

RE-APPERANCE OF *PORELLA ARBORIS-VITAE*  
IN THE BIESZCZADY NATIONAL PARK

KATARZYNA BUCZKOWSKA, ALINA BĄCZKIEWICZ

K. Buczkowska, A. Bączkiewicz, Department of Genetics, Institute of Experimental Biology, Adam Mickiewicz University in Poznań, Umultowska 89, 61-614 Poznań, Poland, e-mail: androsac@amu.edu.pl

(Received: June 6, 2009. Accepted: March 8, 2010)

**ABSTRACT.** At present three species from the genus *Porella* are found in the Bieszczady National Park. The most numerously represented species is *Porella platyphylla*. Apart from *P. platyphylla* two very rare species from the same genus, i.e. *P. arboris-vitae* and *P. cordaeana*, are also found. The paper also compares the current occurrence of species from the genus *Porella* with literature data from the 1950's and 1990's.

**KEY WORDS:** bryophytes, liverworts, rare epiphytic species, *Porella*, Primeval Beech Forest

## INTRODUCTION

Liverworts are plants exhibiting high sensitivity to environmental changes, particularly anthropopressure and related substrate eutrophication and air pollution, thus they may be used in the monitoring of environmental changes. They may be indicators of stability of the environment, remaining unchanged over long time periods in a given area (STEWART 1995). Environmental changes caused by human activity result in the flora of liverworts declining in some regions. This process of decline of liverwort populations is also observed in Poland, where certain species disappear rapidly, which is evident in case of epiphytic species, e.g. from genera *Porella*, *Metzgeria* and *Frullania* (SZWEYKOWSKI 1992, SZWEYKOWSKI and BUCZKOWSKA 1996, KLAMA 2002). Many epiphytic liverwort species in Poland are dying out or are threatened with extinction and at present they are rare or very rare components of liverwort flora (SZWEYKOWSKI 1992, 2006, KLAMA 2006).

Four species from the genus *Porella* are found in Poland, i.e. *P. platyphylla*, *P. arboris-vitae*, *P. bauerii* and *P. cordaeana*. Among the above mentioned species only *P. cordaeana*, not being an epiphyte, is most common, while the other species, mainly epiphytic, are rare or very rare (SZWEYKOWSKI 2006). We may still relatively frequently find *P. platyphylla* growing on rocks, while epiphytically growing plants disappear rapidly and are less and less common, especially in the lowlands (SZWEYKOWSKI 2006). One of the scarce locations on the lowlands, where *P. platyphylla* occurs as an epiphyte, is the Białowieża Primeval Forest (KLAMA 2002, STEBEL et AL. 2003). Slightly more often these species may be found in the mountains and one of the regions of their occurrence in Poland comprises beech forests in the Bieszczady Mts Forests of the Bieszczady National Park are considered to be best preserved in Poland

(MICHALIK and KURZYŃSKI 1990). Considerable areas of these forests have retained their natural and even primeval character in certain fragments (ZARZYCKI 1963, KUCHARZYK 2008). At present they are considered to be one of the biggest complexes of primeval and natural beech stands in Europe. The primeval character of some of these forests was partially disturbed as a result of forest economy run in the 20th century, until they were covered by legal protection (KUCHARZYK 2008). The Bieszczady National Park was established as late as 1973, next it was expanded twice and in its present form it has been operating since 1991. It now constitutes the central part of the trilateral International Biosphere Reserve of "The Eastern Carpathians" established under UNESCO auspices (UNESCO 2007). Well-preserved fragments of primeval forests are refuge to many species of mosses, lichens and liverworts, sometimes very rare and unique nationwide (LISOWSKI 1956, GLANC and TOBOLEWSKI 1960, SZWEYKOWSKI and BUCZKOWSKA 1996, KOŚCIELNIAK 2008). Studies on liverworts conducted for many years in the Bieszczady National Park in the 1950's, 1980's and 1990's (SZWEYKOWSKI and BUCZKOWSKA 1996) as well as further observations carried out by the authors of this paper in 2003 and 2008 make it possible to assess the occurrence of species from the genus *Porella* in that area. The period of investigations conducted in the Bieszczady Mts covers the time prior to the establishment of the Bieszczady National Park, as well as 20 and 35 years after its establishment.

