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Condition of semi-natural meadows in northern Finland today — do the classical vegetation types still exist?

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Species-rich, semi-natural meadows in Finland are threatened. During the last century most of them have either been abandoned or changed into cultivated fields. This has resulted in a collapse of species and habitat diversity of the Finnish agricultural landscape. In this study, we tried to define the present state of inland semi-natural meadows on mineral soil in North Ostrobothnia and in immediate vicinity. We compared the material gathered in national inventory of traditional rural biotopes in Finland with two data sets from the beginning of the last century to find out how does the detected species composition correspond to vegetation types established by two early researchers, A. K. Cajander and K. Teräsvuori. The studied meadows' species composition differs markedly from the meadow types described earlier. Present-day meadows are characterized by several nitrophilous species indicating that modern type of management, where supplementary forage is provided for grazing animals, causes eutrophication. Because the open meadows in North Ostrobothnia are in such a poor condition, — eutrophication and resulting low species diversity — the protection of semi-natural habitats more typical of the coastal areas, e.g. seashore meadows, in particular, should be emphasized.

Key words: abandonment, conservation, ecology, grazing, mowing, semi-natural meadows

Introduction

Semi-natural vegetation, i.e., human-influenced plant communities maintained solely by mowing and grazing, are rarer than ever. Their use as a source of animal forage has decreased along with agricultural rationalization and with agrotechnical innovations. As a result, semi-natural meadows and pastures have either been abandoned or changed into cultivated fields (cf. Raatikainen & Raatikainen 1974). In the latter case, frequently occurring ploughing and sowing of commercial forage plants as well as use of chemical fertilizers and pesticides have impoverished the flora and fauna in semi-natural habitats along with their surrounding agricultural areas. Ekstam (1988) states that the change from the early to modern agriculture has, considering solely the effect of fertilizers, been radical: plants that have adapted to nutrient scarcity for centuries suddenly have to cope with a multifold amount of nitrogen load. Further, modern agriculture enabled more intensive and earlier occurring mowing practises which, in turn, reduced the lifelines of archaeophytic plants, that is, plants which invaded Finland long ago with the aid of man (*see* Suominen & Hämet-Ahti 1993). As a result, the number of traditional plant communities has decreased and the remaining ones have become poorer in species. On the other hand, overgrowing of meadows caused by reduced grazing is the most significant cause for species loss in Finland; nowadays 22% of the threatened species live in semi-natural habitats (Rassi *et al.* 2001).

The decline of Finnish semi-natural habitats started at the end of the 18th century, continued during the 1900s and is still going on. According to Soininen (1974) the area of semi-natural meadows decreased from 1.6 million hectares to 600 000 hectares within 40 years (1880–1920). Yet, it is assumed that their condition was tolerable as late as in the 1960s (Vainio *et al.* 2001). After that, accompanied by the field decimation act, started a rapid decline of semi-natural meadows (Raatikainen 1986). It is estimated that at the turn of millennium there are 20 000 hectares of traditional rural biotopes left, of which only a small fraction is still managed continuously (Vainio *et al.* 2001). This decline caused by the development of Finnish cultivation techniques and animal husbandry is a part of the larger changes in rationalization of agriculture occurring in the entire western Europe (cf. During & Willems 1984, Berendse *et al.* 1992, Schaminée & Meertens 1992, Eriksson 1995, Losvik 1999, Pärtel *et al.* 1999, Stampfli & Zeiter 1999, Bullock *et al.* 2001, Cousins *et al.* 2003).

The protection of semi-natural habitats in practice means continuation and bringing back the old ways of management, grazing and mowing. During the 1980s a special project was established in Sweden to allow financial aid to farmers who maintain semi-natural habitats (Anonymous 1986). In Finland a similar kind of help has been provided since 1995, while smaller pilot projects had been carried out earlier. Next steps for large-scale activities in improving living conditions for meadow flora and fauna would include e.g. a substantial increase in incentive bonuses for farmers to keep the remaining semi-natural habitats managed and development of wide-range organic cultivation in cropping systems, which means cessation of using chemical fertilizers and pest control over large areas near valuable semi-natural habitats.

The aim of this study was to define the present state of inland semi-natural meadows on mineral soil in the North Ostrobothnia regional environment centre's administrative district. The axiom based on the several observations throughout Finland (Jutila *et al.* 1996, Vainio & Kekäläinen 1997, Jantunen *et al.* 1999, Bergman & Kalpio 1999, Hering 1999, Lehtomaa 2000) is that (1) fertilising effects, particularly nutrient leaching from surrounding non-traditional pastures, constitute a severe problem for the remaining semi-natural meadows, and (2) that meadows that were abandoned have signs of deterioration caused by overgrowing. Although the report by Vainio and Kekäläinen (1997) presents the overall picture of the state of the remaining meadows, there was no possibility — just from the report-style reasons — to examine the issue thoroughly from the ecological point of view.

The present study is based on data collected by eight different field researchers in 1992–1996. Results of the inventory were documented in special forms accompanied with presence/absence of species lists of each plant community found. The collected material is compared with two separate studies performed in the beginning of the 1900s from the area (Cajander 1909, Teräsvuori 1926) to find out whether the described "old/classical" meadow types still exist. In short, our aim was to answer the following specific questions:

1. What is the species composition of semi-natural meadows in northern Finland?
2. What environmental conditions does the present species composition reflect?
3. How well does the detected species composition correspond to established vegetation types?
4. How do the given conservation values and diversity measures meet?
5. In the light of earlier classifications, how "traditional" are the described semi-natural meadows?

