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ELEMENT CONCENTRATION CADASTERS OF HALOPHYTIC PLANT COMMUNITIES IN HUNGARY

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Accumulation of sodium and chloride is characteristic of the halophytic asteraeous and chenopodiaceous plants. The K/Na ratio in the obligate halophytes is generally less than 1, although their potassium content is also high.

In addition, the foliage of some halophytes (e.g. Camphorosma annua, Lepidium cartilagineum, Lotus tenuis, Scorzonera parviflora) contains rather high quantities of heavy metals. In the roots and leaves of Pholiurus pannonicus several heavy metals and rare elements can be detected, the quantities of which are very low in other plant species. Monocots are characterized by a smaller total content of detectable elements as well as an element concentration cadaster of narrower range (0.1–1000 µg/g), than dicots.

Introduction

The aim of the so-called multielement investigations carried out within the framework of the International Biosphere-Geosphere Program is the detection of the chemical composition of the different components (such as: soil, vegetation) of ecosystem (c. LIETH and MARKERT 1985, 1988; MARKERT 1986). An investigation of several plant communities in Hungary was accomplished with the above-mentioned aims. In the present work the chemical composition of the soils and the vegetation of some salty areas in the floristic region of the Eu-Pannonicum is presented.

The area of the solonetz and solonchak saline soils, developed secondarily (as a result of drainage) in the Hungarian Great Plain is about 600 000 ha. A great part of this region, where plant communities composed of characteristic halophytes are occurring, is under nature conservation.

Material and Methods

Sampling was carried out following the prescriptions of the multielement cadaster investigations (cf. LIETH and MARKERT 1985, 1988).

Sampling sites investigated were as follows:

1. **Apajpuszta, Kiskunság National Park.** Five exemplars each of the following species of the mosaic-like plant communities (Lepidio-Camphorosmetum annuae, Agrosti-Caricetum distantis) occurring on solonchak soils were sampled: Agrostis alba, Artemisia santonicum, Festuca pseudovina, Carex distans, Juncus gerardi, Lepidium cartilagineum, Limonium gmelini, Lotus tenuis, L. siliquosus, Plantago maritima, Scorzonera parviflora, Podospermum canum, Puccinellia distans.

2. **Hortobágy National Park.** Five exemplars each of the following species of the plant communities (Camphorosmetum annuae, Artemisio-Festucetum pseudovinae) occurring on the solonchak-solonet soils were sampled: Artemisia santonicum, Atriplex hastata, A. littoralis, Camphorosma ovata, Festuca pseudovina, Juncus gerardi, Kochia prostrata, Limonium gmelini, Lotus tenuis, Pholiusrus pannonicus, Puccinellia distans.

(The names of species occurring on both sampling sites were underlined.)

Soil samples from each 10 cm layer of a 1 m deep soil profile were also collected at both sites.

Prior to digestion, the different organs (such as roots, stems, leaves, inflorescences) of the plants were separated. After digestion the amounts of the following elements were determined by a Thermo-Jarrel Ash ICP-AES in the soil and plant samples: Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Si, Sr, Ti, V, Zn. The chloride content was determined by a chloride ion analyzer made by Radelkis, Hungary.

Results of investigations

Element content of soils

The pH of the investigated salty soils is alkaline or very alkaline. The pH-values measured in the soil profiles of Hortobágy and Apajpuszta were 8.2-8.3 and 9.3-10.5, respectively (Tables 1-2).

On the basis of the ratio between the two cations (STEFANOVITS 1992) the profiles in Apajpuszta and Hortobágy are of the calcium-magnesium and the magnesium-calcium character, respectively. In the latter soil profile a higher sodium content (3325-8278 $\mu\text{g/g}$) was also detected. The total amount of the detected elements was also higher in the soil profile of Hortobágy. In this sample, the contents of Al (5824-11 899 $\mu\text{g/g}$) and heavy metals (8964-14 688 $\mu\text{g/g}$) also exceeded those of Apajpuszta. The heavy metal contents in the soil of Apajpuszta ranged from 2375 to 6387 $\mu\text{g/g}$.

Amongst heavy metals, the quantity of iron was significant in the soil samples. However, Mn, Zn, V and Pb were also detected in rather high quantities. The investigated heavy metals (Co, Cu, Cr, Fe, Mn, Ni, Pb, V, Zn) although also detected in the lower soil layers, concentrated in the 50 cm surface layer because of the upward streaming of water in these soils. The amount of detectable chloride was low.

Table 1

Element concentration in the subsequent layers of the profile of the sodic soil in Apajpuszta (in $\mu\text{g/g}$ d.w.)

Layers in cm:	0—10	10—20	20—30	30—40	40—50	50—60	60—70	70—80	80—90	90—100
Al	3207	4248	5238	3319	2594	2022	1434	1532	1106	959
As	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ba	30.1	50.5	49.0	38.8	29.0	20.5	13.1	28.9	16.3	9.2
Ca	38986	8695	9605	10273	10371	9595	44407	49102	37030	39309
Cd	0.39	0.39	0.48	0.32	0.31	0.25	0.17	0.21	0.17	0.16
Cl	1.0	1.0	0.8	0.0	1.0	1.0	2.0	1.0	1.0	2.0
Co	2.5	3.4	3.4	2.5	2.1	1.9	1.3	1.4	1.6	1.9
Cr	3.9	5.3	6.3	3.9	2.9	2.2	1.3	1.5	0.78	0.50
Cu	4.9	6.2	5.3	3.9	3.3	6.1	2.2	2.9	2.2	2.5
Fe	4140	5067	6181	4074	3485	2938	2337	2696	2253	2245
Ga	2.8	4.3	5.7	3.9	3.7	3.6	2.2	3.3	2.6	2.9
K	526	593	707	383	244	173	112	127	103	107
Li	5.4	7.9	93.	6.9	6.2	5.1	2.7	3.2	1.9	1.6
Mg	5908	8468	9159	9832	13043	13490	7716	11529	6425	4914
Mn	138	161	154	124	126	133	114	138	111	106
Mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na	3769	2185	1897	1289	670	478	291	366	305	293
Ni	6.5	9.4	9.9	7.8	6.6	5.7	3.8	3.8	3.5	4.2
P	281	218	230	192	210	242	130	132	98.8	95.4
Pb	3.8	3.1	2.7	2.1	2.0	1.9	1.4	1.2	1.7	2.3
Se	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Si	1123	1160	1235	1213	1156	1166	1020	1068	857	772
Sr	48.9	98.9	106	121	135	110	70.8	127	77.4	52.3
Ti	16.5	13.3	18.2	12.2	13.5	18.3	25.8	24.8	22.4	22.4
V	4.3	4.0	4.9	4.5	4.7	4.2	2.8	3.0	2.6	6.1
Zn	15.2	18.3	19.4	13.4	11.8	10.1	8.5	7.7	7.2	6.1
pH in water	10.5	10.3	10.2	10.0	9.9	9.6	9.3	9.4	9.4	9.5
pH in n KCl	9.9	9.6	9.5	9.4	9.2	9.0	8.7	8.9	8.9	9.0

Table 2

Element concentrations in the subsequent layers of the profile of the sodic soil in Hortobágy (in $\mu\text{g/g}$ d.w.)

Layers in cm:	0—10	10—20	20—30	30—40	40—50	50—60	60—70	70—80	80—90	90—100
Al	5824	10868	11462	11899	10871	9828	8944	8794	8352	8727
As	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B	0.0	5.6	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ba	61.1	90.1	75.1	81.5	102	136	138	105	93.9	97.9
Ca	3878	4908	2223	2522	4709	19624	7277	10456	10211	60664
Cd	0.54	0.60	0.68	0.59	0.55	0.61	1.77	0.82	0.84	1.0
Cl	1.0	1.0	ny	1.0	1.0	1.0	2.0	1.0	1.0	2.0
Co	10.3	11.0	10.2	10.2	9.6	8.2	7.0	7.4	8.1	9.1
Cr	11.4	21.2	22.3	22.5	19.9	17.6	15.6	15.3	14.7	16.1
Cu	14.8	21.7	21.3	21.7	19.6	16.9	12.2	11.8	12.1	13.4
Fe	8476	13052	14160	14270	13097	11646	11215	11867	11327	12547
Ga	3.5	10.9	11.0	10.4	10.1	9.2	7.9	8.6	9.0	8.6
K	822	1618	1674	1637	1467	1274	982	868	880	860
Li	8.5	17.6	18.7	19.1	17.8	17.3	17.7	17.7	17.6	17.8
Mg	2161	3859	4072	4168	4366	5489	7012	7170	7419	7217
Mn	351	246	207	240	292	270	288	284	295	349
Mo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na	3324	8264	8278	7445	6645	6027	4405	3772	3934	4016
Ni	18.6	30.9	34.9	39.1	43.0	36.7	28.0	26.1	26.9	29.3
P	161	124	120	126	147	220	301	293	270	283
Pb	26.1	16.5	17.2	12.0	11.5	9.6	7.8	7.7	7.9	10.3
Se	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Si	774	868	851	737	726	804	836	664	791	780
Sr	19.7	51.4	34.2	33.8	39.8	45.2	73.8	82.4	83.3	67.6
Ti	8.4	7.0	7.0	5.7	6.0	6.6	7.4	6.9	7.7	9.0
V	19.1	18.5	17.4	15.6	14.6	13.9	12.3	12.2	11.3	12.6
Zn	35.7	52.6	57.2	56.3	54.7	49.4	44.8	43.5	43.8	46.8
pH in water	8.2	8.2	7.2	8.2	8.2	8.2	8.3	8.3	8.3	8.3
pH in n KCl	8.1	8.1	8.1	8.1	8.1	8.1	8.3	8.3	8.3	8.3

Table 3

Element contents in the leaves of the investigated species in Apajpuszta (in $\mu\text{g/g}$ d.w.)

	Ca	K	Mg	Na	Cl	Σ heavy metals*	Σ elements investigated**	K/Na
<i>Lotus tenuis</i>	<u>12955</u>	10258	3513	3711	80	236	32070	2.76
<i>L. siliculosus</i>	<u>17415</u>	10708	2882	288	130	206	35415	3.71
<i>Plantago maritima</i>	3556	3360	2489	<u>19523</u>	<u>600</u>	253	30900	0.17
<i>Lepidium cartilagineum</i>	9249	10495	3074	<u>32949</u>	160	<u>642</u>	63266	0.31
<i>Artemisia santonicum</i>	5236	11348	<u>9234</u>	9423	130	251	31325	1.22
<i>Scorzonera parviflora</i>	<u>17125</u>	12748	4202	<u>26163</u>	<u>900</u>	<u>692</u>	63542	0.48
<i>Podospermum canum</i>	<u>12708</u>	11275	4689	4651	270	507	37241	2.42
<i>Limonium gmelini</i>	5334	10441	6495	<u>17618</u>	<u>770</u>	164	42115	0.59
<i>Carex distans</i>	3954	6126	<u>976</u>	447	70	<u>589</u>	13206	13.7
<i>Juncus gerardi</i>	3220	6337	5931	6556	200	298	22854	1.62
<i>Agrostis alba</i>	3751	4602	942	2576	90	610	13216	1.78
<i>Festuca pseudovina</i>	3136	4239	1037	1680	50	492	10856	3.27
<i>Puccinellia distans</i>	3021	1957	1111	7398	65	354	15317	0.26

*Heavy metals: Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, V, Zn.

**Elements investigated: Ca, K, Mg, Na and heavy metals.

Table 4

Element contents in the leaves of the investigated species in Hortobágy (in $\mu\text{g/g}$ d.w.)

	Ca	K	Mg	Na	Cl	Σ heavy metals*	Σ elements investigated**	K/Na
<i>Lotus tenuis</i>	<u>14405</u>	5885	<u>6480</u>	4856	260	1676	36353	1.25
<i>Artemisia santonicum</i>	4140	9493	2250	9432	100	216	29458	1.00
<i>Podospermum canum</i>	6975	<u>19532</u>	3466	9723	430	537	41565	2.00
<i>Atriplex hastata</i>	3190	9466	1001	<u>11645</u>	<u>1370</u>	208	29040	0.8
<i>A. littoralis</i>	<u>13062</u>	<u>13384</u>	<u>7990</u>	<u>28555</u>	<u>800</u>	382	67356	0.4
<i>Camphorosma annua</i>	4161	<u>13385</u>	2366	<u>26845</u>	370	917	50599	0.44
<i>Kochia prostrata</i>	<u>10913</u>	<u>12974</u>	3514	3750	30	<u>1103</u>	33815	3.40
<i>Limonium gmelini</i>	4523	8631	5610	<u>10545</u>	<u>730</u>	125	31554	0.8
<i>Juncus gerardi</i>	3004	4519	1202	3357	90	473	13945	1.3
<i>Festuca pseudovina</i>	1231	4407	1584	1584	30	908	10899	2.78
<i>Pholiurus pannonicus</i>	1802	1141	930	2541	10	<u>3454</u>	12120	0.4
<i>Puccinellia distans</i>	1585	3089	781	1968	40	768	9999	1.5

*Heavy metals: Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, V, Zn.

**Elements investigated: Ca, K, Mg, Na and heavy metals.

Table 5
Element concentration cadasters of the organs of
Limonium gmelini sampled in Hortobágy

	0.01	0.1	1	10	100	1000	10000 $\mu\text{g/g}$
Inflorescence	Co	Pb	Ba	Al	Si	Ca	<u>K</u>
		Se	Cu	B		Mg	
		Ti	Li	Fe		Na	
		V	Ni	Mn		P	
				Sr			
				Zn			
Stem	Cd	Co	Ba	Al	P	Ca	
		Ga	Cu	B	Si	K	
		Mo	Li	Fe		Mg	
		Pb	Mn	Sr		Na	
		Se	Ni	Zn			
		Ti					
Leaf	Cd Co	Ga	Ba	Al	Cl	Ca	<u>Na</u>
		Ni	Cu	B	Si	K	
			Li	Fe		Mg	
			Mo	Mn		P	
			Pb	Sr			
			Se	Zn			
Root	Cd Cr		Ti				
			V				
		Cd	Co	B	Mn	Al	
		Cr	Ga	Ba	P	Ca	
			Li	Cu	Si	Fe	
			Mo	Sr		K	
			Ni	Ti		Mg	
			Pb	Zn		Na	
			V				

Element cadaster of plants

On alkaline soils obligate and facultative halophytes occur alike. Amongst obligate halophytes, some species of the Chenopodiaceae family, such as Atriplex hastata, A. littoralis, Camphorosma annua as well as members of other families, such as Artemisia santonicum, Lepidium cartilagineum, Limonium gmelini, Plantago maritima and Podospermum canum can be mentioned. The leaves (when comparing the element contents of plants, the chemical composition of leaves was taken into consideration) of the above listed species contain high quantities of Na (Tables 3–4). These species can be classified as sodic halophytes.

