Problems of grass biology
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The role of grass species in forest communities with Carex brizoides of the Silesian Upland

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Abstract: This paper analyses the role of grass species in transformed forest communities with *Carex brizoides* L. (sea grass) in the Silesian Upland (southern Poland). In the study area, 27 grass species have been found, more than 30% of which are forest species of the following classes: *Alnetea glutinosae*, *Quercetea robori-petraeae* and *Querco-Fagetea*, and 30% are meadow species (*Molinio-Arrhenatheretea*). The remnant represent rush communities (*Phragmitetea*) – 11%, and clear-cut communities (*Epilobietea angustifolii*) – 7.5%, single species represent heathes (*Nardo-Callunetea*), sandy grasslands (*Koelerio-Corynephoretea*) and moss-sedge high moors (*Scheuchzerio-Caricetea*). The species most often found in forest communities with *Carex brizoides* are *Festuca gigantea, Deschampsia* [*Avenella*] *flexuosa* and *D. caespitosa*, which do not seem to be affected by the presence of sea grass.

An analysis of similarities between patches of various communities with *Carex brizoides* as well as an ordination analysis (PCA) in regard to their specific composition of grass species show that the most frequent grasses and which are in great numbers are an important differentiating factor in the floristically homogeneous phytocoenoses.

Key words: grass, *Carex brizoides,* forest communities, Silesian Upland

INTRODUCTION

Grasses play a significant role in the formation of various communities. They are an important component of typical grass communities, such as hay-growing meadows or pastures, and of other communities as well, both in open areas, e.g. segetal or edge of forest communities, and in most forest communities. It is in forest phytocoenoses that representatives of certain grass species occurring in masses can act as indicators of the state of ecological balance. The characteristic 'grassy' quality of some forest communities is regarded as a form of degeneration.

Among the effects of direct and indirect human impact on the forests of the Silesian Upland, where for centuries the natural environment has been undergoing various

transformations, is the massive occurrence of *Carex brizoides* L. in the ground cover (CELIŃSKI *et al.* 1978; CABAŁA 1990; SIERKA 2001; SIERKA & ORCZEWSKA 2001) – a process called – cespitisation (OLACZEK 1974).

The aim of the present paper is:

to define the contribution of selected grass species to the composition of ecologically disturbed forest communities in which the ground cover has been dominated by *Carex brizoides*;

to identify the grass species which, in spite of the high competitiveness of *Carex brizoides*, occur in large numbers in the studied phytocoenoses; and

to determine the role of grasses in differentiating degenerated patches of forest communities with *Carex brizoides*.

THE STUDY AREA

The research area is delimited after KONDRACKI (2001). The Silesian Upland comprises 5 mesoregions – Chełm Ridge (341.11), Tarnowskie Góry Ridge (341.12), Katowice Upland (341.13), Rybnik Plateau (341.15), and Jaworzno Hills (341.14) (Fig. 1) – and is geologically diversified. Apart from vast uplands and valleys, there are also considerable elevations, of which the highest is St. Anna Hill, 400 m a.s.l.

Upper Carboniferous rocks are the main geological structures of this area, essential to the economy of the region (GILEWSKA 1972). They are overlaid by a thick layer of postglacial matter, such as sand, gravel and clay. The diversity, distribution and condition of forest communities, which cover approximately 20% of the area, are closely connected with the character of habitats and with the type and intensity of human impact (CELIŃSKI *et al.* 1991).

