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Role of Calamagrostis epigejos in forest communities of Silesian Upland (S Poland)

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Abstract: In the present paper the role of *Calamagrostis epigejos* (L.) Roth (bush grass) in woodland communities of the Silesian Upland is analysed. Phytosociological relevés with the presence and without the investigated species were compared. Biotopic conditions, expressed by Ellenberg indicators, and selected traits of forests phytocoenoses and significance of their variability due to presence of this expansive grass species were studied. It is concluded that the role of *C. epigejos* as well as its influence on understorey species is minor. *C. epigejos* tends to occur abundantly in forest with loose stands with species-poor ground flora but with high cover.

Key words: *Calamagrostis epigejos*, forest communities, Silesian Upland, southern Poland, Ellenberg indicators, Braun-Blanquet approach, DCA

INTRODUCTION

Calamagrostis epigejos (L.) Roth (bush grass, wood small-reed) is a common species which has been long known as species highly competitive, frequently and abundantly occurring in anthropogenic habitats. According to phytosociological classification the species mainly occurs in clear-cut communities from the *Epilobion angustifolii* alliance (MATUSZKIEWICZ 2001). This plant grows at optimum of full light but it is also tolerant to relative semi-shade conditions. It can be indicator of low level of ground water (REBELE & LEHMANN 2001). However, if dryness of substratum is combined with nutrients deficiency then *C. epigejos* is not capable to spread (SÜß *et al.* 2004). Spread of bush grass is associated with clonal type of its growth and an ability of root growth down to a depth of 2.3 m as well as their fast regeneration after previous damage (REBELE & LEHMANN 2001). Due to shoot competition for light and root competition for nutrients it can exclude other species especially in sites of high fertility (REBELE 2000). BOLTE (1999) gave five main factors recognized as favoring expansion of this species in woodlands exemplified by scots pine forests. These are: site

euthropication by anthropogenic nitrogen input, soil disturbance, herbivory, stand-level microclimate, and increase of irradiance following canopy thinning. The latter is responsible for cause of its competitive behavior.

The problem of bush grass presence in forest communities most frequently is considered in the context of its influence on the regeneration of tree stands or on the growth of seedlings in young pine plantations. Also a lot of attention is paid to the manners of chemical control of this species, regarded as a weed (PRUDIC 1991; DROGOSZEWSKI 1995; SCHMIDT *et al.* 1996; MRAZEK 1999). Rather little is know about its occurrence in forests (BOLTE 1999) and its impact on the structure of forest communities.

Therefore in this paper we attempted to answer the following questions:

(*1*) what is the share of bush grass in investigated forest communities?

(*2*) what are biotopic requirements of the studied species in forest conditions?

(*3*) do forest phytocoenoses with and witout *Calamagrostis epigejos* differ from each other?

THE STUDY AREA

The investigated area is situated at the Silesian Upland (S Poland) and covers about 4000 km^2. This geographical unit comprises 5 mesoregions and is geologically diversified (Fig. 1). Upper Carboniferous rocks are the main geological structures of this area and are essential to the economy of the region (cf. KOZYREVA *et al.* 2004). They are oyerlaid 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).

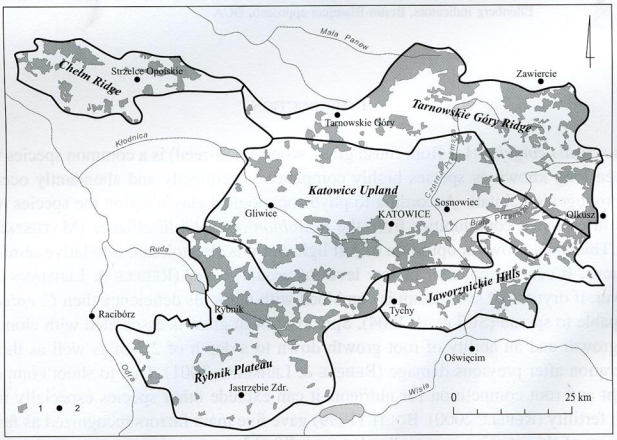


Fig. 1. Situation of the study area. 1 – forests; 2 – towns

Material and methods

Data collection

The frequency of *Calamagrostis epigejos* in forest communities of the study area was estimated on the basis of phytosociological relevés collected by the authors in 1997–2002 and literature data (Cabała 1990; Wika & Cabała 1994). Total of 409 phytosociological relevés were taken into account. The criterion of relevés selection was the occurrence of *C. epigejos,* at least, in one relevé from phytosociological table of a given forest association. Syntaxonomical classification of the communities was applied following the authors. In order to show ecological amplitude of the studied species the indicator values for light (L), continentality (K), temperature (T), soil moisture (F), soil reaction (R), nitrogen (N) according to Ellenberg *et al.* (1992) were calculated. The evaluations procedure followed Bornkamm (2002) and other authors i.e. mean indicator values for relevés with *C. epigejos* were computed on the basis of the averages for phytosociological records. Bush grass was excluded from the computations. During the calculations only presence/absence data were used instead of cover values of species following recommendations of Dzwonko and Loster (2000). Cover values of 7-degree Braun-Blanquet scale (1964) were transformed using the following scale: r = 0.1%, + = 0.5, 1 = 5%, 2 = 17.5%, 3 = 37.5%, 4 = 62.5%, 5 = 87.5% because of its better use for statistical analyses (cf. Van der Maarel 1979).