## MATERIAL AND METHODS

In the course of field studies conducted in 2008 in the Bieszczady National Park a total of 52 samples were collected of the genus *Porella* (Table 1, 2). From each site small samples of living plants were collected for

genetic analyses. Collected samples were subjected to isoenzymatic analyses. Five stems were collected from each sample and a total of 260 plants were analysed. All samples were identified based on isoenzymatic markers (BUCZKOWSKA and BĄCZKIEWICZ 2008, BĄCZKIEWICZ et AL. unpubl.). Following genetic analyses all collected samples were dried and deposited at the POZW herbarium. Data collected in this study were compared with literature data concerning investigations on liverwort flora in that area in the years 1950-1995 (SZWEYKOWSKI and BUCZKOWSKA 1996).

## RESULTS

Studies showed that at present in the Bieszczady National Park, apart from *P. platyphylla*, there are also two very rare species from this genus, i.e. *P. arboris-vitae* and *P. cordaeana*. Among analysed 52 samples a total of 37 belonged to *P. platyphylla*, 14 to *P. arboris-vitae* and one to *P. cordaeana*.

*Porella platyphylla* is at present the most frequent epiphytically growing species from the genus *Porella* in the Bieszczady Mts. Currently the occurrence of *P. platyphylla* was reported in nine localities, out of which only in three it had also been recorded in 1955 and 1992 (SZWEYKOWSKI and BUCZKOWSKA 1996), while six sites were new. At present *P. platyphylla* is even more common than in the 1950's. Observations conducted to date indicate that in the Bieszczady Mts the occurrence of this species is dependent on old beech stands. It grows there only on bark of old beech trees and less frequently sycamore in stream valleys, first of all on stream slopes, with higher humidity. This species is characterised by a relatively high isoenzymatic variation (BUCZKOWSKA and BĄCZKIEWICZ 2008, BĄCZKIEWICZ et AL. unpubl.). Most of the analysed samples were fertile, 12 samples were composed solely of female plants, six of male plants and three samples were mixed, whereas in five samples sporophytes were found. Spore formation yields a potential capacity for this species to disseminate.

*Porella arboris-vitae* in the 1950's in the Bieszczady Mts was found in 18 stations, locally even in large numbers. These stations were found in the western part of the Western Bieszczady, where it grew on bark of old beech trees. Despite intensive field observations in the 1980's and 1990's no samples of this species were found, which resulted in *P. arboris-vitae* being considered extinct in that area (SZWEYKOWSKI and BUCZKOWSKA 1996, SZWEYKOWSKI 2006). In the course of field studies conducted in the Bieszczady National Park in 2008 *P. arboris-vitae* was again found on five stations (Table 1, 2). Except for the sites on slopes of Dział Mt and slopes of Jawornik Mt in the Górna Solinka Valley, at present the observed stations of this species are new in relation to those known from the 1950's. Most currently recorded plants grew on bark on old beech trees, only two samples were found on bark of an old sycamore and one sample was recorded on a rock. All colonies grew in stream valleys, which provided them with higher humidity. Only one colony collected in the valley of the Wielki Lutowy stream was fertile and consisted of male plants. A lack of sporophytes indicates a predominance

of vegetative propagation in this species. Isoenzymatic analyses showed very low variation both within and between populations.

*Porella cordaeana* in the Bieszczady Mts was known from only one locality (from Połonina Wetlińska) recorded in 1955 (SZWEYKOWSKI and BUCZKOWSKA 1996). In the course of field studies in 2008 the occurrence of this very rare species in the Bieszczady Mts was also recorded in another locality in the valley of the Wielki Lutowy stream.

The occurrence of *P. bauerii* was not confirmed in places recorded in 1955 and 1995 despite intensive search for this species in its former sites.

