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ASSESSMENT OF HUMAN ACTIVITY IMPACT UPON THE BLACK ALDER FOREST COMMUNITIES

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Black alder stands make up 6.7 % of Lithuanian forests, part of which are drained. Forest drainage causes changes in black alder communities. This paper deals with changes in ground water level, microrelief, floristic composition of drained black alder forest communities (association *Carici elongatae-Alnetum* Koch 1926).

Key words: Lithuania, black alder forest, drainage, communities, changes.

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Introduction

Black alder stands make up 6.7 % of Lithuanian forests, and go after the pine, birch, spruce forests. The largest areas of black alder forests occur in the territories of Marijampolė, Kazlų Rūda, Šakiai, Zarasai, Ignalina, Veisiejai state enterprises (Anonymous 2007).

According to the phytocoenological hierarchical system, Lithuanian black alder forests belong to 2 classes: Q*uerco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937 and *Alnetea glutinosae* Br. –Bl. et Tx. 1943 (Matuszkiewicz 2006; Patalauskaitė 1994 a,b).

Scientific publications, discussing Lithuanian black alder stands in different aspects, are not numerous (Brundza 1937; Kapustinskaitė 1983; Motiekaitytė 1984; Balevičienė 1991; Patalauskaitė 1994a; Prieditis 1997). In majority of these publications the descriptions of black alder communities are given and different classification approaches are discussed. The most exhaustive study about black alder and their stands was published by T. Kapustinskaitė (1983). In this monograph, botanical, ecological characteristics and the role of black alder in the communities are revealed; forest typological research review and description of black alder forest types are presented. The monograph deals with the problems of forest productivity increment and the influence of drainage on black alder stand forest productivity. The changes in dominant vascular plant species and black alder forest types on drained plots are described, too.

The problems discussed in this paper partly interrelate with the works of T. Kapustinskaitė. The trends of anthropogenic influence on the black alder forest are discussed, but the systems of forest communities classification are different. The Braun-Blanquet floristic-phytosociological approach was applied, and black alder forest communities of large association *Carici elongatae-Alnetum* Koch 1926 of the *Alnetea glutinosae* class were investigated. Natural dynamic processes of the communities and changes, caused by human activity, are described. The changes in floristic composition of the communities (vascular plants and bryophytes) were investigated.

Scientists of neighbouring countries (Bušs, Āboliņa 1968) studied vegetations successions of drained coniferous forests and ascertained phytocoenological groups of plants as indicators. The tendencies of successions in vegetation cover of coniferous and black alder forests are quite similar. While summarizing the results of their own research and researches of other specialists on processes occurring in drained coniferous forests, K. Bušs, A. Āboliņa (1968) accentuated 3 stages of successions occurring in the vegetation cover. During the first stage, the changes in the vegetation cover are slight, only vitality of some hygrophytes reduces. During the second stage, the growth of trees considerably strengthens, and many hygrophytes disappear from the herbal cover. Significance of some species (*Ledum palustre, Vaccinium myrtillus, Pyrola, Calamagrostis canescens*, etc.) temporarily increases. During the third stage, the changes stabilize; the vegetation cover becomes similar to the vegetation cover of non-wetland forest types. The duration of these stages depends upon the forest type existing before drainage and the intensity of drainage.

Material and Methods

Forest communities were investigated according to the approach of Braun-Blanquet geobotanical school (Braun-Blanquet 1964; Aleksandrova 1969; Ellenberg 1956). Geobotanical relevés were made in the plots of 400 m² with typical homogenous vegetation. The abundance and coverage of each species were determinated according to Braun-Blanquet scale. Total vegetation coverage was evaluated visually and recorded in a percentage scale for each vegetation layer.

The relevés of black alder forests made in Kamanos State Strict Nature Reserve in 2004 – 2006 and the relevés throughout Lithuania made in 1994 - 2006 were used. In total, 150 phytocoenological records were analysed. Drained and undrained black alder swamp communities were compared and 5 stages of degradation (I - V) were described, according to microrelief, ground water regime and floristic composition. The communities of undrained plots were arranged into a control group (0 stage).

Approach and names of syntaxa are presented following R. Pott (1995), W. Matuszkiewicz (2006).

The indicator values of moisture for vascular plants are presented by H. Ellenberg, for bryophytes – by R. Düll (Ellenberg et al. 1992).