Material and methods

The material was composed from forms filled during inventory of traditional rural biotopes in North Ostrobothnia regional environment centre's administrative district. Most of the meadows (91) are located in the Ostrobothnia Oulu biogeographical province (Obo), 13 in Ostrobothnia kajanensis (Ok), 10 in Ostrobothnia media (Om) and 14 in Regio kuusamoënsis (Ks) (Table 1). According to the landscape area division (Anonymous 1992) most of the meadows belong to North Ostrobothnia riverside and coast (PPjr), while others are distributed evenly into different landscapes (Table 1). Only two meadows belong to Middle Ostrobothnia riverside and coast (KPjr). The criterion for meadows in this study was to include all habitats classified as open semi-natural meadows on mineral soil (cf. Pykälä *et al*. 1994). The species data consist of presence/absence species lists of each separate plant community found. The environmental variables described verbally in field forms were transformed into numerical values. For example conservation value evaluated by the inventor included several criterions including type of management, representativeness, rareness, speciality, diversity, size, etc. (for detailed criteria *see* Pykälä *et al*. 1994). For the range of values for categorical and nominal environmental variables *see* Appendix 1.

Differences in species number, number of community types and bush cover in different levels of landscape (six levels), biogeographical provinces (four levels), management (managed/abandoned), management means (mowed/grazed/mowed and grazed), the effect of former field use, year since abandonment and phenolology was studied by means of one-way ANOVA (for environmental values *see* Appendix 1). If the assumptions of ANOVA (normality and homogeneity of variances) were not met the data was log-transformed before the analysis. If ANOVA yielded a significant result treatment means were compared with Tukey's HSD. Correlations between different parameters were studied by means of Pearson's (or in case of conservation value by means of Spearman's) correlation coefficient.

Ordinations were performed with the CANOCO program version 4 (ter Braak & Šmilauer 1998). Compositional gradients of the data set in relation to the measured environmental variables were investigated using Canonical Correspondence Analysis (CCA; ter Braak 1986). In the ordination diagram nominal variables (1) in use, (2) abandoned, (3) grazing, (4) mowing and (5) former field use are presented as centroids and categorical variables as arrows.

Table 1. Numerical facts of meadows divided into provinces (*see* text) and landscapes (*see* Appendix 1).

	Province			
	Obo	Ok	Om	Ks
Number of meadows	91	13	10	14
Total area (ha)	88.8	18.5	5.2	11.0
Total species number	302	150	140	117
Average species number (± S.E.) per meadow	48.4 ± 2.0	45.9 ± 3.8	55.5 ± 3.4	29.3 ± 2.6
Total species number in the province[1]	588	562	606	506

	Landscape					
	PPjr	PPn	Knv	Suo	KPjr	Ksv
Number of meadows	74	15	13	10	2	14
Total area (ha)	67.7	18.4	18.9	5.2	2.2	11.0
Total species number	287	177	153	140	55	117
Average species number (± S.E.) per meadow	48.7 ± 2.3	44.1 ± 3.5	49.5 ± 3.3	55.5 ± 3.4	45.5 ± 1.5	29.3 ± 2.6

[1]Based on the calculations by Suominen and Hämet-Ahti (1987).

The significance of each individual environmental variable was tested using the Monte Carlo permutation test with 1999 randomized runs (variables included one at a time). Finally, species data was compared with corresponding dry–moist meadow types presented by Cajander (1909) and Teräsvuori (1926). Their data was converted to presence/absence scale, pooled with the present data and thereafter examined with detrended correspondence analysis (DCA; Hill & Gauch 1980). Default options of the program (detrending by segments, nonlinear rescaling) were performed to best measure the degree of species turnover (beta diversity) and illustrate the difference between present day's meadows to the classical types.

Results

Characteristics of the inland meadows on mineral soil in the study area

Inland meadows on mineral soil are not, in fact, very typical for the examined landscapes. There are still quite large areas of coastal meadows on mineral soil in seashores of Ostrobothnia Oulu and Ostrobothnia media regions, while eastern areas, Ostrobothnia kajanensis and Regio kuusamoënsis are characterized merely by peatland meadows (presently considered to be mire vegetation). Inland meadows on mineral soil are therefore scarce; the counties Kuusamo, Ii, Kuivaniemi, Pudasjärvi, Oulainen and Taivalkoski stand out from the others, having totally over eight hectares of meadows each (Vainio & Kekäläinen 1997). Most of the sites (58%) are located in PPjr landscape (Table 1). Comparison between the meadows in different landscapes shows that meadows in Ksv had fewer species as compared with those in other landscapes except in PPn ($F_{4,121}$ = 4.704, P = 0.001, Tukey's HSD: P = 0.002, P = 0.143, P = 0.022, and P = 0.003 between Ksv and PPjr, PPn, Knv and Suo (for abbreviations *see* Appendix 1). There were too few meadows in KPjr to be included in the comparison.

When biogeographical provinces are considered, the Kuusamo region has significantly fewer species as compared with other provinces (log-transformed data: $F_{3,124}$ = 6.887, P < 0.001; Tukey's HSD: P < 0.001, P = 0.02, P = 0.001 between Kuusamo and Obo, Ok and Om, respectively) (Table 1). However, one must remember that 71% of the sites are located in Obo. During the survey 302 taxa were found in Obo, which is 51% of the total species number found in the province (cf. Suominen & Hämet-Ahti 1987). The corresponding values for Ok, Om and Ks are: 150 (26.7%), 140 (23.1%) and 117 (23.1%), respectively. The number of established "actual" meadow species (*see* Pykälä 2001) in the mentioned provinces are 108, 113, 123 and 83, respectively, and it becomes clear that the species composition of the studied meadows consists of a vast number of species, which have come from various surrounding original biotopes, such as forests, mires, fens, lake- and riversides etc. (cf. Ekstam *et al*. 1988).

