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INFLUENCE OF MANAGEMENT CESSATION ON REEDBED AND FLOODPLAIN VEGETATION ON THE KLOOSTRI FLOODPLAIN MEADOW IN THE DELTA OF THE KASARI RIVER, ESTONIA

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Abstract. The practice of cutting and grazing seminatural meadows is diminishing in Estonia like in the rest of Europe. As a result, plant species diversity is decreasing and species composition is changing on these meadows. The extent and speed of changes depend greatly on the ecological conditions of the habitats. The influence of management cessation on reedbed, floodplain marsh, and floodplain meadow vegetation was analysed on a landscape transect in the Kloostri floodplain, West Estonia. The above-ground biomass and litter were measured in 20 sample plots along the landscape transect in 1996. The species composition and cover data were compared with those estimated nine years earlier, in 1987, when the area was still under management. Above-ground biomass of reedbed was 1900–2100 g/m^2, which coincides well with the earlier data. The biomass of floodplain meadow communities was 300–800 g/m^2. Litter was abundant and in most floodplain meadow communities its amount was higher than that of biomass. Using Ward's method of the coefficient of squared Euclidean distance for ordination of the species cover data from 1987 and 1996, it was found that the vegetation of drier sites (on higher elevations) had changed most notably while there were no changes in the sample plots of reedbed. The species composition of floodplain communities had changed a little; a few species common for pastures had disappeared. Differences between plant communities had decreased, vegetation had become more uniform. The dominance of tall grasses and sedges had increased.

Key words: floodplain meadow, reedbed, above-ground biomass, litter, cessation of management.

INTRODUCTION

Hay cutting and grazing intensity influence directly the vegetation of seminatural meadows. According to Grime (1979), in nutrient-rich habitats species richness and shoot density increase when light conditions improve. Therefore, mowed and/or grazed meadows are more diverse and richer in species than unmanaged meadows. It is also known that under some circumstances mowing can diminish the species richness, as recorded on fen meadows in Norway, where competition on light is lacking (Moen, 1995; Aune et al., 1996), as well as on Nordic primary meadows (Sambuk, 1928, cited by Pork, 1973). Cessation of management on seminatural meadows brings about an extensive alteration in their species composition. Vegetation succession commences as soon as hay-making ceases (Moen, 1995). The main obvious changes are formation of a heavy litter layer and invasion of shrubs (Pork, 1981, 1985; Moen, 1995). Light conditions become worse, soil nutrient and moisture content increase, and phenologically later species gain an ascendancy (Pork, 1985).

The main factors that determine the distribution pattern of plant species and vegetation units on river floodplains are moisture, nutrient, and disturbance intensity gradients (Day et al., 1988). Of these factors, moisture is the most significant (Prach, 1992). It interacts with the two others. Nutrient richness of floodplain soils results from the sediments brought by flooding water and high microbial activity in shallow flooding water (Pork, 1973). The vegetation of floodplain meadows responds rapidly to all changes in the whole river catchment area (Prach et al., 1990).

Floodplain vegetation is very sensitive to the annual variation of the moisture and nutrient conditions, which causes fluctuations in the species composition of plant communities. Plant communities form belts along the river channel according to change in moisture and nutritional conditions which vary along the height gradient (Prach, 1992). Successional changes in grassland communities are also induced by cessation of management (Pork, 1973). These successional changes cannot be easily differentiated from the annual fluctuations (Vissak & Mägi, 1987).

The aim of the present study was to estimate changes in species composition and above-ground plant biomass of reedbed and floodplain meadows over a nine-year period after the cessation of cutting and grazing practice.

STUDY SITE

The Kloostri floodplain meadow lies on an area of 420.6 ha in the delta of the Kasari River, West Estonia. It is part of the biggest floodplain in Estonia, the Kasari floodplain. Geomorphologically this area belongs to the central part of the West Estonian Lowland. The bedrock consists predominantly of Silurian calcareous marl of the Jaani Stage. The glacier left behind till plains, which were later covered with glacilacustrine and marine deposits. Nowadays the neotectonic land uplift is up to 2–3 mm per year (Vallner et al., 1988). The upper part of the studied landscape transect emerged from the sea about 1100–1700 years ago, its lower part is on the sea level.

