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Vegetation studies on rocky grasslands in the Pilis Mountain (Hungary) II.

by
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A b s t r a c t : The article contains the second part of cenological investigations on rocky grasslands carried out at 8 sites of the Pilis Mountains in the Pilis Biosphere Reserve in its limestone range. At each of the 8 sites 8–15 samples have been examined and compared with each other according to their floral elements, ecological requirements, life-forms and cenological character. The 100 sample plots were analysed by cluster analysis with the help of computer.

INTRODUCTION

In part I we examined and compared the flora list and some ecological parameters of two places situated fairly from each other (SZERDAHELYI, 1988). In this paper, cenological investigations were carried out in one habitat at 8 sites and their ecological parameters were compared, too. The place of our investigations was the southwestern slope of Pilis Hill and the slope of the plateau. This part of the hill was chosen because this place is an important habitat in floristic respects (the presence of the endemical species *Ferula sadleriana* and several *Corydalis* species and hybrids) and we wanted to make perceptible the occurrence of the degradation.

The limestone rock grass communities are rich in species, including several rare plants. In the last years we noticed many changes in the vegetation. Till now many sites were hardly to reach but by building roads, these places became easily accesible. At the same time other areas are closed away from tourists and hang gliders for reasons of preservation. In these places we noticed hard invasional influences, several species appeared in great quantity. At some places the changes in flora have been explained by degradation processes.

MATERIAL AND METHOD

100 quadrates of 8 sites, each of them 2x2 m, were sampled according to the Braun-Blanquet method (1964). The number of samples were different in case of sites (8 to 15 samples in at a site). The data were collected from July to August in 1988. The exposition of the slope was

southwest with a gradient of 30–50°. (see Table 1.) We marked 8 sites in this rocky grassland similar to each other in many characters. First SOÓ presented data about this association of „Carex humilis- Festuca sulcata-Stipa joannis association complex" (1930). Later this association was described as Cleistogeno-Festucetum rupicolae by SOÓ (1964–80). This association is in connection with POLGÁR's paper with his floristic list (1933). In the fifties', MÁTHÉ (1956) and ZÓLYOMI (1958) gave details about this association. In his paper ZÓLYOMI gave a floristic list from a „Diplachno-Festucetum sulcatae matricum" association of the Buda Mountains.

The distribution of the floral elements, cenological character and life-forms of the species can be seen in Fig. 1–3. In Fig. 4 we used the ecological parameters as given by SOÓ (1964–80) and PRISZTER (1985). The notation is as follows: R (soil requirement), T (temperature requirement), F (water requirement), N (nitrogen requirement). The cover values were transformed according to the van der MAAREL method (1979), to render them suitable for analysis by a computer programme. The data of the sample plots were processed by the help of computer, using Czekanowski's index of similarity in a cluster analysis (see the dendrogram in Fig. 8.). The programme used PODANI's Syn-Tax III methods (1988).

The arrangement of the samples is as follows: site I with samples 1–10, site II with samples 11–25, site III with samples 26–40, site IV with samples 41–55, site V with samples 56–70, site VI with samples 71–82, site VII with samples 83–91, site VIII with samples 92–100.

Abbreviations on Fig. 1: A – Circumpolar, B – Continental, C – Eurasian, D – Mediterranean, E – Submediterranean, F – European, G – Central–European, H – South Eurasian, K – Pannonian, L – Balkan, M – Pontian, O – Carpathian, P – other e. g., East Alpine, Sarmatian, Cosmopolitan species.

Abbreviations on Fig. 2: A – indifferent, B – Festuco-Brometea, C – Festuco-Bromea, D – Festucetum valesiacae, E – Festucion rupicolae, F – Festucion vaginatae, G – Asplenio- et Seslerio-Festucion, Seslerio- et Bromo-Festucion, H – Quercetea, K – Querco-Fagea, L – Fagetalia, M – Tilio-Acerion, N – Orno-Cotinion, O – others e. g., Prunetalia, Secalietea, P – Seslerio-Festucion pallentis species.

Abbreviations on Fig. 3: Th – therophyton, TH – hemitherophyton, G – geophyton, H – hemikryptophyton, Ch – chamaephyton, N and M – phanerophyton species.

RESULTS

The rock grass communities are very sensitive to degradational occurrences (e. g. treading). On the base of our observations we noticed that where tourism is advanced, the degradational processes appear immediately. This process could be indicated at several species (e. g. *Sideritis montana, Agropyron repens, Chondrilla juncea, Bromus japonicus, Bromus squarrosus*). At the habitat of *Ferula sadleriana* the result of fencing in important species immigration started (e. g. *Centaurea micranthos, Arrhenatherum elatius, Agropyron repens*). This immigration would make a new balance approaching the original conditions. The distribution of the phytogeographical spectrum could be seen in Fig. 1. The quantity of Mediterranean (D), Central-European (G) and cosmopolitan, adventive (P) elements are different at the 8 sites. There is no difference in the quantity of other elements. The continental (B) elements are missing at site I. Observing the distribution of the cenological character on Fig. 2, the quantity of the indifferent (A) elements is the highest at site III. The level of the Festuco-Bromea and

Festuco-Brometea (B, C) elements is the lowest at site III. The quantity of Quercetea elements is the highest at the site VII.

The distribution of the life-forms can be seen on Fig. 3. The high level of the therophyton and the hemitherophyton species (Th, TH) is characteristic. The level of the other elements (Ch, G, H) is comparatively constant.

The distribution of the H values is shown at the 8 sites on Fig. 4. All of the sites have almost the same number of indifferent (R_o) species. At site II, we could see a kind of nivellation of the R values which is a sign of the degradation.

On Fig. 5. we can see the distribution of the T values. The quantity of the indifferent (T_o) species is almost the same on all sites. At the sites I–IV, the T_1 elements are present, while these values are missing on the sites V–VIII.

The distribution of the water requirement of the 8 sites (F) is shown on the Fig. 6. We can see that the level of the indifferent elements (F_o) is very low, somewhere they are missing. The appearnace of the xerophilous communities is the most characteristic at the site I and site VIII. The influence of the milder exposition is shown at the sites III, V, VI, VII. On the site IV, the F_4 elements appear. This is caused by the microrelief (valley influence).

The distribution of the N requirement can be seen on Fig. 7. The number of indifferent species (N_o) is very few, on site V they are missing. The lowest level of the N_3 elements is on the site VIII. The quantity of N_1 elements is the highest on the sites I and VIII. Probably, this is the native condition of the communities.

Running data, we gave the result the clustering of a matrix of the Czekanowski's similarity index. There are three centres in the dendrogram. Several samples are obtained only at 0.65 value. There is no close connection among them (Fig. 8).

This dendrogram shows that the individual differences dominate among the samples, more than the connection among the sites.

A c k n o w l e d g e m e n t s are due to Dr. M. RAJCZY for his advice on suitable methods for the computer analysis.