Abandonment versus management

The average size of a meadow included in this study is ca. one hectare and includes on average ca. 3.6 community types regardless if it is abandoned or not ($F_{1,126}$ = 0.017, P = 0.897). The average time that an unused meadow has been abandoned is surprisingly long, more than 15 years, and still they were included in the field survey. This reflects the rarity of traditionally managed meadows in today's Finland. Because there are so few managed meadows, the field researchers included abandoned, attractively looking sites too. The long abandonment period of unused meadows also tells a different story: signs of management prevail quite well in the terrain.

The species number in managed meadows is not significantly ($F_{1,126}$ = 0.452, P = 0.503) higher than in abandoned ones (Table 2). Conservation value is, however, evaluated to be slightly higher in meadows under management (≈ 3.6 ≈ local+) than in abandoned ones (3.2 ≈ local) (for value classification *see* Appendix 1). This, however, is an artefact; as the inventor knows that the meadow is abandoned, it influences automatically the conservation value decision.

Tree cover is low in managed as well as in abandoned meadows (Table 2); naturally as the wooded meadows (= meadows with more than 10% tree cover) were placed in a different category. However, there is a clear trend of higher bush cover in abandoned meadows ($F_{1,126}$ = 15.116, $P < 0.001$); overgrowing is evident. Finally, abandoned meadows tended to be more often of field origin (39 %) than presently managed meadows (26 %).

Closer separation of used meadows into mowed, grazed and mowed and grazed meadows reveals the common feature in present management of semi-natural meadows, namely that meadows are usually solely grazed (Table 2). Average species number and number of community types are highest in mowed meadows, although their combined area is as low as six hectares. Among abandoned sites, no significant differences between former management regimes were found. There were too few mowed + grazed sites to make reliable conclusions about their indicative values.

The species frequency distribution (Fig. 1) shows that the mode class for species number per meadow type is 30–44 (in 36 meadows), but meadows with 15–74 species are also quite common. According to the correlation matrix, the species number correlates significantly with the community number per area, with the conservation value, with the tree and bush cover and finally with the meadow size (Table 3).

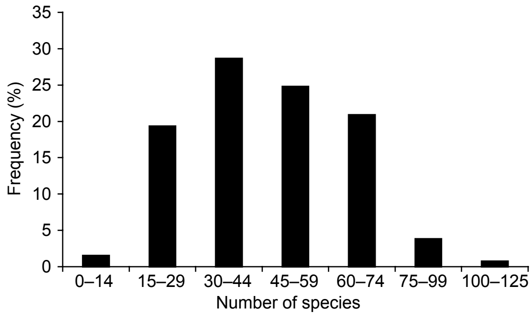

Fig. 1. Species frequency distribution of the 128 meadows studied.

In contrast, the correlation between the species number and duration (in years) of abandonment is slightly, though not significantly, negative. Besides, it can be seen that the number of community types correlates with the tree and bush cover. Finally, the bush cover correlates with abandonment and the meadow size.

Species composition in relation to management

The dominant species composition in managed and abandoned sites was quite similar. Most of the listed 50 most abundant species thrived well in both managed and abandoned sites (Appendix 2). Typical species for meadows in use are e.g.:

Table 2. Numerical values for used/abandoned meadows divided by different management modes (Note: in abandoned meadows the management refers to the latest type of use). In abandoned meadows the number of differently used sites do not match the overall sum because in 13 sites the former management type was unknown. Numbers are averages if not differently indicated.

	In use	Mowing	Grazing	Mowing + grazing	**Abandoned**	Mowing	Grazing	Mowing + grazing
Number of sites	69	11	52	6	59	11	20	15
Total area (ha)	60.6	6.0	50.6	4.0	62.9	9.7	18.4	22.6
Average meadow size (ha)	0.9	0.5	1.0	0.7	1.1	0.9	0.9	1.5
Conservation value (median)	3.6	4.0	3.0	2.5	3.2	3.0	3.0	3.0
Tree cover (%)	5.8	4.5	6.3	3.4	6.2	7.6	6.5	5.0
Bush cover (%)	4.0	2.3	4.5	3.0	10.2	14.7	7.5	11.1
Number of community types	3.6	4.5	3.5	2.7	3.6	3.7	2.9	4.2
Number of meadows with former field use	18	2	13	3	23	11	19	14
Species number (± S.E.)	47.6 ± 2.1	50.9 ± 4.3	47.0 ± 2.4	38.5 ± 4.6	45.5 ± 2.4	40.9 ± 2.7	49.5 ± 5.5	44.4 ± 3.5

Carum carvi, *Cerastium fontanum*, *Equisetum arvense*, *Galium palustre*, *G. uliginosum*, *Plantago major*, *Poa annua*, *Polygonum aviculare* coll., *Rumex longifolius*, *Stellaria media* and *Urtica dioica*, that is, species indicating somewhat intense eutrophication. Correspondingly typical species for abandonment are e.g.: *Epilobium angustifolium*, *Rubus idaeus*, *Trientalis europaea*, *Silene dioica* and *Veronica longifolia*.

There are few abundantly occurring species that benefit from grazing or mowing (Appendix 2). Over 20 of the most abundant species occur in sites under both management modes. The species typical of grazing are *Achillea ptarmica*, *Equisetum arvense*, *Galium uliginosum*, *Poa annua*, *Polygonum aviculare* coll., *Ranunculus repens*, *Rumex longifolius* and *Stellaria media*, among others. Interestingly, many species that grow in abandoned meadows occur abundantly also among mown meadows: *Anthoxanthum odoratum*, *Leucanthemum vulgare*, *Rhinanthus minor* and *Viola canina*. Other typical species for mowing are: *Alchemilla* spp., *Nardus stricta*, *Populus tremula*, *Ranunculus auricomus*, *Tanacetum vulgare* and *Vaccinium myrtillus*.