Names of vascular plants follow Z. Gudžinskas (1999), of bryophytes – I. Jukonienė (2002).

Results and Discussion

Forests of *Alnetea glutinosae* class *Carici elongatae-Alnetum* association occupy wetlands with surface ground water, which determines the microrelief. The trees occupy hummocks and hold their trunks above the water. According to records, used in this paper, all layers of these communities are quite rich in species: trees – 11 species, shrubs – 9, herbs – 112 , bryophytes – 56. On an average 39 species per record were registered. Only two constant tree species occur: *Alnus glutinosa* and *Betula pubescens*. The constant herb species are presented on Table 1, those of bryophytes – Table 2. Different plant species occupy hummocks and spaces among them because of diverse humidity conditions. Among the constant species of shrubs, *Frangula alnus* and *Ribes nigrum* prevail on hummocks; *Salix cinerea, Salix aurita* grow both on hummocks and in depressions. In the herb layer, tall vascular plants dominate; their average coverage is 70 %. Different species of herbs are distributed according to the soil humidity, too. Mesophytes grow on hummocks, hygromesophytes and hygrophytes – in depressions (Table 1).

Distribution of bryophytes is similar, but they depend more on the soil humidity. The hummocks are entirely covered with bryophytes, but on the top of hummocks mostly xeromesophytes grow, on the bottom of hummocks – mesophytes, and in depressions – hygromesophytes (Table 2).

During dry years, short fluctuations may take place: ground water disappears from the surface, in the depressions the sprouts of vascular plants and thickets of bryophytes (*Calliergon giganteum, Brachythecium rivulare, Calliergonella cuspidata, Plagiomnium elatum, Plagiomnium ellipticum, Climacium dendroides*) appear, whereas before the drought they are found on the edges of depressions, on rotten trees or branches lying in the depressions.

Table 1. Constant species of vascular plants of black alder forest communities according to the index of humidity by H. Ellenberg (5 – mesophytes, 8 – hygromesophytes, 9 – hygrophytes).

Species of hummocks	Species of depressions
Anemone nemorosa 5	*Calamagrostis canescens* 9
Dryopteris carthusiana 5	*Carex acutiformis* 9
Majanthemum bifolium 5	*Carex caespitosa* 9
Oxalis acetosella 5	*Carex elongata* 9
Vaccinium myrtillus 5	*Lycopus europaeus* 9
	Scutellaria galericulata 9
	Filipendula ulmaria 8
	Lysimachia vulgaris 8
	Lythrum salicaria 8
	Solanum dulcamara 8
	Thelypteris palustris 8

The structure of forest communities of the association *Carici elongatae-Alnetum* (*Alnetea glutinosae* class) changes because of economic activities. Human activities induce the occurrence of alien species in these communities. Due to specific conditions in wetlands, the invasive species are not aggressive. In the course of investigations in drained coniferous forests, K. Bušs, A. Āboliņa (1968) noted that on slopes of drainage ditches such species as *Cirsium arvense, C. vulgare, Tussilago farfara, Chenopodium album, Sonchus arvensis, Polygonum aviculare* establish, but they do not last in forest communities. Forest cutting and drainage cause the greatest changes. If forest cutting is carried out in winter, when the surface is covered with ice, the microrelief is not damaged and natural successions can take place. Flora composition of cutting areas of wetland black alder forest and birch forests little differs from flora composition of stands. Only proportion of species and general herb coverage change (Karazija, 1988).

Forest drainage causes critical changes in the black alder communities. The first distinct change

Tab. 2. Constant species of bryophytes of black alder forest communities according to the index of humidity by R. Düll (4 – xeromesophytes, 5 and 6 – mesophytes, 7 and 8 – hygromesophytes, 9 – hygrophytes)

Top of hummocks	Bottom of hummocks	Depressions
Lepidozia reptans 5	*Fissidens adianthoides* 8	*Calliergon giganteum* 8
Dicranum scoparium 4	*Mnium hornum* 6	*Brachythecium rivulare* 7
Hylocomium splendens 4	*Rhizomnium punctatum* 6	*Calliergonella cuspidata* 7
Pleurozium schreberi 4	*Tetraphis pellucida* 6	*Plagiomnium elatum* 7
Rhytidiadelphus triquetrus 4	*Lepidozia reptans* 5	*Plagiomnium ellipticum* 7
		Climacium dendroides 6

