Suo 38(2): 29—36, 1987

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RELATION OF PEAT NUTRIENTS TO GROUND VEGETATION COMMUNITIES ON SEDGE PINE FENS

TURPEEN RAVINTEISUUDEN SUHDE PINTAKASVILLISUUTEEN SARARÄMEILLÄ

Schneider, H. & Westman, C. J. 1987: Relation of peat nutrients to ground vegetation communities on sedge pine fens. (Tiivistelmä: Turpeen ravinteisuuden suhde pintakasvillisuuteen sararämeillä.) — Suo 38:29—36. Helsinki.

Vegetation and peat nutrient data from 167 sample plots representing microsites on sedge pine fens are related. The plant data was analysed by two numerical multivariate methods: DECORANA-ordination and TWINSPAN-classification. The connection between the results of the numerical analyses and the surface peat nutrient contents is discussed. Phosphorus, calcium and magnesium showed the closest relationship to those plant sociological variations that were interpreted as trophy-dependent. The variation in soil data within classes could not be diminished by using numerical classification methods instead of the Cajanderian peatland site type.

Keywords: peatland classification, peat nutrient contents, multivariate analysis.

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INTRODUCTION

In Finland, practical site type classification for forestry is based upon Cajander's site type theory (1909, 1913). Its basic assumption is that the same factors that determine the timber producing capacity also determine the species composition of the ground vegetation. All sites having a more or less similar ground vegetation are thus considered to form a (upland) forest or a peatland site type.

Traditionally, the term "trophy" or "trophic status" has been used to describe the fertility of the soil as reflected by the ground vegetation. According to Heikurainen, (1953, 1985) peat pH and calcium content are correlated to site type trophic status as well as total nitrogen content. Puustjärvi (1968) showed that pH, which is mostly determined by the calcium content of the surface peat, primarilly determines the species composition of the ground vegetation in uniform hydrological conditions and thus the peatland site type.

A great proportion of peatland site types are so-called composite types, i.e. their vegetation consists of a mosaic-like mixture of different plant communities (Laine et al. 1986). The relation between surface nutrient contents and ground vegetation composition is considered to be somewhat more complex on these site types than on genuine peatland site types, i.e. where the above-mentioned mosaic-like mixture cannot be found.

The aim of this study is to compare variation in the ground vegetation with the variation in the nutrient contents of the underlying surface peat. Only sedge pine fens were included in the material in order to limit the hydrological variation within the data as much as possible. An attempt is also made to classify these subcommunities into ecologically meaningful groups. Within- and between-group variation in nutrient contents of these groups will thereafter be discussed.

MATERIAL AND METHODS

The material consists of 167 sample plots from 51 sedge pine fens in their natural state from that part of Finland covered by the temperature sum range of 800 to 1350 d.d. (threshold value 5°C). The material has previously been used to describe the climatic variation in total surface peat nutrient contents (Westman 1979) and the relation of the peatland site type to surface peat physical and chemical properties (Westman 1981). (For a detailed description of the material, these works can be consulted.)

The sample plots were laid out on different site types as follows. (The site types were classified according to Heikurainen 1968 and the present English terminology is according to Laine et al. 1986. Finnish abbreviations are given in brackets.)

Low-sedge *S. papillosum* pine fen	(LkR)	44	sample plots
Tall-sedge pine fen	(VSR)	97	”
Herb-rich sedge birch-pine fen	(RhSR)	26	”

The sample plots were randomly laid out on the mire plane or on hummocks but hollows were disregarded. The mean percentage cover of each plant species was estimated on a 0.5 m^2 circular sample plot. Names of vascular plants are according to Hämet-Ahti et al. (1984) and bryophyte names according to Koponen et al. (1977).

Two volumetric peat samples (0.75 dm^3) were taken from the center of these sample plots from the 0—10 cm and 10—20 cm layers. In this paper, we discuss total nutrient contents in the whole sampling layer (0—20 cm). Vertical nutrient distribution has been discussed in detail by Westman (1981). Total nutrient contents were determined by standard laboratory methods (see Westman 1981) and are expressed gravimetrically (mg/g) and volumetrically (mg/cm^3), the latter being computed using bulk density values.