Ordination

After preliminary CCA runs, seemingly trivial environmental variables containing plenty of random variation (*see* Appendix 1) were excluded from the analysis, and the 13 most essential ones were left for final ordination. After omitting species occurring in fewer than six sites, 172 vascular taxa were included in the ordination data matrix.

The low eigenvalues for the first two ordination axis 0.13 and 0.076 reveal quite a poor relationship between the species and environmental variable matrices. Percentage variance accounted for by the first two axes of the species-environment biplot is 43.1%. The main gradient in the diagram, moisture, increases from right to left (Fig. 2). Other environmental variables correlate better with the vertical axis. According to Monte Carlo permutations, the variables except the number of community types, bush cover and fertilization were found to be statistically significant ($P = 0.005$). The ordination results are in concordance with the pattern emerged from the plain species tabulation. The species placed in the left-hand side of the diagram are typical of moist meadow depressions and watersides (Fig. 2).

Meadows in use (low right) are indicated by *Matricaria matricarioides*, *Alopecurus geniculatus*, *Capsella bursa-pastoris*, *Stellaria media*, *Poa annua* and, surprisingly, *Oxalis acetosella*, a species typical of herb-rich forests. The presence of *O. acetosella* in open meadows results, most likely, from the presence of wooded meadows in the vicinity. Abandonment indicators include e.g. *Salix phylicifolia*, *Epilobium angustifolium*, *Vaccinium uliginosum*, *Trientalis europaea* etc. In most of the mown meadows, management had ceased long ago, which explains the close relationship between the nominal variables "mowing" and "abandonment". Indicators for meadows formerly used for cultivation (Field) include *Galeopsis bifida* and *Calamagrostis epigejos*. The latter species spreads easily from ditch verges to meadows after management cessation. Large meadow areas are indicated by *Molinia caerulea*, *Phalaris arundinacea*, *Carex nigra*

Table 3. Pearson's (or in case of Conservation value Spearman's) correlations coefficients between measured variables. $N = 128$ (except in years after abandonment $N = 118$). * = $P < 0.05$, ** = $P < 0.01$. **ERRATUM**

	Species number	No. of community types	Conservation value	Tree cover size	Bush cover	Meadow
No. of community types	0.35**					
Conservation value	0.39**	0.08				
Tree cover	0.37**	0.27**	0.16			
Bush cover	0.20*	0.23**	0.05	0.29**		
Area	0.19*	0.12	0.06	–0.05	0.23**	
Years after abandonment	–0.14	0.02	–0.16*	0.06	0.22 *	0.01

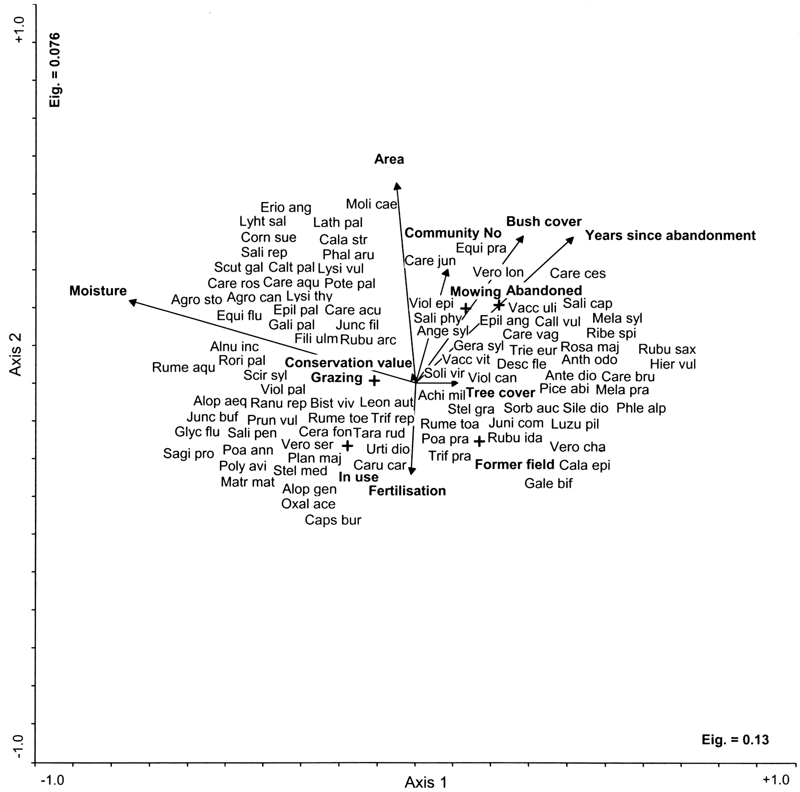

Fig. 2. CCA species–environment biplot of the data. Species names are presented in four (family)/three (species) first letter abbreviations (exceptions: Care jun = *Carex nigra* ssp. *juncella*, Rume toa = *Rumex acetosa*, Rume toe = *Rumex acetosella*).

ssp. *juncella*, *Lathyrus palustris* and *Calamagrostis stricta*, species typical of meadows that have been originally cleared from peatlands. Thus, the value of distinguishing peatland meadows and meadows on mineral soil using these species is seemingly marginal.