Geobotanically the area belongs to the region of the West Estonian meadows and forested meadows, and to the subregion of the Kasari River basin (Laasimer, 1965). The vegetation of this area was influenced by river regulation in the 1930s, when the Kasari River was channelled. Additional ditches were dug in the 1950s and the 1970s (Veering, 1983). As a result, vegetation became less hygrophilous (Kumari, 1973). In spite of the wide-scale water level regulation spring floods are still common. In addition inundation with sea water may occur during the vegetation period.

The area has been used for hay-making for centuries. After the river regulation, mowing became irregular and was replaced by cattle grazing in the early 1980s. Grazing almost stopped at the end of the 1980s and since then the area has been unmanaged.

METHODS

The plant cover was studied on 20 sample plots of 2 × 2 m on a 500 m long landscape transect established along an elevation gradient (from 0 to 3.4 m) (Fig. 1). The topographic plan and soil and bedrock typology follow Zobel & Kont (1992). The vegetation was studied by Zobel and Kont in 1987 (Zobel & Kont, 1992) and by the present author in 1996.

Syntaxonomy of floodplain vegetation follows Krall et al. (1980). Plant communities are atypical due to lack of management, therefore only community types were identified.

To estimate above-ground plant biomass, litter included, plant material was collected in each sample plot on 0.25 × 0.25 m quadrates in five replications. The samples were dried at 80 °C and weighed. Relative light interception in herb and litter layers was measured with a 35 cm line-sensor pyranometer. Three measurements above and below the layers were taken and average per cent interception of full light was calculated.

The cover of plant species was estimated in per cent and converted according to the Braun-Blanquet scale: < 1% = 0.5, 1–5% = 1, 5–25% = 2, 25–50% = 3, 50–75% = 4, and 75–100% = 5. Cover data and species composition were compared with those of the same sample plots in 1987 (Zobel & Kont, 1992).

Converted cover data were arranged into a raw data table. Ward's method of the coefficient of squared Euclidean distance (Kent & Coker, 1995) was used for ordination of cover data for both study periods, 1987 and 1996. Similarity analysis was applied to study the vegetation change.

RESULTS

A total of 104 vascular plant species were registered in the plant communities along the landscape profile. The change in the species number was not big in comparison with the data from 1987 (from 114 to 104 species). The disappearance