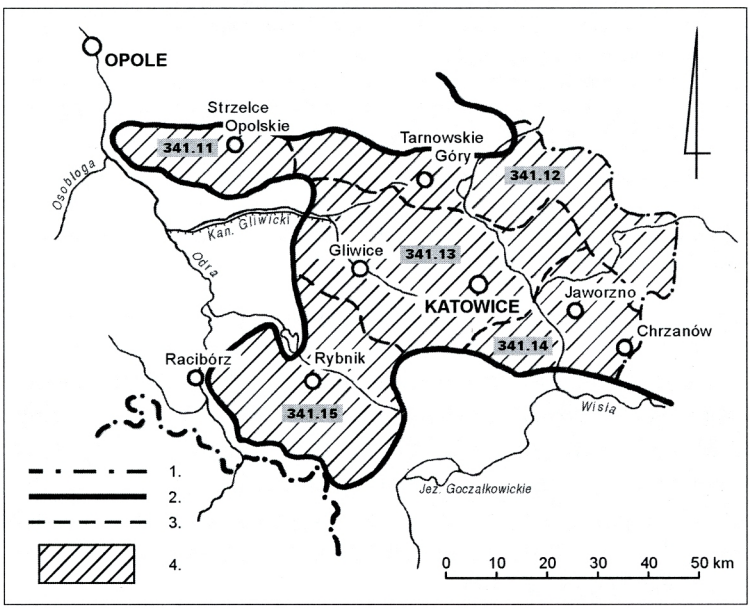

Fig. 1. Localization of the study area (KONDRACKI 1994, modified). 1 – state border; 2 – macroregions border; 3 – mesoregions border; 4 – the study area.

Material and methods

Field study was conducted in the years 1998–2000. Phytosociological relevés were taken in patches of forest communities with *Carex brizoides* using the classical Braun-Blanquet method (Braun-Blanquet 1964). Nomenclature of syntaxonomic units was accepted after Matuszkiewicz (2001), of vascular plants after Mirek *et al.* (1995). The obtained results were analysed in terms of the contribution of grass species to forest communities with *Carex brizoides*, using PROFIT software for geobotanical analysis (Balcerkiewicz & Sławnikowski 1998) and a synthetic table. Investigations were limited to grass species which occurred in forest phytocoenoses with *C. brizoides*. Particular grass species were referred to specific ecological groups according to Zarzycki (1984). Similarities between examined patches were then analysed with the cluster analysis method (Ward method) on the basis of the quantitative contribution of grass species. The role of grasses in differentiation of forest communities with *C. brizoides* was determined by ordering the data with the principal component analysis method (PCA) (Kovach 1998).

Results

Occurrence of grasses in plant communities

In forest communities with *Carex brizoides* in the Silesian Upland, the total of 27 grass species were found. This constitutes more than 11% of all species which occur in floristically impoverished communities with *C. brizoides*.

Classification of forest communities with *Carex brizoides* presents as follows:

Cl. *Salicetea purpureae* Moor 1958
O. *Salicetalia purpureae* Moor 1958
All: *Salicion albae* R. Tx. 1955
Ass. *Populetum albae* Br.-Bl. 1931
Cl. *Alnetea glutinosae* Br.-Bl. et R.Tx. 1943
O. *Alnetalia glutinosae* R. Tx. 1937
All. *Alnion glutinosae* Meijer Drees 1936
Ass. *Ribeso nigri-Alnetum* Sol.-Górn. (1975) 1987
Cl. *Vaccinio-Piceetea* Br.-Bl. 1939
O. *Cladonio-Vaccinietalia* Kiell.-Lund. 1967
All. *Dicrano-Pinion* Libb. 1933
SAll. *Dicrano-Pinenion* Seibert in Oberd. (ed.) 1992
Ass. *Molinio-Pinetum* W. Mat. et J. Mat. 1973
Ass. *Querco roboris-Pinetum* (W. Mat. 1981) J. Mat. 1988
Pinus silvestris-Carex brizoides community
SAll. *Piceo-Vaccinienion uliginosi* Seibert in Oberd. (ed.) 1992
Ass. *Calamagrostio villosae-Pinetum* Staszk. 1958
Cl. *Quercetea robori-petraeae* Br.-Bl. et R. Tx. 1943
O. *Quercetalia roboris* R. Tx. 1931
All. *Quercion robori-petraeae* Br.-Bl. 1932
Ass. *Calamagrostio arundinaceae-Quercetum petraeae* Scam. et Pass. 1959
Cl. *Querco-Fagetea* Br.-Bl. et Vlieg. 1937
O. *Fagetalia sylvaticae* Pawł. in Pawł., Sokoł. et Wall. 1928
All. *Alno-Ulmion* Br.-Bl. et R. Tx. 1943

SAll. *Alnenion glutinoso-incanae* Oberd. 1953
Ass. *Fraxino-Alnetum* W. Mat. 1952
Ass. *Carici remotae-Fraxinetum* Koch 1926 ex Faber 1936
SAll. *Ulmenion minoris* Oberd. 1953
Ass. *Ficario-Ulmetum minoris* Knapp 1942 em. J. Mat. 1976
All. *Carpinion betuli* Issl. 1931 em. Oberd. 1953
Ass. *Tilio cordatae-Carpinetum betuli* Tracz. 1962
Betula pendula-Carex brizoides community
All. *Fagion sylvaticae* R. Tx. et Diem. 1936
SAll. *Luzulo-Fagenion* (Lohm. ex R. Tx. 1954) Oberd. 1957
Ass. *Luzulo pilosae-Fagetum* W. Mat. et A. Mat. 1973
Fagus sylvatica-Carex brizoides community
SAll. *Dentario glandulosae-Fagenion* Oberd. et Müller 1984

The most numerous group of grasses (10 species) was found in the communities: *Fraxino-Alnetum* and *Querco roboris-Pinetum*. Only 2 species were found in *Molinio-Pinetum* and in *Fagus sylvatica-Carex brizoides* community.