## DISCUSSION

The number of recorded samples of species from the genus *Porella* is at present higher (52) than it was in the years 1955-1995, as a total of 36 samples were recorded then. Now species from the genus *Porella* were reported in three new sites, of which two are located east of the Wołosate stream (Table 1, 2), where none of the species from this genus had been reported before (SZWEYKOWSKI and BUCZKOWSKA 1996). The occurrence of *P. platyphylla* was observed to increase from 12 to 37 samples and a re-appearance was found of *P. arboris-vitae*, previously considered to be extinct, which number at present is comparable with the population size recorded in the 1950's. *Porella arboris-vitae* is found mainly in the Beech Primeval Forest in the valley of the river Górna Solinka, a place where it was also most abundant in the 1950's. In certain sites plants are observed in abundance and grow as before, even up to approx. 2-3 m above ground (SZWEYKOWSKI and BUCZKOWSKA 1996). However, a considerable proportion of plants is in poor condition. Almost all plants were found on bark of old beech or sycamore trees growing on stream valley slopes, which provide them with a more humid microclimate. The re-appearance in the Bieszczady Mts of *P. arboris-vitae*, generally a very rare species in Poland (SZWEYKOWSKI 1958, 1960, 1961), may indicate that microhabitat conditions after the establishment of the Bieszczady National Park have been improving. The Bieszczady National Park was established as late as 1973, and the area has been covered by strict protection for 35 years. Before the establishment of the National Park in the Bieszczady Mts forest economy was intensive in that area, which could have resulted in the temporary disturbance of the microclimate, particularly its over drying, and epiphytic species are particularly sensitive in this respect. Forest economy was intensified in the 1960's, at that time the network of roads and forest small-gauge railways were constructed in the Bieszczady Mts for the purpose of transportation of harvested timber. Moreover, a forest railway was built in the Beech Primeval Forest in the valley of the river Górna Solinka to Moczarne (RYGIEL 2002). This resulted in a decrease in the proportion of forested areas in higher parts of the Bieszczady Mts to approx. 55-60% (KUCHARZYK 2008). Changes in forest cover could have resulted in disturbed microclimatic conditions, as a result of which epiphytes more sensitive to changes in humidity, e.g. *P. arboris-vitae*, disappeared.

TABLE 1. Comparison of current occurrence of species from genus *Porella* with literature data

No.	Locality	<i>P. platyphylla</i>			<i>P. arboris-vitae</i>			<i>P. cordaeana</i>			<i>P. baueri</i>		
		1955*	1995*	2008	1955*	1995*	2008	1955*	1995*	2008	1955*	1995*	2008
1	The range Otryt		2										
2	Tworylczyk stream		1										
3	Bereżki village, E slope of the pass Przystup		1	17			2				3		
4	Pszczeliny, slope above the river		3										
5	Stuposiany, S of the village	1											
6	Połonina Caryńska, S slope			3	1								
7	Valley of the river Górna Solinka, S slope of Wielka Rawka Mt				1								
8	Valley of the river Górna Solinka, S and SW slope of Mała Rawka Mt				4								
9	E slope of Wielka Rawka Mt			3									
10	Valley of the river Górna Solinka, Średni Lutowy stream, E slope of Jawornik Mt	1		1	2		5						
11	Valley of the river Górna Solinka, slope above the river	1		1									
12	Valley of the river Górna Solinka, W slope of Dział Mt			3	5		1				1		
14	Valley of the river Górna Solinka, Wielki Lutowy stream			2			5		1				
15	Połonina Wetlińska, S slope			1	2			1			1		
16	Hnatowe Berdo, W slope				1								
17	Smerek, N slope				1								
18	Wetlina village		1		1								
19	Smerek stream		1										
20	Valley of the Terebowiec stream						1						
21	Wołosate village, SW slope of Pacałowa Mt			7									
Total		3	9	38	18	0	14	1	0	1	5	0	0

\*SZWEYKOWSKI and BUCZKOWSKA (1996).