An initial clustering analysis of the material using composite clustering (COMPCLUS, Gauch 1979) indicated some obvious outliers in the material and these were omitted in the subsequent analyses. To express plant sociological gradients in the vegetation data, an ordination using detrended correspondence analysis (DECORANA, Hill 1979a) was performed. The sample plot scores along each ordination axis were correlated to surface peat nutrient content values using non-parametric (Spearman) correlation coefficient. In addition, a hierarchical classification, i.e. two-way indicator species analysis (TWINSPAN, Hill 1979b), was computed and the groups formed were contrasted with respect to nutrient contents using non-parametric (Kruskal-Wallis) analysis of variance. Non-parametric statistics were used in order to avoid the possible need to normalize the data.

RESULTS AND DISCUSSION

COMPCLUS clustering

Because of the limited ecological range and the resulting limited plant sociological variation of the data, only splitting the data into approximately six clusters was considered reasonable when performing the COMPCLUS classification. The available parameters were set thereafter and the computation yielded 17 clusters. (For computation details, see Schneider 1985.) Of these, 11 consisted of only one or two samples. These samples were treated as outliers and omitted in further analyses. According to Gauch (1979, 1982), outliers are assigned rather to small clusters than to large ones.

The outliers fell roughly into three categories: (1) sample plots having a geographically extreme location in the northern part of the study area with abundance of northern species, e.g. *Sphagnum lindbergii*, (2) sample plots with a clearly eutrophic plant composition, the main material ranging from oligotrophic sites (low-sedge *S. papillosum* pine fens) to mesotrophic ones (herb-rich sedge birch-pine fen) and (3) observations from extremely poor hummock microsites.

DECORANA ordination

DECORANA ranked species scores on the first two axes are presented in Table 1. An *a priori* interpretation of the DCA axes based on a knowledge of the ecology of the species was compared to the correlations between site scores and peat property variables (Table 2).

Axis 1 is interpreted primarily as a trophic gradient with slight characteristics of a hydrology gradient, which was to be expected by the selection of site types. Ordinations of peatland data sets with wider ecological ranges have usually revealed the nutrient and hydrology gradients as two separate axes (e.g. Jeglum 1972, Pakarinen & Ruuhijärvi 1978, Starr 1984). With increasing axis score, the nutrient and wetness requirements of the plants decrease with a few exceptions. No clear ecological interpretation of Axis 2 could be found although it explains a great propor-

Table 1. Species ranked DCA scores on the first two ordination axes.
Taulukko 1. DCA-pisteluvut kasvilajeille kahdella ensimmäisellä ordinaatioakselilla.