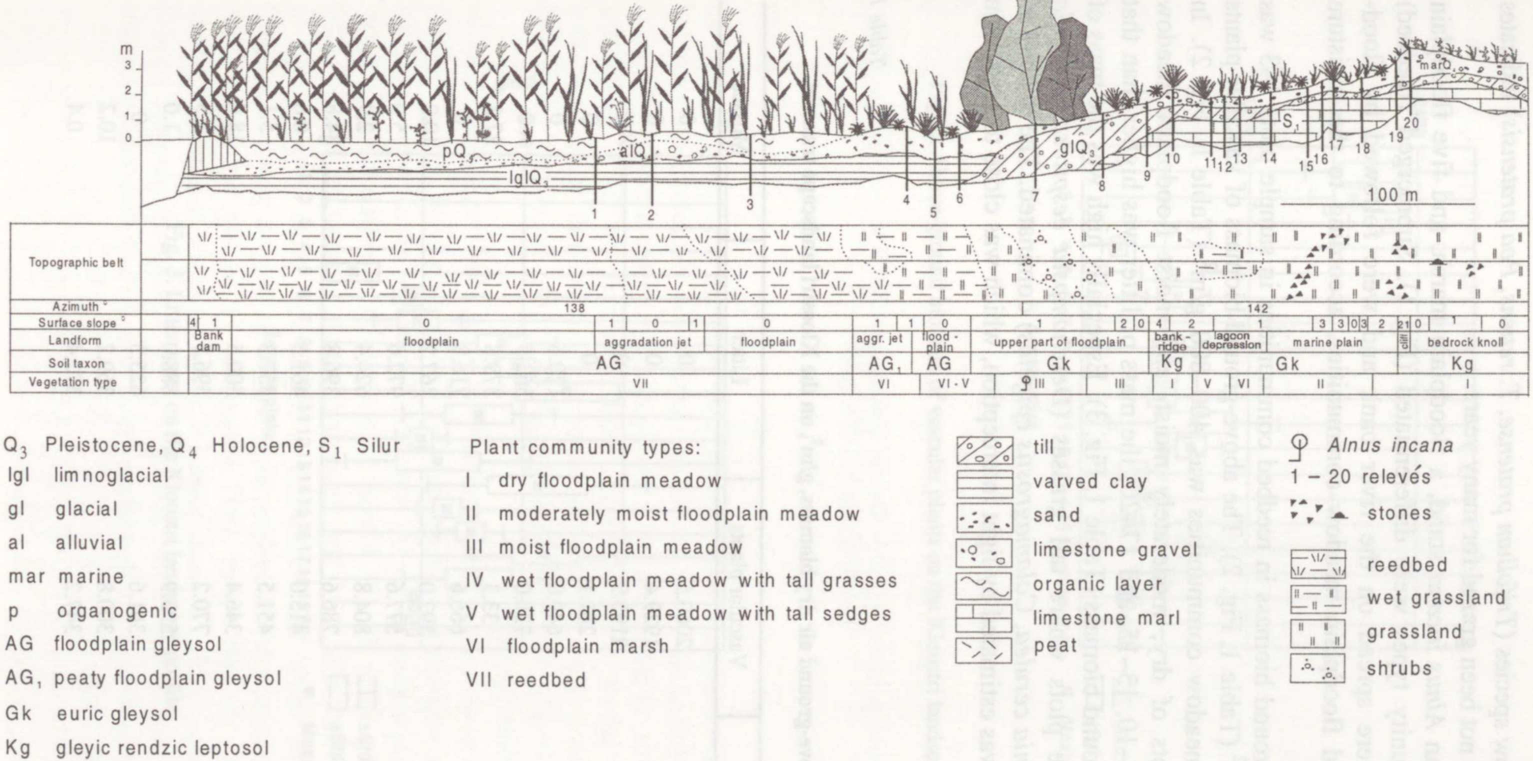

Fig. 1. Landscape profile in the Kloostri floodplain meadow.

of typical meadow species (*Trifolium pratense*, *T. repens*, *Poa pratensis*) indicates that the area has not been grazed for many years.

A reedbed, an *Alnus incana* stand, a floodplain marsh, and five floodplain meadow community types were differentiated (Fig. 1). Submerged (reedbed) communities were spread on the river bank and were followed by floodplain marsh and floodplain meadow communities, according to the moisture conditions.

The above-ground biomass in reedbed communities in sample plots 1–3 was 1900–2100 g/m^2 (Table 1, Fig. 2). The above-ground biomass of vascular plants of floodplain meadow communities was 400–800 g/m^2 (Table 1, Fig. 2). In most study plots of dry, moderately moist, and moist floodplain meadow (sample plots 8–10, 13–15, and 17–20) the mass of litter was higher than that of the above-ground biomass (Table 1, Fig. 3). Especially high was the mass of litter in sample plots where tall grasses (*Deschampsia cespitosa*, *Avenula pratensis*, *Molinia cerulea*, *Calamagrostis epigeios*) dominated. The density of the litter layer was estimated by light interception, which was close to maximum (Fig. 4).

Table 1

Mean above-ground air dry biomass, g/m^2, on the Kloostri landscape transect

Sample plot	Vascular plants	Litter	Mosses
1	2060.5	0	0
2	1929.4	0	0
3	2193.9	0	0
4	261.1	0	0
5	649.0	120.6	0
6	728.0	363.5	0
7	33.3	379.8	27.2
8	666.6	716.8	0
9	592.0	767.2	10.2
10	577.6	972.6	5.0
11	804.8	624.4	2.9
12	786.6	396.8	84.8
13	415.0	461.5	0.6
14	451.5	857.3	5.1
15	346.4	500.5	18.6
16	770.2	596.5	1.3
17	593.9	888.0	1.0
18	361.6	625.3	0
19	300.8	369.2	10.2
20	347.2	372.4	0.4