For each phytosociological relevé number and average cover of all species and of functional plant types i.e. including Grime's strategies, dispersal mode excluding *Calamagrostis epigejos* were assessed. For purposes of detailed analyses forest communities with a high frequency of *C. epigejos* (at least 30% within specific community) were chosen i.e. *Leucobryo-Pinetum, Querco roboris-Pinetum,* and *Luzulo pilosae-Fagetum.* Total of 219 relevés in these three communities were taken into account. During these analyses groups of relevés with presence and absence of *C. epigejos* were compared in relation to environmental conditions (expresed by Ellenberg's indicator values) and differences in structure and species composition.

Data analysis

The relationships between cover of *Calamagrostis epigejos* and distinguished variables of plant communities were examined using Spearman rank correlations tests. The differences between patches with *C. epigejos* and patches without this species were characterized by the length of gradient of Detrended Correspondence Analysis (DCA, CANOCO programme) (ter Braak & Šmilauer 2002).

The Spearman rank correlation test was used to examine significance relationship between the cover of *Calamagrostis epigejos* and DCA axes in the case of chosen forest communities.

Differences between forest communities with and without *Calamagrostis epigejos* were tested by non-parametric ANOVA Kruskal-Wallis test. They were applied using computer programme STATISTICA. In all cases level of significance was at least $p < 0.05$. Nomenclature follows Mirek *et al.* (2002) and Matuszkiewicz (2001).

Results

Synecological amplitude of *Calamagrostis epigejos* in forest communities

Obtained results show that in the investigated area *Calamagrostis epigejos* occurs in 11 forest communities representing 4 classes: *Alnetea glutinosae* class: *Ribeso nigri-Alnetum*; *Vaccinio-Piceetea* class: *Leucobryo-Pinetum*, *Molinio-Pinetum*, *Calamagrostio villosae-Pinetum*, *Querco roboris-Pinetum*; *Quercetea robori-petraeae* class: *Calamagrostio arundinaceae-Quercetum petraeae*; *Querco-Fagetea* class: *Fraxino-Alnetum*,

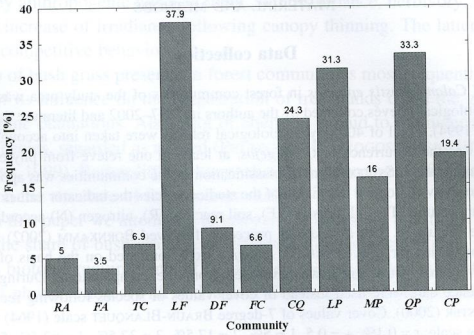


Fig. 2. Frequency of *Calamagrostis epigejos* (L.) Roth in forest communities of the Silesian Upland. **CP** – *Calamagrostio villosae-Pinetum*; **CQ** – *Calamagrostio arundinacae-Quercetum petraeae*; **DF** – plant community from sub-alliance *Dentario glandulosae-Fagenion*; **FA** – *Fraxino-Alnetum*; **FC** – *Fagus sylvatica-Cruciata glabra* community; **LF** – *Luzulo pilosae-Fagetum*; **LP** – *Leucobryo-Pinetum*; **MP** – *Molinio-Pinetum*; **QP** – *Querco roboris-Pinetum*; **RA** – *Ribeso nigri-Alnetum*; **TC** – *Tilio cordatae-Carpinetum betuli*

Tilio cordatae-Carpinetum betuli, Luzulo pilosae-Fagetum, Fagus sylvatica-Cruciata glabra, a plant community from sub-alliance *Dentario glandulosae-Fagenion. Calamagrostis epigejos* occurs with various frequency in analysed communities (Fig. 2). The studied species most frequently was recorded in three of them: *Luzulo pilosae-Fagetum, Leucobryo-Pinetum* and *Querco roboris-Pinetum.*

Habitat preferences of *Calamagrostis epigejos* in forest communities

Calamagrostis epigejos in woodlands of the Silesian Upland grows in semi-shady, rarely in shady or well lighted habitats. The values of continentality index indicates sub-oceanic but spreading eastward gradient. The average value of moisture indicator characterizes moist sites mainly on fresh soils, however, the species was found more frequently in moister sites than in drier ones. The values of R and N indices reveal the preferences of the species to occur on moderate acid soils and rather poor in available nitrogen (Fig. 3).