Ecological groups of grasses

Among the grass species found in the area, little over 30% were forest species of the classes *Alnetea glutinosae*, *Quercetea robori-petraeae* and *Querco-Fagetea*. Another 30% were meadow species (class *Molinio-Arrhenatheretea*). Other species represented rush communities (class *Phragmitetea*) – 1% and clear-cut areas communities (*Epilobietea angustifolii*) – 7.5 %, and single species represented heathes (*Nardo-Callunetea*), sandy grasslands (*Koelerio-Corynephoretea*) and moss-sedge high moors (*Scheuchzerio-Caricetea*) (Fig. 2). The obtained results show that in forests with *Carex brizoides* the most common grass species (found in more than 25% of communities) were: *Festuca gigantea, Deschampsia* [*Avenella*] *flexuosa, D. caespitosa* and *Melica nutans*, which, except the last mentioned species, were marked by high constancy and coverage. Important

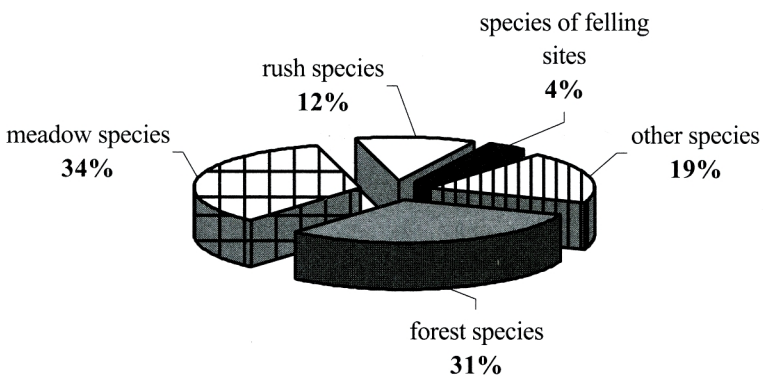

Fig. 2. Percentage participation of the ecological grups of grass species in the forest communities with *Carex brizoides* L.

Table 1. Occurrence and constancy classes of grass species in forest communities with *Carex brizoides* L.

