Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2008, 5 A, 23–30

SPECIES RICHNESS AND FLORISTIC COMPOSITION OF VEGETATION AFTER ENVIRONMENTAL DISTURBANCE IN PEAT BOGS

Wojciech Ejankowski

Department of Botany and Hydrobiology, The John Paul II Catholic University of Lublin,
C.K. Norwida str. 4, 20-061 Lublin, wejan@kul,lublin.pl

Summary. Species richness and floristic composition before environmental disturbance and after creation of experimental gaps in vegetation canopy was studied in two peat bogs in the region of Polesie Lubelskie (Eastern Poland). The aim of the study was to test the role of disturbance in shaping of species richness and floristic composition in peat bog vegetation. In sites devoid of vegetation cover and upper soil layer emerged more seedlings than ramets from vegetative growth. Share of seedlings in overgrowing fields was higher in open bog than in forest bog. Species richness increased after disturbance in both sites. Sexual strategy played a significant role in species emerged in regenerating vegetation and absent before gaps were created. Vegetative type of reproduction contributed to restoration of former species composition. Natural disturbances owing to activity of animals may influence positively species richness in plant communities.

Key words: environmental, disturbance, floristic composition, peat bogs, sexual and vegetative reproduction, species richness

INTRODUCTION

Disturbance in vegetation cover is interesting particularly due to its role in the formation of canopy gaps and the role of gaps as „safe sites" for development of seeds [Harper 1977]. Natural disturbances in peatlands can occur owing to peat erosion, activity of animals, as treading and rooting up the ground. Human activity can change habitat conditions similarly by peat excavation, because vegetation is removed and thick layer of soil is harvested in this case [Lavoie *et al*. 2003].

Establishment and survival of seedlings in plant communities are often diminished by dense vegetation cover and deep litter layer [Overbeck *et al*. 2003, Borkowska 2004]. Gaps are considered to be „regeneration niches" enabling emergence of new individuals and new species, and shaping species richness in plant communities [Grubb 1977].

Initial development of vegetation on peat surface is determined by resources of seed bank and other diasporas in soil [Campbell *et al*. 2003, Lavoie *et al*. 2003]. In harsh arctic and alpine environments sexual reproduction is limited and vegetative reproduction is widespread [Grime 2001]. This strategy seems to play a great role also in peatland species, since many plants in bogs propagate clonally and soil seed bank is considered to be poor in peatlands [Jauhiainen 1998]. However, the role of sexual and vegetative strategy varies in species and depends on the environmental conditions [Falińska 1979, Silvertown *et al*. 1993].

The aim of the study was to test the role of canopy gaps in peat bogs in shaping the species richness and floristic composition. The relative importance of sexual and vegetative strategies in reproduction of plants was analysed in contrasting types of bogs.

MATERIAL AND METHODS

The study was carried out in two ombrotrophic peatlands – Małe Bog and Żłobek, located near the town Włodawa in the region Polesie Lubelskie, Eastern Poland [Kondracki 1998]. Swampy pine forests with *Pinus sylvestris* L. and *Betula pubescens* Ehrh., raised and transitional bog vegetation dominate in Żłobek [Fijałkowski and Pietras 1990]. The Żłobek bog was assessed to be relatively dry according to water level measurements (unpubl. data), in opposition to the well-hydrated Małe Bog, covered mostly by open peat bog vegetation. In both sites low layer of vegetation comprised mainly cotton-grass *Eriophorum vaginatum* L. and *Sphagnum* mosses.

Transects were staked out in forest vegetation in Żłobek (forest bog) and in open bog vegetation in Małe Bog (open bog). Study plots consisted of squares, separated 1 m away from one another, 0.5 m long and 0.5 m in width. Eight squares in Małe Bog and nine squares in Żłobek were used in the study. Species composition was determined in experimental plots before gaps were created. Vegetation and 5 cm of peat deposit were removed in each site in April 2006.

The number of seedlings and vegetative sprouts emerged in canopy gaps were monitored between May and November, 2006. Every month seedlings and ramets were collected and identified. Identification of seedlings was performed on the ground of keys acc. to Csapodý [1968] and Muller [1978]. In the case of family *Cyperaceae* seedlings were identified mainly on the ground of nuts and utricles [Kowal 1958], with support of comparative collection. The nomenclature of species follows Mirek *et al*. [2002].