Relations of *Calamagrostis epigejos* with structure and species composition of forests

The Spearman rank correlation analysis shows some significant relations between cover of *Calamagrostis epigejos* and variables of plant communities in regard to their structure and participation of particular groups of plant species (Table 1). There is weak positive but significant correlation between average cover of bush grass and cover of other understorey species. Also cover of all species including trees and shrubs as well as plants from moss layer were positively correlated with its cover. Analyzing correlations of the cover of species from individual layers there are no any significant relationships of the examined grass

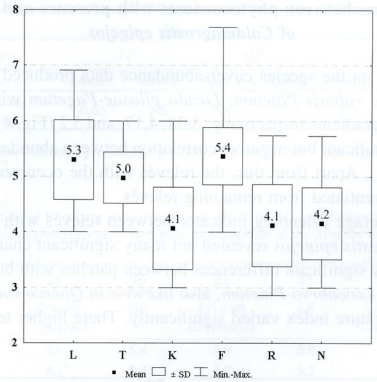


Fig. 3. The average values of Ellenberg indicators in relevés with *Calamagrostis epigejos* (L.) Roth in woodlands of the Silesian Upland

species with cover of trees, shrubs and mosses separately. Taking into account number of species from ground flora there is no any significant correlations, however, cover of 5 bush grass is weakly and negatively correlated with number of all remaining species and with number of woody plant species from shrub and tree layers (Table 1).

There is weak positive correlation between cover of *Calamagrostis epigejos* and the value of light indicator. The cover of bush grass is weakly positively correlated with cover of competitors and SR-strategists (Table 1). Also weak positive correlations of *C. epigejos* cover with abundance of anemochores, epizoochores and barochores were observed (Table 1).

Table 1. Relationships between average cover of *Calamagrostis epigejos* (L.) Roth and variables of plant communities. In the table only significant correlations were given

Variables	Correlation coefficient	Probability
Cover of all species except *C. epigejos*	r = 0.31	0.0009
Cover of ground flora except *C. epigejos*	r = 0.3	0.0013
Number of all species except *C. epigejos*	r = -0.24	0.013
Number of trees and shrubs	r = -0.21	0.02
Light indicator L	r = 0.2	0.041
Cover of SR-species	r = 0.23	0.01
Cover of anemochores	r = 0.31	0.001
Cover of epizoochores	r = 0.23	0.016
Cover of barochores	r = 0.20	0.037

Differences between phytocoenoses with presence and absence of *Calamagrostis epigejos*

The DCA carried out on the species cover-abundance data produced first axes for *Leucobryo-Pinetum, Querco roboris-Pinetum, Luzulo pilosae-Fagetum* with eigenvalues: 0.36, 0.51, 0.59 and length gradients respectively: 3.38, 4.17, and 5.2 (Fig. 4). Only in *Leucobryo-Pinetum* there is a significant but negative correlation between abundance of bush grass and the first axis (Table 2). Apart from this, the relevés with the occurrence of *Calamagrostis epigejos* are not differentiated from remaining relevés.

Comparison of average Ellenberg indicator between relevés with the presence and the absence of *Calamagrostis epigejos* revealed not many significant changes (Table 3). There are no any statistically significant differences between patches with bush grass and without the species in case of *Leocobryo-Pinetum*, also likewise in *Querco roboris-Pinetum,* where only values of temperature index varied significantly. There higher temperature value was

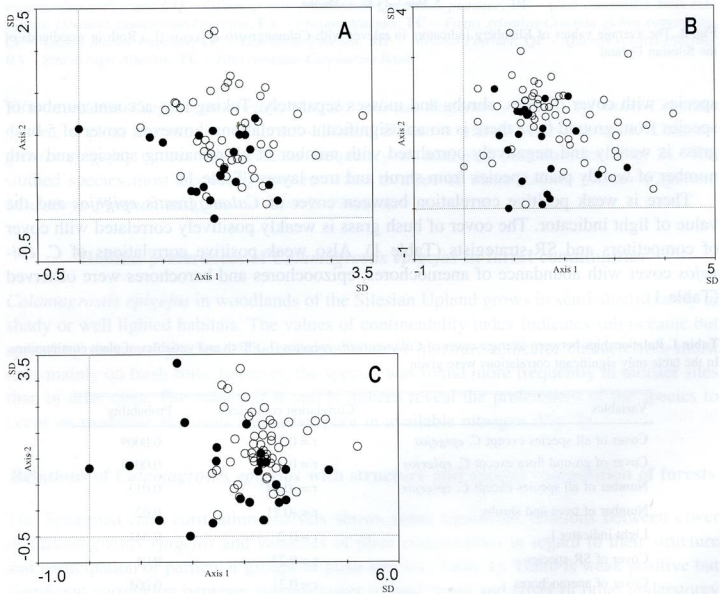


Fig. 4. DCA diagrams of relevés score of *Leucobryo-Pinetum* (A), *Querco roboris-Pinetum* (B) and *Luzulo pilosae-Fagetum* (C) along first two axes. Relevés with the occurrence of *Calamagrostis epigejos* (filled circles), and ones without this species (empty circles)