CCA site/environment biplot spread meadows representing different landscapes randomly throughout the ordination hyperspace, suggesting that the landscapes suffer from lack of individual character when it comes to meadow types (Fig. 3). The same concerns the meadows in different biogeographical provinces.

Also DCA ordination of the combined species data of present day meadows and classical types yielded quite low eigenvalues for the first two axes (Fig. 4). The percentage variance accounted for the first four axes was 53.5% and the estimated beta diversity along the first axis was 2.8 in terms of S.D. units. Despite the low beta diversity value, ordination clearly emphasizes the difference between present day's meadows and classical types; hardly any resemblance can be found. The inventoried present day's meadows constitute a uniform group, especially along the first ordination axis. Closest to present day's meadows are Teräsvuori's (1926) *Agrostis canina* and *Deschampsia cespitosa* types. The remaining classical types distinguish, not including Cajander's (1909) *Deschampsia cespitosa* type, clearly from each other. According to species ordination diagram (Fig. 5) the present day meadows are indicated by several grazing tolerant and nitrophilous species (*see* the species mentioned above).

Discussion

Overall state of the meadows in the study area

The results give support for the observation that traditional rural biotopes in North Ostrobothnia and in the immediate vicinity are, at least as regards open meadows on mineral soil, in poor condition (cf. Vainio & Kekäläinen 1997). Traditional use has ceased in most of the areas and

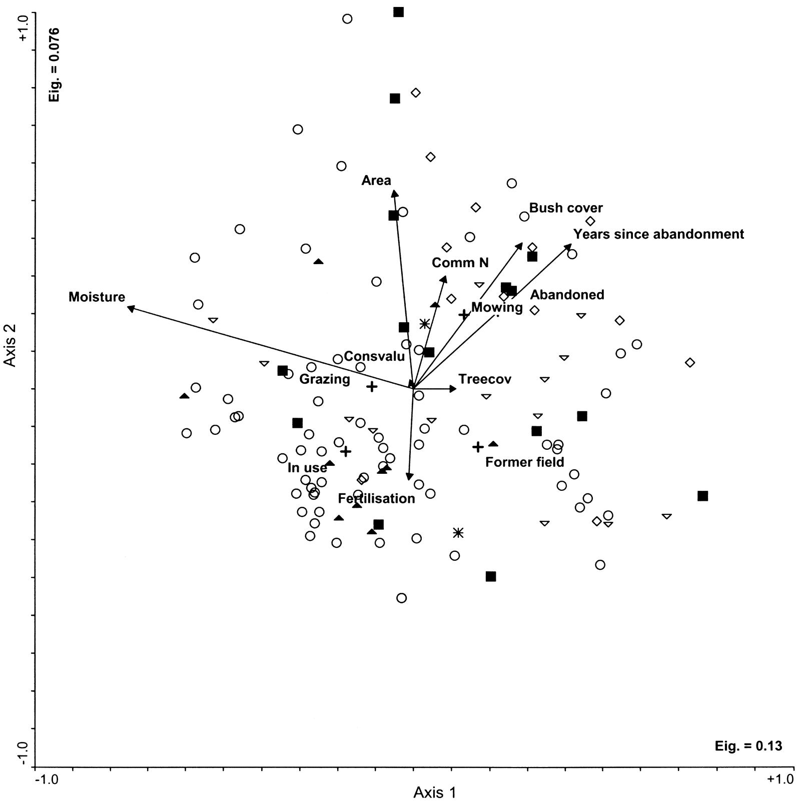

Fig. 3. CCA site–environment biplot of the data. Symbols refer to meadows in different landscapes: ○ = North Ostrobothnia riverside and coast, ■ = North Ostrobothnia's mire expanse), ▲ = Suomenselkä area, * = Middle Ostrobothnia riverside and coast and ▽ = Kuusamo hillside. Nominal variables are presented as centroids (bold crosses).

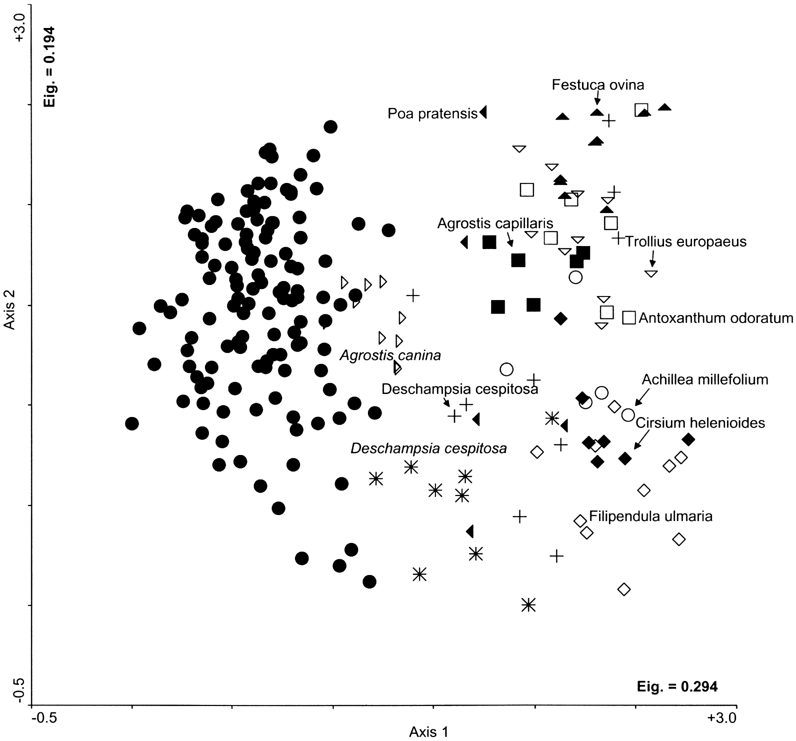

Fig. 4. DCA ordination of the investigated meadows (●) in relation to Cajander (1909) and Teräsvuori (1926) types. Latin names for Teräsvuori's types are written in italics.