Table 6

Element concentration cadasters of the
organs of Pholiurus pannonicus sampled in
Hortobágy

		0.1	1	10	100	1000 $\mu\text{g/g}$
Leaf	Cd	B	Ba	Mg	Al	
		Co	Cl	Mn	Ca	
	Cr	Cu	Sr	P	Fe	
		Ga	Ti	Si	K	
		Li	Zn		Na	
		Ni				
		Pb				
		V				
Stem	Cd	B	Ba	Al	Ca	
		Co	Zn	Fe	Na	
	Cr	Cu		K		
		Ga		Mg		
		Li		Mn		
		Ni		P		
		Pb		Si		
		Sr				
		Ti				
		V				
Root	Cd	B	Ba	K	Al	
		Co	Cu	Mn	Ca	
	Cr	Cr	Ni	Na	Fe	
		Ga	Pb	P	Mg	
		Li	Sr	Si		
			Ti			
			V			
			Zn			

A higher amount of Na (32 949 $\mu\text{g/g}$) was detected in the leaves of Lepidium cartilagineum, which species has been mentioned by WEISSENBÖCK (1969, cit. in ELLENBERG 1982) as having a high Na-demand.

In the leaves of plants accumulating higher amounts of Na, the Ca content is relatively lower. The Ca/Na ratio in the leaves of obligate halophytes is less than 1 (Tables 3—4). The foliage of the salt accumulating Plantago maritima also contains a small amount of Ca (cf. KÖNIGSHAFEN and KINZEL 1986). Nevertheless, in the leaves of some halophytes (e.g. Lepidium cartilagineum, Scorzonera parviflora, Podospermum canum, Atriplex littoralis) beside Na, a relatively high amount of Ca was also detected.

The chloride contents of the investigated alkaline soils in Apajpuszta and Hortobágy are similarly low. However, the leaves of some halo-

Table 7

List of elements detected in higher amounts than the average in the roots and leaves of the investigated species

	Roots	Leaves
<i>Lotus tenuis</i>	Al, Ca, Cu, Ga, Li Sr, Zn	B, Ca, Fe, K, Li, Pb, Sr, Ti, V, Zn
<i>L. siliculosus</i>	Ca, Cu, Mg, Sr, V, Zn	Ba, Ca, Cl, K, Sr
<i>Plantago maritima</i>	B, Na	Cu, Mg
<i>Lepidium cartilagineum</i>	K	Cl, Co, Fe, K, Mg, Mn, Na, Si
<i>Artemisia santonicum</i>		Cl, Cu, K, P, Zn
<i>Scorzonera parviflora</i>		Cl, Ba, Ca, Fe, K, Mg, Zn
<i>Podospermum canum</i>	Ba, Cu, Fe, K, Mn	Al, Ba, Cl, Ca, Cu, K, Mg, Na, Sr, Zn
<i>Atriplex hastata</i>	B, K, P	Cl, Na, Ni, P
<i>A. littoralis</i>		Co, K, Mn, Na
<i>Camphorosma ovata</i>	Cl	Cl
<i>Kochia prostrata</i>	Ca, K	Al, B, Ca, K, Mn
<i>Limonium gmelini</i>	B, Cu, Mo, Ni, Sr	B, Cl, K, Mg, Mo, Na, Se, Zn
<i>Carex distans</i>	Pb, Si, Zn	Pb
<i>Juncus gerardi</i>	Al, Ba, Co, Cu, Fe, Li, Ga, Mg, Mn, Ni, Pb, Si, Ti, Zn	K, Pb
<i>Agrostis alba</i>	Al, Ba, Fe, Ga, Mn, Ni, Pb, Ti, Zn	Fe, Mn
<i>Festuca pseudovina</i>	Al, Cu, Fe, Ga, Mn, Ni, Pb, V, Zn	Al, Fe
<i>Pholiurus pannonicus</i>	Co, Cr, Cu, Fe, Ga, Ni, Pb, V	B, Cr, Co, Fe, Ga, Li, Mn, Ni, Pb, Ti, V
<i>Puccinellia distans</i>	Al, Ca, Ga, Mn, Na, Ni, Ti, Zn	Na, Si

phytes (e.g. *Plantago maritima*, *Atriplex hastata*, *A. littoralis*, *Scorzonera parviflora*, *Limonium gmelini*) contain a high amount of this element. In the foliage of some chenopoidaceous species beside Na and Cl a higher quantity of K was also detected. In the obligate halophytes the K/Na ratio is generally less than 1 (ALBERT 1982). A higher Na content of the soil, or rather a higher uptake of Na by the plant seems to interfere with its K uptake (ALBERT 1982).

Table 8

Element contents of the leaves of Agrostis alba (in $\mu\text{g/g d.w.}$) sampled on chernozem and solonchak soils, respectively

	Ca	K	Na	Mg	Σ heavy metals	Σ elements investigated	K/Na
Jászfalu (chernozem soil)	3149	8383	272	1780	544	15477	30.8
Fülöpháza (chernozem soil)	2218	9250	678	2079	335	16429	13.6
Apajpuszta (solonchak soil)	3751	4602	2576	942	610	13326	1.7

The leaves of the species of the Papilionaceae family (such as Lotus tenuis, L. siliculosus) contain a high amount of a Ca and a relatively lower amount of Na. The element accumulation of their roots is also significant (Table 7).

The leaves of some halophytes (e.g. Camphorosma annua, Lepidium cartilagineum, Lotus tenuis, Scorzonera parviflora) are characterized by an elevated heavy metal (Fe, Mn and Zn) content as well. This phenomenon can be observed first of all in the species occurring on the soils containing a higher amount of heavy metals in Hortobágy. The heavy metal content of the annual Pholiurus pannonicus is conspicuous. In the roots and leaves of this species several such heavy metals or rare elements (such as Co or Ga) could have been detected, which occur in other species only in rather low amounts (Table 7). In the roots of Juncus gerardi some rare elements (such as Ga and Li) were also detectable. Samples from Hortobágy contained more heavy metals. OTTE et al. (1993) also established that plants of salt marshes, such as Spartina anglica and Aster tripolium, depending on the Cd, Cu and Zn content of the soils, are also capable of accumulating higher quantities of heavy metals.

Agrostis alba samples, occurring on chernozem and wet alkaline soils, respectively, showed different chemical composition of their leaves. In the leaves of plants grown on the solonchak soil, the K content is lower, and the Na content is 3-9 times higher than in the leaves of plants collected on the chernozem soil. Thus, the K/Na ratio is much lower in the plants of the sodic soil (Table 8).

The leaves and roots of Agrostis alba grown on sodic soils contain higher quantities of heavy metals (e.g. Fe, Mn, Ni, Pb). Some heavy metal tolerant populations and ecotypes of this species, occurring on soils containing higher quantities of heavy metals are well known (HUNTER et al. 1987; DUWENSEE 1993).

Pholiurus pannonicus
Hortobágy



Stem Ca: 1032 $\mu\text{g/g}$
K: 717
Mg: 470
Na: 2252
Cl: -
Heavy metals 887

Leaf Ca: 1802
K: 1141
Mg: 930
Na: 2541
Cl: 10
Heavy metals 3554

Shoot Ca: 2246
K: 886
Mg: 1163
Na: 839
Cl: 5
Heavy metals 4956

The total amount of detected elements is always higher and the range of their occurrence is wider (24.705–66.566 $\mu\text{g/g}$) in the dicots than in the monocots (9.959–15.252 $\mu\text{g/g}$).

As example can be mentioned the element concentration cadasters of one dicotyledonous and one monocotyledonous characteristic halophytic plant species, respectively. The detectable elements are present in the dicotyledonous species within a wider range (0.01–10.000 $\mu\text{g/g}$, Tables 6–7).

The investigated elements occurred in the roots and leaves of some species in higher quantities. These can be considered as accumulator species (Table 8).

The intensive root system of monocots — compared with the extensive root system of dicots — contains several elements in higher quantities.

Puccinellia distans
Hortobágy

Apaj

Ca: 1637
K: 3080
Mg: 1292
Na: 2051
Cl: -
Heavy metals 272

Ca: 3021
K: 1957
Mg: 1111
Na: 7398
Cl: 65
Heavy metals 352

Ca: 1040
K: 3858
Mg: 581
Na: 5224
Cl: -
Heavy metals 148

Ca: 11482
K: 1505
Mg: 2913
Na: 10269
Cl: 30
Heavy metals 2296



Inflorescence

Ca: 1134 ug/g
K: 720
Mg: 496
Na: 556
Cl: -
Heavy metals 177

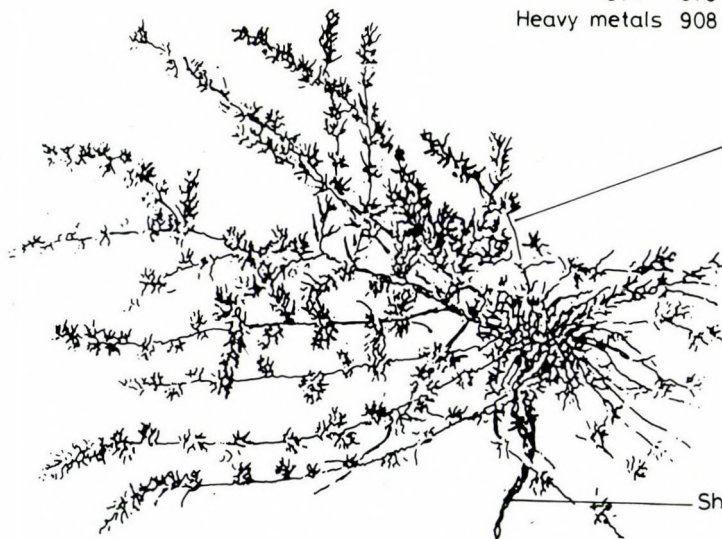
Leaf Ca: 1585
K: 3089
Mg: 781
Na: 1968
Cl: 40
Heavy metals 768

Stem Ca: 1184
K: 2472
Mg: 669
Na: 1904
Cl: -
Heavy metals 374

Shoot Ca: 6710
K: 2127
Mg: 3440
Na: 3112
Cl: 30
Heavy metals 1728

Camphorosma annua
Hortobágy

Leaf , Ca: 4164
K : 13385
Mg: 2366
Na: 26845
Cl : 370
Heavy metals 908



Stem Ca: 3071
K : 11377
Mg: 1803
Na: 19073
Cl : -
Heavy metals 351

Shoot Ca: 2331 $\mu\text{g/g}$
K : 8645
Mg: 1415
Na: 7848
Cl : 30
Heavy metals 392

Limonium gmelini

Hortobágy

Apaj

Ca : 3317
K : 13040
Mg : 2438
Na : 5335
Cl : -

Heavy metals 284

Ca : 1627
K : 8750
Mg : 1898
Na : 3184
Cl : -

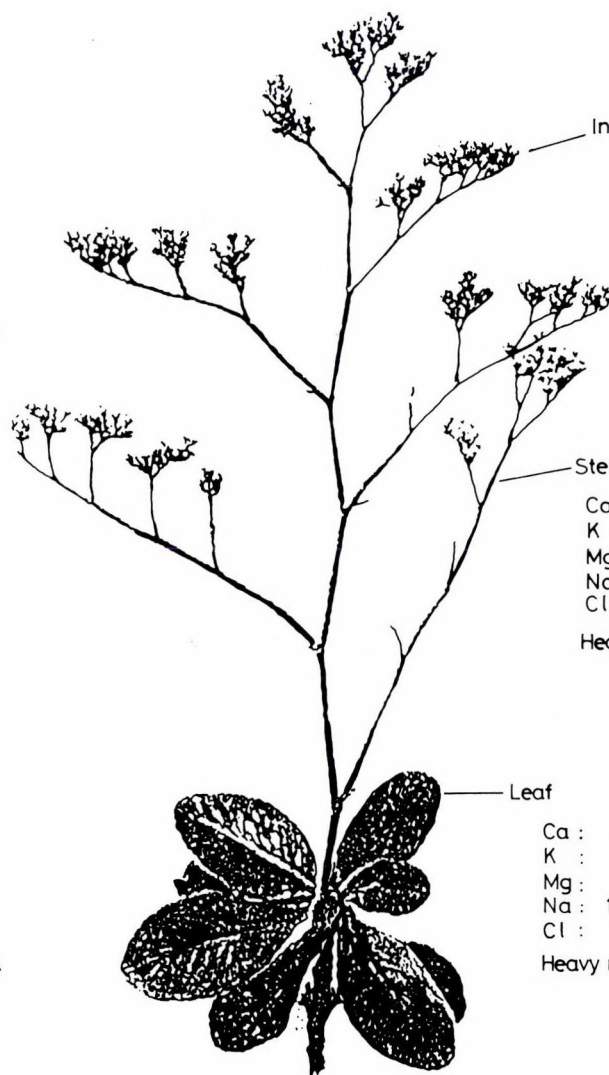
Heavy metals 617

Ca : 5334
K : 10441
Mg : 6495
Na : 17618
Cl : 770

Heavy metals 164

Ca : 8801
K : 3097
Mg : 2216
Na : 3184
Cl : 90

Heavy metals 617



Inflorescence

Ca : 2210
K : 13020
Mg : 3276
Na : 5354
Cl : -

Heavy metals 133

Stem

Ca : 1047
K : 7211
Mg : 1274
Na : 4064
Cl : -

Heavy metals 86

Leaf

Ca : 4523
K : 8631
Mg : 5610
Na : 10595
Cl : 730

Heavy metals 125

Shoot

Ca : 3269 $\mu\text{g/g}$
K : 2678
Mg : 2023
Na : 1632
Cl : 300

Heavy metals 2192

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CLASSIFICATION-ANALYTIC MODELS FOR VEGETATION AND NUTRIENT RELATIONS OF MANGROVE SWAMPS IN WEST AFRICA

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Vegetation-nutrient relations in mangrove swamps were modelled by classification of species according to occurrence within certain ranges of soil nutrient values. Although overlap was observed in the distribution of most species, restricted occurrences were noted particularly within one range of magnesium values. Simple correlation analysis revealed mangroves as related to soil nutrients at highly statistically significant levels. The sum of exchangeable cations, at concentrations present in the soils was observed to be limiting to mangrove performance, while saturation of the exchange complex by magnesium promoted the performance of species. Multiple regression analysis revealed the performance of canopy species to be highly explained by magnesium and calcium while the groundlayer was explained by iron, organic, carbon and manganese. The analyses indicated species performance to be significantly determined by varying levels and proportions of nutrients in mangrove soils.