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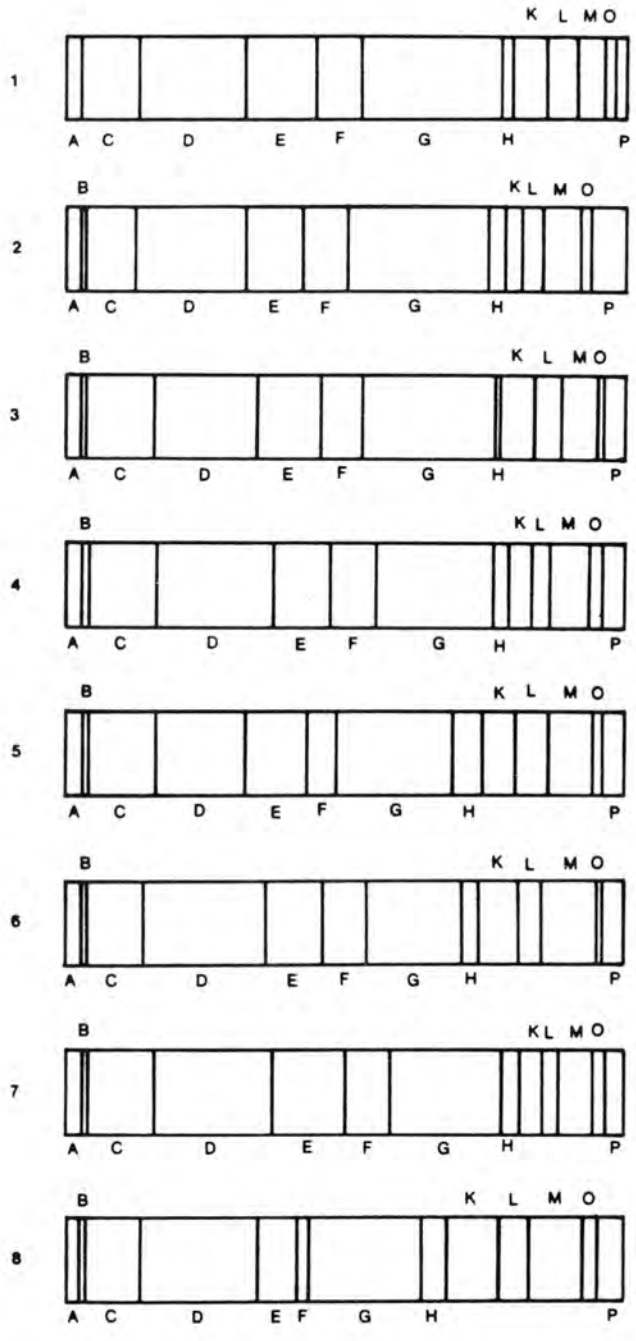