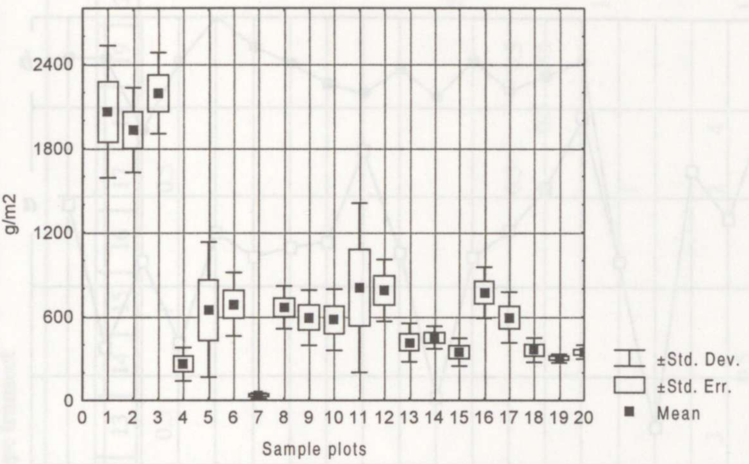

Fig. 2. Above-ground biomass of vascular plants on the Kloostri landscape profile.

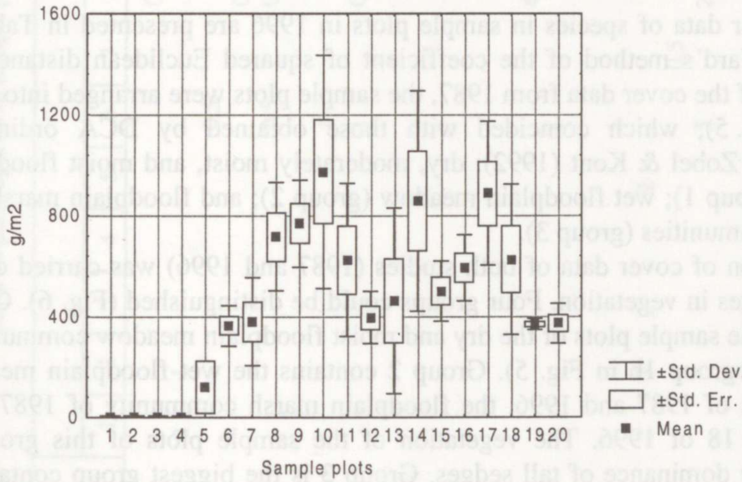

Fig. 3. Litter mass on the Kloostri landscape profile.

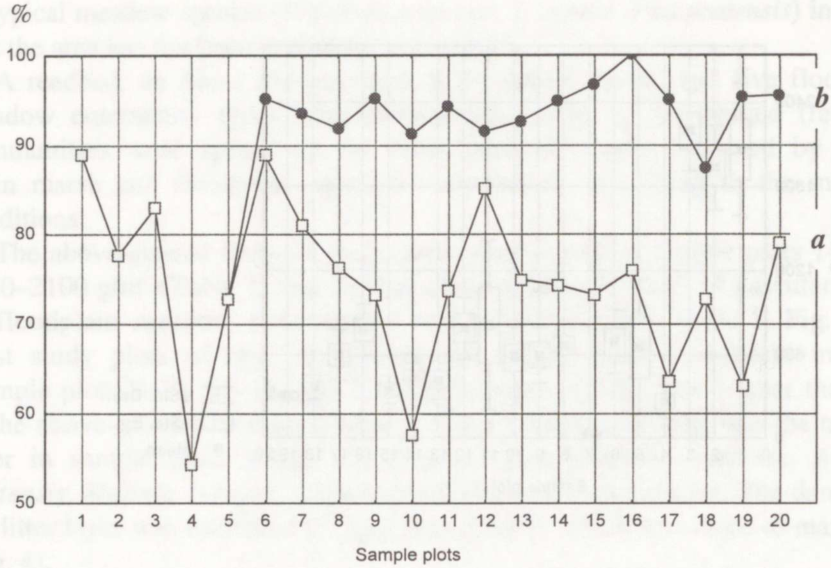

Fig. 4. Light interception in vegetation of the Kloostri landscape profile (% of total light): *a*, in herb layer; *b*, in herb and litter layers.

The cover data of species in sample plots in 1996 are presented in Table 2. Applying Ward's method of the coefficient of squared Euclidean distance for ordination of the cover data from 1987, the sample plots were arranged into three groups (Fig. 5), which coincided with those obtained by DCA ordination provided by Zobel & Kont (1992): dry, moderately moist, and moist floodplain meadow (group 1); wet floodplain meadow (group 2); and floodplain marsh and reedbed communities (group 3).