AXIS/AKSELI 1		AXIS/*AKSELI 2*	
Eigenvalue/*ominaisarvo* 0.52		Eigenvalue/*ominaisarvo* 0.32	
Species/*laji*	Score/*pisteluku*	Species/*laji*	Score/*pisteluku*
Calluna vulgaris	4817	*Lysimachia vulgaris*	4587
Pleurozium schreberi	4405	*Deschampsia flexuosa*	4587
Sphagnum fuscum	4393	*Eriophorum latifolium*	3980
Empetrum nigrum	4210	*Sphagnum papillosum*	3627
Rubus chamaemorus	4121	*Sphagnum subsecundum*	3199
Polytrichum strictum	3993	*Trichophorum cespitosum*	3139
Sphagnum rubellum	3913	*Carex lasiocarpa*	3013
Vaccinium uliginosum	3906	*Peucedanum palustre*	2852
Ledum palustre	3470	*Sphagnum rubellum*	2844
Andromeda polifolia	3005	*Drepanocladus fluitans*	2795
Sphagnum cuspidatum	3004	*Sphagnum cuspidatum*	2663
Trichophorum cespitosum	2997	*Deschampsia cespitosa*	2615
Chamaedaphne calyculata	2827	*Calliergon stramineum*	2426
Carex pauciflora	2455	*Carex pauciflora*	2332
Eriophorum vaginatum	2441	*Vaccinium uliginosum*	2313
Betula nana	2369	*Andromeda polifolia*	2257
Scheuchzeria palustris	2347	*Calluna vulgaris*	2200
Vaccinium oxycoccos	2129	*Calamagrostis purpurea*	2039
Molinia coerulea	2074	*Menyanthes trifoliata*	2026
Sphagnum magellanicum	2014	*Sphagnum riparium*	1964
Sphagnum papillosum	1489	*Potentilla palustris*	1930
Sphagnum recurvum coll.	1327	*Polytrichum strictum*	1858
Carex limosa	1266	*Carex magellanica*	1787
Eriophorum angustifolium	932	*Sphagnum fuscum*	1750
Carex lasiocarpa	872	*Sphagnum magellanicum*	1564
Sphagnum lindbergii	843	*Melampyrum pratense*	1542
Melampyrum pratense	747	*Molinia coerulea*	1460
Sphagnum russowii	433	*Betula nana*	1413
Carex rostrata	424	*Eriophorum vaginatum*	1346
Peucedanum palustre	421	*Ledum palustre*	1231
Melampyrum sylvaticum	267	*Vaccinium oxycoccos*	1199
Sphagnum subsecundum	264	*Pleurozium schreberi*	1144
Calliergon stramineum	131	*Eriophorum angustifolim*	1012
Drepanocladus fluitans	105	*Sphagnum recurvum* coll.	869
Equisetum palustre	34	*Epilobium palustre*	790
Polytrichum commune	3	*Carex chordorrhiza*	779
Eriophorum latifolium	—22	*Carex limosa*	766
Lysimachia vulgaris	—159	*Empetrum nigrum*	734
Deschampsia flexuosa	—159	*Equisetum palustre*	717
Carex chordorrhiza	—233	*Rubus chamaemorus*	282
Menyanthes trifoliata	—259	*Scheuchzeria palustris*	131
Potentilla erecta	—267	*Carex rostrata*	113
Drepanocladus exannulatus	—410	*Melampyrum sylvaticum*	103
Epilobium palustre	—565	*Sphagnum russowii*	—45
Calamagrostis purpurea	—753	*Drepanocladus exannulatus*	—423
Potentilla palustris	—827	*Polytrichum commune*	—640
Carex magellanica	—860	*Chamaedaphne calyculata*	—865
Sphagnum riparium	—894	*Calliergon cordifolium*	—1054
Deschampsia cespitosa	—1430	*Sphagnum lindbergii*	—1725
		Potentilla erecta	—1953

Table 2. Spearman rank correlation coefficients between surface peat nutrient contents (grav. = mg/g; vol. = mg/cm^3) and the sample plot DECORANA ordination scores.
Taulukko 2. Turpeen ravinnepitoisuuksien (grav. = mg/g; vol. = mg/cm^3) ja DECORANA-ordinaation koealojen pistelukujen välinen Spearmanin järjestyskorrelaatiokerroin.

	Axis/*Akseli* 1		Axis/*Akseli* 2	
	grav.	vol.	grav.	vol.
N	—0.468	—0.395	0.172	0.106
P	—0.701	—0.542	—0.245	—0.082
K	—0.106	—0.297	0.001	0.066
Ca	—0.679	—0.593	—0.048	0.005
Mg	—0.590	—0.548	—0.206	—0.056

n = 155
Critical value/*kriittinen arvo (5 %) = 0.150*

tion of the variation in the data (Axis 1 eigenvalue = 0.52, Axis 2 eigenvalue = 0.32). High scores seem to be associated with species prefering moving surface water, but similar species are also found with the lower scores.