Fig. 1. Distribution of phytogeographical spectrum on the sites

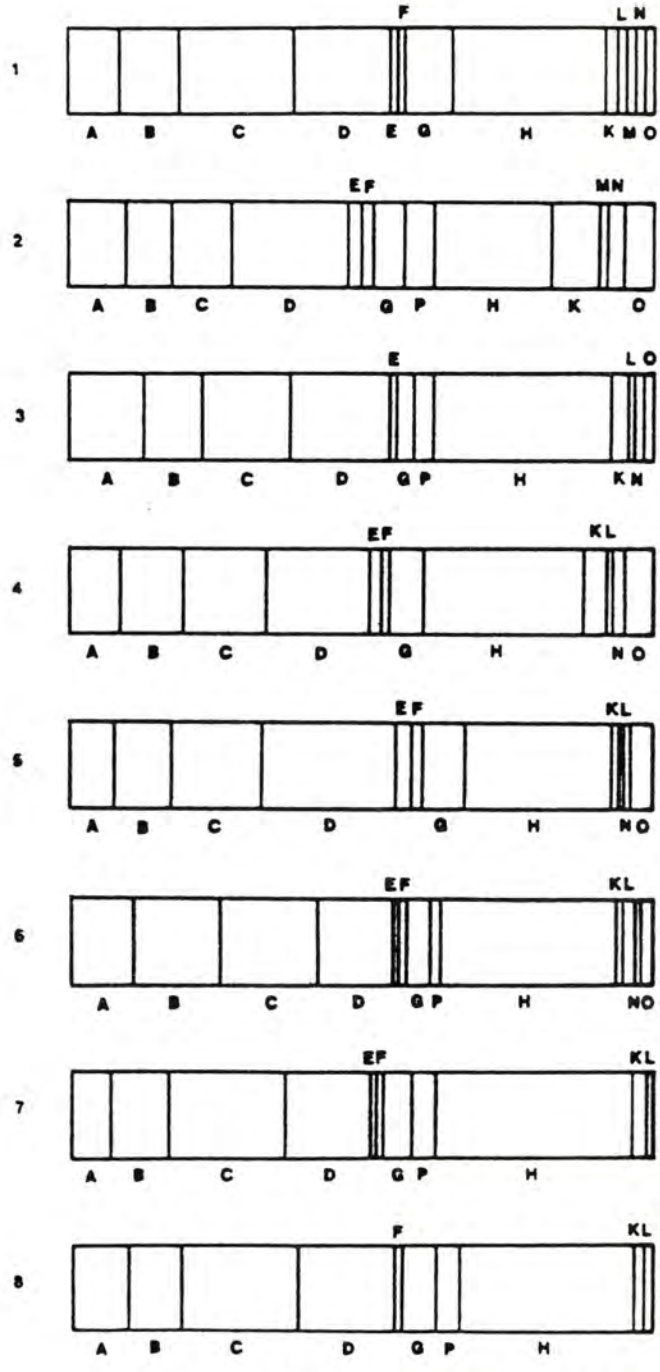


Fig. 2. Distribution of cenological characters on the sites

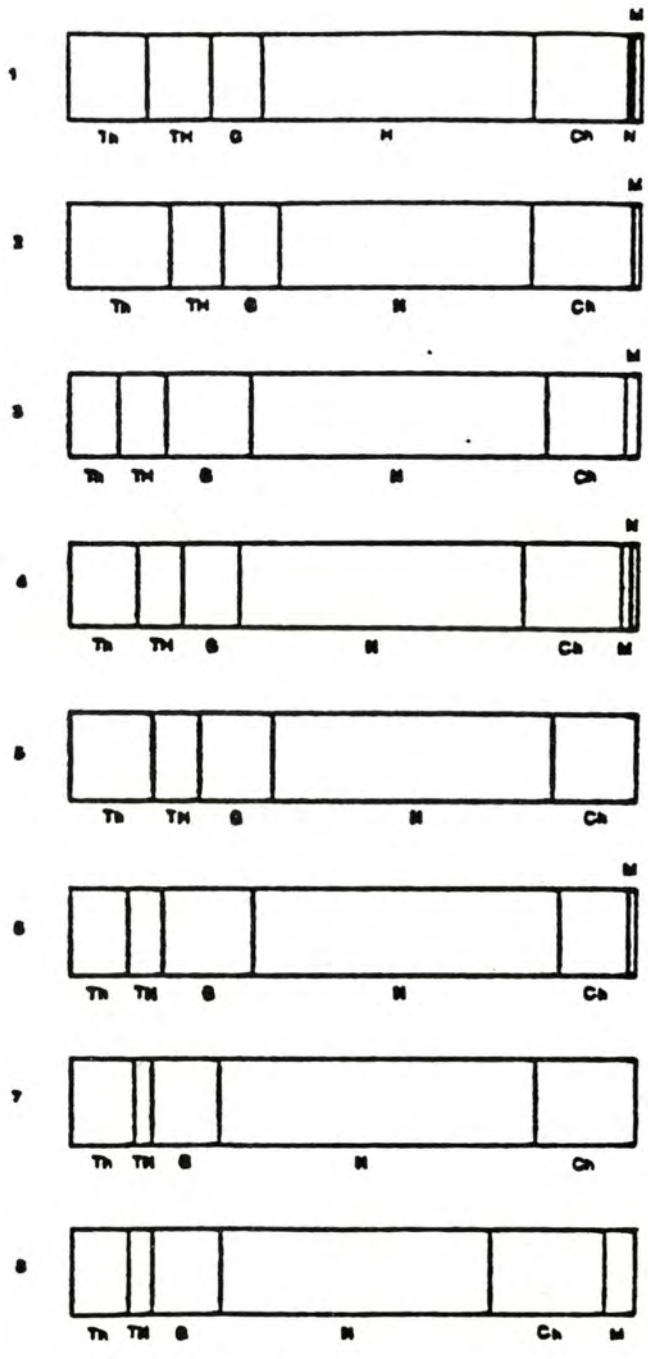


Fig. 3. Distribution of life-forms on the sites

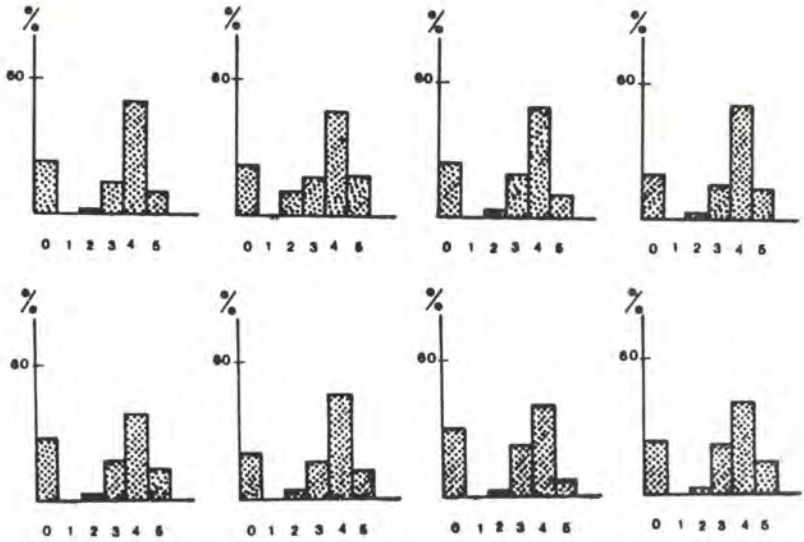


Fig. 4. Distribution of the R values on the sites