Ordination of cover data of both studies (1987 and 1996) was carried out to reveal changes in vegetation. Four groups could be distinguished (Fig. 6). Group 1 contains the sample plots of the dry and moist floodplain meadow communities of 1987 (subgroup 1b in Fig. 5). Group 2 contains the wet floodplain meadow communities of 1987 and 1996, the floodplain marsh community of 1987, and sample plot 18 of 1996. The vegetation of the sample plots of this group is described by dominance of tall sedges. Group 3 is the biggest group containing sample plots 14, 15, and 16 of 1987 (subgroup 1a in Fig. 5), which were dominated by *Carex nigra*, *Avenula pratensis*, *Deschampsia cespitosa*, *Sesleria caerulea*, and *Trifolium montanum*, and most of the floodplain meadow sample plots of 1996. Group 4 contains floodplain marsh and reedbed community sample plots of both study years.

Table 2

Cover of plant species in sample plots on the Kloostri landscape transect

Species	Sample plot																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Achillea millefolium								0.5	0.5	1	0.5		0.5		1		0.5			
Acorus calamus	2	1																		
Agropyron repens						0.5					0.5									
Agrostis canina								0.5				1								
A. capillaris						0.5	1	0.5												
Alchemilla sp.									1	1										
Alisma plantago-aquatica			1			1														
Allium schoenoprasum						1		0.5		0.5										
Angelica sylvestris							1			0.5										
Anthyllis vulneraria									0.5		0.5									
Avenula pratensis									2	2										2
A. pubescens										0.5									1	
Briza media									0.5	0.5							0.5		0.5	
Calamagrostis epigeios								4		2							4	0.5	0.5	
Caltha palustris						1						1		1						
Campanula rotundifolia										0.5	2									1
Cardamine pratensis						1											1			
Carex cespitosa	2	3	2		2	1														
C. digitata							0.5													
C. disticha						5		2			5	3	3				2	4		
C. flacca									0.5					0.5						1
C. hirta									1	0.5				1	1				1	1
C. nigra						2			0.5		1				0.5					1
C. panicea								0.5				0.5		0.5	1	0.5			1	
Centaurea jacea								1	1	1					1	1			2	2
Cirsium acaule									1	1										0,5

Table 2 continued

Species	Sample plot																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cnidium dubium								1							2					
Dactylis glomerata							0,5			1						0,5				
Dactylorhiza incarnata													0,5	0,5	0,5	0,5	0,5			0,5
Deschampsia cespitosa						1		1			1	1	0.5	2	1	1				
Eleocharis uniglumis			0.5	1				1												
Equisetum fluviatile	0.5	1	0.5	0.5	0.5						0.5									
E. pratense													0.5	0.5						
Festuca ovina										0.5									2	
F. rubra								3												
Filipendula ulmaria						1	1	1												
F. vulgaris							0.5		1	1							1		0.5	1
Galium boreale								0.5	0.5	0.5	0.5						1	0.5	1	
G. mollugo							0.5	2							0.5					
G. palustre			0.5			0.5					0.5	0.5								
G. verum								2	1	1	1		1		1	0.5	1	0.5	1	0.5
Geum rivale							0.5	1		0.5	1	1	0.5					0.5	0.5	
Glyceria maxima	2	4	4	2	5															
Inula salicina						0.5													0.5	
Iris pseudacorus	0.5			0.5		1					3									
Juncus bufonius			1	1		1								0.5						
Lathyrus palustris						3														
L. pratensis						1		1		0.5			1	1	1	0.5	0.5	0.5	1	
Luzula multiflora									0.5	0.5									0.5	
Mentha aquatica						1								0.5	0.5	0.5	0.5			
Molinia caerulea								2		2		1	2	3	3	3			1	
Phalaris arundinacea		3				0.5	1													
Phleum pratense								1		0.5	0.5				0.5					