Introduction

Mangroves are trees which occur along brackish/saline intertidal estuaries and shorelines in the tropics and subtropics. The mangrove soils consist of peat, calcareous mud and sandy deposits in which nutrient levels fluctuate due to the complex hydrology of the estuaries and littoral areas. For example, cation concentrations in mangrove soils have been observed to correlate with extent of tidal inundation and seepage (NAIDOO (1980). But since mangrove species often exhibit zonation in a spatial context from the shores inland, the relationships between the mangroves and nutrient factors are often viewed in terms of differences in values of soil nutrients between monospecific zones of species (CLARKE and HANNON 1967; MOORMAN and PONS 1974; HUYNH-CONG-THO and EGASHIRA 1976).

In South Africa, Naidoo (1980) related the occurrence of the mangrove species Avicennia nitida to a cation exchange capacity (CEC) range of 23.7 me/100 g to 83.3 me/100 g, while Bruguiera spp. occurred within a CEC range

41.0 me/100 g to 67.6 me/100 g. But in Australia, CLARKE and HANNON (1967) maintained that the CEC in mangrove soils ranged from 0.38 ± 0.08 me/100 g at the surface to 0.84 ± 0.59 me/100 g in the subsurface. In the Gambia, West Africa, GIGLIOLI and THORNTON (1965) found that Sesuvium portulacastrum and Paspalum vaginatum occurred where 15% of the exchange complex was sodium. In Mexico, THOM (1967) related the occurrence of Rhizophora spp. to soils with very high organic matter content (52.4%) while GIGLIOLI and THORNTON (1965) found that the same species occurred in soils with organic matter values ranging from 8.7% to 12.3%. The fundamental observation is that there exists a considerable overlap in values for soil nutrient from mangrove stands dominated by different species. Sometimes the differences in values within stands are as great or greater than differences between stands. Hence the aims of this paper are to establish the strength of the relationship and to determine the precise mathematical forms of these relationships between mangroves and soil nutrient based on vegetation and soil measurements at the same sites. The basic approach is quantitative, involving the use of simple correlation coefficients and multiple regression analysis.

Study area

The study area for this investigation is the coastal zone of Nigeria in West Africa, which lies between the River Niger delta ($7^{\circ}30'E$) and Rio del Ray ($8^{\circ}30'E$) in the Cameroon Republic. Within this coastal stretch, mangroves occur in the estuaries of the Imo River, Kwa Ibo River and Cross River (Fig. 1). The three estuaries, connected to each other by means of interriverine creeks constitute a homogeneous ecological unit. Mangroves generally occur in mixed stands in the swamps although SAVORY (1953) recognized Rhizophora racemosa as the pioneer species along certain channel segments. The area has a humid tropical climate with a mean annual rainfall of 4021 mm and average relative humidity of about 80%. Temperatures are high throughout the year with a maximum of $30^{\circ}C$ and a minimum of $22^{\circ}C$. The coastal beachridge sands lying between the estuaries are influenced by Atlantic storm waves. Within the estuaries, tidal flushing may occur up to 20 km upstream. However, tidal amplitude is generally low, averaging 2.01 m at spring tides and 1.07 m at neap tides (RAMANATHAN 1981). The estuarine mangroves are the most complex in West Africa in terms of the number of species present (CHAPMAN 1976).

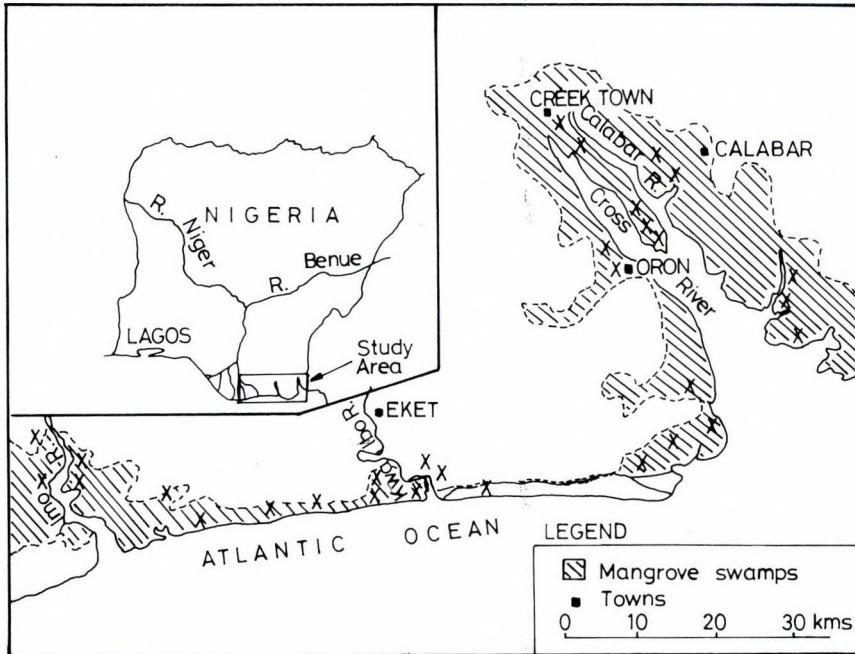


Fig. 1. Mangrove swamps of the study area, showing location along the Nigerian coast. XX ... X represent approximate transect positions

Methods

Vegetation

The vegetation was sampled in 10 x 10 m quadrat's regularly spaced at 20-m intervals along transects established from the shores inland. Transect length was determined by the width of swamp but each contained at least two quadrats. The vegetation, of generally low stature was stratified into A stratum (>3 m tall), B stratum (1-3 m tall) and C stratum (<1 m tall). The frequency of occurrence of species in each stratum was noted. Coverage values of A stratum species were determined in the 10 x 10 m quadrats using the crown-diameter method (MUELLER-DOMBOIS and ELLENBERG 1974). Each 10 x 10 m quadrat was subdivided into 5 x 5 m subquadrats to facilitate visual coverage estimates of the B stratum species while a further 1 x 1 m subdivision enabled estimates for the C stratum to be obtained.

Soils

Soil sampling was performed in each quadrat using a "corer" (GIGLIOLI and THORNTON 1965) to obtain core samples to a depth of 40 cm. The samples were analysed in the laboratory for the following nutrient factors: pH, in 1:2 soil to water suspension using glass electrode (JACKSON 1962); organic carbon, by the Walkley-Black wet oxidation method (JACKSON 1962); available phosphorus, by the Bray No. 1 method (JACKSON 1962); exchangeable cations (Ca^{++} , Mg^{++} , K^+ , Na^+), by extraction with 1 N ammonium acetate at pH 7, and concentrations of cations

determined by atomic absorption and flame photometry; cation exchange capacity (CEC) was the summation of exchangeable cations and exchange acidity; micronutrient levels (manganese and iron) were determined from total elemental analysis digestion extracts of samples using atomic absorption spectrophotometry.

Analysis

To meet the requirements for parametric statistics, species coverage values were transformed to the square-root of the original values while the nutrient variables approximated normal distribution after $\log_{10}$ transformations (GREGORY 1973).

The simple correlation coefficient (r) was used to examine the strength of the relationship between species and the nutrient variables. The possibilities as to the meaning of a significant correlation were regarded in terms of (i) direct causal relationship or partial causal relationships, and (ii) indirect causal relationship or mutual interaction of the two variables. Hence a significant correlation served as an indication of a relationship most unlikely to have occurred by chance.

Predictive multiple linear regression analysis was used to determine the precise mathematical forms of the relationship between the species and the soil nutrients. The linear "model" is of the form:

$$Y = a + b_1X_1 + b_2X_2 + \dots b_nX_n + SE$$

where Y = dependent (species-estimated) variable, plus a residual e ; a = Y intercept; b = partial regression coefficients; X = independent (nutrient-predictor) variable; and SE = standard error of estimate. Stepwise elimination multiple regression procedures were used to develop the predictive "models". Multicollinearity between the nutrient variables was eliminated using HAUSER's (1974) criterion. The computer programme (STWMULT) was IBM supplied.

Results

Distribution of mangroves within specified ranges of nutrient values in the swamps

Of the 68 plant species encountered in the tidal estuaries and coastal beachridge zone, only the occurrence of fourteen species with frequency greater than 5% (Table 1) could be classified within arbitrary ranges of some nutrient variables, and these excluded duplications of occurrences in the A and B strata. Mangrove samplings, treated as a single item within the C stratum occurred across all ranges of nutrient values and was excluded from the classification. Inclusions of same species in the A, B and C strata also created complications in the classification as it was difficult to establish ranges of nutrient values for exclusive occurrences of the species. Hence a species was idealized as representative if its occurrence in at least one of the strata clearly related to the range of nutrient values.

Within the A stratum, only Rhizophora mangle (freq. 48.7%) and Rhizophora harrisonii (freq. 15.8%) were restricted to a field moist pH range of

Table 1

Species grouped according to occurrence within ranges of some nutrient determinants and factors in mangrove swamps

Species		pH (field moist)			Organic carbon (%)		P (μgml^{-1})			Ca (me/100 g)		Mg (me/100 g)		CEC (me/100 g)	
		5.0-5.5	5.6-6.0	6.1-6.5	3.5-5.0	5.1-12.0	1.5-5.0	5.1-10.0	10.1-15.5	5.5-10.5	10.6-15.5	10.5-15.5	15.6-25.5	15.5-25.5	25.6-45.5
<u>Avicennia africana</u>	(A)		X	X**	X	X**	X			X	X		X	X	X**
<u>Rhizophora mangle</u>	(A)		X		X	X		X			X		X		X
<u>Rhizophora racemosa</u>	(A)	X*	X			X		X		X	X		X	X	X**
<u>Nypa fruticans</u>	(A)	X*	X		X	X**	X	X		X	X	X		X	X**
<u>Raphia vinifera</u>	(A)		X	X**		X	X	X		X*			X	X	X
<u>Rhizophora harrisonii</u>	(A)		X		X			X			X		X		X
<u>Conocarpus erectus</u>	(B)			X	X	X			X				X	X	X
<u>Pandanus candelabrum</u>	(B)	X			X*	X			X	X			X		X
<u>Phoenix reclinata</u>	(B)	X	X		X	X		X		X	X		X		X
<u>Triumfetta rhomboidea</u>	(C)		X		X		X	X		X		X*		X	
<u>Acrostichum aureum</u>	(C)	X	X			X	X			X	X		X		X**
<u>Sesuvium portulacastrum</u>	(C)		X		X		X			X	X	X		X	X
<u>Vossia cuspidata</u>	(C)		X	X**	X	X		X		X*		X		X*	
<u>Acutas afer</u>	(C)			X**	X	X	X	X		X*		X		X*	

*Occurrence may fall below the specified range.

**Occurrence may fall above the specified range.

(A), (B), (C) = Vegetation strata.

5.6 to 6.0 (Table 1). Rhizophora racemosa (freq. 51.3%) and Nypa fruticans (freq. 30.0%) occurred at the lowest pH range (5.0-5.5), while Avicennia africana (freq. 58.8%) and Raphia vinifera (freq. 12.5%) occurred at the highest pH values (6.1-6.5). HESSE (1961) had also observed that A. africana soils were associated with lower acid conditions than Rhizophora spp. soils. An observation made in the present study was that R. racemosa and N. fruticans usually occurred in mixed stands along shorelines in the mangrove zone while Raphia spp. is basically an upland species with low frequency of occurrence in the mangrove zone. Hence Raphia soils are less acidic, and are similar to A. africana soils. In the B stratum, Conocarpus erectus (freq. 5.8%) occurred within the highest pH range while Pandanus candelabrum (freq. 7.9%) occurred within the lowest range. Two species in the C stratum (Triumfetta rhomboidea, freq. 8.3%; Sesuvium portulacastrum, freq. 26.6%) were restricted to a pH range of 5.6 to 6.0 while Acutis afer (freq. 8.3%) exceeded the highest range of 6.1 to 6.5. Overlap was observed for the occurrences of Acrostichum aureum (freq. 30.6%) and Vossia cuspidata (freq. 8.6%).

Apart from Rhizophora racemosa, Raphia vinifera and Rhizophora harrisonii, the occurrences of other species in the A stratum were not restricted to the classified ranges of organic carbon values (Table 1). Avicennia africana and Nypa fruticans were associated with the highest organic carbon values exceeding the range of 5.1% to 12.0%, probably due to the dense pneumatophores of A. africana and the fibrous root mats of N. fruticans. In the B stratum, R. harrisonii was restricted to low organic carbon range (3.5%-5.0%). Three C stratum species (Triumfetta rhomboidea, Acrostichum aureum and Sesuvium portulacastrum) occurred within exclusive ranges of organic carbon values. A. aureum which occurred within the highest range (5.1%-12.0%) was observed to possess more extensive fibrous root systems than T. rhomboidea and S. portulacastrum.