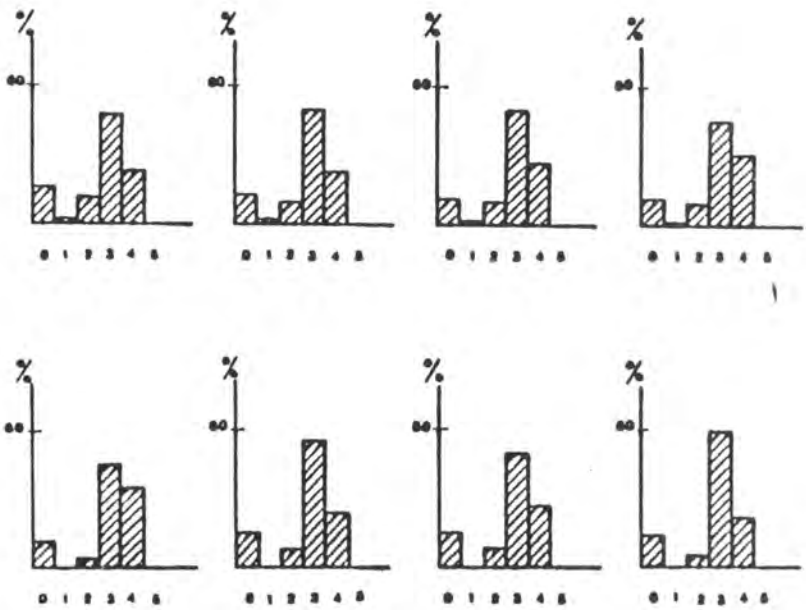


Fig. 5. Distribution of the T values on the sites

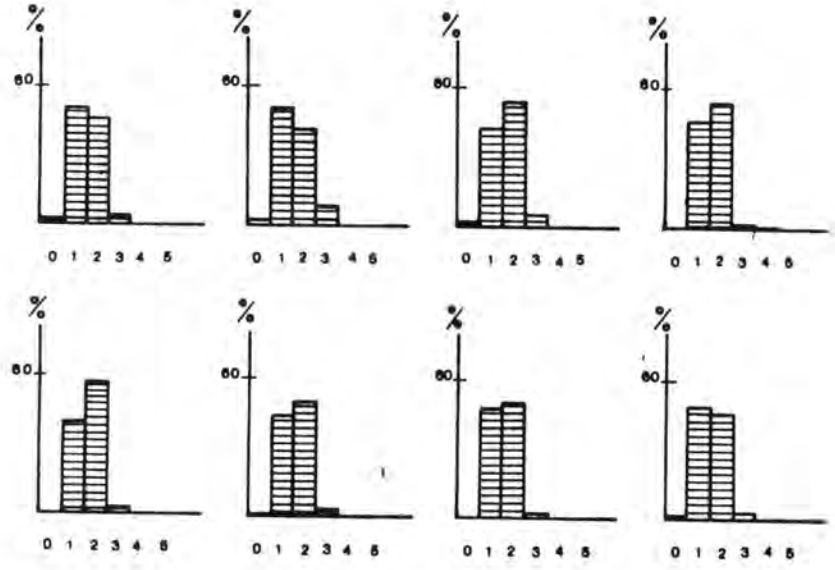


Fig. 6. Distribution of the F values on the sites

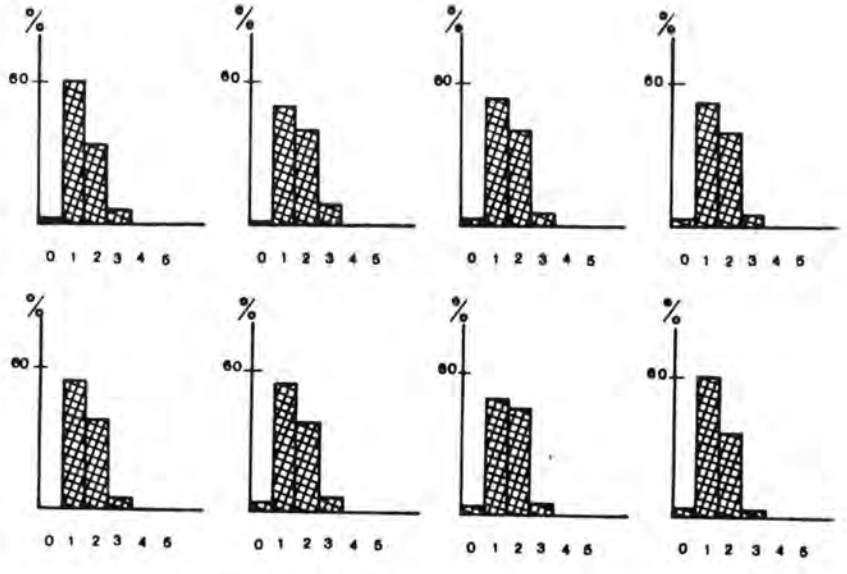


Fig. 7. Distribution of the N values on the sites

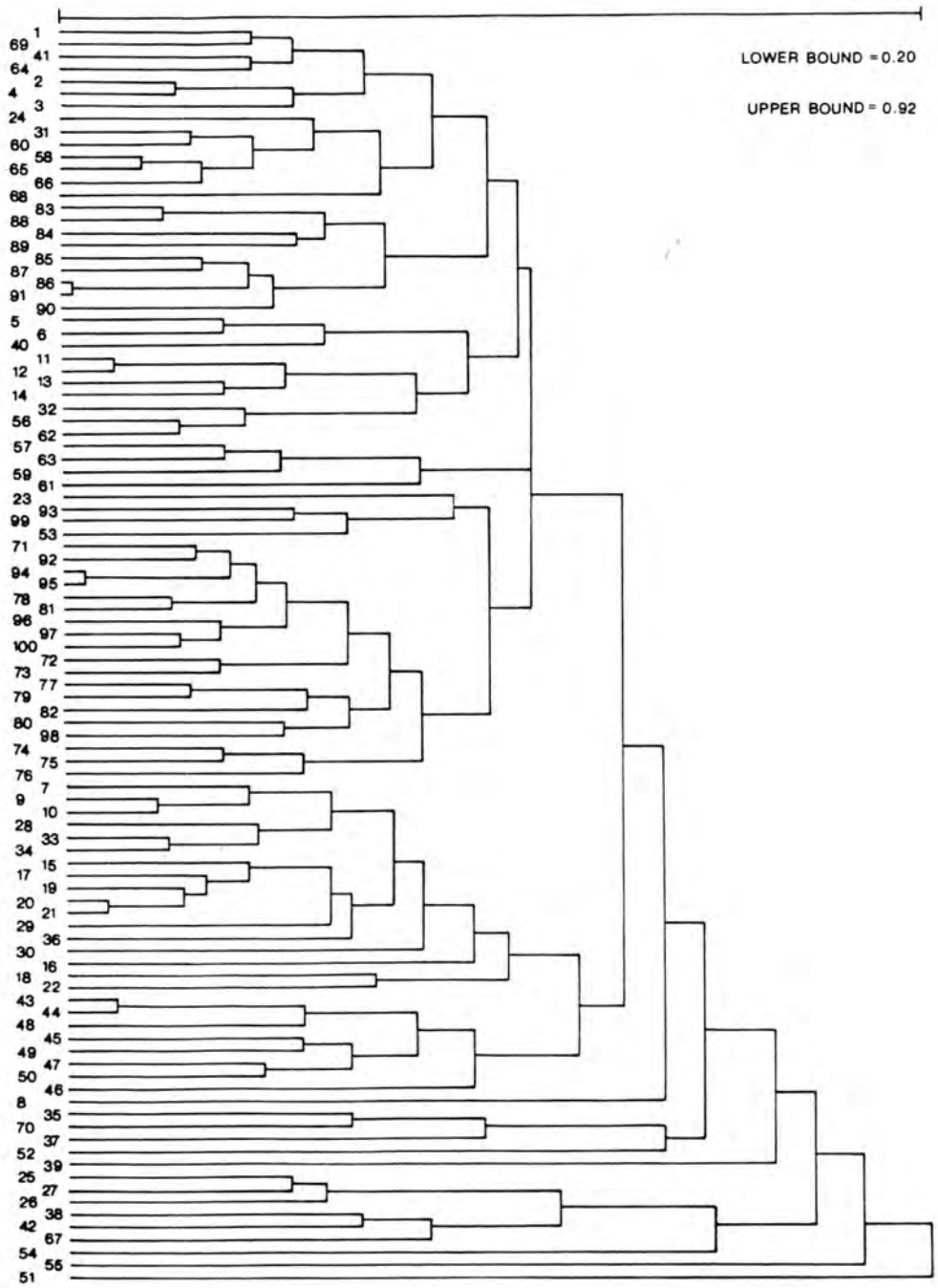
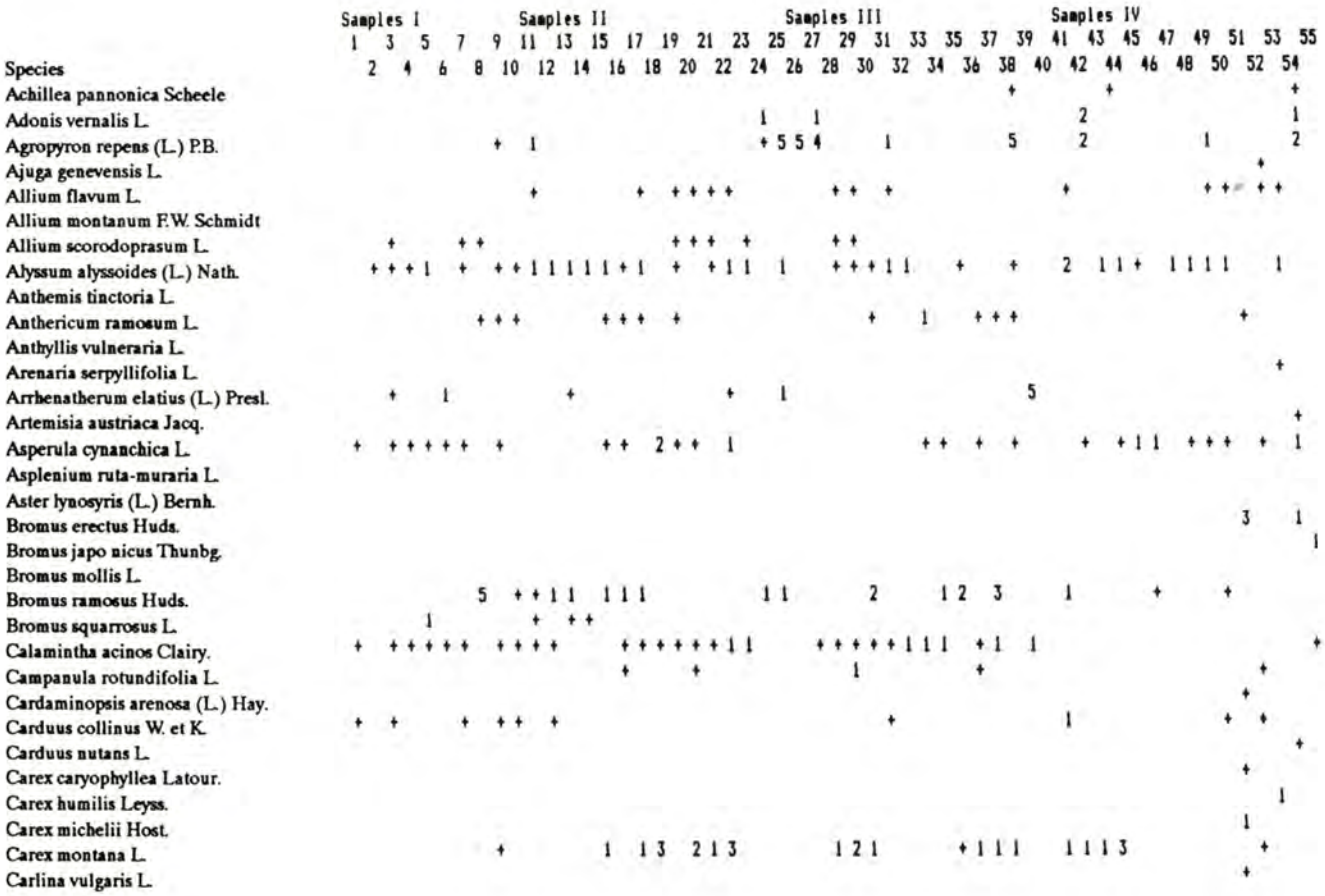