Table 3. The impact of land reclamation upon the microrelief of black alder communities

Stages of degradation	I	II	III	IV	V
Microrelief	Without changes	Slight signs of degradation appear on the hummocks	Hummock degradation signs: holes and bare roots of trees	Hummocks are degraded: a lot of holes and all roots of trees are bare	Small hummocks with flat surface
Ground water	From time to time appears on the soil surface	No ground water on the soil surface	No ground water on the soil surface	No ground water on the soil surface	No ground water on the soil surface

Table 4. Changes in the vertical structure of black alder communities at different stages of degradation

I	II	III	IV	V
Hummocks *Frangula alnus* and *Picea abies* sprouts become more abundant	Hummocks *Frangula alnus* and young *Picea abies* become more abundant	Hummocks Young *Picea abies* thrive	Hummocks *Picea abies* become usual in the II layer of trees	Hummocks *Picea abies* appear in the I layer of trees
Depressions Without changes	Depressions *Salix aurita, Salix cinerea* become more abundant and *Frangula alnus* appear	Depressions Solitary individuals of *Picea abies* appear, *Frangula alnus* become abundant	Depressions *Viburnum opulus, Corylus avellana* appear	Depressions *Viburnum opulus, Corylus avellana* grow, young *Picea abies* thrive on light plots

in drained plots is a decline of ground water level (Kapustinskaitė, 1983). The regularities of ground water level fluctuation on drained and undrained plots are similar, but on drained plots, the ground water is lower. As a result, the soil humidity of the surface layers also changes. Gradually the physical and chemical characteristics of soil change: the peat subsides, the mass of its volume becomes heavier. The process of decomposition of organic matter becomes more intensive, ash content and the amount of ash substances increase.

Drainage of wetland forests causes irreversible successions. Only if ditches of drainage network are completely eliminated, biogeocoenoses, similar to those existing before drainage, could recover (Karazija, 1988).

Forest drainage is a reason for significant changes in the communities of the association *Carici elongatae-Alnetum*. When the regime of ground water changes, gradual changes in floristic composition, vertical and horizontal structure, and microrelief of the communities appear. The number of species decreases, especially among bryophytes. K. Bušs, A. Āboliņa (1968), during investigations of the drained coniferous forests, also determined reduction in species composition of the communities.The changes in the herb layer of drained black alder forest were noted by other researchers as well. T. Kapustinskaitė (1983) recorded herb changes in the investigation plots near the drainage ditches. During 20 years, certain species (*Oxalis acetosella, Cirsium oleraceum, Ranunculus repens, Filipendula ulmaria* and in some records – *Urtica dioica*) were replaced by other species – hygrophytes (*Carex vesicaria, Thelypteris palustris, Calla palustris*). S. Karazija (1988) recorded the following changes in herbal coverage of drained black alder forest (*Alnetum caricosum* forest type): the amount of *Carex vesicaria* and other hygrophytes decreases, while the abundance of hygromesophytes (*Filipendula ulmaria, Deschampsia caespitosa, Agrostis stolonifera, Dryopteris, Lysimachia*) increases; mesophytes appear (*Oxalis acetosella, Maianthemum bifolium*, etc). The first- or second-mentioned become dominant, depending on the drainage intensity.

Similar tendencies in drained black alder forests (the decrease of hygrophytes and their gradual replacing by mesophytes) were observed by the author, as well. This process was analysed and in this paper 5 stages of degradation (I–V) were described (Table 3, 4, 5).

Forest drainage changes a characteristic view of the communities of *Carici elongatae-Alnetum* (the ground water is on the surface of soil, the hummocks are covered with bryophytes and sparsely distributed vascular plants, a lot of hygrophytes in depressions). The changes in microrelief are also observed: when ground water disappears from the surface of soil, the overdried soil of hummocks falls out from the roots of trees and the roots become bare. Gradually the hummocks break down, become flat (Table 3).