Magnesium and available phosphorus were the nutrient variables to which species showed the least variation in niche relations (Table 1). In the A stratum, Nypa fruticans and Raphia vinifera occurred within an overlapping phosphorus range (1.5-10.0 μgml^{-1}) as Triumfetta rhomboidea and Acutis afer in the C stratum. There was no variation in species occurrences across the ranges for magnesium values, although T. rhomboidea also occurred below the lowest range of 10.5 to 15.5 me/100 g.

A similarity was observed in species occurrences within the ranges for calcium and cation exchange capacity, particularly in the A stratum where Rhizophora mangle and Rhizophora harrisonii were restricted to the highest

values (Table 1). However, in the B stratum, Pandanus candelabrum was also restricted to an exclusive range of calcium and CEC while Phoenix reclinata (freq. 5.0%) occurred within the highest CEC range (25.6-45.5 me/100 g). In the C stratum, occurrence of A. aureum exceeded the highest range for CEC, while occurrences of Vossia cuspidata and Acutis afer were observed below the lowest range for both calcium and magnesium.

Since many classes of nutrient values as desired may be obtained for mangrove occurrences, the importance of the foregoing analysis lies in recognizing idealized ecological groups and species niche relations to soil nutrients. The realibility of the established relations is affected by the complex hydrology of the estuaries and coastal areas.

Bivariate correlation solution

Table 2 presents the correlation coefficients between species coverage values and soil nutrient variables. Only correlation "models" at significance $P = 0.01$ and above are reported. Two species in the A stratum (Rhizophora mangle and Rhizophora racemosa) show strong negative relationships with pH ($P = 0.001$), while Conocarpus erectus and Vossia cuspidata in the B and C strata respectively relate positively with pH. R. mangle and R. racemosa are often associated in mixed stands along channel levees. Hence regulation of acid conditions by tidal flushing may be responsible for the strong negative relationships. C. erectus and V. cuspidata are positively correlated with pH ($P = 0.001$) since the species occur most frequently in the inner and upland swamps that experience lesser tidal flushing than the shorelines.

Several species are highly correlated with organic carbon (Table 2). The strongest positive relationships are achieved by Avicennia africana, Rhizophora mangle and Nypa fruticans in the A stratum, and Acrostichum aureum and Sesuvium portulacastrum in the C stratum. The dense pneumatophores of A. africana and the extensive fibrous roots of N. fruticans, A. aureum and S. portulacastrum probably account for the high organic carbon content of soils associated with these species. Apart from Rhizophora racemosa, the negatively correlated species (Raphia vinifera, C. erectus and P. candelabrum) do not develop extensive root mats in tidal swamps.

Available phosphorus and CEC are highly correlated with A stratum and C stratum species. The strongest positive relationships with phosphorus are achieved by R. vinifera and Rhizophora racemosa ($P = 0.001$) in the A stratum

Table 2

Coefficients of correlation between selected species and soil nutrient factors

		Percentage coverage		Correlation coefficients (r)**							
Species		Range	Mean $\pm$ SD	pH	Org. C.	P	Ca	Mg	CEC	Mn	Fe
<u>Avicennia africana</u>	(A)*	5.5–98.5	22.9 $\pm$ 19.4		0.63	-0.40	-0.52		-0.48		0.47
<u>Rhizophora mangle</u>	(A)	5.0–80.4	12.6 $\pm$ 10.2	-0.52	0.57				-0.58		0.55
<u>Rhizophora racemosa</u>	(A)	4.5–82.5	12.1 $\pm$ 9.6	-0.56	-0.40	0.54			-0.65		-0.45
<u>Nypa fruticans</u>	(A)	4.0–96.5	15.9 $\pm$ 10.8		0.64	-0.58	0.50		-0.63		
<u>Raphia vinifera</u>	(A)	1.5–77.2	4.3 $\pm$ 3.6		-0.38	0.60	0.47	0.62			0.58
<u>Rhizophora harrisonii</u>	(A)	2.5–33.4	3.8 $\pm$ 4.2			-0.36		0.55			-0.43
<u>Conocarpus erectus</u>	(B)	0.8– 2.6	1.2 $\pm$ 0.8	0.49	-0.36					-0.36	
<u>Pandanus candelabrum</u>	(B)	0.6– 3.8	1.4 $\pm$ 1.2		-0.34					-0.36	
<u>Phoenix reclinata</u>	(B)	0.5– 1.8	0.9 $\pm$ 0.6				-0.39	0.35			-0.61
<u>Triumfetta rhomboidea</u>	(C)	0.5– 2.7	0.9 $\pm$ 1.5				0.57			0.54	0.40
<u>Acrostichum aureum</u>	(C)	4.0–14.3	6.6 $\pm$ 4.8		0.49		-0.40	0.54	0.35	0.39	0.52
<u>Sesuvium portulacastrum</u>	(C)	3.5–12.0	8.4 $\pm$ 2.2		0.35	0.55	0.62	0.50		0.53	0.50
<u>Vossia cuspidata</u>	(C)	2.5– 6.4	3.2 $\pm$ 2.4	0.38		0.43		0.46			0.58
<u>Acutis afer</u>	(C)	0.5– 2.6	1.8 $\pm$ 0.9				0.38	0.45		0.52	0.47

* (A), (B), (C) = Vegetation strata.

** $r > 0.26$, $P = 0.01$; $r > 0.34$, $P = 0.001$.

and S. portulacastrum and V. cuspidata ($P = 0.001$) in the C stratum. R. racemosa and Raphia vinifera are dominant along shorelines although the latter species is also an upland species. Similarly, Sesuvium portulacastrum is most frequent in saline swamps while Vossia cuspidata is also a freshwater/upland species. The negatively correlated species (A. africana, N. fruticans, R. harrisonii) dominate in brackish/saline areas as mixed stands on point-bars and tributary channels. CEC shows strong negative relationships with A stratum species but a positive relationship with Acrostichum aureum in the C stratum. This is an indication that the sum of cation concentrations at the levels occurring in the swamps soils may constitute stress to mangrove performance. Considering the positive relationships of all species with magnesium, and the positive and negative relationships of species with calcium, it is clear that mangroves are selective in terms of cation requirements. Saturation of the exchange complex by magnesium apparently increases mangrove performance.

Manganese is negatively correlated with B stratum species (C. erectus, P. candelabrum) but positively correlated with C stratum species (mainly strand species). Iron shows positive relationships the C stratum species and may also be related to soil profile differentiation in the irregularly inundated strand zone. Positive relationships of iron with A. africana, R. mangle and Raphia vinifera in the A stratum also indicate differentiation of soil horizons on the levees and inner/upland swamps where these species are frequently encountered.

Multiple regression solution

The significant multiple regression equations based on the highest multiple correlation coefficient are presented in Table 3. For all regression "models", a multiple coefficient of determination (R^2) of 0.52 and above were included in the equations. Since R^2 is equal to the percentage of variation which the multiple regression is accountable for i.e. the level of explanation, it follows that all regression equations presented account for 52% or above of the variance.

The most frequently retained soil nutrient variable is magnesium, in ten out of fourteen equations (Table 4). Calcium, phosphorus and iron occur in eight equations each while organic carbon and manganese are retained in six and five equations respectively. pH occurs in three equations. Apart from pH which is not significant in the B stratum, all nutrient factors are

Table 3

Predictive multiple regression equations based on performance of species along soil nutrient parameters using logarithmic transformations

A stratum	
<u>Avicennia africana</u>	$Y = -2.360 - 1.081(\text{Mg}) + 0.832(\text{Fe}) + 0.621(\text{Ca}) + 0.301(\text{P}) + 0.265$ ($R^2 = 79.8\%$).
<u>Rhizophora mangle</u>	$Y = -4.254 - 1.343(\text{Ca}) + 1.025(\text{pH}) + 0.931(\text{Mn}) + 0.176$ ($R^2 = 83.7\%$).
<u>Rhizophora racemosa</u>	$Y = -1.362 + 1.738(\text{Ca}) + 0.696(\text{Mg}) - 0.312(\text{P}) - 0.271$ (Org. C.) ± 0.246 ($R^2 = 76.4\%$).
<u>Nypa fruticans</u>	$Y = 8.932 - 0.748(\text{Mg}) + 0.003(\text{Ca}) - 0.402$ (Org. C.) $+ 0.146$ ($R^2 = 63.8\%$).
<u>Raphia vinifera</u>	$Y = 10.327 + 0.386(\text{P}) + 0.511(\text{Mg}) - 0.628(\text{Fe}) - 0.314(\text{pH}) + 0.436$ ($R^2 = 60.8\%$).
<u>Rhizophora harrisonii</u>	$Y = 3.111 + 0.783(\text{Mg}) + 0.692(\text{Ca}) - 0.019(\text{Fe}) + 0.298$ ($R^2 = 52.6\%$).
B stratum	
<u>Conocarpus erectus</u>	$Y = 1.619 + 1.298(\text{Mn}) + 0.537(\text{P}) - 0.976(\text{Mg}) - 0.012(\text{Ca}) + 0.368$ ($R^2 = 74.5\%$).
<u>Pandanus candelabrum</u>	$Y = -0.412 - 0.120(\text{Org. C.}) + 0.026(\text{P}) \pm 0.367$ ($R^2 = 57.3\%$).
<u>Phoenix reclinata</u>	$Y = -1.163 - 1.828(\text{Mg}) + 2.159(\text{Ca}) \pm 0.414$ ($R^2 = 56.5\%$).
C stratum	
<u>Triumfetta rhomboidea</u>	$Y = -4.196 + 0.013(\text{Mg}) + 0.018(\text{Fe}) - 0.008(\text{Org. C.}) + 0.022(\text{P}) - 0.029(\text{pH}) \pm 0.335$ ($R^2 = 70.8\%$).
<u>Acrostichum aureum</u>	$Y = 4.595 - 0.366(\text{Fe}) - 0.842(\text{Mg}) - 0.026(\text{P}) - 0.007$ (Org. C.) ± 0.192 ($R^2 = 89.1\%$).
<u>Sesuvium portulacastrum</u>	$Y = -0.539 - 0.020(\text{Org. C.}) + 0.012(\text{Mn}) + 0.004(\text{Fe}) + 0.338$ ($R^2 = 59.8\%$).
<u>Vossia cuspidata</u>	$Y = -5.396 + 1.041(\text{Mg}) - 0.442(\text{Fe}) + 0.017(\text{Mn}) + 0.009(\text{P}) \pm 0.396$ ($R^2 = 63.8\%$).
<u>Acutis afer</u>	$Y = 1.554 + 1.386(\text{Mn}) - 1.407(\text{Fe}) \pm 0.418$ ($R^2 = 59.2\%$).

significant to the performance of species across all strata of the vegetation. However, calcium is more significant to the performance of the A and B strata than to C stratum species, while iron and manganese are more significant to the performance of the C stratum than to A and B strata species. Magnesium is highly significant across all strata of the vegetation.

Table 4 also indicates the percentage contribution of each nutrient variable to the total variance of the regression equations. In the A

Table 4

Percentage contribution of each explanatory nutrient variable to the total variance of regression equations

Species		Contribution of each explanatory variable (%)							Total % explanation
		Mg	Ca	P	Fe	Org. C.	Mn	pH	
<u>Avicennia africana</u>	(A)	43.6**	10.3**	3.5*	21.4**				79.8
<u>Rhizophora mangle</u>	(A)		70.4**				5.9**	7.4**	83.7
<u>Rhizophora racemosa</u>	(A)	21.2**	44.1**	7.9*		5.2*			76.4
<u>Nypa fruticans</u>	(A)	55.6**	7.0*			1.2			63.8
<u>Raphia vinifera</u>	(A)	3.1*		52.6**	2.7*			2.4*	60.8
<u>Rhizophora harrisonii</u>	(A)	40.8**	9.6*		2.2*				52.6
<u>Conocarpus erectus</u>	(B)	4.2**	3.1*	5.1**			62.1**		74.5
<u>Pandanus candelabrum</u>	(B)			4.2*		53.1**			57.3
<u>Phoenix reclinata</u>	(B)	52.7**	3.8**						56.5
<u>Triumfetta rhomboidea</u>	(C)	48.0**		1.3	18.5**	2.0*		1.2	70.8
<u>Acrostichum aureum</u>	(C)	7.9**	5.4*	5.8*	65.2**	4.8*			89.1
<u>Sesuvium portulacastrum</u>	(C)				6.0**	44.6**	9.2**		59.8
<u>Vossia cuspidata</u>	(C)	46.7**		1.7*	12.0**		3.4**		63.8
<u>Acutis afer</u>	(C)				8.6**		50.6**		59.2
Total number of occurrences		10	8	8	8	6	5	3	

**Significant at the 1% level.

*Significant at the 5% level.

(A), (B), (C) = Vegetation strata.

stratum, the performance of N. fruticans relates to nutrient availability in terms of magnesium (55.6%) and calcium (7.0%) from the total variance of 63.8%. A. africana is related to magnesium (43.6%), iron (21.4%) and calcium (10.3%) from a total variance of 79.8%. The performance of R. mangle is highly explained by calcium (70.4%), pH (7.4%) and manganese (5.9%) while R. racemosa is related to calcium (42.1%), magnesium (21.2%) and phosphorus (7.9%) out of a total variance of 76.4%. The performance of R. harrisonii is highly related to magnesium (40.8%) and calcium (9.6%). Differences in nutrient relations for Rhizophora spp. are accounted for by the spatial segregation of Rhizophora in the swamps. Raphia vinifera which is also an upland species is highly explained by available phosphorus (52.6%), while other nutrient factors are of lesser significance. Magnesium, calcium and phosphorus have been selected by the regression procedure as the most important soil nutrients with respect to canopy species performance.

In the B stratum, the performance of P. reclinata is highly explained by magnesium (52.7%) out of a total variance of 56.5%. The other species (C. erectus, P. candelabrum) are related to manganese and organic carbon which account for much more than 50% of the total variance.