Fig. 8. Dendrogram of a matrix of Czekanowski's index of similarity

Table. Species and their cover values in sample plots



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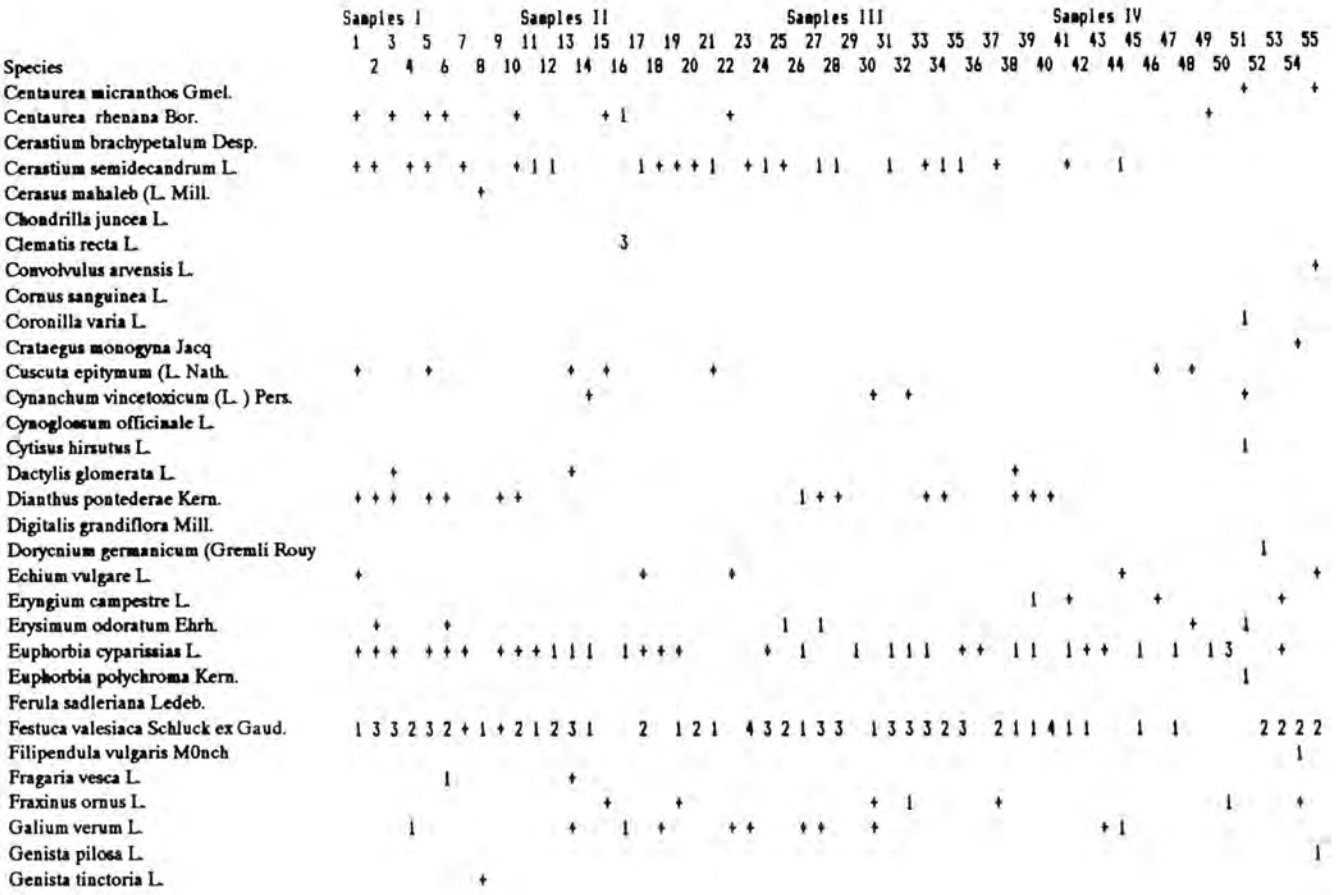

Samples I
Samples II
Samples III
Samples IV
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54
Species
Centaurea micranthos Gmel.
Centaurea rhenana Bor.
Cerastium brachypetalum Desp.
Cerastium semidecandrum L.
Cerasus mahaleb (L. Mill.
Chondrilla juncea L.
Clematis recta L.
Convolvulus arvensis L.
Cornus sanguinea L.
Coronilla varia L.
Crataegus monogyna Jacq
Cuscuta epitymum (L. Nath.
Cynanchum vincetoxicum (L.) Pers.
Cynoglossum officinale L.
Cytisus hirsutus L.
Dactylis glomerata L.
Dianthus pontederae Kern.
Digitalis grandiflora Mill.
Dorycnium germanicum (Gremli Rouy
Echium vulgare L.
Eryngium campestre L.
Erysimum odoratum Ehrh.
Euphorbia cyparissias L.
Euphorbia polychroma Kern.
Ferula sadleriana Ledeb.
Festuca valesiaca Schluck ex Gaud.
Filipendula vulgaris M0nch
Fragaria vesca L.
Fraxinus ornus L.
Galium verum L.
Genista pilosa L.
Genista tinctoria L.

Table (cont. 2.)