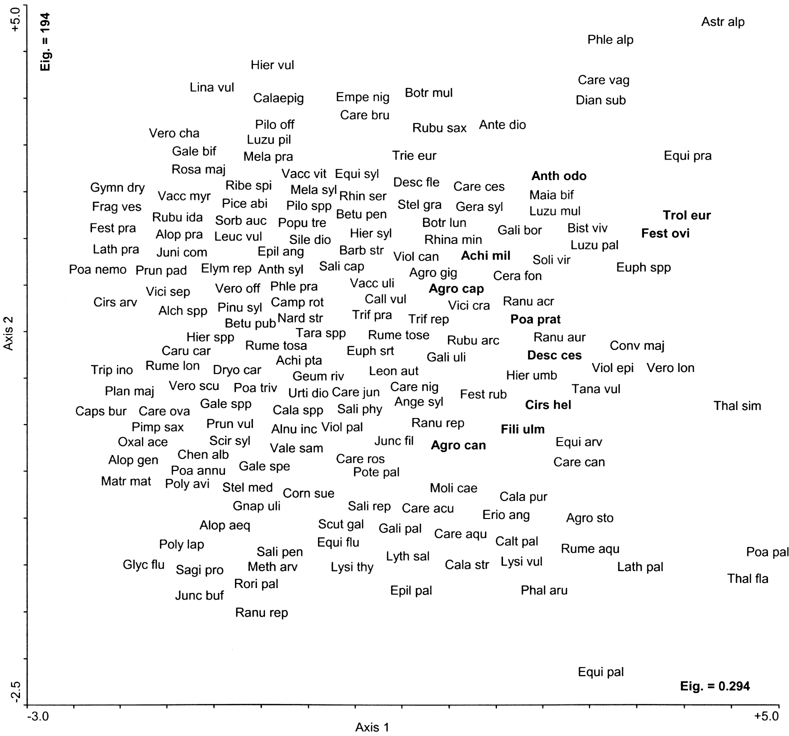

Fig. 5. DCA ordination of the species. Species names are presented in four (family)/three (species) first letter abbreviations (exceptions as in Fig. 3). Dominant species presented in Cajander (1909) and Teräsvuori (1920) classifications are in bold.

meadows are becoming overgrown. Only 27% of the meadows included are still grazed and 2% are mowed continuously. Further, the remaining managed sites have few community types and low species numbers. High abundance of typical species for nutrient-rich sites, e.g., *Poa pratensis*, *Ranunculus acris*, *R. repens*, *Rumex acetosa* and *T. repens* (Ekstam & Forshed 1992, Ellenberg *et al*. 1992) indicate that modern type of management, where supplementary forage is provided for grazing animals, causes eutrophication. Combined with incorrect mowing time, low species diversity is inevitable. Scarcity of species with high indication value for traditional habitats (cf. Ekstam & Forshed 1992, Pykälä 2001) strengthens the message: only two endangered meadow species grew in the studied meadows, *Botrychium lunaria* (in nine sites) and *B. multifidum* (eight sites), which indicates that only a fraction of the inventoried meadows are able to provide refuges for species adapted to traditional management practises.

As already mentioned, meadow abandonment leads to decrease in species number (Fig. 6). Although in our case the decrease is not statistically significant, the overall trend is consistent with several other studies (Willems 1983, Bakker 1987, Losvik 1988, Huhta 1997). On average after 25–30 years of abandonment, new species from the surroundings start to invade, despite the fact that many of the original meadow species still persist in the area (Fig. 6). Ceased management has also evidently raised the overall nutrient levels, especially those of nitrogen, in every study site available to plants, mainly through accumulated litter. This combined with increased competition for light (cf. Willems 1983) has created a situation where species compositions described in the beginning of the last century are no longer possible.

Studied vegetation types in relation to Cajander-Teräsvuori classifications

The species composition of the studied meadows differs markedly from Cajander's (1909) and Teräsvuori's (1926) classifications. Cajander described his series along riversides affected by annual floods, the extreme ends of land vegetation being (from wet to dry) *Carex aquatilis* and *Festuca ovina* meadows. Teräsvuori's (1926)

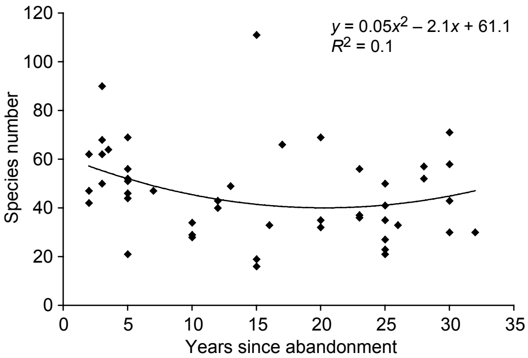

Fig. 6. Species number in relation to years since abandonment. The presented trendline for sites is fitted for the second order polynomials.

meadows included here were in the Lumijoki and Liminka districts (Obo; PPjr). As seen from the DCA ordination figure, today's meadows most resemble Teräsvuori's *Agrostis canina* and *Deschampsia cespitosa* types. However, despite the similarities, there is a fundamental difference between the today's and classical (Teräsvuori's) types. For example, today's *Deschampsia cespitosa* meadows represent common mid-seral stages of abandoned semi-natural meadows and fields (Huhta 1997); they are tussocky and poor in species. In contrast, in the beginning of the last century *D. cespitosa* meadows were under sustained use (cf. Soininen 1974). As a result, the earlier *D. cespitosa* meadows were species-richer (cf. Teräsvuori 1920) as compared with today's types (Huhta 1993, 1997). In particular, there seemed to be more room for herb species of smaller stature (compare also: Kalela 1939, Eurola 1967, Kujala 1967).