The performance of I. rhomboideae is explained by magnesium (48.0%) and iron (18.5%) from a total variance of 70.8%. Organic carbon is significant to the performance of S. portulacastrum (44.6%) while A. aureum is explained by iron (65.2%). V. cuspidata and A. afer which are basically upland species are highly explained by magnesium (46.7%) and manganese (50.6%) respectively. The two species are spatially segregated in that Vossia is flood tolerant while Acutis dominate on topographic mounds (UKPONG 1989).

Conclusion

Classification of mangrove species according to occurrence within certain ranges of nutrient factors revealed overlap in species-nutrient relations. However, restricted occurrences of species were observed for ranges of magnesium values. Magnesium although abundant in sea water did not correlate with extent of tidal inundation and therefore spatial location of stands from the ocean. Simple correlations of species coverage with nutrients revealed strong relationships between the nutrients and vegetation performance at highly statistically significant levels. Negative relationships indicated levels of nutrient availability that were limiting to man-

grove performance while positive relationships indicated essential nutrient levels. Multiple regression analysis, used as a search procedure identified the order of those soil variables having the strongest relationship with the mangrove species. The results show clearly that species performance relate significantly to varying proportions of nutrient levels in mangrove swamp soils.

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TIPOS DE LOS ECOSISTEMAS COSTEROS EN CUBA; SU AISLAMIENTO Y FRAGILIDAD ECOLÓGICA

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The author gives a new classification of the coastal ecosystems of Cuba based on their zonation types. In the mangrove vegetation, complete, complex and incomplete or reduced zonation types are distinguished and discussed. Reduction of the zones in the mangrove vegetation can be conditioned by climatic (drought), orographic and endaphic (acidic, ultrabasic rocks etc.) factors. Among others, vegetation types, sandy and rocky coastal plant communities and zonation types, their vulnerability and role in environment protection are discussed.

Introducción

Desde el punto de vista ecológico y de protección del ambiente los ecosistemas costeros se pueden considerar como elementos de una zona guardafrontera ambiental, que es capaz de defender los ecosistemas interiores de las islas del efecto destructivo del oleaje del mar y de la penetración de las corrientes marinas. Por otra parte, la vegetación costera también actúa como un "cordon aduanero", que pretende controlar el flujo de las materias provenientes por erosión de los biogeociclos de los ecosistemas terrestres. En esta forma los ecosistemas costeros no son capaces solamente de disminuir la pérdida de los nutrientes inorgánicos, que constituyen un recurso agroecológico importantísimo en la vida de las islas, sino sirven también como un biofiltro ambiental, que pueden proteger las zonas litorales y sublitorales marinas de muchos contaminantes provenientes de las áreas industriales y agropecuarias.

Hay que tener en cuenta, además, que los ecosistemas costeros ocupan necesariamente un porcentaje considerablemente más grande del territorio de las islas, como en los países continentales, motivo que aumenta más aún su importancia ecológica y socio-económica en los países islenos. En la Isla de Cuba, donde el largo de las costas constituye 5746 km, la vegetación costera

cubre más de 8000 km², o sea 8% del territorio nacional aproximadamente, no incluido en este la superficie de la cayería del Archipielago Cubano, que casi en su totalidad de 3715 km² esta cubierta por ecosistemas costeros.

Los ecosistemas costeros se pueden clasificar en tres grupos grandes: los manglares, los de las costas arenosas o de las playas, y los de las costas rocosas o de los seborucos. Entre ellos, la mayor importancia, en todos sentidos, tienen los manglares.

Los manglares

El manglar — como lo definieron los distintos autores — es un ecosistema costero tropical amfibio, ubicado en la interfase tierra firme/mar abierto, caracterizado por cierta diversidad taxonómica vegetal, cuya característica comun es la forma eco-fisionómica arbórea y una serie de adaptaciones morfológicas, ontogenéticas y fisiológicas especiales (como los raices fúlcreas, neumatóforos, viviparismo, la alta tensión osmótica celular etc.).

Por otra parte el manglar representa una unidad integrada, auto-suficiente y bastante rigurosamente controlada por las condiciones ambientales especiales, como son las inundaciones periodicas marinas, la salinidad fluctuante, la alta retención de agua de los suelos, a las cuales sus componentes vegetales unimales estan altamente adaptados.

Segun ODUM (1964) y PANNIER (1980) el manglar es un ecosistema abierto en relación al flujo de energia y materia, de los cuales depende, que reacciona ostensiblemente a cualquier influencia anormal externa. Su caracter dinámico se manifiesta en los cambios en su estructura floristica y faunistica (como dinámica poblacional), por los procesos de transformación continua de sus suelos (dinámica pedológica), y por su capacidad de fijación de energia y síntesis de materia orgánica bajo la influencia reguladora de los factores ambientales particulares de su ambiente (como dinámica productiva).

En cuanto a la composición floristica, los manglares más ricos en especies arbóreas del mundo viven en el Archipielago Sur-Oriental de Asia, donde esta vegetación esta formada por no menos de 22 especies arbóreas, mientras que los manglares de India consisten de 15, los de Africa oriental de 12; en las costas occidentales de África de 6 y en las costas pacificas de America de Sur solamente de 4 especies arboreas. Por esta razón muchos autores consideran, que el centro de evolución de esta formación vegetal debe ubicarse en el Archipielago Malaysiano.

Composición

En Cuba los manglares estan compuestos de 4 especies arbóreas y alrededor de 20 especies arbustivas, herbáceas, lianas y epifitos. La cuatro especies del manglar son: el mangle rojo (Rhizophora mangle), el mangle prieto (Avicennia germinans), el patabán (Laguncularia racemosa) y la yana (Conocarpus erecta); los arbustos más comunes son el perejil de costa (Batis maritima), el palo de gallina (Lycium carolinianum), entre las plantas herbáceas: el helecho del manglar (Acrostichum aureum) la grama de costa (Distichlis spicata) las trepadoras más comunes son: el cativo mangle (Rhadenia biflora) y el bejuco reviente chivo (Sarcostemma clausum), mientras que los epifitos más frecuentes son los curujeyes más xerofiticos, la Tillandsia bulbosa y la Tillandsia recurvata.

Unidades fitosociológicas

Segun la clasificación fitocenológica de los manglares, basada en la composición florística de las comunidades, 6 asociaciones fueron reconocidas y analizadas por BORHIDI, MUÑIZ y DEL RISCO (1979): la asociación del mangle rojo, permanentemente inundada (Rhizophoretum manglis), la asociación del mangle rojo y mangle prieto periodicamente inundada por las mareas diarias (Rhizophoro-Avicennietum germinatis), la asociación de la Avicennia germinans y Batis maritima, el manglar de los arrecifes coralinos; la asociación de la yana y del patabán en los pantanos salobres (Conocarpo-Laguncularietum racemosae); la asociación de la yana y del helecho del manglar en los pantanos salados (Acrosticho-Conocarpetum erectae) y por ultimo, la asociación del manglar seco, rara- y brevemente inundado, muy salado, el Distichlio-Conocarpetum erectae. Tenemos que mencionar, que estas asociaciones no incluyen todos los tipos de los manglares cubanos, que requieren investigaciones fitocenológicas más amplios y más profundas todavia.

Clasificación fisiográfica

PANNIER y PANNIER (1980) propusieron una clasificación fisiográfica de los manglares de Venezuela basado en la estructura vertical de las comunidades y distinguieron los tipos siguientes: 1. Manglares de ensenada, 2. Manglares ribereanos, 3. Manglares de franja, 4. Manglares de lavado periódico, 5. Manglares enanos. En el caso de los manglares de Cuba no ha sido posible encontrar las correlaciones necesarias entre las habitades y estructuras características de estos tipos.

Zonación como principio de la clasificación

Consideramos, que para entender y conocer bien la característica y función ecológicas de los manglares, necesitamos una clasificación ecológica de ellos, basada en criterios ecológicos, que se manifiestan más aparentemente es la zonación horizontal del manglar. El número de las zonas, su secuencia y distribución paralela o mosaica es rigurosamente controlada por la salinidad del agua y del suelo, la que depende del clima, de la fisiografía, del sustrato geológico y del suelo de la costa.

Utilizando estos criterios, los manglares siguientes podemos distinguir en Cuba:

1. Manglar de zonación completa: se encuentra en las costas fangosas, paulatinamente emergidas del mar. Este tipo del manglar se encuentra en la costa Norte de la Península de Guanahacabibes, y de las provincias de Villa Clara, Ciego de Avila y Camagüey, entre Cárdenas y Nuevitás, mientras que en la costa Sur este tipo de manglar domina entre Casilda y Niquero a lo largo de las costas meridionales de las provincias Sancti Spiritus, Ciego de Avila, Camagüey y Tunas, además en las costas occidentales de la provincia Granma. Consideramos, que este es el manglar típico, porque su zonación es completa, sus zonas son suficientemente anchas para formar cada una su biótopo y asociaciones autónomas, y sus zonas se ubican paralelamente a lo largo de un gradiente ecológico caracterizado por la disminución de la duración de la inundación marina y por el aumento de la salinidad y la tensión osmótica en los suelos.

El manglar típico consiste de 4 zonas vegetales arbóreas. Entre los niveles de la marea mínima anual y de la marea baja mar adentro encontramos la zona del mangle rojo, mayormente no más ancho de 50—100 m, en suelos de tensión osmótica entre 26—32 atmósferas, capaz de compensar el oleaje del mar por sus raíces fúlcreas y multiplicarse por viviparismo. La segunda zona tierra adentro está formada por una franja potente del mangle prieto, que se sitúa entre los niveles de las mareas bajas y altas. La tensión osmótica de su suelo varía entre 30—36 atmósferas, y la anchura de su zona puede llegar hasta 5—6 km. La tercera zona está formada por el patabán en el nivel de las mareas altas, en suelos de tensión osmótica entre 34—37 atmósferas. Esta zona a menudo se evoluciona en forma transitoria en la que los componentes se mezclan, formando una subzona Avicennia-Laguncularia, donde la Laguncularia desarrolla neumatóforos, y una subzona Laguncularia-Conocarpus sin neumatóforos. La cuarta zona está formada por la yana (Conocarpus

erecta) entre los niveles de las mareas altas y máximas anuales. Este arbol tiene la mayor tolerancia de salinidad y sus poblaciones se extienden en una franja muy ancha de varios kilómetros, sobre suelos de tensión osmótica de entre 36—42 atmósferas. En suelos más salados los individuos de yana se secan y se mueren y detrás de la zona de Conocarpus encontramos la zona a veces muy ancha de los sufrutices suculentos del Batis maritima y Salicornia perennis en suelos de tensión osmótica entre 42—50 atmósferas. En esta zona ecológicamente muy extrema ya en los hundimientos mínimos de la superficie desaparece la vegetación de las plantas superiores dejando lugares para la cobertura membranacea del cianófito Nostoc commune. Este tipo de zonación se puede observar en un transepto muy ilustrativo en La Isabela, costa Norte de la provincia Villa Clara.

Aunque este tipo del manglar esta bastante distribuido en las costas cubanas, encontramos también un número elevado de tipos de zonación diferentes. En la memoria de los casos, encontramos zonaciones más complejas de la que tiene el manglar típico.

2. Manglares de zonaciones complejas: Se desarrollan zonaciones complejas en las costas bajas formadas por arrecifes, que por su elevación paulatina se concierten en areas de piedra hueca caracterizada por seibadales y pantanos subcosteros cársicos de diversa profundidad, formando un mosaico irregular de los distintos biótopos aptos para las poblaciones de especies diferentes del manglar. La situación se complica todavia, cuando un carso costero regularmente inundado se coincide tierra adentro con una area cenagosa. Para este tipo de zonación encontramos ejemplos en la Península de Zapata y en la parte Sur de Isla de Pinos también, lo que vamos a ilustrar en un perfil de vegetación confeccionado en la Península de Zapata, entre Las Salinas y Buenaventura, paralelamente con la costa occidental de la Bahía de Cochinos (BORHIDI 1991, p. 295).

Aquí la zonación empieza con una linea estrecha del mangle rojo en el borde exterior de los arrecifes, a continuación sigue una area muy extensa de arrecifes y seibadales poco profundos poblados por el mangle prieto asociado con Batis maritima; la próxima zona tierra adentro es una area de piedra hueca cubierta por una capa muy poco profunda de fango y arena salada, inundada solo para periodos cortos. Es esta zona domina la Conocarpus erecta asociada con la gramínea Distichlis spicata. Pero en esta misma zona encontramos muchos hundimientos de distinto tamaño y distinta profundidad, que son prácticamente lagunas sublitorales cársicas, en las cuales el agua salada del mar se mezcla con el agua dulce oligotrófico de la

ciénaga. Consecuentemente se forma un mosaico irregular de las lagunas de aguas poco profundas y mas salobres, pobladas por la Laguncularia racemosa y de las lagunas de aguas mas profundas y menos salobres, poblados por la Rhizophora mangle. Aumentando el espesor del suelo y su contenido de materias orgánicas se desarrolla una zona nueva que es la del bosque de ciénaga salobre, formado por la Conocarpus erecta y por el júcaro de pantano, Bucida palustris. Al fondo de la Bahía, donde las aguas de la ciénaga llegan al mar, esta zona está sustituida por una franja ancha del mangle rojo, la que tierra adentro se continua en una segunda zona de Conocarpus y Bucida palustris.