In the 1980 and 1990's specimens of this species could not be found in their former localities, where they had been recorded in the 1950's, e.g. in the Beech Primeval Forest in the Górna Solinka Valley, where it was most abundant at that time (SZWEYKOWSKI and BUCZKOWSKA 1996).

Impoverishment of epiphyte flora is a common phenomenon, it does not concern only the Bieszczady Mts, thus causes of the disappearance and gradual re-appearance of *P. arboris-vitae* may be more general, e.g. periodical climatic fluctuations, particularly its over-drying, as well as atmospheric pollution and acid rain (SZWEYKOWSKI and BUCZKOWSKA 1996).

The frequency of occurrence and dissemination of the analysed species may be determined by the manner of propagation. *Porella arboris-vitae* is a dioecious species, it very rarely produces fertile specimens and sometimes in a given area colonies composed of plants of only one sex are reported, e.g. in Great Britain female specimens are found relatively often, while male specimens

were not reported at all, which prevents fertilization, as a result of which sporophytes are not produced (PATON 1999). Similar information was reported by MÜLLER (1951-1958). In Scandinavia fertile specimens, both male and female, are generally rare, also in that region no sporophyte-forming plants were recorded (DAMSHOLT 2002). In turn, in Poland male plants are found, one colony was reported in 1955 (SZWEYKOWSKI and BUCZKOWSKA 1996), while the second – in the course of this study. As it results from literature data (MÜLLER 1951-1958, PATON 1999, DAMSHOLT 2002, SZWEYKOWSKI 2006), this species does not form spores, thus it is unlikely that the re-occupation of this area by this species could occur via spores. Plants have survived in that area in a very poor form, only in the most advantageous places and they next were reestablished when conditions improved. *Porella platyphylla* is also dioecious; however, in that species fertile plants are frequently found. Among 37 collected samples, 12 were composed solely of female plants, seven of male plants, three were

TABLE 2. A list of localities of analysed species from genus *Porella*

Locality	Habitat	POZW No.	Collector	Date
<i>P. arboris-vitae</i>				
Bereżki village, E slope of the pass Przysłup	rotten trunk of old beech at the tourist road, 716 m	42042	KB	2008-08-22
	on bark of old beech, 807 m	42052	KB	2008-08-22
Valley of the river Górna Solinka, W slope of Dział Mt	on bark of old beech, 705 m	42066	KB	2008-08-25
Valley of the river Górna Solinka, Wielki Lutowy stream	on bark of old sycamore in beech forest on slope above the stream, 733 m	42063 – together with <i>P. platyphylla</i>	KB	2008-08-26
	on bark of old beech on slope above the stream, 742 m	42084♂	KB	2008-08-26
	on bark of old sycamore on bank of the stream, 752 m	42071	KB	2008-08-26
	on bark of old beech on bank of the stream, ca. 1.5 m above ground, 754 m	42064	KB	2008-08-26
	on bark of old beech on bank of the stream, ca. 2-3 m above ground, 754 m	42057	KB	2008-08-26
	on bark of old beech, on bank of the stream, 783 m	42079	KB	2008-08-27
Valley of the river Górna Solinka, Średni Lutowy stream, E slope of Jawornik Mt	on bark of old beech, about 8 m from the stream, 783 m	42037	KB	2008-08-27
	on bark of old beech, about 10 m from the stream, ca. 2.5-3 m above ground, 783 m	42080	KB	2008-08-27
	on bark of old beech, on bank above the stream, 787 m	42059	KB	2008-08-27
	on bark of old beech, on bank above the stream, 798 m	42081	KB	2008-08-27
Valley of the Terebowiec stream	on rock on the right side of the road, 731 m	42045	KB	2008-08-30
<i>P. platyphylla</i>				
Bereżki village, E slope of the pass Przysłup	on bark of old beech in forest on slopes above the stream, 709-821 m	42043, 42049, 42039, 42041♀♂ c. spor, 42046, 42040♀, 42036, 42048, 42044, 42050♀, 42038, 42047♀, 42053, 42065♂, 42054♂, 42076♀, PO312♂	KB	2008-08-22
Valley of the river Górna Solinka, W slope of Dział Mt	on bark of old beech on slope above the stream, 685-711 m	42070, 42051♀, PO403♀, PO404♀	KB	2008-08-25
Valley of the river Górna Solinka, Wielki Lutowy stream	on bark of an old beech in forest on slope above the stream, 733 m	42069, 42062	KB	2008-08-26
Valley of the river Górna Solinka, Średni Lutowy stream, E slope of Jawornik Mt	on bark of an old beech, about 10 m from the right bank the stream, ca. 2 m above ground, 756 m	42060♂	KB	2008-08-27
Połonina Caryńska, S slope	on bark of old beech at the tourist road, 803-810 m	42073, 42072	KB	2008-08-28
E slope of Wielka Rawka Mt	on bark of an old beech at the tourist road, 726 m	42061♀, 42058♀, PO902♀	KB	2008-08-31
Wołosate village, SW slope of Pacałowa Mt	on bark of old beech on slopes above the stream, 774-890 m	42063♀ c. per, 42074♀♂ c. spor, 42078♂, 42055, 42083♀ c. per, 42075♀♂ c. spor, 42067♂, 42077♂	KB	2008-09-01
<i>P. cordaeana</i>				
Valley of the river Górna Solinka, Wielki Lutowy stream	on rock on bank of the stream, 712 m	42068	KB	2008-08-26