Table 2. Spearman rank correlations between DCA axes and relevés with *Calamagrostis epigejos* (L.) Roth

Community	*LP*		*QP*		*LF*	
	Axis 1	Axis 2	Axis 1	Axis 2	Axis 1	Axis 2
Relevés with *C. epigejos*	-0.65**	NS	NS	NS	NS	NS

Explanations: P denotes probability: $p < 0.05$; ** $p < 0.01$; NS – non significant value

Table 3. Comparison of values of Ellenberg indicators values within forest communities between the patches with the presence and absence of *Calamagrostis epigejos* (L.) Roth in woodlands of the Silesian Upland

Number of relevés	23	46	21	55	22	52
Ellenberg/ community	*QP* with *C. epigejos*	*QP*	*LP* with *C. epigejos*	*LP*	*LF* with *C. epigejos*	LF
L	5.6	5.4	5.9	5.8	5.1***	5.7
T	5.1*	5.3	5.2	5.3	5.2	5.3
K	4.5	4.3	4.8	4.7	3.7	3.7
F	5.6	5.6	5.6	5.6	5.6	5.4
R	4.7	4.6	3.9	3.9	4.9***	5.5
N	4.6	4.6	3.9	3.8	4.9*	4.7

Explanations: P denotes probability: $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; no symbols-non significant

recorded in forest stands without of *C. epigejos*. As the *Luzulo pilosae-Fagetum* community is concerned relevés without the occurrence of *C. epigejos* are characterized by higher light availability, more basic soil reaction and higher content of nitrogen.

Discussion

The results confirm preferences of *Calamagrostis epigejos* to occur in coniferous and mixed coniferous forests (Rebele & Lehmann 2001). Its invasion in pine stands and pine plantations in habitats of deciduous forests were observed in recent decades (Rebele & Lehmann 2001). Fact of occurrence of this species in differentiated habitats in relation to environmental conditions is resulted from its wide ecological scale (Rebele & Lehmann 2001). The average indexes for *C. epigejos* in the study area are similar to those reported by Ellenberg *et al.* (1992) for Central Europe. High standard deviations of both soil reaction and nitrogen supply indexes, obtained in our results, confirm a wide tolerance of bush grass to nitrogen content and pH (Ellenberg *et al.* 1992). The present study indirectly show the preferences of *C. epigejos* for lighted sites what is in concordance with other studies showing positive relationship between light availability and its higher cover-abundance (Bolte 1999). Lower value of light indicator in the case of *Luzulo pilosae-Fagetum* in phytocoenoses with the presence of the studied species can result from time of vegetation sampling during vegetation season and degree of foliage of trees. Fact of appearance of

this species in forest communities with a loose tree stands can be one of different forms of degenerations *sensu* OLACZEK (1974) which were observed in the study area (CABAŁA 1990; SIERKA & CHMURA 2004). The sod formation, manifested by strong development of grass cover (cf. ŁASKA 2001) composed of species with expansive properties (CHMURA & SIERKA 2004) is cespityzation.

Increasing abundance of *Calamagrostis epigejos* leads to impoverishment of species richness and transformation of structure of forest communities, similarly as other species e.g. more expansive *Carex brizoides* (FALIŃSKI 1998; DZWONKO & GAWROŃSKI 2002) which additionally hinders growth of other species. DZWONKO (2001) found positive influence of the light intensity on the numbers of trees, shrubs and non-woodland species and anemochores. This is congruent with this study where with increasing cover of *C. epigejos,* due to higher light intensity, cover of above-mentioned species groups increased. Lack significant of differences between phytocoenoses with and without *C. epigejos* as well the fact that the studied species do not affect cover of remaining herbaceous species, indicate that it does not play considerable role in forest communities and its participation can be treated as supplementary relationship (FALIŃSKI 1998).

CONCLUSIONS

(*1*) *Calamagrostis epigejos* is a species of wide synecological and autecological amplitude encompassing almost all types of forest communities, occurring in the Silesian Upland.

(*2*) *Calamagrostis epigejos* tends to occur in patches of communities with well developed ground flora but characterized by the large light availability.

(*3*) The studied species weakly affects the species richness and structure of phytocoenoses.

(*4*) The forest phytocoenoses with the occurrence of *Calamagrostis epigejos* do not differ significantly in relation to species composition and environmental conditions from forest stands without the species.

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