3. Zonaciones reducidas: En casos numerosos encontramos zonaciones incompletas o reducidas del manglar, cuando falta alguno de los factores ecológicos, que condicionan su desarrollo completo. Estos factores limitantes pueden ser climáticos, fisiográficos y edáficos.

a) Zonaciones reducidas climáticas

El factor climático limitante en Cuba y en las Antillas es la sequía. HAGEN (1980), VAN STEENIS (1941, 1958) postularon, que el poco desarrollo del manglar en las regiones áridas se ha atribuido a la falta de aportes sedimentarios que acrecienten las costas y preparen un sustrato adecuado para la colonización por el manglar. CINTRÓN y colaboradores (1980) investigaron los manglares de las costas áridas de Puerto Rico y de las Islas Virgenes y encontraron, que en un clima de 800—1100 mm de lluvia anual, se desarrollan solamente dos franjas del manglar, las de la Rhizophora y de la Avicennia. En lugar de la zona de la Laguncularia se encuentra una laguna hipersalada con árboles muertos, y la zona de Conocarpus esta sustituida de una zona del salitral. A mi juicio, la zonación reducida del manglar en las costas áridas no debe tanto al poco aporte sedimentario, sino a la acumulación rápida del sal provocada por la evaporación elevada en los suelos no controlados continuamente por las inundaciones del mar. En Cuba esta zonación reducida del manglar se presenta en la región seca de Guantánamo, donde se ocurre también, que en algunas costas muy áridas, la zonación del manglar se reduce hasta una sola franja del mangle rojo.

b) Zonaciones reducidas orográficas

Las condiciones fisiográficas también pueden impedir el desarrollo de la zonación completa del manglar. Para esto encontramos buenos ejemplos en las playas de la costa Sur de la provincia Habana, que no son playas

verdaderas. Su característica es, que son costas rocosas bajas en transición entre el arrecife y el seboruco bajo, las que no son inundadas pero estan regularmente influidas subterráneamente por el agua del mar. Estos manglares consisten de una franja estrecha de Avicennia y Laguncularia que cubre la duna arenosa baja del borde del mar, despues de una zona mas baja poblado por Avicennia, detrás de esta una zona salada cubierta por gramíneas halofíticas y por ultimo, una franja bastante ancha de la Conocarpus erecta. En esta zonación el mangle rojo se presenta solo en los estuarios.

c) Zonaciones reducidas edáficas

PANNIER y PANNIER (1980) describen el proceso de la acidificación de los suelos del manglar desfavorable para ello, que puede ser neutralizado por el contenido de carbonato de calcio del sustrato geológico o de los sedimentos depositados por los rios. Los autores destacan, que la acidez elevada del suelo afecta la vegetación del manglar. En Cuba conocemos dos sustratos geológicos ácidos, que son capaces de reducir grandemente la zonación del manglar. Uno de ellos es la arena de cuarcita o arena blanca, donde los manglares ocupan una franja estrecha, controlada por las inundaciones del mar, a menudo formada por una linea del mangle rojo. En estos casos el pinar abierto de la arena o las sabanas arenosas derivadas de ellos llegan hasta el borde del mar, fenómeno bastante raro, que se refleja en el nombre de varios lugares, que se llaman: "Sabanalamar".

El otro sustrato ácido, que reduce la zonación del manglar es el latosol de la serpentina. Los manglares sobre serpentina forman mayormente una franja estrecha del mangle rojo, o mas raramente consisten de dos zonas muy estrechas de la Rhizophora mangle y de la Laguncularia racemosa. Detrás del manglar se desarrollan pinares o a veces matorrales esclerófilos siempre-verdes. Estas areas de serpentina, pegadas al manglar, siempre son muy interesantes desde el punto de vista florístico. Porque los suelos ferríticos con su alto porcentaje de ferrioxido y de metalas pesados ejercen un efecto ecológico extremadamente fuerte a las plantas superiores, que responden a este efecto desarrollando nuevos taxa adaptados a estos suelos. Esta tensión ecológica de los latosoles se aumenta aun más condicionada por la influencia de la agua salada del mar causando un choque ecológico verdadero. Este tipo de manglares encontramos por la costa Norte de la provincia Pinar del Rio, entre la Mulata y Playa Morrillo, al Este de Puerto Padre, en la Bahia de Naranjo y en la costa Norte de las Provincias Holguin y Guantánamo, entre Cananova y la Bahia de Taco.

Al finalizar la revista de los manglares cubanos, consideramos necesario de acentuar, que las zonaciones mencionadas son características para la parte Norte del área del Caribe y sobre todo para las Antillas Mayores. En otras regiones neotropicales, el porte ecológico, la fuerza competitiva de las mismas especies pueden ser diferentes, las que determinan otros tipos de zonaciones, como fue reportado por LESCURE (1980) de las costas de Guyana Francesa.

Costas arenosas

Las costas arenosas con la mayor frecuencia se encuentran entre Habana y Varadero por la costa Norte de Cuba, y en áreas pequeñas dispersas de las bahías orientales protegidas del viento y del oleaje del mar (como Playa Pesquero Nuevo, Guardalavaca etc.).

Zonación de la vegetación

La vegetación de las costas arenosas se presenta con una uniformidad bastante grande en todos los trópicos en cuanto a su zonación y composición florística. En su zonación se puede distinguir 5 franjas bastante estrechas que son las siguientes:

a) Vegetación abierta pionera, formada por los ejemplares rastreros de la Ipomoea pes-caprae, Canavalia maritima y pequeños cespedes suculentos de Philoxerus vermicularis y Sesuvium portulacastrum.

b) Cespedes cerrados formados por Uniola virgata, Distichlis spicata, Sporobolus virginicus y Spartina juncea.

c) Franja subarbustiva formada por la Borrichia arborescens y la Tournefortia o Mallotonia gnaphaloides.

d) Franja estrecha del matorral de la playa formada por la Suriana maritima y Baccharis halimifolia.

e) Zona de la uva caleta; matorral o bosque bajo formado mayormente con la dominancia de la Coccoloba uvifera, en las costas más áridas sustituida por la Casasia clusioides, Scaevola plumieri en las costas Nor-orientales o por la Leucaena leucocephala, en la costa Sur de Oriente.

Costas rocosas

Las costas altas rocosas están distribuidas en varias partes de Cuba. Sus mayores áreas son: la costa Sur de la Península de Guanahacabibes, las costas rocosas del Norte de Habana y Matanzas, entre Mariel y Varadero, la costa Sur de Cuba Central entre Cienfuegos y Casilda, la costa Norte oriental entre Nuevitas y Banes, la costa Sur de Oriente entre Cabo Cruz y Maisí.

Mientras que la composición florística de los manglares y de las costas arenosas consiste de especies de amplia distribución, la vegetación de las costas rocosas tiene su propia característica de la región Caribe, y dentro de esto, cada una de las regiones costeras tienen su flórmula particular, con sus endémicos regionales y locales. Por ejemplo la vegetación de las costas rocosas de la Península de Guanahacabibes tiene 9 especies y un género endémico, la de los seborucos de Habana y Matanzas tiene 12 especies endémicas, la de la zona Cienfuegos—Casilda tiene otra 12 especies más, los seborucos de la costa Nor-oriental 25 especies endémicas locales, mientras en la costa Sur de Oriente el número de las especies endémicas es más que 100, con dos géneros endémicos locales: Cubacroton y Caribaea.

Zonación de la vegetación

Aunque la vegetación de las costas rocosas altas, mayormente no tenga contacto inmediato con el mar, la salpicadura del mar forma una zonación claramente distinguible de la vegetación orófila en las terrazas bajas, pegadas al mar. Estas zonas son las siguientes:

a) Vegetación pionera, abierta, formada mayormente por plantas restreras suculentas, como Lithophila muscoides, Trianthema portulacastrum, Sesuvium portulacastrum.

b) Vegetación moderadamente cerrada, formada mayormente por plantas acolchonadas, sufrutices y arbustos rastreros, como Rachicallis americana, Borrichia arborescens, Strumpfia maritima, la forma rastrera de la Conocarpus erecta y la subendémica Erithalis vacciniifolia.

c) Matorrales espinosos costeros, que en cada una de las áreas mencionadas tienen sus asociaciones particulares, endémicas.

Fragilidad y aislamiento de los ecosistemas costeros

No cabe duda, que entre los tres ecosistemas costeros aquí discutidos, el manglar es el sistema ecológico más organizado, más estratificado en el espacio horizontal y vertical formando una red de barreras defensivas muy eficientes en la zona frontera de las islas, frente a la invasión de los elementos ajenos a la flora y fauna muy especializada y desempeña un papel importante también en la filtración y retención de los agentes contaminantes del ambiente. Además, el manglar tiene la mayor potencia y vigor para renovarse rápidamente, debido a su gran capacidad de fijación de energía. Al mismo tiempo, el manglar representa uno de los ecosistemas más productivos de nuestra planeta, y por esto es una tarea ecológica-económica muy importante que encontremos los compromisos necesarios para su utilización racional manteniendo su capacidad proteccionista en favor de los demás ecosistemas importantes de las islas.

Podemos determinar, que cada vez mas completa es la zonación, y cada vez mas ancha es la franja del manglar, tanto mas eficiente es su labor en la protección del ambiente. El problema importante es, en este sentido, que los manglares en aquellas costas tienen sus zonaciones mas reducidas y su valor defensivo más debilitado, donde coinciden con los ecosistemas terrestres más frágiles, más extremadamente adaptados. Precisamente en las áreas donde la vegetación de serpentina esta en contacto con el manglar se extinguieron algunos elementos endémicos más notables de la flora de Cuba, como el género Phyllacanthus Griseb. en la Playa Morrillo, la Acacia Roigii en la Playa Herradura y llegó al margen de la extinción el género endémico monotípico Kodalyodendron Borhidi et Acuña en la Playa de la Vaca, cerca de Moa.

Por otra parte, hay que subrayar reiteradamente, que a pesar, de su estabilidad aparente y potencia regenerativa enorme, el manglar es un ecosistema bastante frágil y es sumamente sensible a los cambios del nivel freático. Lo que una zona de seibadales va a convertirse en un manglar de alta producción o en una zona salinaria inutil, depende de nosotros, cuando planificamos y realizamos los planes de drenaje de las costas. La salinización es parte de una tendencia global de la desertificación de nuestra planeta, la que tenemos que impedir con todos esfuerzos.

La importancia defensiva de las playas en la vida de las islas es mucho menor que la de los manglares. Las playas representan practicamente la puerta abierta de las islas, donde la fase pionera de la costa arenosa

ofrece un terreno fácil de establecerse, para muchos invasores, como el coco, el árbol de pan, la yerba bermuda y muchas otras. Hay que admitir, al mismo tiempo, que de esta zona pionera, la penetración en los ecosistemas terrestres no es fácil, y esta fuertemente controlada por la franja importante de la Coccoloba uvifera. Pero cuando construyendo playas de recreo sustituímos la zona de Coccoloba con una población de Casuarina, confeccionamos una carretera ancha para la invasión de las plantas ajenas.

Llegando por fin a la vegetación de las costas rocosas, tenemos que descartar, que estos ecosistemas no tienen ninguna zonación o estratificación de valor defensivo, consecuentemente estos ecosistemas son lo más frágiles. Agrava su situación, que estos ecosistemas no representan valores económicos, aunque con sus riquezas florísticas enormes deban convertirse en uno de los bancos genéticos mas importantes de la isla. Nuevamente estas áreas estan favorizadas, como áreas de construcciones, empresas industriales, depósitos, con el fin, de no ocupar tierras fértiles para objetivos de este tipo. Pero la utilización de estas áreas surge varios problemas. Estas costas rocosas tienen su evolución de flora y fauna aislada por millones de años, cada una de estas áreas tiene su flórula propia muy especializada, única. Los daños que sufre, son irrecuperables, y las áreas destruidas de esta vegetación se convierten rápidamente en colecciones muy ricas de malas yerbas, que afectan despues las áreas de cultivos. Otro problema grande de estas áreas, que no son aptos para cualquier tipo de biofiltración y de esta forma, las instalaciones industriales des estas zonas contaminan directamente el mar.

Llegado al final de las conclusiones, los ecosistemas costeros tienen una importancia enorme en la vida productiva de las islas y en su protección del ambiente. Todos de ellos ofrecen a nosotros promesas de una vida prospera y beneficiosa como recursos naturales, áreas recreativas y como recursos naturales, áreas recreativas y como reservas genéticas para el futuro. Por todo esto no requieren más que un manejo comprensivo y respetuoso.

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DENSITY DEPENDENT AND DENSITY INDEPENDENT REPRESENTATION OF INDIRECT SPATIAL SERIES ANALYSIS

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A density independent representation of indirect spatial series analysis is proposed and it is compared to the density dependent representation. In this case the indirect spatial statistics are plotted against the average number of individuals instead of the plot size. Differences of density dependent and independent representations are displayed by the analysis of three (semi-artificial) communities which have different densities but the same pattern. Density dependent and independent representations suggest strikingly different interpretations which should be bear in mind during the analysis of spatial pattern. I also mention some further possibilities to create density-free representations.

Introduction

Spatial statistics are usually plotted against the (logarithm) of plot size in botanical applications (JUHÁSZ-NAGY and PODANI 1983). Direct spatial statistics are straightforwardly derived from the vegetation of sampling plots. The case of indirect spatial statistics is more sophisticated. The number of plots having different species list is counted for a given plot size and the statistics characterizing the vegetation are calculated from this derived data set. These methods were developed by JUHÁSZ-NAGY (1976) and he used these statistics with a special sampling arrangement which use a series of increasing plot sizes. It is mentioned as spatial series analysis (PODANI 1992; TÓTHMÉRÉSZ 1994). Indirect spatial statistics in a spatial series analysis always have a global maximum; sometimes also have more than one local maxima (BARTHA 1990; PODANI 1984; TÓTHMÉRÉSZ and ERDEI 1992). The maxima of these statistics indicate particularly important plot sizes, usually mentioned as characteristic areas (JUHÁSZ-NAGY 1967). Using the characteristic areas of different indirect spatial statistics a characteristic ordering and characteristic interval can be defined which have crucial role in describing the vegetation's coenological states (JUHÁSZ-NAGY 1967; BARTHA 1990).

The density of vegetation is frequently different for the compared communities. The size of the maximum area, however, depends on the density of vegetation. It was first demonstrated by BARTHA and HORVÁTH (1987) using computer simulation. This and other problems related to characteristic areas in indirect spatial series analysis are discussed by PODANI et al. (1993). But we are interested in the pattern of vegetation and the density has a scaling effect. Thus a density-free representation of indirect spatial statistics may be useful to compare the pattern of communities. It is also stressed by the observation that in the case of rarefaction diversity ordering and direct spatial series analysis the density dependence also has curicial effect (TÓTHMÉRÉSZ 1993) and the interpretation of the result may be influenced vigorously by the density independent representation (TÓTHMÉRÉSZ and MATUS 1993, 1994).