Jaccard's coefficient was calculated and UPGMA method was used in cluster analysis. Emergence of seedlings and ramets was analysed by two-way ANOVA [Sokal and Rohlf 1995]. Data were log-transformed, if they did not fit the assumptions of analysis of variance. Calculations were performed with MVSP ver. 3.1 and Statistica ver. 8.0.

RESULTS

Species richness in vegetation canopy in Małe Bog and Żłobek increased after disturbance. In open bog six species occurred in undisturbed vegetation, and nine species emerged in gaps, including four which were new in species composition and were found only in seedling pool – *Carex canescens*, *C. nigra*, *Oxycoccus palustris* and *Salix* sp. One species (*B. pubescens*) disappeared after gap formation. In forest bog nine species emerged, and eight species were found before disturbance. Three new species in floristic composition were recorded in seedling pool of forest site – *Carex rostrata*, *C. vesicaria*, *Salix* sp. *Eriophorum angustifolium* Honck. and *P. sylvestris* were absent in gaps in comparison to undisturbed sites.

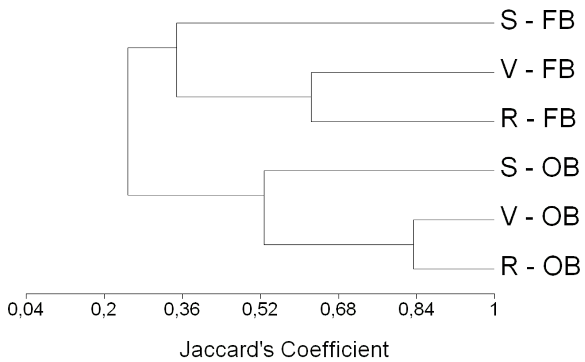

Fig. 1. Cluster analysis of species composition in experimental gaps. Signatures: S – seedlings, R – Ramets, V – vegetation before disturbance, OB – open bog, FB – forest bog

Table 1. Number of ramets and seedlings per m^2 in regenerating vegetation in gaps after disturbance in open and forest bog

Species	Open bog		Forest bog	
	Ramets	Seedlings	Ramets	Seedlings
Andromeda polifolia L.	-	-	60	-
Betula pubescens Ehrh.	-	-	-	8.4
Carex canescens L.	-	20*	-	-
Carex lasiocarpa Ehrh.	103	1	1.3	-
Carex nigra Reichard	-	0.5*	4.4	49.8
Carex rostrata Stokes	-	-	-	0.4*
Carex vesicaria L.	-	-	-	0.9*
Eriophorum vaginatum L.	49.5	275	3.1	6.7
Juncus sp.	15.5	375	-	-
Lysimachia vulgaris L.	2.5	3.5	-	-
Oxycoccus palustris Pers.	-	0.5*	57.3	32.9
Peucedanum palustre (L.) Moench	0.5	3.5	-	-
Salix sp.	-	0.5*	-	0.4*
Total	171	680	126.7	99.6

* species new in floristic composition

Due to differences in species composition, forest bog and open bog are separated in cluster plot (Fig. 1). Vegetative and sexual reproduction of plants were observed during revegetation of disturbed patches. Species composition of plants regenerated vegetatively by ramets was similar to vegetation before disturbance, whereas seedling pools were relatively different from former plant communities. Seedlings of *Carex nigra* and *V. oxycoccus* emerged mainly in forest bog, while offsprings of *Lysimachia vulgaris*, *Peucedanum palustre* and *Juncus* sp. (including *J. effusus* L.) were observed only in open bog. Emergence of a few species, e.g. *E. vaginatum* and *Salix* sp., was similar in both types of bogs (Tab. 1).

Generally, seedlings were more abundant than vegetative ramets ($F = 4.52$, $P < 0.05$). Number of total offsprings from sexual and vegetative reproduction was higher in open bog than in forest bog ($F = 8.11$, $P < 0.01$). Sexual reproduction was strongly enhanced in open bog ($F = 6.05$, $P < 0.05$), while number of seedlings in forest bog was similar to vegetative ramets (Tab. 1, Fig. 2).