mixed and in five samples the presence of sporophytes was recorded. Sporulation gives a potential for dissemination of this species. Studies conducted in populations of *P. platyphylla* in North America also showed that this species is characterised by a high isoenzymatic variation (WYATT et AL. 2005).

The Bieszczady National Park, due to the preservation of large fragments of forests in the natural condition, has been the location where many rare mosses (LISOWSKI 1956), liverworts (SZWEYKOWSKI and BUCZKOWSKA 1996) and lichens have been reported (GLANC and TOBOLEWSKI 1960). Studies conducted by KOŚCIELNIAK (2006) showed that many rare lichen species recorded in the 1960's have survived to the present and some species, which in other regions of Poland are strongly endangered or considered extinct, are reported frequently and are not endangered or the degree of threat is low. Similar observations concern epiphytically growing species from the genus *Porella*, including very rare *P. arboris-vitae*, found in the Bieszczady Mts much more frequently than in other regions of the country. The above data stress the extreme importance of the Bieszczady National Park for the preservation of rare species of liverwort flora.

#### Acknowledgements

We would like to thank the Director of the Bieszczady National Park for many facilities provided during the field work. This work was financially supported by grant no. 0503/PO4/2005/29 from the Polish Ministry of Science and Higher Education.

#### REFERENCES

- BUCZKOWSKA K., BĄCZKIEWICZ A. (2008): Genetyczna zmienność wątrobowca *Porella platyphylla* w Bieszczadzkim Parku Narodowym. In: Międzynarodowa XV Konferencja Naukowo-Techniczna „Zapobieganie zanieczyszczeniu, przekształcaniu i degradacji środowiska”. 27-28 listopada, Szczyrk.
- DAMSHOLT K. (2002): Illustrated flora of Nordic liverworts and hornworts. Nordic Bryological Society, Lund.
- GLANC K., TOBOLEWSKI Z. (1960): Porosty Bieszczadów Zachodnich. Pr. Kom. Biol. PTPN 21, 4.
- KLAMA H. (2002): Distribution patterns of liverworts (Marchantiopsida) in natural forest communities (Białowieża Primeval Forest, NE Poland). University of Bielsko-Biała, Bielsko-Biała.
- KLAMA H. (2006): Red list of the liverworts and hornworts in Poland [Czerwona lista wątrobowców i glików w Polsce]. In: Red list of plants and fungi in Poland [Czerwona lista roślin i grzybów Polski]. Eds Z. Mirek, K. Zarzycki, W. Wojewoda, Z. Szela. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków: 21-33.
- KOŚCIELNIAK R. (2008): Znaczenie lasów o charakterze pierwotnym i naturalnym dla zachowania różnorodności gatunkowej porostów w Bieszczadach [The importance of primeval and natural forests for preservation of species diversity of lichens in the Bieszczady Mts.]. Rocz. Bieszcz. 16: 67-76.