	Plant community with *Carex brizoides* / Species	*Fraxino-Alnetum*	*Populetum albae*	*Ribeso nigri-Alnetum*	*Ficario-Ulmetum minoris*	*Calamagrostio arundinaceae-Quercetum petraeae*	*Calamagrostio villosae-Pinetum*	*Molinio-Pinetum*	*Betula pendula – Carex brizoides*	*Pinus sylvestris – Carex brizoides*	*Fagus sylvatica – Carex brizoides*	*Querco roboris-Pinetum*	*Carici remotae-Fraxinetum*	*Luzulo pilosae-Fagetum*	*Dentario glandulosae-Fageion*	*Tilio cordatae-Carpinetum betuli*
		Number of relevé														
		25	**7**	**8**	**8**	**12**	**9**	**6**	**7**	**6**	**6**	**17**	**7**	**9**	**6**	**37**
	Carex brizoides	V^{2-5}	V^{+-4}	V^{1-3}	V^{1-5}	V^{+-3}	V^{+-5}	V^{4-5}	V^{1-3}	V^{+-2}	V^{+-2}	V^{+-4}	V^{+-2}	V^{+-5}	V^{4-5}	V^{3-5}
1	*Festuca gigantea*	III^{+-2}	II^{+}	II^{1}	IV^{+-1}	III^{1}			I+				III^{+-1}	II+	II^{1}	II^{+-3}
2	*Deschampsia [Avenella] flexuosa*			I^{2}	I^{+}	III^{+-1}	III^{+-2}	II^{+-1}				IV^{+-2}	IV^{+-2}			
3	*Deschampsia caespitosa*	III^{+-2}	I^{1}	II^{+-1}	II^{1}		I^{+}		III^{+-1}		I^{1}	III^{+-2}			I^{1}	
4	*Melica nutans*				I^{2}					I^{1}		I^{+}	II^{+-1}	II^{r-+}	I^{+}	I^{+-1}
5	*Milium effusum*	I^{2}									I^{1}		III^{1}	I^{+}	II^{+}	I^{+-1}
6	*Calamagrostis epigejos*	I^{+}				I^{+}						I^{+-1}		I^{+}		I^{+-1}
7	*Poa trivialis*	I^{1}	I^{+}	II^{+-2}		I^{+}										
8	*Poa nemoralis*											I^{2}		III^{+-1}	I^{1}	II^{+-2}
9	*Calamagrostis villosa*				I^{1}		V^{4-5}					I^{+}				
10	*Brachypodium sylvaticum*					I^{+}						I^{+}	II^{+-2}			I^{+-1}
11	*Phalaris arundinacea*		IV^{+-2}	II^{+}												
12	*Molinia caerulea*						I^{1}	V^{3-4}				I^{+-1}				
13	*Festuca ovina*			I^{3}					I^{+}			I^{+}				
14	*Anthoxanthum odoratum*				II^{1}	II^{+-1}										
15	*Agrostis canina*		I^{1}	I^{+}												
16	*Holcus lanatus*	I^{1}	I^{+}													
17	*Poa pratensis*		III^{+-1}									I^{+}				
18	*Calamagrostis canescens*			II^{+-1}												
19	*Agrostis capillaris*									II^{+}						
20	*Dactylis glomerata*															I^{1}
21	*Glyceria fluitans*	I^{1}														
22	*Agrostis stolonifera*	I^{1}														
23	*Heracleum sphondylium*	I^{+}														
24	*Phleum pratense*	I^{+}														
25	*Festuca rubra*													I^{+}		
26	*Glyceria maxima*			I^{+}												
27	*Holcus mollis*						I^{+}									

components which gave character to individual communities were the following grass species: *Calamagrostis villosa* (V^{4-5}) in *Calamagrostio villosae-Pinetum*, *Molinia caerulea* in *Molinio-Pinetum* (V^{3-4}) and *Phalaris arundinacea* (V^{+-2}) in *Populetum albae*. The forest species *Poa nemoralis* (III^{+-1}) was most frequently noted in acid beech wood, *Millium effusum* (III^{1}) in *Carici remotae-Fraxinetum*, and *Poa pratensis* (III^{+-1}) in *Populetum albae*. Other species, although found in many communities, played a minor role in their formation. *C. brizoides* in all the analysed communities scored V on constancy and from (+) to 5 on coverage (Table 1).

Analysis of the importance of grass species

The analysis of similarity based on the quantitative contribution of grass species to the communities reveals that grasses play a major role in determining the character of forest phytocoenoses with *Carex brizoides*. On the basis of the obtained dendrogram, three main groups of communities can be identified (Fig. 3):

I. a group of communities living in humid habitats with *Festuca gigantea, Deschampsia caespitosa* and *Poa trivialis*, and a rush species *Phalaris arundinacea*;

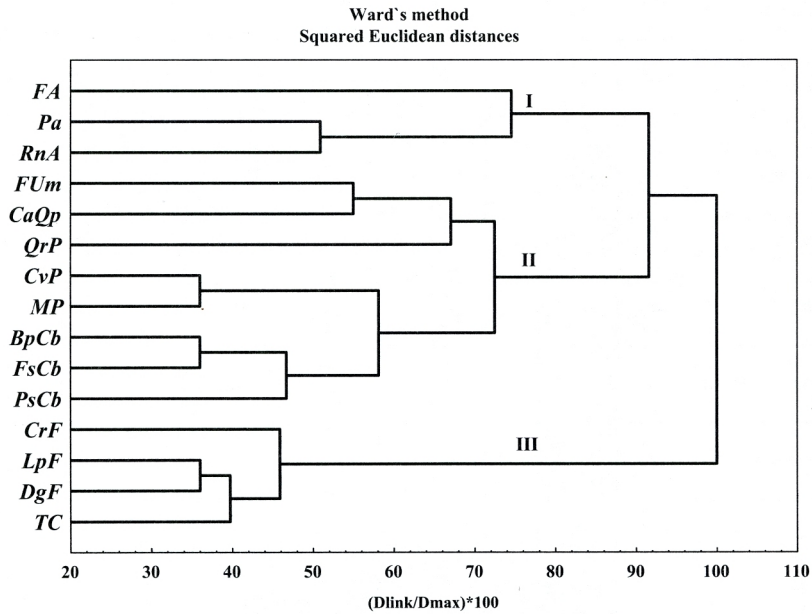

Fig. 3. Classification of forest communities with *Carex brizoides* L. Dendrogram based on the percentage cover of grass species (Ward's method and Square Euclidean distances).