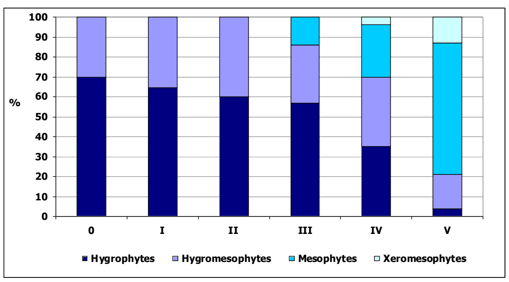

Fig. 1. Changes in proportion of ecological groups of vascular plants during different stages of black alder forest degradation

In horizontal structure the changes in floristic composition and coverage of vascular plants and mosses were observed. Although the number and coverage of hygrophytes decrease, nevertheless the number and coverage of mesophytes increase. When ground water disappears from the surface, the species of hummocks spread into drained depressions. During the I and II stages, hygrophytes and hygromesophytes prevail (Fig. 1). At these stages hygrophyte species, characteristic to the *Alnetea glutinosae* (*Calamagrostis canescens, Carex elongata, Lycopus europaeus, Solanum dulcamara, Thelypteris palustris*), *Phragmitetea* R. Tx. et Prsg 1942 (*Carex acutiformis, C. rostrata, C. vesicaria, Equisetum palustre, Galium palustre, Glyceria fluitans, Iris pseudacorus, Naumburgia thyrsiflora, Peucedanum palustre, Phragmites australis, Poa palustris, Scutellaria galericulata*) and *Scheuchzerio-Caricetea nigrae* (Nordh. 1937) R. Tx. 1937 (*Carex cinerea, C. flava, Comarum palustre, Menyanthes trifoliata, Ranunculus flammula, Viola palustris*) classes were registered. However, in comparison with undrained communities, the number of hygromesophytes increases. *Deschampsia caespitosa, Cirsium oleraceum, Ranunculus repens* occur and become abundant. During the III stage *Vaccinium myrtillus,* which usually grows only on hummocks, and mesophytes: *Carex sylvatica* (from the *Querco-Fagetea* Br.-Bl. et Vlieg. 1937 class), *Oxalis acetosella* appear in the drained depressions. During the IV stage, the number of mesophytes increases. Besides the species already mentioned above, *Brachypodium sylvaticum* (*Querco-Fagetea*

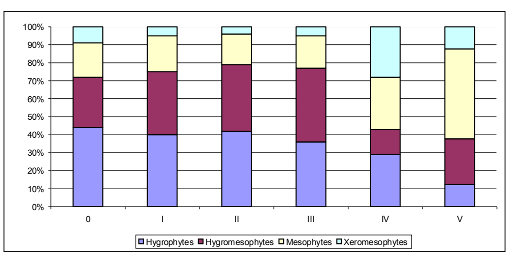

Fig. 2. Changes in proportion of ecological groups of bryophytes during different drainage stages of black alder forest

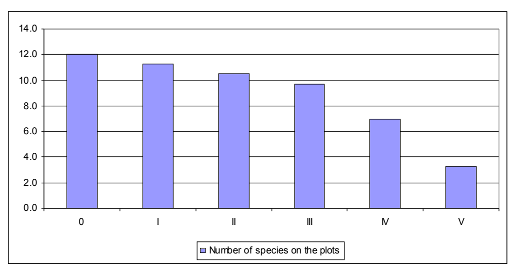

Fig. 3. Changes in the quantity of bryophytes during different stages of black alder forest degradation

class), *Equisetum pratensis, Carex flacca, Prunella vulgaris, Ranunculus acer* and xeromesophyte *Vicia sylvatica* occur in the drained depressions. During the V stage, the number of hygrophytes decreases. The only hygrophyte species – *Carex vaginata*, that is not common to the communities of *Alnetea glutinosa* class, was recorded. The number of hygromesophytes was very small, only *Cirsium oleraceum, Crepis paludosa, Deschampsia caespitosa, Lysimachia vulgaris* were found. The depressions were occupied by *Dryopteris carthusiana, Vaccinium myrtillus,* mesophytes from *Querco-Fagetea* class: *Anemone nemorosa, Brachypodium sylvaticum, Carex sylvatica,* from *Vaccinio-Piceetea* class: *Majanthemum bifolium, Mycelis muralis, Orthilia secunda, Oxalis acetosella, Pyrola minor*, from the list of accompanying species: *Dryopteris dilatata, Fragaria vesca, Solidago virgaurea* and xeromesophytes from the *Querco-Fagetea* class: *Hepatica nobilis, Melica nutans, Melampyrum nemorosum* and from the list of accompanying species: *Viola riviniana*.