Spearman rank correlation coefficients between site scores and gravimetric and volumetric peat nutrient contents for the first two axes indicated the importance of fertility. For Axis 1, there were significant correlations for N, P, Ca and Mg, both volumetrically and gravimetrically expressed while potassium was significantly correlated only when expressed volumetrically. The correlation coefficient was highest for calcium and phosphorus. The nitrogen coefficient was clearly lower than that of phosphorus and calcium while that of magnesium was intermediate.

Community trophic status has been previously shown to be strongly correlated with peat calcium content (and pH value), poorly or not correlated with potassium and phosphorus, and intermediately correlated with nitrogen (e.g. Heikurainen 1953, Vahtera 1955). According to Puustjärvi (1968), both nitrogen and phosphorus are not involved in the determination of peatland site type because their contents are determined by the vegetation itself. In this material, however, a strong correlation with phosphorus contents was found.

The weak correlation with total potassium can be attributed to the weak adsorption and high mobility of the K$^+$ ion in organogenic soils (Troedsson & Nykvist 1973). The potassium ion is much less tightly bound in the organic exchange sites than are other metal cations and is easily leached out of dead organic matter (Thompson & Roeh 1978). However, the coefficient for K is higher and becomes statistically significant when the content is expressed on a volumetrical basis. A weak correlation between trophic status and potassium content expressed volumetrically (mg/cm^3 or kg/ha per layer) is also reported by Westman (1981).

When expressed volumetrically, other nutrients show lower correlation coefficients than the corresponding gravimetrical values. For P, the difference is statistically significant. A possible reason for this is that the potassium content (grav.) is negatively correlated to bulk density while the other nutrients are positively (N, P, Ca) or not (Mg) correlated to bulk density (Table 3).

Table 3. Spearman correlation matrix of gravimetrically expressed nutrient contents, bulk density (BD) and ash content.
Taulukko 3. Korrelaatiomatriisi, josta ilmenee gravimetrisesti ilmaistujen ravinnepitoisuuksien sekä turpeen tiheyden (BD) ja tuhkapitoisuuden (ash) väliset Spearmanin korrelaatiokertoimet

	N	P	K	Ca	Mg	BD
P	0.63					
K	—0.13	0.08				
Ca	0.48	0.48	0.09			
Mg	0.22	0.35	0.22	0.70		
BD	0.57	0.30	—0.43	0.19	0.07	
ash	0.67	0.56	0.01	0.62	0.45	0.34

n = 155
Critical value/*kriittinen arvo* (5%) = 0.15

Multicollinearity between bulk density, cation exchange capacity and potassium content is largely discussed by Westman (1981). The differences in correlation between nutrients and bulk density affect the correlation coefficients between nutrients and DCA Axis 1 scores when changing to volumetrical values as the sample plot scores are negatively correlated to bulk density.

Few significant correlations were found between Axis 2 site scores and nutrient contents. Only nitrogen, phosphorus and magnesium were significantly, though very weakly, correlated. Nitrogen was positively correlated and the two other elements negatively. Again, correlation coefficients were slightly lower for volumetrically expressed contents with the exception of potassium.

TWINSPAN vegetation classification

On basis of the TWINSPAN dendrogram output, the vegetation was classified into 7 groups (Figure 1). The groups ranged from the one with the most oligotrophic vegetation (group 1), with a great proportion of hummock relevees, to mesotrophic vegetation, represented by groups 6 and 7. There were, however, some clear exceptions from this trend. Group 2 consists of samples from relatively wet sites, which was indicated by the abundance of, for example, *Sphagnum cuspidatum* and *Trichophorum cespitosum*; species not abundant in any of the other groups. Groups 3 and 4 represent the same trophy level (tall-sedge pine fens) but differ in geographic location from each other, group 4 representing sites mainly from northern Finland and group 3 sites from southern Finland. The vegetational difference consists primarily of a greater abundance of *Carex pauciflora* in the northern group. Group 6 consists of the most demanding (herb-rich) vegetation within the material, while groups 5 and 7 are meso-oligotrophic.