It is hard, or even impossible, to find habitats in today's north Finnish rural landscapes that have species compositions corresponding to those described by Cajander (1909) and Teräsvuori (1926). The situation might have been different if moister vegetation types, especially along riversides, had been included. However, most of the flood and flooded meadows have been abandoned decades ago, and thus are today growing thickets and young forests. When comparing the present day's vegetation with those earlier described, it should be kept in mind that most of the presently inventoried areas consist of many different, small-sized vegetation types. Atypical species for otherwise coherent types come from, e.g., small depressions and ditch verges and are commonly included in species list and thereby included in the described type. This naturally complicates classifying, as we cannot be sure which species belong within a "homogenous" type — if there are any — and which come from edges and ecotones. Besides, it must be kept in mind that the present day's classifications (Pykälä 1994) rely on roughly physiognomical categorizations by sward height, dominant growth form and moisture (e.g. grass/herb/dwarf shrub-dominated, wet-moist-dry, etc.), as opposed to classifications based primarily on dominant plant species (*see* Cajander 1909, Teräsvuori 1926). All in all, this leaves the question: Are there any classical meadow types left?, somewhat unanswered. It seems probable that classical types do exist, especially regarding extreme ends of the meadow vegetation series, where mainly abiotic factors, aridity or dampness maintain meadows open, regardless of human influence. In contrast, a vast variety of moist, moderately moist and moderately dry meadow types created and maintained by old agriculture seem to have shrunk into few eutrophicated types, be they tall herb-, tussocky grass dominated- or intensively grazed low-grass meadows.

Because only weak correlations between the measured ecological and conservation values were detected, it is clear that also other than biological factors, such as physiognomy and aesthetic values of the landscape, are emphasized in the original evaluation of the meadows (cf. Vainio & Kekäläinen 1997). Any given conservation values are thus not directly related to diversity values. This is, of course, typical of this type of large-scale surveys, but it does not necessarily promote the protection of valuable biotopes. On the other hand, what is there left to protect: only remnants of mineral soil meadows still persist and also their condition is alarming. It is understandable if instead of biological diversity one has to begin to emphasize the protection and restoration of picturesque landscape areas, if anything. Because of the lack of representative inland meadows on mineral soil in the area, the protection of habitats more typical of the coastal areas, e.g. seashore meadows in particular, should be emphasized.

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Appendix 1. Codes for the environmental variables.

Variable	Landscape name							
	North Ostrobothnia riverside and coast	North Ostrobothnia's mire expanse	Kainuu hillside	Suomenselkä area	Middle Ostrobothnia riverside and coast	Kuusamo hillside		
Landscape abbreviation	PPjr	PPn	Knv	Suo	KPjr	Ksv		
Landscape code	1	2	3	4	5	6		
Biog. province	Obo	Ok	Om	Ks				
Biog. province code	1	2	3	4				
Area (ha)	num. value							
Conservation value	None	Local–	Local	Local +	Provincial–	Provincial	Provincial +	National
Conservation value code	1	2	3	4	5	6	7	8
Moisture	Dry	Moist	Wet					
Moisture code	1	2	3					
Tree cover	% value							
Bush cover	% value							
No. of community types	num. value							
In use	No	Yes						
In use code	0	1						
Abandoned	No	Yes						
Abandoned code	0	1						
Years since aband.	num. value							
Grazing	None	Yes						
Grazing code	0	1						
Mowing	None	Yes						
Mowing code	0	1						
Fertilization	None	Intermediate	Heavy					
Fertilization code	0	1	2					
Former field	No	Yes						
Former field code	0	1						
Performer	num. value							
Date	num. value							
Year	num. value							

Appendix 2. Frequencies for 110 commonest species arranged with decreasing order along with their occurrence in managed, grazed and mowed areas. Indicators for traditional use of meadows are indicated with an asterisk (according to Pykälä 2001).