Methods

I have simulated three semi-artificial communities. Each of them was a 4-species community. In the case of the first community the number of individuals of the species were the following: 130, 45, 17 and 9. The total number of individuals was 201. In the case of the second community the total number of individuals was 10 times higher than in the case of the first community. In the case of the third one the total number of individuals was 50 times higher than in the case of first community. Each community was simulated to be completely spatially random. Complete spatial randomness (CSR) involves that (i) the number of individuals in any plot A with area $\text{area}(A)$ follows a Poisson distribution with mean $\lambda \cdot \text{area}(A)$, and (ii) given n individuals in a plot A , the individuals are an independent random sample from the uniform distribution on A (CRESSIE 1991; DIGGLE 1983). In (i), the constant λ is the intensity, or mean number of individuals per unit area. The number of species and individuals of the first simulated community is identical with the number of dominant shrubs (Fraxinus excelsior, Carpinus betulus, Fagus silvatica and Acer pseudoplatanus in the Rejtec Project Research Area in a 5 m by 5 m sample plot.

The diversity of species combinations was used to characterize the spatial pattern of communities; this is an indirect spatial statistics which was proposed by JUHÁSZ-NAGY (1967). Calculations were partly made by an early version of MULTI-PATTERN which was under development that time (ERDEI and TÓTHMÉRÉSZ 1993).

Results

The curves of the indirect spatial statistics are quite different for the communities using the usual density dependent representations (Fig. 1). The maximum area is 2195 cm^2 for the first community. 356.2 cm^2 for the second one and 85.32 cm^2 for the third community (Table 1). The theoretical

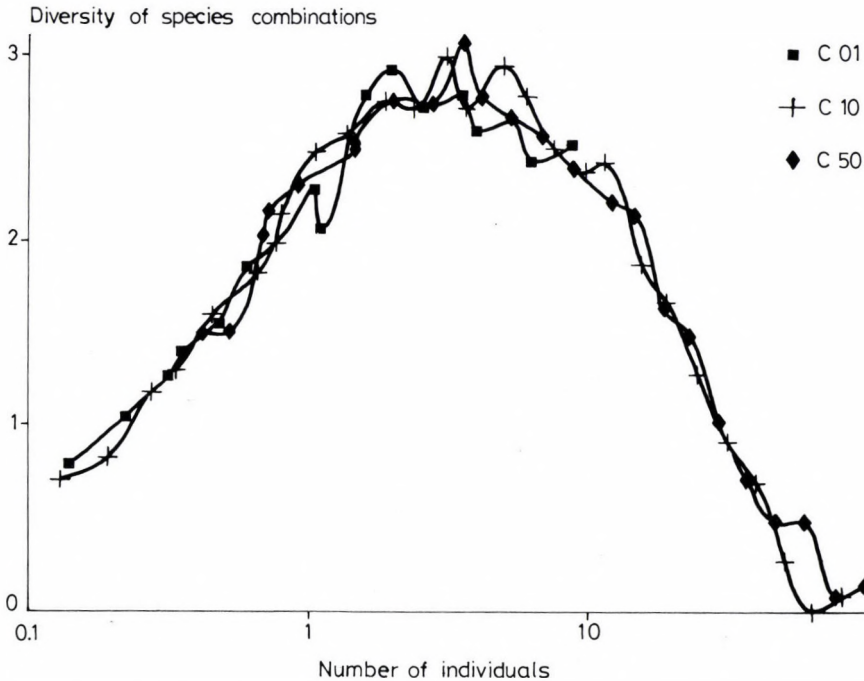


Fig. 1. Diversity of species combinations plotted against the logarithm of plot size for three completely spatially random communities. Hundred plots were used for each plot size. The theoretical values for an infinitely large communities are also indicated

values calculated for infinitely large communities having the same community structure and same intensity as the finite, simulated communities, are 3654 cm^2 , 369.7 cm^2 and 72.3 cm^2 using 200 different plot sizes. It was calculated by the method proposed by T. CZÁRÁN (1992). The smallest plot size was 100 cm^2 and the largest one was $60\,000 \text{ cm}^2$. In the case of density independent representations the curves of the indirect spatial statistics in a spatial series analysis are identical; differences are resulted in by the sampling error caused by the finiteness of point pattern and the limited number of plots (Fig. 2). The maximum areas are at 2.32, 3.10 and 2.27 individuals. The theoretical value of the average number of individuals at the maximum area for an infinitely large community is 2.90 individuals.

Table 1

Maximum areas and the average number of individuals at the maximum area for three completely spatially random communities. The number of species and the relative frequencies of the species are the same for each communities, just the densities are different

Total number of individuals	201	2010	10050
Theoretical value of the statistics for a CSR pattern (200 plot sizes was used)			
diversity of species combinations	2.907	2.907	2.907
maximum area (sq. cm)	3654	369.7	72.3
number of individuals	2.94	2.97	2.91
Statistics is estimated from realized CSR pattern (30 plot sizes and 100 plots for each plot size)			
diversity of species combinations	2.921	2.993	3.068
maximum area (sq. cm)	2395	356.2	85.32
number of individuals	2.32	3.10	2.27
Statistics is estimated from realized CSR pattern (200 plot sizes and 5000 plots for each plot size)			
diversity of species combinations	2.911	2.971	2.971
maximum area (sq. cm)	3181	344.9	83.1
number of individuals	2.66	2.76	3.32

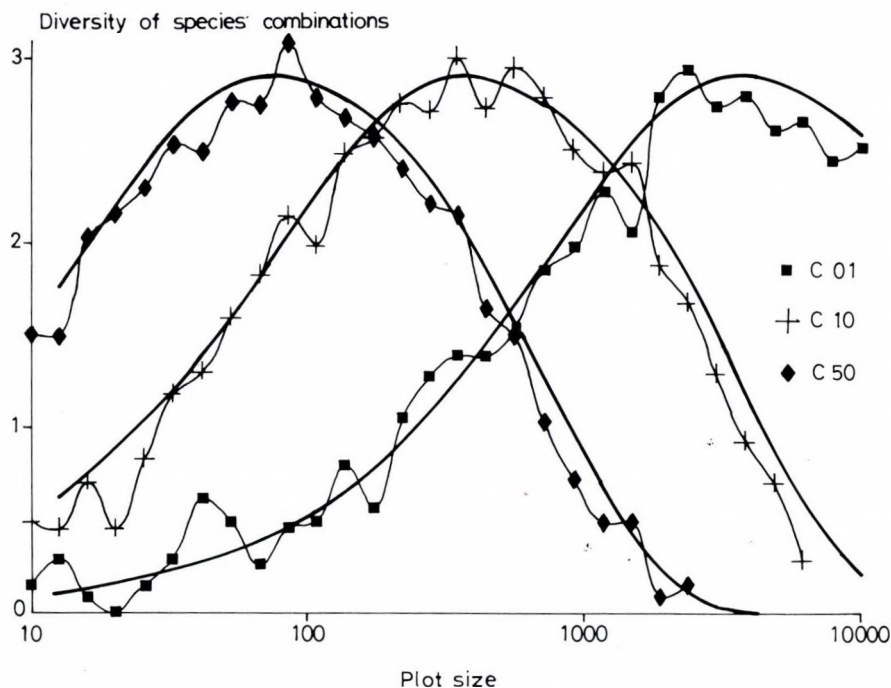


Fig. 2. Diversity of species combinations using a density independent representation. It is plotted against the average number of individuals. The same data sets were used as in the case of Fig. 1

Discussion

There is an increasing interest in null models in ecology (CASHWELL 1976; CONNOR and SIMBERLOFF 1986; SIMBERLOFF 1983). Exploring the community structure and pattern it is vital how to choose the null model to which the actual pattern of community is compared. An increased number of individuals with any changes in the community structure and pattern certainly indicate no deviation from the null model. It is well reflected by a density independent representation, while it may be not so evident using a density dependent representation. Especially not, when the pattern is different from the null model just for a limited range of the scale and at the same time the density of the community also has changed.

In a recent work on graphical perception CLEVELAND (1990) proposed to distinguish between scale information in the data and the physical information, which is left when the scale information is removed; the physical information relates to pattern perception. The density independent relation, proposed in this paper is similar to this idea. The density of the plant community has a scaling effect and it is removed by a density independent representation. This representation focuses on the effect of pattern.

The density independent representation is quite natural in the case of rarefaction type diversity ordering (TÓTHMÉRÉSZ 1993) and direct spatial series analysis. Using a direct spatial series analysis (TÓTHMÉRÉSZ and MATUS 1993, 1994) demonstrated that the density dependent and density independent representation produce significantly different ecological conclusions. In the case of indirect spatial series analysis the basic differences are evident from the presented computer simulation although I do not present a field study in this paper.

Further perspectives

The effect of dominant species may also dominate the contribution of the subdominant and other species although they may have real importance in the formation of the whole pattern of the community. However, the indirect spatial statistics developed by JUHÁSZ-NAGY are additive; i.e., each of them is produced as the sum of the individual curves of the species' spatial characteristics. A special representation of the indirect spatial statistics, where the individual contributions of the species are summed up in a density independent way may eliminate this problem. This type of density independent representation may also be useful to eliminate the artifacts produced by the rare species. TÓTHMÉRÉSZ and ERDEI (1992) have demonstrated that rare species may produce serious artifacts in the case of spatial series analysis. Using the special density independent representation discussed here, this problem is naturally overcome because the rare species have such a low density that they contribute to the community's pooled statistics at a very low density or at a huge plot size which is usually irrelevant from the point of the study. Another way to create a "density independent" representation is to use the number of species combination to re-scale the spatial series statistics. In the case of indirect spatial series analysis the number of species combinations has analogous role to the

number of individuals in the case of direct spatial series analysis. However, there are significant differences. The number of individuals is increasing with the plot size, while the number of species combinations is increasing up to a characteristic plot size and after that it decreases. Both possibilities mentioned in this paragraph to create a "density independent" representation are unusual. Especially the second one, which is based on the number of species combinations. Therefore, they need further studies using field data sets and computer simulations.

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PIONEER PHASE OF SUCCESSION IN A RUDERAL WEED COMMUNITY

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Successional changes of a weed community after the abandonment of goose breeding were studied on permanent plots in a sandy region of East-Hungary (Nyírség). Slow increase of the number of species was found while no trend was detected in the change of cover. Initial stage was characterized by summer annuals while later winter annuals and some groups of perennials appeared. The first one and a half years were dominated by ruderal weeds; after that species having indifferent coenological character became abundant. Climax grasses are still rare. Dominance-diversity curves show that in the initial stage the assemblage was strongly dominated by a few species; in later stages less extreme abundance relations were typical.

Introduction

Weed communities are in the focus of intensive interest partly because of their enlarged spread and economic importance. Flora of ruderal areas often bears exotic plants as these spots are usually nutrient-rich, open habitats representing low-competition circumstances which is favoured by newly introduced adventive plants. As many of weed species were widely introduced their associations provide similar objects of research throughout the world. Another reason for their increased study is due to the rapid processes of vegetation development especially in the pioneer phase.

Their description and classification in Hungary commenced more than fifty years ago with works of FELFÖLDY (1942), BALÁZS (1944) and TIMÁR (1950) and their agricultural significance has been stressed since then (UJVÁROSI 1954). Data on seasonal aspects in crops and on changing weed vegetation were published by UJVÁROSI (1966a, b). A detailed life-cycle system useful in practical questions of weed-control and in studying seasonal changes of weed vegetation was elaborated (UJVÁROSI 1952).

One of the first attempts to describe initial phase and succession of ruderal communities and to analyze its causes is that of UBRIZSY (1955).

Trends in vegetation cover, species richness, changing life-form composition and appearance of seasonal aspects are given by him as attributes in progressive succession of ruderal associations. The development of spatial pattern in primary succession of a strip coal mined area, an extended habitat for ruderal associations, was described using information statistical methods and was modelled by computer simulations (BARTHA 1991, 1992; CZÁRÁN and BARTHA 1989).

Floristic records were presented on ploughlands and ruderal sites of the 'Nyírség' (GONDOLA 1969) while relevant agricultural publications from the study area also available (HALÁSZ 1969; SÁPI 1980).

A new and common disturbing agent both on alkalic and sandy regions of the Great Hungarian Plain is extensive goose breeding. Hundreds to tens of thousands of geese are kept temporarily in natural grasslands devastating aboveground vegetation almost completely. On freshly created bare surfaces processes of regeneration are initiated from the seed bank and immigrant propagules.

The aim of this paper is to characterize floristic and phytosociological composition in the pioneer phase of secondary succession and to describe changes in dominance structure and in life-form composition of vegetation at an abandoned goose-breeding farm.

Site and Prehistory

Study area

The study area is situated in East-Hungary, 25 km to the East of the city of Debrecen in the vicinity of Vámospércs village (47°32' N, 21°58' E). The surrounding region called 'Nyírség' is characterized with wind-blown inland sand dunes of Pleistocene origin. Soils derived from sand contain a limited amount of humus and are almost completely lacking calcium; thus, are moderately acidic with pH values 4.5-5.5 in topsoil and 3.5-4.5 in subsoil. Mean annual temperature of the area is about 10.0 °C while average annual precipitation is around 600 mm. Within-year distribution of rainfall is often uneven, summer droughts are common.

The study site is positioned on a small sand dune of 3.5 m relative height. Its original vegetation similarly to the close surroundings was a dry perennial pasture which phytosociologically can be regarded as a transi-

tion between Festucion vaginatae and Cynodonto-Festucion with grasses Festuca pseudovina, F. vaginata, Cynodon dactylon and Corynephorus canescens. Arable fields, plantations of black-locust and a water-pool seasonally covered by water can also be found within 150 m distance.

Site prehistory

We suppose that the site was not ploughed in the last decades as weeds with dormant seeds such as Chenopodium album and Ambrosia elatior abundant in neighbouring arables are missing from post-disturbance vegetation almost completely.

The area was declared as a nature reserve in the eighties and during last years the stand was only exploited by occasional grazing of a herd of about 15 cattle. Accidental activity of rabbits was also noticed.