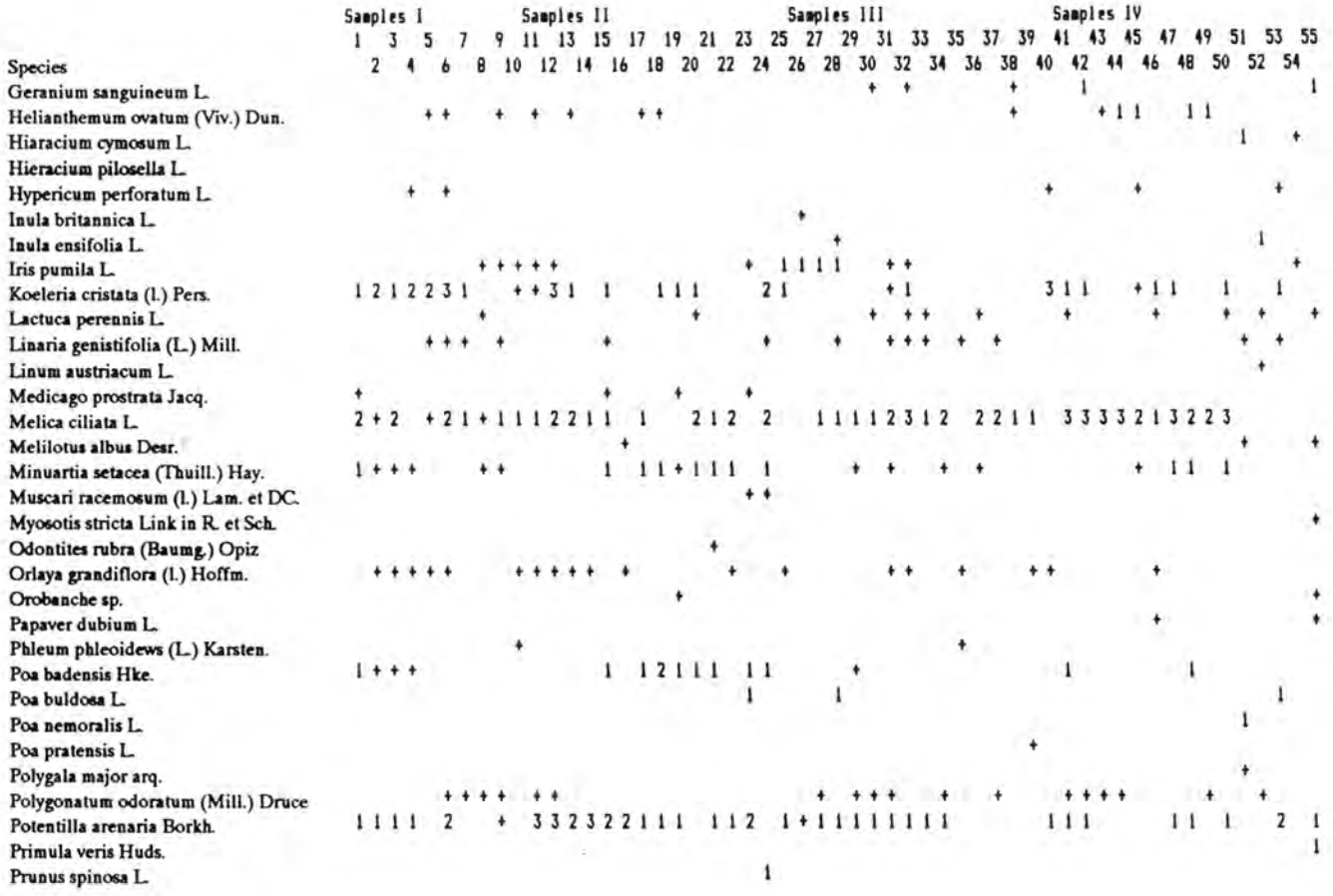

Samples I
Samples II
Samples III
Samples IV
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54
Species
Geranium sanguineum L.
Helianthemum ovatum (Viv.) Dun.
Hiaracium cymosum L.
Hieracium pilosella L.
Hypericum perforatum L.
Inula britannica L.
Inula ensifolia L.
Iris pumila L.
Koeleria cristata (l.) Pers.
Lactuca perennis L.
Linaria genistifolia (L.) Mill.
Linum austriacum L.
Medicago prostrata Jacq.
Melica ciliata L.
Melilotus albus Desr.
Minuartia setacea (Thuill.) Hay.
Muscari racemosum (l.) Lam. et DC.
Myosotis stricta Link in R. et Sch.
Odontites rubra (Baumg.) Opiz
Orlaya grandiflora (l.) Hoffm.
Orobanche sp.
Papaver dubium L.
Phleum phleoidews (L.) Karsten.
Poa badensis Hke.
Poa buldosa L.
Poa nemoralis L.
Poa pratensis L.
Polygala major arq.
Polygonatum odoratum (Mill.) Druce
Potentilla arenaria Borkh.
Primula veris Huds.
Prunus spinosa L.

Table (cont. 3.)