Species name	In use	Abandoned	Grazed	Mowed
Trifolium repens	94.2	61.0	94.2	90.9
Deschampsia cespitosa	92.8	93.2	92.3	100.0
Achillea millefolium	92.8	89.8	94.2	90.9
Ranunculus acris	88.4	89.8	86.5	90.9
Leontodon autumnalis	87.0	54.2	84.6	90.9
Agrostis capillaris	84.1	76.3	80.8	90.9
Rumex acetosa	81.2	71.2	80.8	81.8
Campanula rotundifolia	79.7	71.2	75.0	100.0
Trifolium pratense	76.8	62.7	71.2	90.9
Ranunculus repens	75.4	44.1	84.6	45.5
Poa pratensis	71.0	57.6	73.1	72.7
Vicia cracca	69.6	67.8	71.2	72.7
Filipendula ulmaria	69.6	54.2	73.1	54.5
Phleum pratense	68.1	72.9	63.5	90.9
Stellaria graminea	66.7	71.2	61.5	81.8
Urtica dioica	66.7	30.5	75.0	36.4
Festuca rubra	65.2	62.7	65.4	72.7
*Bistorta vivipara**	63.8	35.6	57.7	90.9
Taraxacum agg.	62.3	49.2	63.5	45.5
Cerastium fontanum	62.3	28.8	63.5	45.5
Rubus arcticus	59.4	57.6	63.5	54.5
Viola palustris	58.0	27.1	61.5	45.5
Plantago major	58.0	15.3	57.7	45.5
Solidago virgaurea	56.5	74.6	55.8	72.7
Rumex acetosella	56.5	32.2	51.9	81.8
Carex nigra agg.	55.1	37.3	53.8	63.6
Juniperus communis	53.6	57.6	53.8	54.5
Betula pubescens	50.7	55.9	50.0	63.6
Achillea ptarmica	50.7	42.4	53.8	27.3
Carum carvi	47.8	28.8	51.9	45.5
Sorbus aucuparia	46.4	55.9	48.1	45.5
Anthriscus sylvestris	46.4	44.1	46.2	54.5
Juncus filiformis	46.4	35.6	48.1	36.4
Galium uliginosum	46.4	27.1	50.0	27.3
Poa annua	46.4	10.2	53.8	18.2
Festuca ovina	44.9	40.7	40.4	63.6
Stellaria media	43.5	6.8	50.0	27.3
Elymus repens	42.0	49.2	38.5	63.6
Polygonum aviculare agg.	42.0	1.7	46.2	27.3
Luzula multiflora	40.6	37.3	32.7	72.7
Equisetum arvense	40.6	28.8	44.2	27.3
Geranium sylvaticum	39.1	71.2	32.7	72.7
Salix phylicifolia	39.1	55.9	44.2	27.3
Pinus sylvestris	39.1	45.8	38.5	36.4
Rumex longifolius	39.1	28.8	42.3	27.3
Galium palustre	39.1	25.4	40.4	36.4
Cirsium helenioides	37.7	33.9	42.3	27.3
Angelica sylvestris	36.2	57.6	38.5	27.3
Deschampsia flexuosa	36.2	54.2	26.9	72.7
Vaccinium vitis-idaea	36.2	52.5	34.6	45.5
Viola canina	33.3	45.8	30.8	54.5
Alnus incana	33.3	25.4	36.5	27.3
Potentilla palustris	33.3	25.4	36.5	27.3
Picea abies	30.4	40.7	32.7	18.2
Leucanthemum vulgare	30.4	32.2	28.8	45.5
*Nardus stricta**	30.4	20.3	26.9	45.5
Lathyrus pratensis	29.0	16.9	30.8	27.3
Matricaria matricarioides	29.0	1.7	30.8	27.3
Vaccinium myrtillus	29.0	39.0	26.9	36.4
Equisetum fluviatile	27.5	13.6	32.7	18.2
Veronica serpyllifolia	27.5	8.5	32.7	0.0
Ranunculus auricomus	27.5	20.3	28.8	36.4
Rhinanthus minor	27.5	37.3	23.1	63.6
Alchemilla spp.	27.5	25.4	23.1	45.5
Carex acuta	26.1	30.5	28.8	18.2
Anthoxanthum odoratum	26.1	61.0	19.2	63.6
Lysimachia thyrsiflora	24.6	16.9	26.9	27.3
Valeriana sambucifolia	24.6	30.5	25.0	36.4
Populus tremula	24.6	28.8	23.1	45.5
Epilobium angustifolium	24.6	67.8	23.1	18.2
Trientalis europaea	23.2	42.4	25.0	18.2
Galium boreale	23.2	13.6	25.0	18.2
Tanacetum vulgare	23.2	30.5	21.2	45.5
Carex aquatilis	23.2	20.3	21.2	27.3
Hieracium spp.	23.2	15.3	19.2	36.4
Caltha palustris	21.7	27.1	25.0	18.2
Capsella bursa-pastoris	21.7	3.4	25.0	9.1
Alopecurus pratensis	21.7	18.6	23.1	18.2
Rubus idaeus	21.7	32.2	23.1	9.1
Prunus padus	20.3	30.5	19.2	36.4
Juncus bufonius	18.8	1.7	23.1	0.0
Silene dioica	18.8	32.2	21.2	18.2
Hieracium umbellata agg.	18.8	30.5	15.4	27.3
Geum rivale	17.4	10.2	19.2	18.2
Prunella vulgaris	17.4	6.8	19.2	9.1
Luzula pilosa	17.4	25.4	17.3	18.2
Euphrasia stricta	17.4	15.3	15.4	36.4
Alopecurus aequalis	15.9	3.4	21.2	9.1
Rumex aquaticus	15.9	3.4	21.2	0.0
Rorippa palustris	15.9	3.4	19.2	9.1
Equisetum sylvaticum	15.9	22.0	17.3	18.2
Carex ovalis	15.9	8.5	17.3	9.1
Epilobium palustre	15.9	11.9	17.3	0.0
*Antennaria dioica**	15.9	22.0	11.5	27.3
Fragaria vesca	14.5	15.3	19.2	0.0
Pilosella agg.	14.5	13.6	15.4	18.2
Vicia sepium	14.5	10.2	15.4	18.2
Calamagrostis purpurea	14.5	18.6	13.5	27.3
Pimpinella saxifraga	14.5	5.1	13.5	18.2
Calluna vulgaris	14.5	28.8	9.6	36.4
Viola epipsila	13.0	20.3	17.3	0.0
Chenopodium album agg.	13.0	5.1	15.4	9.1
Oxalis acetosella	13.0	0.0	15.4	9.1
Alopecurus geniculatus	13.0	3.4	15.4	0.0
Agrostis canina	13.0	8.5	13.5	18.2
Scirpus sylvaticus	13.0	6.8	13.5	18.2
Euphrasia spp.	13.0	3.4	13.5	18.2
Vaccinium uliginosum	13.0	32.2	11.5	27.3
*Veronica longifolia**	11.6	47.5	9.6	27.3