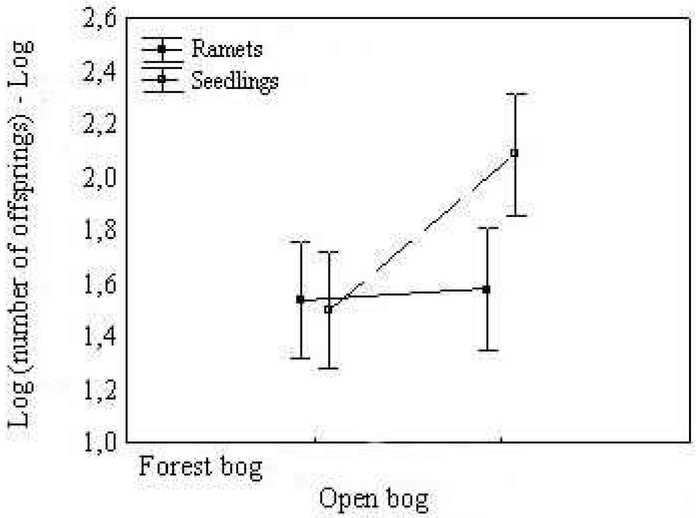

Fig. 2. Number of offsprings originated from vegetative (ramets) and sexual (seedlings) reproduction after disturbance in relation to type of bog

In open bog *Juncus* sp. and *E. vaginatum* dominated in seedling pool, whereas *C. lasiocarpa* was the most abundant species regenerating vegetatively (Tab. 1). In forest bog *Carex nigra* had the highest density of seedlings, while the most numerous vegetative ramets were *O. palustris* and *Andromeda polifolia*.

During the first year after disturbance *A. polifolia* and *C. lasiocarpa* regenerated almost entirely vegetatively (Tab. 1). Sexual reproduction was the only way of emergence of many other species. New individuals of *B. pubescens*, *Salix* sp. and a few species of genus *Carex* originated from seeds.

Regeneration of *E. vaginatum* was more effective in open bog than in forest bog ($F = 71.2$, $P = 0.001$). Sexual reproduction of this species was higher than vegetative ($F = 14.43$, $P = 0.001$). Number of seedlings increased considerably in relation to vegetative ramets in open bog ($F = 20.8$, $P < 0.001$), while no difference in seedlings and ramets was found in forest site ($F = 0.02$, $P > 0.05$).

DISCUSSION

High number of seedlings in comparison to vegetative ramets indicates that the role of sexual reproduction in revegetation of gaps after disturbance in peatlands may be important. The suggestion of Jauhiainen [1998] that the regeneration strategy of peat bog plants is vegetative rather than sexual refers to undisturbed vegetation, but not necessarily to disturbed sites. Plants remaining after gap formation restored vegetatively former species composition. Nevertheless, vegetative propagation can be more advantageous than sexual due to physiological integration and resource sharing among ramets in clonal plants [Stuefer *et al*. 1994].

Similarly as in peatlands, development of seeds in abandoned meadows is enhanced in gaps [Borkowska 2004]. During two years after disturbance in meadow, species regenerated in generative way were more successful, whereas species reproduced vegetatively play important role in the next years. The role of vegetative regeneration after gap formation in peat bog is undoubtedly significant, nevertheless canopy gaps make possible the emergence of new species in vegetation and create opportunities for recruitment from seeds [Lavoie *et al*. 2003]. In clonal plants, reproducing commonly by vegetative growth, establishment from seeds contributes to population growth, especially in favourable years [Weppler *et al*. 2006].

Species recorded in gaps belong in the majority to *Scheuchzerio-Caricetea nigrae* and *Oxycocco-Sphagnetea* classes [Matuszkiewicz 2001]. Plants typical of these communities are colonizers in transitional and final stages in overgrowing of peat pits in Polesie region [Sugier 2006]. In this study, the emergence of species derived from transitional bogs (*Scheuchzerio-Caricetea nigrae*) relied mainly on sexual reproduction, and species characteristic of raised bogs from *Oxycocco-Sphagnetea* class regenerated also vegetatively. This is probably because in raised bogs disturbance causes alterations of micro-relief, and in consequence higher soil hydration. In small scale it is more favourable for species typical of transitional bogs. Thus, canopy gaps in peatlands can be considered as regeneration niches for these species [Grubb 1977]. Species richness was higher in experimental sites than in undisturbed vegetation, independently on the type of bog.