BpCb *– Betula pendula-Carex brizoides* community; ***CaQp*** *– Calamagrostio arundinaceae-Quercetum petraeae;* ***CrF*** *– Carici remotae-Fraxinetum;* ***CvP*** *– Calamagrostio villosae-Pinetum;* ***DgF*** *– Dentario glandulosae-Fagetum;* ***FA*** *– Fraxino-Alnetum;****FsCb*** *– Fagus sylvatica-Carex brizoides* community; ***FUm*** *– Ficario-Ulmetum minoris;* ***LpF*** *– Luzulo pilosae-Fagetum;* ***MP*** *– Molinio-Pinetum;* ***Pa*** *– Populetum albae;* ***PsCb*** *– Pinus sylvestris-Carex brizoides* community; ***QrP*** *– Querco roboris-Pinetum;* ***RnA*** *– Ribeso nigri-Alnetum;* ***TC*** *– Tilio cordatae-Carpinetum betuli.*

II. the most numerous group of communities, which encompasses:
- communities with *Deschampsia caespitosa*,
- communities with few grass species occurring sparsely,
- community *Querco roboris-Pinetum*, with: *Deschampsia* [*Avenella*] *flexuosa* and *D. caespitosa* occurring in large numbers;

III. phytocoenoses shaped by forest grass species, such as *Festuca gigantea, Melica nutans, Milium effusum, Poa nemoralis* and *Brachypodium sylvaticum*.

The results of PCA analysis (Fig. 4) indicate that the species: *Festuca gigantea, Deschampsia* [*Avenella*] *flexuosa, D. caespitosa, Melica nutans, Milium effusum* and *Phalaris arundinacea* play the most important role in differentiation of the studied communities, all of which are marked by simplified, standardized specific composition of the ground cover induced by the massive occurrence of *Carex brizoides*. Typical forest species (*Melica nutans, Milium effusum* or *Festuca gigantea*) are accompanied by species indicative of, e.g., stand thinning (*Calamagrostis epigejos*), soil humidity (*Phalaris arundinacea, Agrostis canina* and *Poa pratensis*) or impoverished and acid habitats (*Deschampsia* [*Avenella*] *flexuosa*).