The mean nutrient contents of the TWINSPAN groups, gravimetrically and volumetrically expressed, and bulk density values are given in Table 4. The analysis of variance indicated significant differences between the groups at 5 % significance level for all nutrients, both gravimetrically and volumetrically expressed.

The nutrients showed clearly different trends with respect to the TWINSPAN classification. Nitrogen contents were related to both trophy and bulk density of the peat. The highest contents could be noted in the groups with the highest bulk densities (6 and 2). (The dependence of nitrogen content upon bulk density has been noted earlier in connection with the results of the DECORANA ordination (Table 3) and discussed by Westman (1981)). This relation is due to the fact that bulk density and nitrogen contents both increase with increasing degree of humification (Kivinen 1937, Päivänen 1973).

Phosphorus and nitrogen show similar trends between groups as could be expected as these nutrients are correlated to each other (Table 3). Both are bound organically (Kaila 1956) but nitrogen is more clearly correlated to bulk density since nitrogen contents are 10 to 100 times higher. The lower F-value for nitrogen is due to higher variations in nitrogen

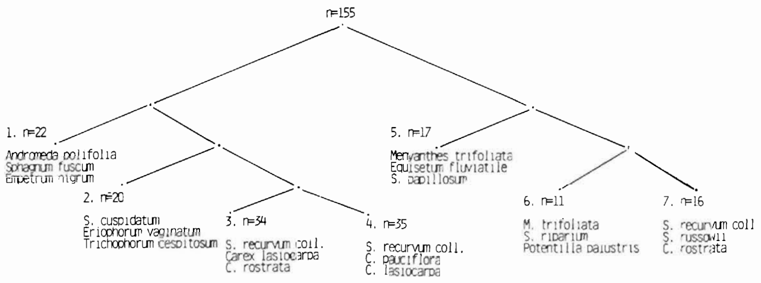

Figure 1. TWINSPAN analysis dendrogram with indicator species and number of sample plots in vegetation groups 1...7.
Kuva 1. TWINSPAN luokitustulosta kuvaava dendrogrammi. Kasvillisuusryhmien 1...7 koealalukumäärät ja indikaattorilajit.

Table 4. The average nutrient contents and average bulk density (BD; g/dm^3) of the TWINSPAN groups together with their standard deviations. $_g$ = gravimetrical content (mg/g); $_v$ = volumetrical content (mg/cm^3). The values of the Kruskal-Wallis test statistic (F) are also given.

Taulukko 4. TWINSPAN-ryhmien keskimääräiset ravinnepitoisuudet ja turpeen tiheydet (BD; g/dm^3) keskipoikkeamineen. $_g$ = gravimetrinen pitoisuus (mg/g); $_v$ = volumetrinen pitoisuus (mg/cm^3). Kruskal-Wallis varianssianalyysin testisuureen (F) arvot jokaiselle muuttujalle.

TWINSPAN	variable/*muuttuja*										
group/ *ryhmä*	N_g	N_v	P_g	P_v	K_g	K_v	Ca_g	Ca_v	Mg_g	Mg_v	BD
1	10.3 ± 2.8	.43 ± .18	.47 ± .18	.019 ± .008	1.04 ± .40	.037 ± .014	2.13 ± .57	.09 ± .04	.61 ± .16	.024 ± .010	40.4 ± 9.9
2	15.1 ± .69	.96 ± .69	.56 ± .18	.034 ± .022	.93 ± .55	.046 ± .029	2.26 ± .93	.13 ± .09	.54 ± .16	.028 ± .010	56.7 ± 21.8
3	12.2 ± 3.4	.51 ± .31	.65 ± .18	.026 ± .012	1.22 ± .39	.041 ± .019	1.51 ± .84	.11 ± .06	.58 ± .12	.023 ± .012	38.9 ± 13.7
4	13.2 ± 3.0	.53 ± .23	.65 ± .16	.026 ± .009	1.51 ± .39	.050 ± .016	2.67 ± .48	.13 ± .06	.86 ± .28	.032 ± .011	36.7 ± 9.9
5	15.1 ± 3.9	.88 ± .52	.84 ± .22	.048 ± .027	1.04 ± .58	.051 ± .025	4.23 ± 2.36	.23 ± .16	.97 ± .32	.051 ± .025	54.1 ± 20.1
6	22.7 ± 3.4	1.96 ± .53	.99 ± .23	.079 ± .018	.84 ± .49	.054 ± .023	5.57 ± 1.68	.46 ± .19	1.14 ± .43	.081 ± .033	82.5 ± 18.3
7	15.0 ± 2.5	.87 ± .34	.97 ± .15	.051 ± .017	1.24 ± .49	.053 ± .021	5.15 ± 1.34	.25 ± .06	1.08 ± .30	.052 ± .017	50.0 ± 14.8
F	48.2	49.9	59.9	54.3	24.1	14.0	58.7	58.0	63.0	63.9	42.4

