, Š. and Feráková, V. 1993: Red list of ferns and flowering plants (Pteridophyta and Spermatophyta) of the flora of Slovakia (the second draft). *Biológia* (Bratislava), **48**: 361-385.
- Mirek, Z. and Piękoś-Mirkowa, H. 1992: Contemporary threat to the vascular flora of the Polish Carpathians (S Poland). *Veröff. Geobot. Inst. ETH, Stiftung Rübel, Zürich*, **107**: 151-162.
- Mirek, Z., Piękoś-Mirkowa, H., Zajac, A. and Zajac, M. 1995: Vascular plants in Poland. A checklist. *Polish Botanical Studies, Guidebook Series*, **15**: 1-303.
- Paclová, L. 1960: Poniklec jarný - *Pulsatilla vernalis* (L.) Mill. v Tatranskom Národnom Parku. *Sborník prác o Tatranskom Národnom Parku*, **4**: 102-108.
- Paclová, L. 1971: Neue Höhenmaxima der Gefäßpflanzen in der subnivalen Stufe der Hohen Tatra (Vysoké Tatry). *Acta Fac. Rer. Nat. Univ. Comen. Botanica*, **19**: 257-273.
- Paclová, L. 1977: Rastlinstvo subnivalného stupňa Vysokých Tatier. *Zborník Prác o Tatranskom Národnom Parku*, **19**: 169-256.
- Pawłowska, S. 1951: Sasanki. *Chrońmy przyr. ojcz.*, **7**: 3-18.
- Pawłowska, S. 1966: Floristic statistics and elements of the Polish Flora. In: *The vegetation of Poland*. (ed. W. Szafer) pp.138-241. Pergamon Press Ltd, Oxford & PWN - Polish Scientific Publishers, Warszawa.
- Pawłowski, B. 1929: Elementy geograficzne i pochodzenie flory tatrzańskiego piętra turniowego. *Rozpr. Wydz. Mat.-Przyr. PAU*, 68, Ser. B 3, 28, 3, Kraków.
- Pawłowski, B. 1930: Zapiski florystyczne z Tatr. Cz. III. - *Acta Soc. Bot. Pol.*, **7**: 127-138.
- Pawłowski, B. 1931: Maxima wysokościowe kilkudziesięciu roślin Tatrzańskich. *Spraw. Komis. Fizjogr. PAU*, **65**: 153-158.
- Pawłowski, B. 1956: Flora Tatr. **1**. pp. 669. Państwowe Wydawnictwo Naukowe, Warszawa.
- Pawłowski, B., Sokołowski, M. and Wallisch, K. 1928: Zespoły roślin w Tatrach. Część VII. Zespoły roślinne i flora doliny Morskiego Oka. *Rozpr. Wydz. Mat.-Przyr. PAU A/B*, **67**: 171-311.
- Piękoś-Mirkowa, H. and Miechówka, A. 1999: Nowe stanowiska sasanki wiosennej *Pulsatilla vernalis* i bylicy skalnej *Artemisia eriantha* w Tatrzańskim Parku Narodowym. *Chrońmy przyr. ojcz.* **55**: 74-79.
- Piękoś-Mirkowa, H., Mirek, Z. and Miechówka, A. 1996: Materiały do flory ekologicznej Tatrzańskiego Parku Narodowego. Część I. *Fragm. flor. geobot. Ser. Polonica*, **3**: 77-84.
- Suza, J. 1936: *Pulsatilla vernalis* v Liptovských holich na Slovensku. *Věda přírody*, **17**: 265.
- Wójtowicz, W. 1993: *Pulsatilla vernalis* (L.) Miller - sasanka wiosenna. In: *Polska czerwona księga roślin*, (eds. K. Zarzycki and R. Kaźmierczakowa), pp. 64-65. Instytut Botaniki i Instytut Ochrony Przyrody, Polska Akademia Nauk, Kraków.
- Zarzycki, K. and Szelaż, Z. 1992: Czerwona lista roślin naczyniowych zagrożonych w Polsce. In: *Lista roślin zagrożonych w Polsce*. (eds K. Zarzycki, W. Wojewoda and Z. Heinrich), pp. 87-98. Instytut Botaniki, Polska Akademia Nauk, Kraków.

Received 18 December 1998; revised 12 January 1999; accepted 7 March 1999.