Table 2 continued

Species	Sample plot																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Phragmites australis	4	3	2																	
Pimpinella saxifraga									0.5	1										
Plantago media									1											1
Poa angustifolia							0,5	0,5												
P. palustris										0,5							0,5	1		
Polygonum persicaria					1						0.5	0.5	0.5	0.5						
Potentilla anserina						4		1			1	1								
P. erecta									0.5								0.5		1	0.5
P. reptans							1									0.5				
Primula farinosa									0.5										0.5	
P. veris									0.5			0.5	0.5							1
Prunella vulgaris									1		1								0.5	
Ranunculus acris						1		1	0.5	0.5			0.5	0.5					0.5	
R. polyanthemos															1	1	0.5			0.5
Rubus saxatilis							2													
Rumex aquaticus		1	1		1															
Sesleria caerulea									3	3			2	2	2	1			4	5
Solanum dulcamara											0.5									
Stachys palustris		0.5				0.5	1													
Stellaria palustris		0.5			2	2														
Succisa pratensis						1		2	1			0.5	0.5	1	2	1	1	1	0.5	1
Taraxacum sp.						2														
Thalictrum flavum							1													0.5
Trifolium montanum									1	1						0.5			2	2
Typha angustifolia			1			1														
Valeriana officinalis							1					0.5	0.5							
Veronica chamaedrys									0.5	1							1	1		0.5
Vicia cracca						0.5				1		0.5		1		0.5	0.5		0.5	

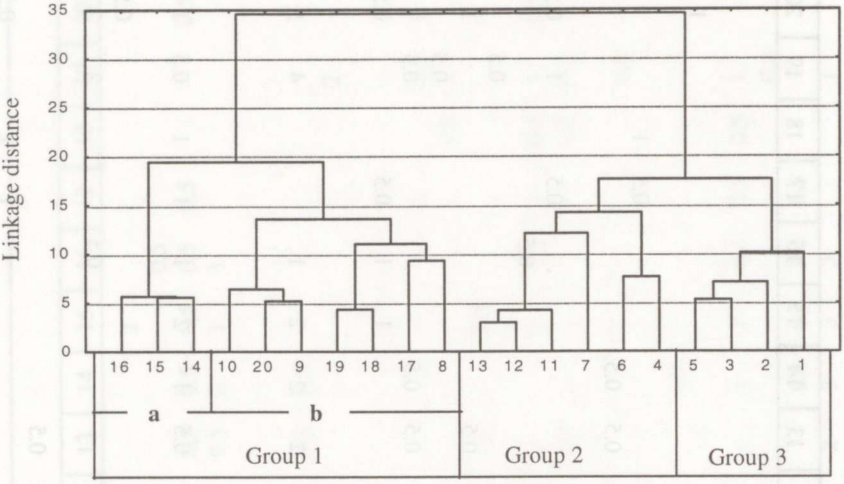

Fig. 5. Dendrogram of similarity analysis of vegetation on the Kloostri landscape profile, data of 1987.

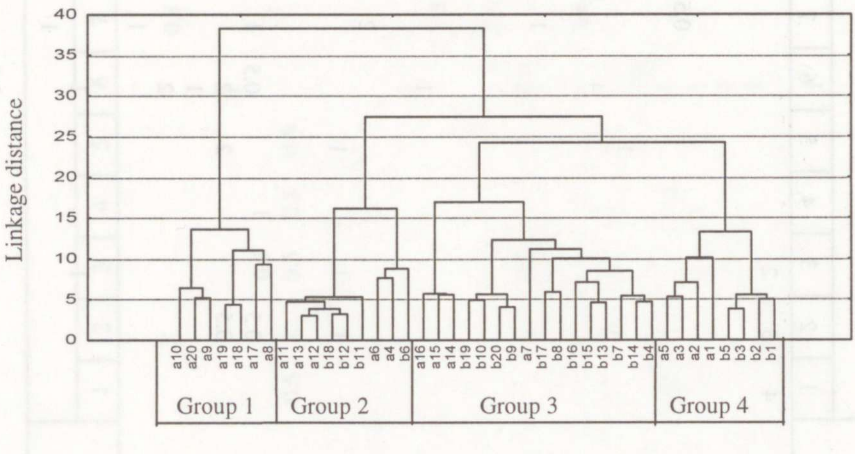

Fig. 6. Dendrogram of similarity analysis of vegetation on the Kloostri landscape profile: *a*, data of 1987; *b*, data of 1996.

DISCUSSION

Because of the geological youth (Silurian age) of the area and its limestone bedrock, the floodplain grassland has some features characteristic of limestone grassland. Therefore, the vegetation of the upper part of the landscape transect (Fig. 1) was interpreted as a limestone grassland (alvar) vegetation by Zobel & Kont (1992). In this study the vegetation units were taken from Pork et al. (1981).