contents in groups with high surface peat bulk density values.

Although K did not correlate significantly with DCA axis 1, K contents between the TWINSPAN groups are significantly different. The contents do not, however, follow the supposed trophic order of the groups in the same logical way as do other nutrients. An interesting, though difficult to explain, fact is that the F-value was considerably lower for volumetrically expressed potassium. Such a difference cannot be seen for the other nutrients. The between-group variation considerably diminishes while the within-group variation remains the same or increases, the latter effect being seen also for other nutrients than K. A possible explanation would be that, unlike other elements, K concentration is not influenced by decomposition.

Differences between TWINSPAN groups are clearly seen for calcium and magnesium. For calcium, this result was expected from the DCA ordination and previous studies. For magnesium, previous studies (e.g. Vahtera 1955) suggest that magnesium relates very poorly to the site type.

TWINSPAN group 2 can be considered the most exceptional one in the material. The mean bulk density was the second highest among the groups, although there is considerable variation, while the vegetation represented the lower end of the trophic scale. Generally, bulk density increases with increasing trophy in this material. Vegetation dominated by *Sphagnum cuspidatum* and featuring high peat nutrient contents has already been noted by Westman (1981) who suggests occasional inclusion of wood remains as a cause of the individual high bulk density observations. The two most extreme bulk density observations (141 and 112 g/dm^3) were considered as outliers and rejected in addition to the outliers identified by plant sociological methods. However, group 2 showed an unexplainably high mean bulk density linked with high contents of the nutrients bound in the organic matrix (nitrogen and phosphorus) and naturally with all volumetrically expressed contents even after this correction.

As was noted, group 4 is the northernmost one of the two comparable groups 3 and 4. (The material is somewhat biased in this respect, since the mean temperature sums for the peatland site types are: low-sedge *S. papillosum* pine fen 975 d.d., tall-sedge pine fen 1053 d.d., and herb-rich sedge birch-pine fen 1162 d.d. Groups 3 and 4 are, however, both from tall-sedge sites.) Group 4 seemed to have slightly higher nutrient contents but t-tests showed statistically significant differences only for potassium and magnesium (expressed in both ways) and gravimetrical calcium. Such a difference within a site type has been explained by the nutrient demand of the vegetation being higher under less favourable climatic conditions (Westman 1979).

Group 6 represented the highest trophy level within the material and also has the highest nutrient contents. This was seen most clearly when considering volumetrically expressed contents because also the mean bulk density is high in this group.

CONCLUSIONS

Ordination of a peatland vegetation data set with a restricted hydrology gradient should yield only one interpretable ordination axis, reflecting the variations in peat nutrient contents. However, some TWINSPAN groups showed clear exceptions from the expected nutrient gradient. These can be considered subgroups within each broader (microsite) group corresponding to the peatland site types. The restriction to only one main nutritional gradient was confirmed by comparison with peat nutrient contents. The above-mentioned subgroups also featured distinctive soil properties.

Using the vegetation composition of the sample quadrats directly to form groups rather than the site type in which they were located was expected to diminish the within-group variation (Westman 1981). This was not the case: the coefficients of variation within the peatland site types and the TWINSPAN groups formed are of about the same magnitude (Schneider 1985). Describing the vegetation on larger sample plots might have altered the vegetation classification and given a more precise classification result, thus reducing the within-group variation.