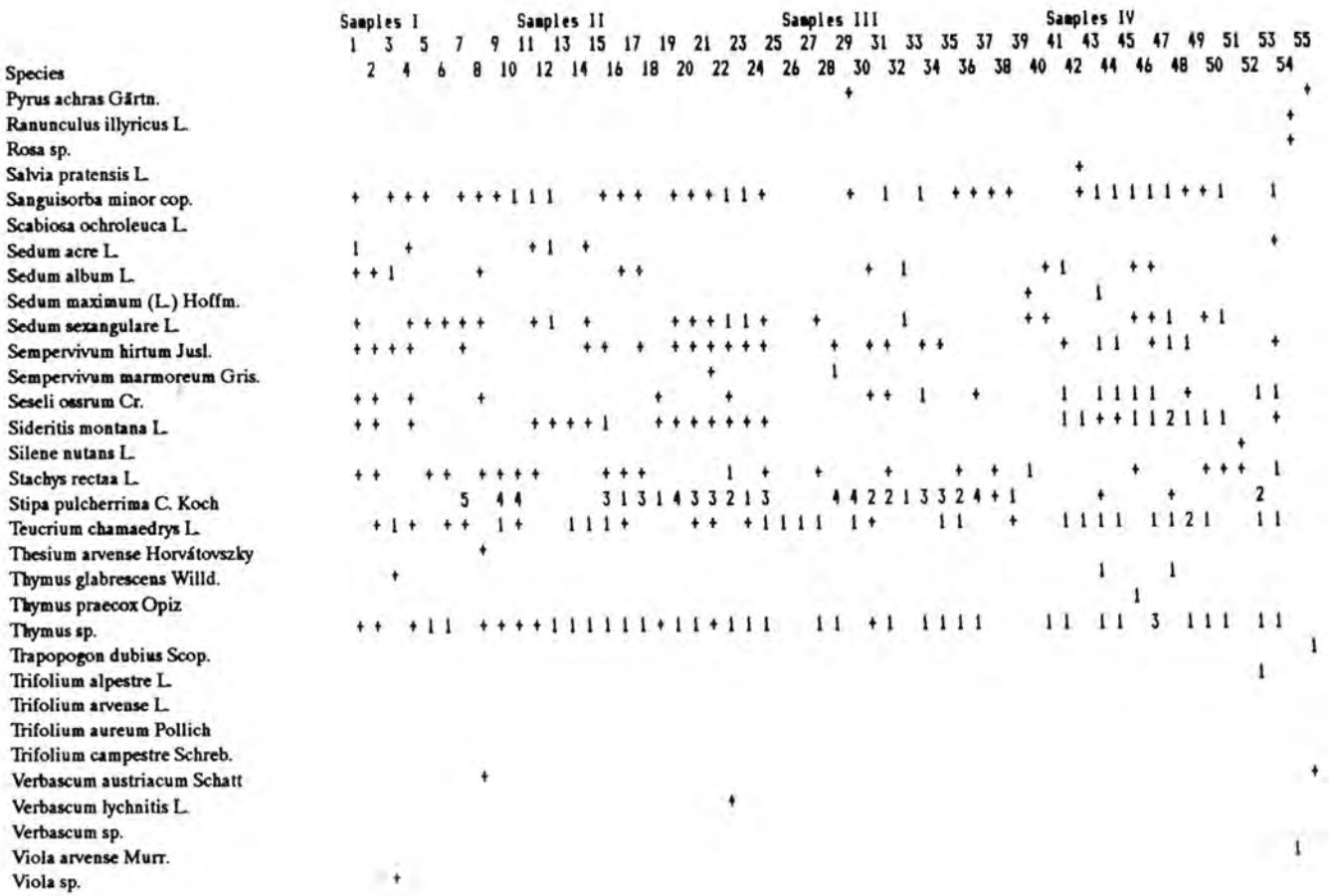

Samples I
Samples II
Samples III
Samples IV
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54
Species
Pyrus achras Gärtn.
Ranunculus illyricus L.
Rosa sp.
Salvia pratensis L.
Sanguisorba minor cop.
Scabiosa ochroleuca L.
Sedum acre L.
Sedum album L.
Sedum maximum (L.) Hoffm.
Sedum sexangulare L.
Sempervivum hirtum Jusl.
Sempervivum marmoreum Gris.
Seseli ossrum Cr.
Sideritis montana L.
Silene nutans L.
Stachys rectaa L.
Stipa pulcherrima C. Koch
Teucrium chamaedrys L.
Thesium arvense Horvátovszky
Thymus glabrescens Willd.
Thymus praecox Opiz
Thymus sp.
Trapopogon dubius Scop.
Trifolium alpestre L.
Trifolium arvense L.
Trifolium aureum Pollich
Trifolium campestre Schreb.
Verbascum austriacum Schatt
Verbascum lychnitis L.
Verbascum sp.
Viola arvense Murr.
Viola sp.

Table (cont. 4.)

Species	Samples V 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	Samples VI 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	Samples VII	Samples VIII	f	K	A-D
Achillea pannonica Scheele	+ + +			+ 1	8	I	+-1
Adonis vernalis L.					4	I	1-2
Agropyron repens (L.) P.B.	3 1	3 1 + 1 + 2 2 1 + +			23	II	+-5
Ajuga genevensis L.					1	I	+
Allium flavum L.	+ + + +	+ + + + 1 + + + + + + + + + 1 + + + +		+ + + +	40	II	+-1
Allium montanum F.W. Schmidt	+ +				2	I	+
Allium scorodoprasum L.	+ + + +	+ + + + + +		+ +	20	I	+
Alyssum alyssoides (L.) Nath.	+ 1 1 1 1 1 1 1 + +	3 1 1 1 1 2 + 1		+ 1 1 1 +	59	III	+-3
Anthemis tinctoria L.		1 + 1 + 1 1 1 1		1 + 1 + + 1	14	I	+-1
Anthericum ramosum L.	+				14	I	+-1
Anthyllis vulneraria L.		1 1 1			3	I	1
Arenaria serpyllifolia L.					1	I	+
Arrhenatherum elatius (L.) Presl.	1 1	1 + 1 1			12	I	+-5
Artemisia austriaca Jacq.					1	I	+
Asperula cynanchica L.	+ 1 1 1 + + 1	+ + + 1 + + + +		1 + 1	46	III	+-2
Asplenium ruta-muraria L.		+			1	I	+
Aster lynosyris (L.) Bernh.	+				1	I	+
Bromus erectus Huds.					2	I	1-3
Bromus japo nicus Thunbg.					1	I	1
Bromus mollis L.		+ + + +			4	I	+
Bromus ramosus Huds.	1	+ + 1 + + 1 1 1 + + +		+ 1	30	III	+-5
Bromus squarrosus L.	+ 1 1 + + 1		+ +	+ +	14	I	+-1
Calamintha acinos Clairy.				+	30	III	+-1
Campanula rotundifolia L.	+ +				7	I	+-1
Cardaminopsis arenosa (L.) Hay.					1	I	+
Carduus collinus W. et K.	+ 1 + +	1	+ 1	1	18	I	+-1
Carduus nutans L.					1	I	+
Carex caryophyllea Latour.					1	I	+
Carex humilis Leyss.					1	I	1
Carex michelii Host.					1	I	1
Carex montana L.	1 2				21	II	+-3
Carlina vulgaris L.					1	I	+

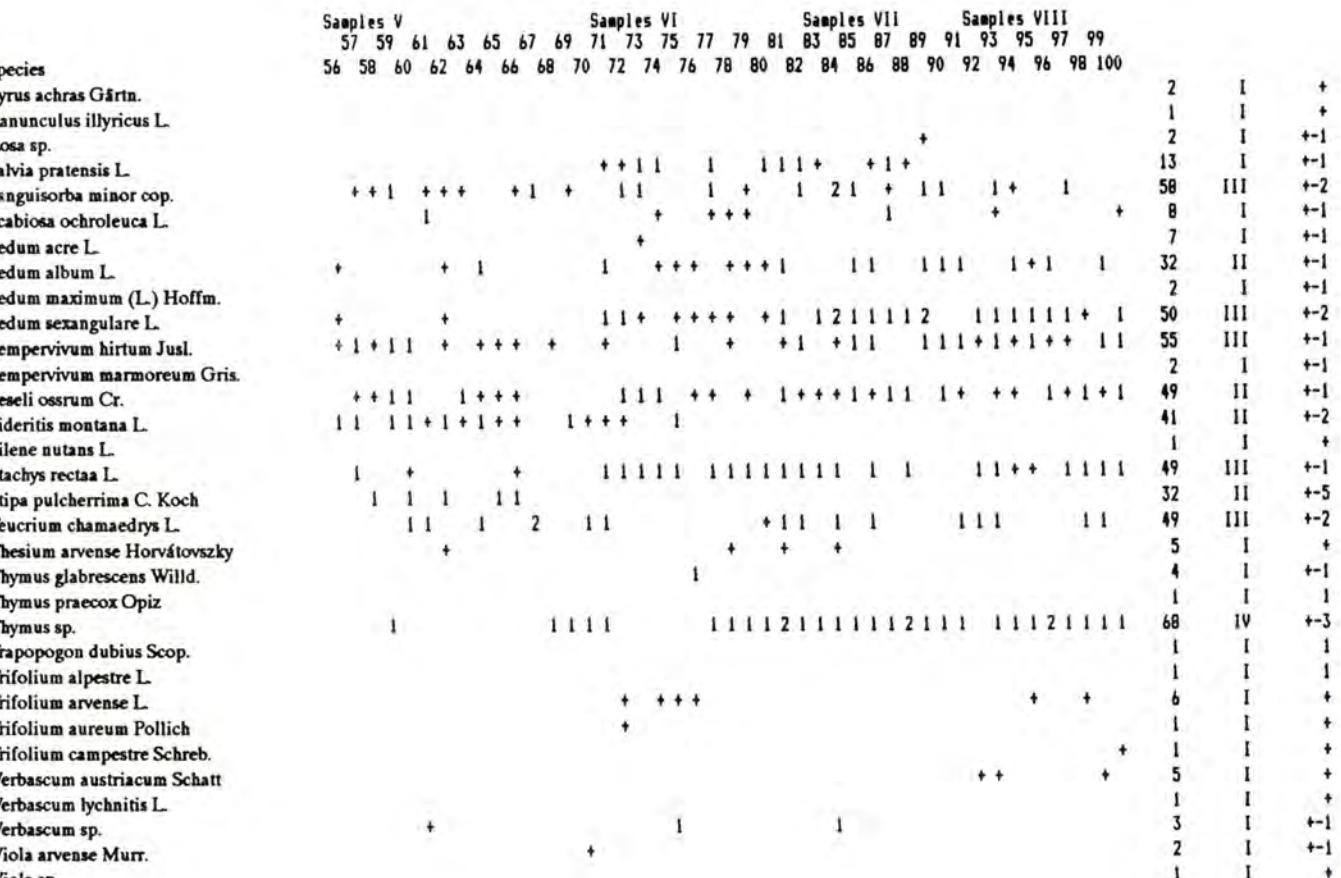
Table (cont. 5.)