The reedbed communities have not been influenced by cutting and grazing practice as is characteristic of the adjacent floodplain meadow communities. The main anthropogenic influence there has been input of nutrients from the agricultural area of the whole river catchment. In the 1980s such nutrient input was high (Porgasaar & Simm, 1985). Agricultural land use declined sharply in the 1990s as a result of economic changes (Ehrlich, 1996), which reduced the input of the nutrients to the water of Matsalu Bay. However, the expected change in the above-ground productivity of reedbed due to this change did not occur. The above-ground biomass in the reedbed communities in sample plots 1–3 was 1900–2100 g/m^2. It coincides well with earlier data (1800–2200 g/m^2) on biomass estimation in Matsalu reedbed (Ksenofontova, 1985). The expected change in the species composition of reedbed due to changed nutritional conditions or due to annual variability, did not occur either. In the ordination analysis the reedbed sample plots of both study years arranged close to each other (group 4 in Fig. 6).

Yields of hay on different floodplain meadow types in Estonia are usually 40–500 g/m^2, in reed (*Phragmites australis*) communities up to 700 g/m^2 (Krall et al., 1980). Regular mowing diminishes the above-ground biomass by 25–30% (Mander et al., 1995), on fen meadows in Central Norway even by 2/3 (Moen, 1995; Aune et al., 1996). Productivity of floodplain meadows usually does not depend on hay-making as much as on other meadow types because of additional input of nutritional elements brought by inundation water. On floodplain meadows in the delta of the Kasari River the decline of productivity was mentioned after drainage (Pork, 1985) when the duration and extent of flooding diminished.

The value of the above-ground biomass of vascular plants of floodplain meadow communities (Table 1, Fig. 2) is quite high (400–800 g/m^2) compared with the yields on managed floodplain meadows. The total standard crop is significantly higher because of litter. The formation of a heavy litter layer due to cessation of management is typical of seminatural meadows. The biomass of mosses is negligible (Table 1), since a dense litter layer covers the soil surface. The high values of the above-ground biomass can be regarded as a result of cessation of cutting and grazing management. The standard deviation of biomass values was higher in sample plots 5 and 11, which were situated on permanently overmoist sites where the size of individual species is very different and communities more mosaic. The biomass of vascular plants in the grey alder (*Alnus incana*) stand (sample plot 7) is very low because only the herb layer, not trees, was taken into account.

A heavy litter layer influences the species composition of meadows. It reduces the evaporation from the soil surface and prevents the warming of the ground in spring, thus hindering dispersal of annual and biennial species by seeds (Pork, 1981) and the growth of spring ephemerals. It also prevents the dispersal of trees and shrubs by means of seeds.

In the formation of the species composition of meadow communities competition for light prevails. Mowing improves the light conditions and allows more species to germinate (Grime, 1979; van der Maarel, 1988; Tilman & Pacala, 1993; Kull & Zobel, 1995). A dense litter layer on the soil surface hinders the germination of woody species, but also herbaceous species. If mowing can be restarted, the number of species will increase to a great extent (Prach & Straškrabová, 1996) and mass of litter will reduce to a minimum (Moen, 1995).

The best competitors on neglected seminatural grasslands are tall grasses and sedges. On the landscape transect studied *Deschampsia cespitosa*, *Avenula pratensis*, *Molinia caerulea*, *Calamagrostis epigeios*, *Sesleria caerulea*, *Carex panicea*, and *C. disticha* dominated. Extension of the synecological amplitude of species, invasion of species to drier or to wetter sites, and evenness of vegetation are typical of unmanaged meadows (Pork, 1981).

In general, the vegetation of seminatural meadows changes rapidly after the cessation of management. During nine years after the management cessation the differences between plant communities on the studied landscape transect decreased, vegetation became more uniform. The species composition of floodplain communities changed a little. The dominance of tall grasses and sedges increased and a dense litter layer formed.

The biomass and the species composition of the reedbed communities did not change due to the decrease of nutrients in the water.