- KUCHARZYK S. (2008): Lasy o charakterze pierwotnym w Bieszczadzkim Parku Narodowym. [Forest of primeval character in the Bieszczady National Park]. Rocz. Bieszcz. 16: 19-32.
- LISOWSKI S. (1956): Mchy Bieszczadów Zachodnich. Pr. Kom. Biol. PTPN 17, 3.
- MICHALIK S., KURZYŃSKI J. (1990): Roślinność rezerwatu leśnego Puszcza Bieszczadzka nad Sanem. Ochr. Przyr. 47: 93-110.
- MÜLLER K. (1951-1958): Die Lebermoose Europas. In: Dr. L. Rabenhorst's Kryptogamen Flora von Deutschland, Österreich und der Schweiz. Akad. Verlag, Leipzig: 1204-1227.
- PATON J.A. (1999): The liverwort flora of the British Isles. Harley Books, Martins.
- RYGIEL Z. (2002): Bieszczadzkie kolejki leśne. Wyd. Oficyna Wydawnicza „APLA”, Krosno.
- STEBEL A., KLAMA H., WIERZCHOLSKA S., PLÁŠEK V. (2003): *Porella platyphylla* (L.) Pfeiff. (Hepaticophyta, Porellaceae) in the Białowieża Primeval Forest (Poland). Cas. Slezskeho Muz. Opava (A) 52: 270-272.
- STEWART N. (1995): Red data book of European bryophytes. European Committee for the Conservation of Bryophytes Press, Trondheim.
- SZWEYKOWSKI J. (1953): Mszaki Gór Stołowych. Pr. Kom. Biol. PTPN 14, 5.
- SZWEYKOWSKI J. (1958): Prodromus Florae Hepaticorum Poloniae (Plantae Cryptogamae). Pr. Kom. Biol. PTPN 19: 293-303.
- SZWEYKOWSKI J. (1960): Materiały do flory wątrobowców Tatr. Pr. Kom. Biol. PTPN 21, 3.
- SZWEYKOWSKI J. (1961): Materiały do flory wątrobowców Pienin. Pr. Kom. Biol. PTPN 24, 1.
- SZWEYKOWSKI J. (1992): Czerwona lista wątrobowców zagrożonych w Polsce. In: Lista roślin zagrożonych w Polsce. Eds K. Zarzycki, W. Wojewoda, Z. Heinrich. Instytut Botaniki im. W. Szafera, PAN, Kraków: 85-86.
- SZWEYKOWSKI J. (2006): An annotated checklist of Polish liverworts. Krytyczna lista wątrobowców Polski. In: Biodiversity of Poland. Vol. 4. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- SZWEYKOWSKI J., BUCZKOWSKA K. (1996): Liverworts of the Bieszczady Zachodnie Range (Polish Eastern Carpathians) – a vanishing relict boreal flora. Fragm. Florist. Geobot. 41: 865-934.
- UNESCO (2007): Primeval Beech Forests of the Carpathians. <http://whc.unesco.org/en/list/1133>.
- WINNICKI T., ZEMANEK B. (2003): Przyroda Bieszczadzkiego Parku Narodowego. BdPN, Ustrzyki Dolne.
- WYATT R., ODRZYKOSKI I.J., CRONBERG N. (2005): High levels of genetic variation in the haploid leafy liverwort *Porella platyphylla* from the southeastern United States. J. Bryol. 27: 247-252.
- ZARZYCKI K. (1963): Lasy Bieszczadów Zachodnich. Acta Agr. Silv. Ser. Silv. 3: 131.

For citation: Buczkowska K., Bączkiewicz A. (2010): Re-appearance of *Porella arboris-vitae* in the Bieszczady National Park. Rocz. AR Pozn. 389, Bot.-Stec. 14: 33-37.