Scarce recruitment of cotton-grass in forest bog in relation to vegetative reproduction could be explained by low effectiveness of seed production, in spite of relatively high abundance of tussocks observed in forest. Generally, vegetative and sexual reproduction of typical peat bog species was high in well-hydrated peatland. This result confirms that rewetting is prerequisite in restoration of peat bog vegetation. Many wetlands in the region of Polesie Lubelskie were drained due to economic activity, and hydrological conditions are still endangered [Wilgat *et al*. 1991]. Conservation and restoration of peat bog vegetation is possible only in appropriate hydrological conditions. Otherwise, seedlings of woody plant *Betula pubescens*, expansive species overgrowing previously non-forested peat bogs [Tomassen *et al*. 2004, Ejankowski and Kunz 2006], increased in this study in forest bog.

Disturbance in vegetation layer activates soil seed banks and enables development of seeds also from airborne dispersal [Grubb 1977, Grime 2001]. It is unknown whether species in the current study originated from soil seed bank or immediately from seed rain. Seed bank in peat soils in depth of more than 20 cm were found, as reported by Jauhiainen [1998]. However, seeds of two important species colonizing gaps in this study (*E. vaginatum*, *V. oxycoccus*) in two boreal mires were distributed in soil only to 5 cm depth. Immediate seed deposition may be the most important, because cotton-grass is well dispersed via wind through its hairy nuts, and *V. oxycoccus* has the ability to immigrate via animals and water [Campbell *et al*. 2003]. Moreover, seedlings of *E. vaginatum* were found often on infructescences, and remnants of fruits were found near seedlings of *O. palustris*.

CONCLUSION

Natural disturbances in vegetation canopy in peat bogs can affect species richness and floristic composition in plant communities. Sexual reproduction creates opportunity for species absent before gap formation and emerged in regenerating vegetation. Vegetative growth contributes to restoration of previous species composition. Development of forest after desiccation can change the effectiveness of sexual reproduction in typical peat bog plants.

REFERENCES

Borkowska L., 2004. Patterns of seedling recruitment in experimental gaps on mosaic vegetation of abandoned meadows. Acta Soc. Bot. Pol. 73, 343–350.

Campbell D.R., Rochefort L., Lavoie C., 2003. Determining the immigration potential of plants colonizing disturbed environments: the case of milled peatlands in Quebec. J. Appl. Ecol. 40, 78–91.

Csapodý V., 1968. Keimlings-Bestimmungsbuch der Dicotyledonen. Akademiai Kiadó, Budapest.

Ejankowski W., Kunz M., 2006. Reconstructing of Vegetation Dynamics in „Linje" Peat-bog (N Poland) Using Remote Sensing Method. Biodiv. Res. Conserv. 1–2, 111–113.

Falińska K., 1979. Experimental studies of the reproductive strategy of *Caltha palustris* L. populations. Ecol. Pol. 27, 527–543.

Fijałkowski D. Pietras T., 1990. Vegetation cover of projected Żłobek nature reserve near Włodawa. Annales UMCS 45, sec. C, 149–167.

Grime J.P., 2001: Plant Strategies, Vegetation Processes, and Ecosystem Properties. John Wiley & Sons, Chichester.

Grubb P.J., 1977. The maintenance of species richness in plant communities: The importance of regeneration niche. Biol. Rev. Cambridge Philos. Soc. 52, 107–145.

Harper J.L., 1977. Population Biology of Plants. Academic Press, London–New York–San Francisco.

Jauhiainen S., 1998. Seed and spore banks of two boreal mires. Ann. Bot. Fennici 35, 197–201.

Kondracki J., 1998. Geography of Polish regions (in Polish). Wyd. Nauk. PWN, Warszawa.