Species	Samples V 56 57 58 59 60 61 62 63 64 65 66 67 68	Samples VI 69 70 71 72 73 74 75 76 77 78 79 80	Samples VII 81 82 83 84 85 86 87 88 89 90	Samples VIII 91 92 93 94 95 96 97 98 99 100			
Centaurea micranthos Gmel.		+ 1 + +			6	I	+-1
Centaurea rhenana Bor.	+ + + +	+ 1			15	I	+-1
Cerastium brachypetalum Desp.		+ +	2		3	I	+-2
Cerastium semidecandrum L.	+ + + + 1 + +	2 + 1 1 3 2 1 1 1	1 1 1 1 1 + 1 1 1 1 1 1 1 1	1 1 1 1 1 1	59	III	+-3
Cerasus mahaleb (L. Mill.					1	I	+
Chondrilla juncea L.		+			1	I	
Clematis recta L.					1	I	3
Convolvulus arvensis L.					1	I	+
Cornus sanguinea L.				+	1	I	+
Coronilla varia L.					1	I	1
Crataegus monogyna Jacq					1	I	+
Cuscuta epitymum (L. Nath.		+			8	I	+
Cynanchum vincetoxicum (L.) Pers.			+		5	I	+
Cynoglossum officinale L.		1 +			2	I	+-1
Cytisus hirsutus L.					1	I	1
Dactylis glomerata L.			1		4	I	+
Dianthus pontederae Kern.	+ +	+ + + + + + 1	1 + 1	+ + + 1 + + +	34	II	+-1
Digitalis grandiflora Mill.			+		1	I	+
Dorycnium germanicum (Gremli Rouy		1			2	I	1
Echium vulgare L.		1			6	I	+-1
Eryngium campestre L.			+ +	1	7	I	+-1
Erysimum odoratum Ehrh.			1	1 1	9	I	+-1
Euphorbia cyparissias L.	1 1 1 1 1 + 1 + + + 1 + 1 2 + 2 1	1 + 1 1	1 1 1 1 1 1 1 1 1	1 1 1 1 + 1 1	53	III	+-3
Euphorbia polychroma Kern.					1	I	1
Ferula sadleriana Ledeb.				1	1	I	1
Festuca valesiaca Schluck ex Gaud.	3 5 3 3 3 3 3 3 3 3	2 2 1 3 3 3 5 4 5 5 4 3 3 3 3 3 3 3 1	2 2 1 1 2 2 3 3 4 4 3 3 4 4 3		85	V	1-5
Filipendula vulgaris M0nch					1	I	1
Fragaria vesca L.					2	I	+-1
Fraxinus ornus L.		1			8	I	+-1
Galium verum L.	+	+	+	+ +	16	I	+-1
Genista pilosa L.					1	I	1
Genista tinctoria L.					1	I	+

Table (cont. 6.)

Species	Samples V 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70	Samples VI 71 72 73 74 75 76 77 78 79 80 81	Samples VII 82 83 84 85 86 87 88 89 90 91	Samples VIII 92 93 94 95 96 97 98 99 100			
Geranium sanguineum L.		+ + + + 1 + 1 1	1 1 1	1		17	I	+-1
Helianthemum ovatum (Viv.) Dun.	1 +	1	+ +			19	I	+-1
Hiaracium cymosum L.						2	I	+-1
Hieracium pilosella L.				+		1	I	+
Hypericum perforatum L.		+			+	7	I	+
Inula britannica L.						1	I	+
Inula ensifolia L.						2	I	+-1
Iris pumila L.	+ +	1 + + + + 1 1 1 + 1 1		+ 1 + 1 + 2 1	1	38	II	+-2
Koeleria cristata (l.) Pers.	2 1 +	1 1 1 1 1 1 1 1	1 1 1 1 1 1	1 3 1 1 1 1		53	III	+-3
Lactuca perennis L.	+ + + +		1 + +			18	I	+-1
Linaria genistifolia (L.) Mill.	+ + + + + + + +	+	+ + + + +	+ +		30	II	+
Linum austriacum L.						1	I	+
Medicago prostrata Jacq.						4	I	+
Melica ciliata L.	3 1 3 1 2 2 3 + 1 1 2 3 2 2 1	1 1	1 1 2 2 2 1 1 1 2		1	72	IV	+-3
Melilotus albus Desr.						3	I	+
Minuartia setacea (Thuill.) Hay.	1 + + + + 1 1 1 1	+ 1 + + 1	+	1 1 1	1	41	III	+-1
Muscari racemosum (l.) Lam. et DC.		+ + + + +		+		8	I	+
Myosotis stricta Link in R. et Sch.						1	I	+
Odontites rubra (Baumg.) Opiz						1	I	+
Orlaya grandiflora (l.) Hoffm.	+ +					21	II	+
Orobanche sp.	+	+ + +	+	+	+	8	I	+
Papaver dubium L.	+ +					4	I	+
Phleum phleoidews (L.) Karsten.	+ 1	+ + 1 + +	+ +	1	1 +	15	I	+-1
Poa badensis Hke.	+ 1 1 1 1 1 1	1		+ 1		25	II	+-2
Poa buldosa L.	+ 1 1 1	+ +	+ + + 1	1 1 1 1 3 1 1 1		21	II	+-3
Poa nemoralis L.						1	I	1
Poa pratensis L.						1	I	+
Polygala major arq.						1	I	+
Polygonatum odoratum (Mill.) Druce	+ + + +	+ 1 +	+ 1 +			27	II	+-1
Potentilla arenaria Borkh.	1 1 1 1 1 + 1	1 1 2 1 1 1 1 2	1 1 + 1	1 2 2 1 1 3	1 1	66	IV	+-3
Primula veris Huds.						1	I	1
Prunus spinosa L.						1	I	1

Table (cont. 7.)


Samples V
Samples VI
Samples VII
Samples VIII
57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99
56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
Species
Pyrus achras Gärtn.
Ranunculus illyricus L.
Rosa sp.
Salvia pratensis L.
Sanguisorba minor cop.
Scabiosa ochroleuca L.
Sedum acre L.
Sedum album L.
Sedum maximum (L.) Hoffm.
Sedum sexangulare L.
Sempervivum hirtum Jusl.
Sempervivum marmoreum Gris.
Seseli ossrum Cr.
Sideritis montana L.
Silene nutans L.
Stachys rectaa L.
Stipa pulcherrima C. Koch
Teucrium chamaedrys L.
Thesium arvense Horvátovszky
Thymus glabrescens Willd.
Thymus praecox Opiz
Thymus sp.
Trapopogon dubius Scop.
Trifolium alpestre L.
Trifolium arvense L.
Trifolium aureum Pollich
Trifolium campestre Schreb.
Verbascum austriacum Schatt
Verbascum lychnitis L.
Verbascum sp.
Viola arvense Murr.
Viola sp.