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MAJANDAMISE KATKEMISE MÕJU KLOOSTRI LUHA (KASARI JÕE DELTA) ROOSTIKU JA LAMMINIIDU TAIMKATTELE

Laimdota TRUUS

Majandusliku kasutuse lakkamine kutsub poolloodusl ikel niitudel esile taimkatte suktsessioonilise arengu, mille puhul erinevate niidukoosluste vaheldumine lõpeb võsastumise ja metsastumisega. Suktsessiooni kiirus ja ulatus olenevad kasvukoha ökoloogilistest tingimustest. Lamminiitude toitainerikkuse ja hüdroloogilise režiimi omapära (regulaarselt korduvad üleujutused) tõttu kulgeb see protsess aeglasemalt kui veelahkmealade niitudel.

Käesolev töö käsitleb majandamise katkemisest tingitud muutusi roostiku ja lamminiidu taimekooslustes. Uurimine viidi läbi 1996. aastal Kloostri luhal (Kasari jõe deltas) kohas, mille majandamine (varasem niitmine, hilisem karjatamine) katkes 1987. aastal.

Tööd toimusid kahekümnel proovitükil, mis paiknesid piki kõrguse gradienti kulgevat maastikutransekti. Taimkatte klassifitseerimisel lähtuti Eestis seni kasutatud klassifikatsioonist (Krall, H., Pork, K., Aug, H., Püss, Õ., Rooma, I. ja Teras, T. 1980. Eesti NSV looduslike rohumaade tüübid ja tähtsamad taimekooslused. Eesti NSV Põllumajandusministeeriumi Informatsiooni ja Juurutamise Valitsus, Tallinn.). Tüüpiliste niidukoosluste kadumise ja koosluste-vaheliste piiride ähmastumise tõttu eristati taimkattes vaid tüübirühmi. Määrati taimkatte maapealne biomass ja kulu mass. Mõõdeti valguse neeldumist rohustus ja kulus. Hinnati taimkatte liigilist koosseisu ja liikide katvust, mida võrreldi 1987. aasta vastavate andmetega. Taimkatte muutumist selgitati taimeliikide katvuse andmete alusel kasutades Wardsi meetodit.

1996. aastal ühtis roostiku maapealse biomassi suurus (1900–2100 g/m^2) 1980ndate omaga. Tol ajal oli põllumajanduslikust reostusest pärinev toitainete sissekanne Matsalu lahte ulatuslik. Lamminiidu maapealne biomass oli 300–800 g/m^2. See näitaja on kõrge võrreldes niidetavate lamminiitude saagikuse andmetega. Majandamise puudumise tagajärjel oli maapinnale kogunenud tihe kulukiht. Maastikutransekti kõrgemas osas ületas kulu mass elavate taimede biomassi ning peaaegu kogu maapinnale langev valgus neeldus rohustus ja kulus.

Roostiku taimkatte liigilises koosseisus ei leitud uurimisaastate vahel olulisi erinevusi. Mõlemal aastal jaotusid proovialad nelja rühma. Esimese rühma moodustasid 1987. a. maastikutransekti kõrgemas osas kuivemates kasvutingimustes olevad lamminiidu proovitükid. Teise rühma kuulusid 1987. aasta lammisooniidu proovitükid ja osa 1996. aasta lammisooniidu proovitükke. Kolmas rühm oli suurim, sisaldades 1987. aasta lammiaasa (aasarohumaa) proovitükke (14, 15 ja 16); suuremat osa 1996. aasta lamminiidu proovitükkidest (kuivad lamminiidud, lammiaasad, suurkõrreliste lamminiidud) ning mõlema uurimisaasta lepiku alustaimestikku (proovitükk 7). Sellesse rühma kuulus ka 17. proovitüki 1996. aasta taimkate, mis 1987. aasta andmete põhjal oli esimeses rühmas. Neljanda rühma moodustasid mõlema uurimisaasta kõige märjemate kasvukohtade proovitükid (1, 2, 3 ja 5). Lamminiidu taimkattest olid kadunud mõned karjamaadele iseloomulikud liigid, nagu valge ristik (*Trifolium repens*), aasristik (*T. pratense*) ja aasnurmikas (*Poa pratensis*). Majandamise puudumisel toimusid üheksa aasta jooksul lamminiidu taimkattes järgmised muutused: maapinnale kogunes tihe kulukiht; rohustus suurenes kõrgekasvuliste kõrreliste ja tarnade osatähtsus ning vähenesid taimekoosluste vahelised erinevused. Kuivemate kasvukohtade taimkate muutus sarnasemaks märjemate kasvukohtade omale.