Kowal T., 1958. A study on the morphology of fruits of European genera from the subfamilies *Scirpoideae* Pax, *Rhynchosporoideae* Aschers. et Graebner and some genera of *Caricoideae* Pax. (in Polish). Monogr. Bot. 6, 97–150.

Lavoie C., Grosvernier P., Girard M., Marcoux K., 2003. Spontaneous revegetation of mined peatlands: An useful restoration tool? Wetlands Ecology and Management 11, 97–107.

Matuszkiewicz W., 2001. Plant communities guidebook (in Polish). Wyd. Nauk. PWN, Warszawa.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M., 2002. Flowering plants and pteridophytes of Poland. A checklist. W. Szafer Institute of Botany, Polish Academy of Science, Kraków.

Muller F.M., 1978. Seedlings of the North-Western European Lowland. Dr W. Junk B.V. Publishers, Hague, Boston.

Overbeck G., Kiehl K., Abs C., 2003. Seedling recruitment of *Succisella inflexa* in fen meadows: Importance of seed and microsite availability. Appl. Veg. Sci. 6, 97–104.

Silvertown J., Franco M, Pisanty I., Mendoza A., 1993. Comparative plant demography – relative importance of life-cycle components to the finite rate of increase of woody and herbaceous perennials. J. Ecol. 81, 465–476.

Sokal R.R., Rohlf F.J., 1995. Biometry. W.H. Freeman and Company, New York.

Steufer J.F., During H.J. & de Kroon H. 1994. High benefits of clonal integration in two stoloniferous species, in response to heterogeneous light environments. J. Ecol. 82, 511–518.

Sugier P., 2006. Peat vegetation of peatlands in the Polesie National Park and its protected zone. Teka Kom. Ochr. Kszt. Środ. Przyr. 3, 203–208.

Tomassen H.B.M., Smolders A.J.P., Limpens J., Lamers J.P.M., Roelofs J.G.M., 2004. Expansion of invasive species on ombrotrophic bogs: desiccation or high N deposition? J. App. Ecol. 41, 139–150.

Weppler T., Stoll P., Stücklin J., 2006. The relative importance of sexual and clonal reproduction for population growth in the long-lived alpine plant *Geum reptans*. J. Ecol., 869–879.

Wilgat T., Michalczyk Z., Turczyński M., Wojciechowski K., 1991. Lakes of Łęczna-Włodawa region (in Polish). Stud. Ośr. Dok. Fizjograf. 19, 23–140.

BOGACTWO GATUNKOWE I SKŁAD FLORYSTYCZNY ROŚLINNOŚCI TORFOWISK PO WYSTĄPIENIU ZABURZEŃ ŚRODOWISKOWYCH

Streszczenie. Bogactwo gatunkowe i skład florystyczny badane były przed wystąpieniem zaburzeń środowiskowych oraz po wykonaniu eksperymentalnych luk w pokrywie roślinnej na dwóch torfowiskach na Polesiu Lubelskim. Celem pracy była ocena roli zaburzeń w kształtowaniu bogactwa gatunkowego i składu florystycznego roślinności torfowiskowej. Na powierzchniach eksperymentalnych pozbawionych pokrywy roślinnej i wierzchniej warstwy gleby pojawiło się więcej siewek niż ramet pochodzenia wegetatywnego. Udział siewek na zarastających powierzchniach był większy w zbiorowisku nieleśnym niż w zbiorowisku leśnym. Po zaburzeniu nastąpił wzrost liczby gatunków na obu stanowiskach. Reprodukcja generatywna odgrywała znaczącą rolę w przypadku gatunków wcześniej nieobecnych, a pojawiających się w odtwarzającej się roślinności. Wegetatywny typ regeneracji przyczyniał się natomiast do przywracania dawnego składu florystycznego. Naturalne zaburzenia roślinności torfowisk, wywoływane m.in. przez zwierzęta, mogą kształtować bogactwo gatunkowe zbiorowisk roślinnych.

Słowa kluczowe: bogactwo gatunkowe, reprodukcja generatywna i wegetatywna, skład florystyczny, torfowiska, zaburzenia środowiskowe