Although this study suggests a very close relationship between phosphorus and the ground vegetation composition of sedge pine fens, no causal conclusions can be made on basis of this material. The strong correlation of calcium to the trophic gradient was, on the other hand, confirmed.

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TIIVISTELMÄ:

TURPEEN RAVINTEISUUDEN SUHDE PINTAKASVILLISUUTEEN SARARÄMEILLÄ

Kasvipeite kuvattiin 167:llä lyhytkortisia sekä varsinaisia ja ruohoisia sararämeitä edustavalla 0,5 m^2 ympyränäytealalla. Alojen keskeltä otettiin tilavuustarkat turvenäytteet, joista määritettiin pääravinteiden (N, P, K, Ca ja Mg) pitoisuudet. Kasvipeitekuvauksia ei yhdistetty kuvioittain, sillä tarkoituksena oli nimenomaan mikrokasvupaikan kuvaaminen.

Kasvillisuusaineisto analysoitiin kahdella numeerisella monimuuttujamenetelmällä: DECORANA-ordinaatioanalyysillä sekä hierarkisesti ryhmittelevällä TWINSPAN-luokittelumenetelmällä. Tätä ennen voitiin 11 kasvillisuudeltaan selvästi poikkeavaa näytealaa poistaa aineistosta COMPCLUS- (ei-hierarkinen luokittelumenetelmä) analyysin perusteella. Pintaturpeen pääravinnepitoisuuksien suhdetta näin saatuihin analyysituloksiin tutkittiin ei-parametrisella korrelaatioanalyysillä ja varianssianalyysillä.

DECORANA-ordinaation perusteella voitiin kasvillisuusaineistossa erottaa vain yksi päävaihtelusuunta. Akseli on tulkittavissa ensisijaisesti trofia-akseliksi, joskin siinä on myös hydrologia-akselin piirteitä (Taulukko 1). Toiselle akselille on vaikeaa löytää minkäänlaista ekologista merkitystä. Ykkösakselin kanssa korreloivat tilastollisesti merkitsevästi kaikki tutkitut ravinteet kaliumia lukuunottamatta. Korrelaatiokertoimen absoluuttinen arvo oli korkein kalsiumin ja fosforin osalta; fosforin kohdalla yllättävä tulos. Kalium korreloi tilastollisesti merkitsevästi ykkösakselin kanssa ainoastaan silloin kun pitoisuus ilmoitettiin volumetrisesti. Muilla ravinteilla korrelaatiokertoimen absoluuttinen arvo taas laski, fosforin osalta jopa tilastollisesti merkitsevästi, siirryttäessä gravimetrisesti ilmaistuista ravinnepitoisuuksista volumetrisiin (Taulukko 2). Kakkosakseli ei korreloinut johdonmukaisesti ravinnetunnusten kanssa, ja korrelaatiokerroin oli vain muutamassa tapauksessa tilastollisesti merkitsevä.

TWINSPAN-luokituksessa erotettiin seitsemän ryhmää, jotka poikkesivat trofialtaan selvästi toisistaan ja joiden pintaturpeen pääravinnepitoisuuksissa oli selviä eroja (Kuva 1, Taulukko 4). Yhteys pitoisuuksiin ja luokittelutuloksen välillä oli selvin fosforin, kalsiumin ja magnesiumin osalta. Kaliumin yhteys luokittelutulokseen oli epäselvä, joskin tilastollisesti merkitsevä 5 % riskillä. Pitoisuuksien variaatiokertoimet olivat samaa suuruusluokkaa TWINSPAN-ryhmien ja suotyyppien sisällä, joten maatunnuksille ominaista vaihtelua ei voitu tämän aineiston puitteissa pienentää käyttämällä numeerisia menetelmiä.

Received 18. XI. 1986
Approved 10. III. 1987