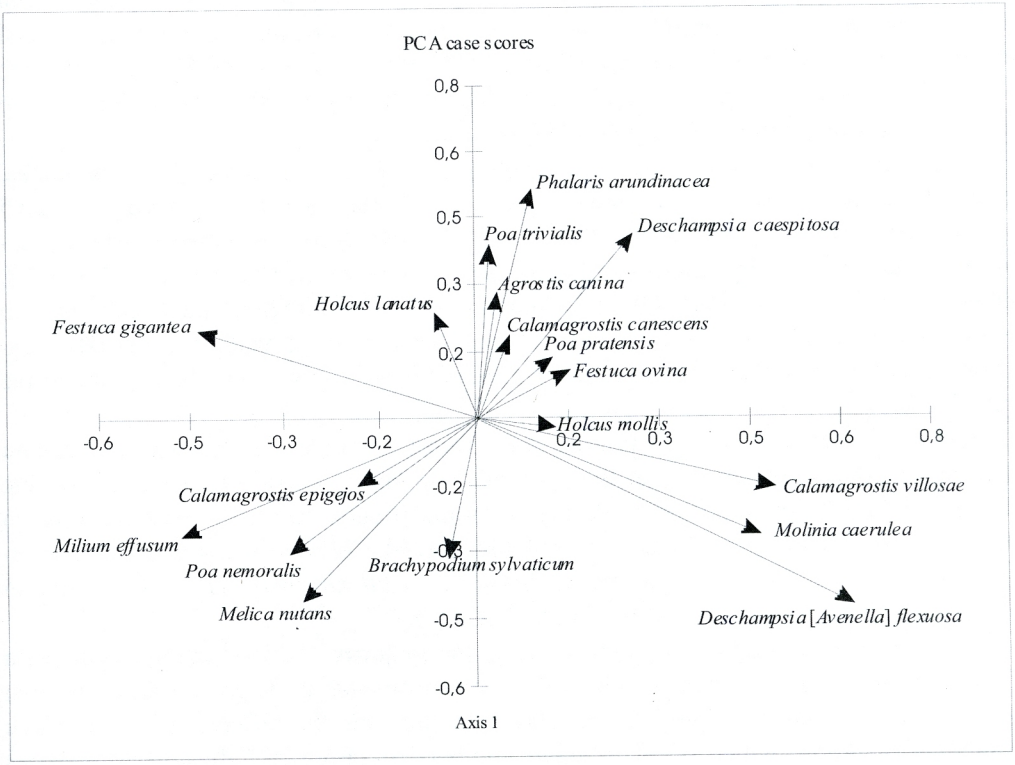

Fig. 4. Results of PCA analysis. Ordination diagram based on the participation of grass species.

Discussion

The large variety of grasses allows their wide distribution (Mizianty 1995), therefore grass species differ concering their tolerance of particular habitat conditions and their adaptability to changeable conditions (Falkowski 1982; Kochanowska *et al.* 1995). Specific conditions which evolve in forest communities when the ecological balance is disturbed are conducive to the development of expansive forms, such as *Carex brizoides*. This sedge usually invades communities of thinned stock (Izdebski *et al.* 1992). The massive occurrence of *C. brizoides* in the undergrowth of forest communities results in physiognomic and floristic uniformity of the ground cover and in a marked fall in the specific biodiversity (Sierka 2002).

So far the inhibiting influence of *Carex brizoides* on other elements of the ground cover has been confirmed only with regard to dicotyledonous plants (Faliński 1998a, b) and young tree seedlings, e.g. *Quercus robur* (Becker & Leavy 1986). Given the tendency that in communities with *C. brizoides* in the ground cover both the number of species and the grass coverage are lower, it is possible that *C. brizoides* acts as an inhibitor also in relation to grasses. This may be connected with the type of growth of the sedge, which forms a net of tightly woven runners at the soil-litter interface, so few species can compete with it. Although a thick layer of slowly decomposing litter formed by the overground parts of *C. brizoides* (Paplińska 1987) inhibits germination and development of mesophyllous forests (Faliński 1998a, b), it is conducive to the growth of perennial plants which develop runners (Balcerkiewicz 2001) and which tend to dominate in phytocoenoses (Falińska 1996).

This may be the reason why in the community *Fagus sylvatica-Carex brizoides*, where *C. brizoides* was the dominant species with the estimated coverage of 62.5 –87.5%, only two grass species were recorded – *Milium effusum* and *Deschampsia caespitosa*, both sparsely. By contrast, in spite of the massive occurrence of *C. brizoides*, grasses played an important role in communities *Molino-Pinetum* and *Calamagrostio vilosae-Pinetum*. *Molinia caerulea* and *Calamagrostis villosa* develop runners (Balcerkiewicz 2002), so in these communities *C. brizoides* was found to be least competitive (Sierka 2001).

The role of grasses in communities with *Carex brizoides* in the Silesian Upland depends, among other things, on the type of community, its origin and degenerating factors. In beech communities bordering on arable fields, *Poa nemoralis* is found to occur in large numbers, in thinned mesophyllous forests – *Milium effusum*, and in coniferous forests – *Deschampsia* [*Avenella*] *flexuosa*. *Calamagrostis epigejos* occurs in masses in clearing communities (Balcerkiewicz 1989).

Thus, grasses are important components of the majority of forest communities with *Carex brizoides*, and species which occur frequently and in large numbers in such communities in the Silesian Upland play a major role in differentiation of these communities. Those which occur in small numbers often act as indicators of changes in the environment.

Conclusions

(*1*) Grasses are important elements of forest communities with *Carex brizoides* which ground cover is largely homogeneous in terms of physiognomy and composition.

(*2*) Species which most often coexist with *Carex brizoides* in forest communities of the Silesian Upland are forms marked by well developed root system (e.g. *Deschampsia caespitosa*, *D.* [*Avenella*] *flexuosa*) or by formation of runners (e.g. *Calamagrostis epigejos, Milium effusum*).

(*3*) Grasses in transformed forest communities with *Carex brizoides* are indicators of both habitat conditions and changes in these phytocoenoses.

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