Similar tendencies are observed in the proportion of different ecological groups of bryophytes at the varying stages of black alder forest degradation (Fig. 2). In undrained black alder forest communities a lot of hygrophytes occur in depressions (*Amblystegium riparium, Aulacomnium palustre, Brachythecium rivulare, Calliergon cordifolium, Campylium stellatum, Plagiomnium elatum, Plagiomnium ellipticum, Sphagnum paluste, Sphagnum squarrosum*), on hummocks (*Dicranum bonjeani, Fissidens adianthoides, Leucobryum glaucum, Polytrichum longisetum, Rhizomnium punctatum*), and hygromesophytes prevail in depressions (*Brachythecium rutabulum, Calliergonella cuspidatum, Climacium dendroides*), on hummocks (*Dicranum scoparium, Mnium hornum, Plagiomnium cuspidatum, Polytrichum commune, Rhytidiadelphus triquetrus, Thuidium delicatulum*). The number and coverage of hygrophytes and hygromesophytes in drained black alder forest communities (I–V stage of degradation) gradually decrease. Hygrophytes and hygromesophytes die out, mesophytes thrive. During the V stage of degradation only 3 species of hygrophytes and hygromesophytes (*Fissidens adianhoides*, *Climacium dendroides, Rhytidiadelphus triquetrus*) were recorded. In depressions and on hummocks mesophytes dominated: *Hylocomium splendens, Pleurozium schreberi, Brachythecium oedipodium* and xeromesophyte *Eurhynchium angustirete.*

The communities of black alder are rich in bryophytes. In undrained black alder forest communities 56 species of bryophytes were recorded, at an average 12 species per phytocoenological record (Fig. 3). During different stages of degradation the number of species on the plots decreases. During the V stage of degradation, only 7 species of bryophytes were found, on the average only 3 species per phytocoenological record. Such diminution in number of species in drained black alder communities takes place because of the degradation of hummocks. The conditions of humidity on hummocks and in depressions become similar. Hygrophytes and hygromesophytes die out, mesophytes prevail.

Gradual changes occur in vertical structure of the communities. Under humidity surplus, trees and shrubs grow only on the hummocks. When the regime of ground water changes, the depressions become drier, conditions for the establishment of bryophytes and herbs, and even for shrubs and trees become favourable. During the I stage of degradation (Table 4), *Frangula alnus* and young *Picea abies* become more abundant only on hummocks. On more drained plots (II and III stage), *Frangula alnus* and *Picea abies* become abundant in depressions. In some communities they form very dense and hardly passable thickets. During the IV stage *Picea abies* becomes usual in the second layer of trees; shrubs in depressions become not so dense; *Viburnum opulus* and *Corylus avellana* (*Querco-Fagetea* class) occur. T. Kapustinskaitė (1983) also indicates that in drained black alder forest types (*Alnetum iridosum*, *Alnetum caricosum, Alnetum caricoso-sphagnosum*), which could be included into the *Carici elongatae-Alnetum* association, trees and shrubs are evenly distributed in depressions. In the depressions of the entire plot *Frangula alnus, Sorbus aucuparia, Viburnum opulus, Padus avium* and *Picea abies* are distributed. During the V stage *Picea abies* is recorded in the first layer of trees together with *Alnus glutinosa* and *Betula pubescens*, which are usual dominants of these communities. In some plots *Picea abies* become dominant. Similar process was also observed by T. Kapustinskaitė (1983) who ascertained that growing conditions in cutting area of 20-year old drained black alder forest (forest type *Alnetum caricosum*) become better for the birch than for black alder. As a consequence, black alder forest was replaced by birch forest with black alder admixture. Favourable conditions for the spruce had formed along the drainage ditches in the distance of 45–65 meters.

Conclusions

Drained plots of black alder communities (association *Carici elongatae-Alnetum* Koch 1926 of the *Alnetea glutinosae* class) are characterised by alterations in microrelief, floristic composition, horizontal and vertical structure. When the level of ground water falls down, the hummocks degrade. There is no difference in the level of humidity on hummocks and in depressions. Therefore, changes in a horizontal structure of the communities occur: the number and coverage of hygrophytes decrease, whereas those of mesophytes increase. The number of bryophyte species on the record plots decreases, because of dead hygrophytes and prevailing mesophytes. Changes in a vertical structure of communities occur: shrubs and trees gradually occupy hummocks and depressions among them and species, which were growing sickly because of humidity surplus, start dominating.

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