Strong dominance of the geophyte Cynodon versus the subordinate status of hemicyptophyte grasses probably indicates a former period of overgrazing. Cattle grazing in perennial sandy pastures of the region is proved to be selective according to Raunkiaer's life-form categories resulting in the spread of geophytes at the expense of hemicyptophytes (MATUS and TÓTHMÉRÉSZ 1991; TÓTHMÉRÉSZ and MATUS 1994).

Disturbance

On the top of the dune a provisional farm-building for approximately 800 geese was established in the early spring of 1989. Animals were kept in the building by night but they were let to graze the surrounding pasture at daytime from March to October. In late autumn the farm was moved and the building was demolished. Inside the former building a 5-10 cm thick layer of goose droppings mixed with feather, litter and food remnants remained back covering soil surface. At the close surroundings of the building aboveground vegetation was removed due to feeding of geese but these parts were not covered with faeces. At small patches next to the walls, however, some remnants of aboveground vegetation consisting mainly of perennial grasses persisted.

Methods

Sampling

In spring 1990 four permanent plots of 3.2 x 3.2 m size were marked out. Plot A is within the former building where faeces layer was left. Plot B is positioned near a patch of surviving geophytes at the former walls, while plot C was staked out on a totally denuded part 20 m away for the building where no aboveground vegetation was left behind. Plot D is centred into a 5 x 5 m area within the former building where the layer of goose droppings was removed (Fig. 1).

Permanent plots were surveyed three times a year at the dates late April, late June and late September in years 1991 and 1992, respectively. Sampling was omitted in April 1990 as aboveground vegetation was still practically absent thus only two surveys were accomplished in this year. Total cover of vegetation, its distribution between species and the number of individuals of species were estimated. In this paper, however, percentage cover data are only discussed.

Data processing

Distribution of Raunkiaer's life-form categories and that of weed's life-cycle classes (UJVÁROSI 1973) were calculated for transformed field data sets with relative cover of species. Importance of phytosociological groups was also displayed on the same data base. Nomenclature for taxa and syntaxa follows SOÓ (1980) and it is the source of Raunkiaer's life-forms categories as well. Species were only regarded to belong to a certain phytosociological division if they were enumerated exclusively from subordinated groups of that but were distinguished as "indifferents" when occurring at groups under different divisions.

Dominance relations were demonstrated by dominance-diversity curves, a common method in studying successional communities (BAZZAZ 1975; WHITTAKER 1965, 1972). This tool is widely used in describing the fast seasonal rearrangement in dominance structure of pioneer weed communities (NUMATA 1982) and that of successional grasslands (HAYASHI et al. 1981).

Degree of succession (DS) was calculated on dominance ratio of cover data (NUMATA 1982):

$$DS = \left[\left(\sum_{i=1}^S d_i l_i \right) / S \right]^v$$

where S is the number of species in the community, d_i is the relative dominance of the i-th species, l_i is the life span value (Th = 1, H, G = 10) while v is the relative total cover of vegetation.

In most of relevés many species were present with insignificant dominance but in spite of it they formed the bulk of species number. This fact resulted in an irrelevant increase of the denominator in NUMATA's formula producing extraordinarily low figures in DS. To eliminate this effect a corrected form was introduced where S was replaced by an 'equivalent number of species', S_e which was calculated as

$$S_e = 1 / \sum_{i=1}^S p_i^2$$

The maximum of 'equivalent number of species' could be as high as the total number of species, but in case of real field data sets it is usually lower. Therefore, the value of 'corrected degree of succession' is much higher than DS.

Results

Cover

No clear seasonal pattern or commonality was observed in changes of percentage cover data. The only exception was the dramatic fall in all plots between June and September 1991. Within-building plots (A and D) were of extremely low cover at the start but values were fluctuating in a very broad range. A more narrow range was typical for plot B and D.

Species richness

There is an obvious trend of increase in number of species per plot. For all relevés of 1990 maximum of species number was only 15, in 1991 it ranged between 11 to 25 and in the last year was between 14 and 31. We have not found, however any clear seasonal fluctuation in this period, there are both great increases and drops from any of the seasons to the next (Fig. 2).

Floristic records

Most of the 80 species registered were common ruderal weeds or plants typical of natural stands published earlier from the region. Floristically interesting was, however, the occurrence of some annuals typical of alkalic grasslands but uncommon on acidic sandy soils. Pholiurus pannonicus (Gramineae) persisted in plots B and C while Ceratocephalus testiculatus (Ranunculaceae) was recorded only in plot C. We suppose that their propagules might have been introduced with the crop for geese or by means of vehicles moving from similar goose-breeding farms of 'Hortobágy'.

We also recorded some acidophilous species reported to be sporadic in the region. These are Herniaria glabra and Spergula pentandra (Caryophyllaceae). It was surprising to find Chamaenerion angustifolium (Onagraceae) a plant typical of mountain clear-cut areas.

Life-form composition

Herbaceous annuals made up the largest part of species set. Hemipterophytes comprised less than one third of it while geophytes and plants of other life-form categories were less numerous. No samplings of trees were found.

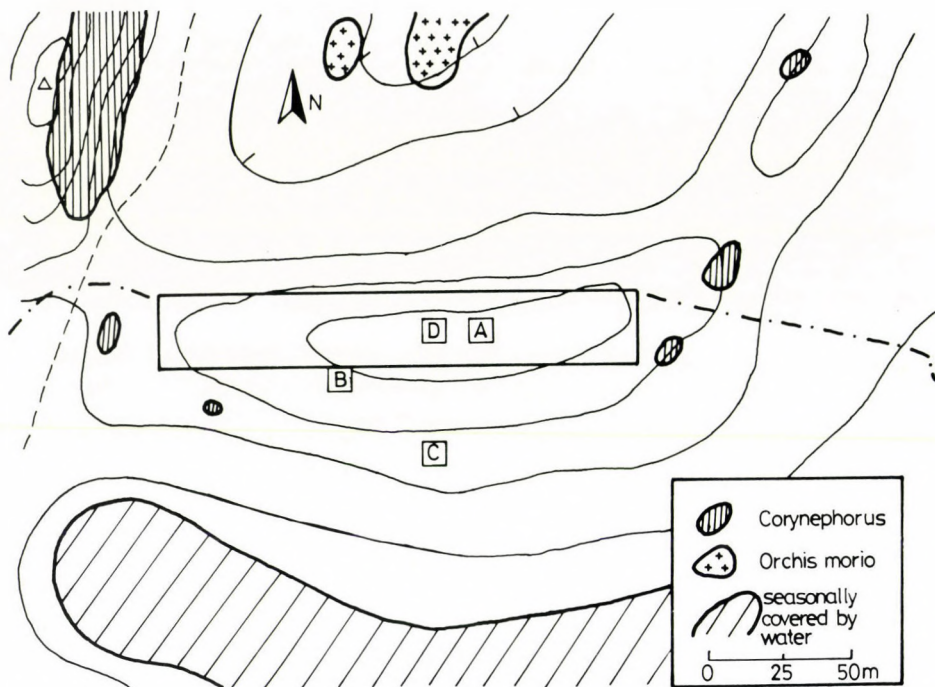


Fig. 1. Map of the study site and the sampling set-up. Plot A and D are inside the demolished farm building; in plot D goose droppings were removed. Plot B is close to a patch of surviving geophytes while plot C was on bare sand

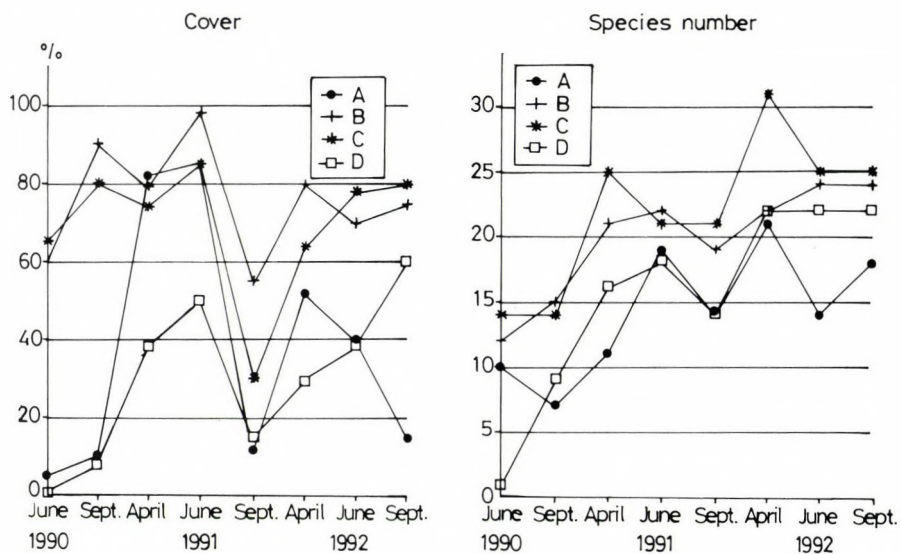


Fig. 2. The changes of the cover and the number of species in plots

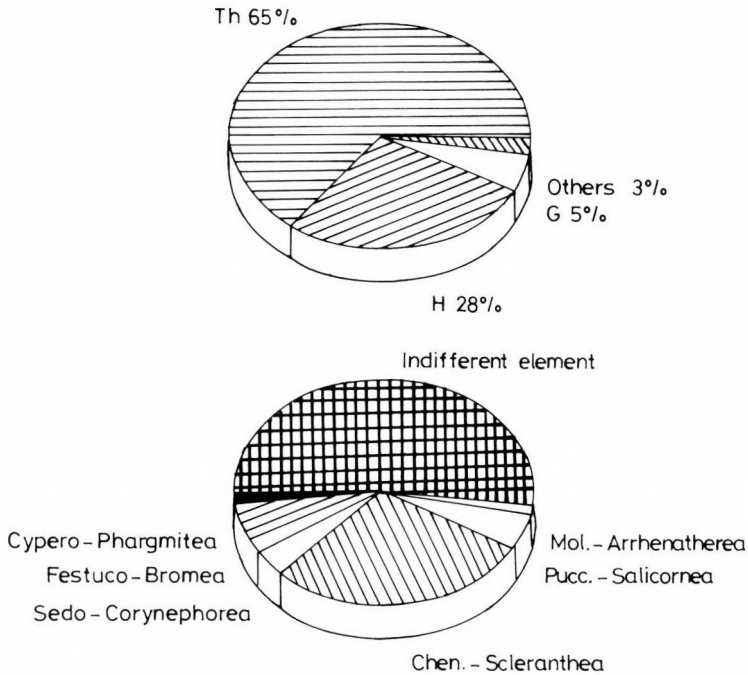


Fig. 3. Life-form composition and phytosociological distribution of the species set

Phytosociological composition

We found seven phytosociological groups to comprise the species list out of which five can be considered as significant ones. Species with indifferent phytosociological character built up more than a half of flora. They occur at two or three divisions out of the first three ones listed below. A quarter of species belonged to the division Chenopodio-Scleranthea while plants typical of Festuco-Bromea and Sedo-Coryneporeia were less numerous. Some Puccinellio-Salicornea species were found in plots B and C, while Molinio-Arrhenathera and Cypero-Phragmitea were represented only with a few elements (Fig. 3).

Dominance structure and its change

Most of species appeared as subordinated ones with minute covers often represented very few or single individuals. Out of the 80 only 25 species reached 5% relative cover at least in one case and plot (hereafter referred

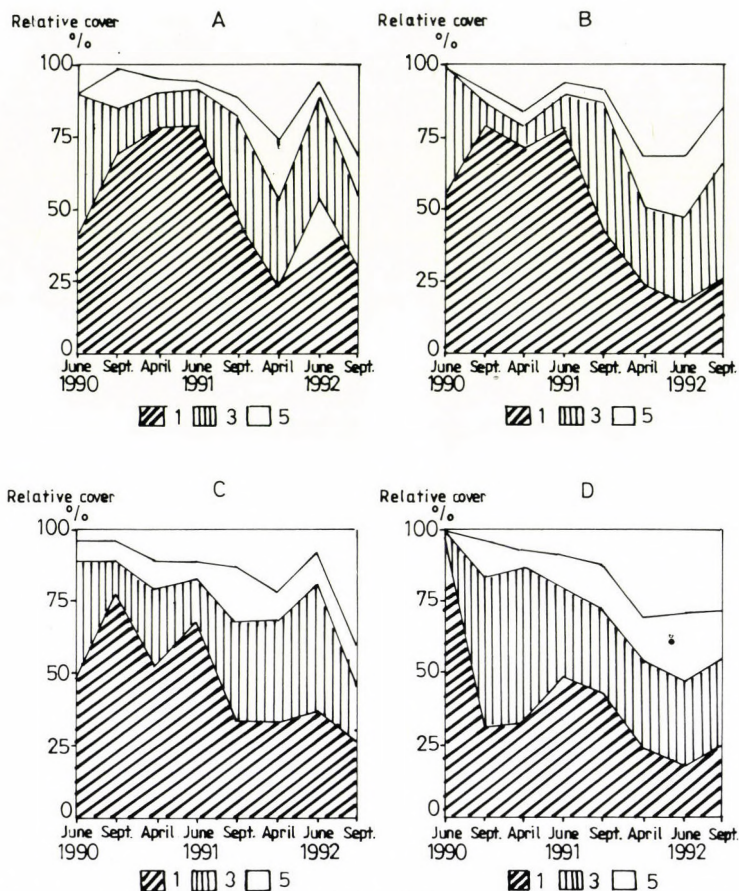


Fig. 4. Changes of the relative covers of the first, first three and first five dominant species, respectively

as frequents). Twelve species were able to exceed 25% relative cover, six to grow over 50% out of which only 4 (*Amaranthus albus*, *Descurainia sophia*, *Sisymbrium altissimum*, *Portulaca oleracea*) to reach top covers above 75%. Cover of the dominant and subdominant species was extremely high, especially in the first year but with a decreasing trend through the study. (Dominant is the species of the highest relative cover in a given plot and date while species with a relative cover over 10% are called subdominants.) Summed cover of the first three most abundant species was 50–75% even by the autumn of 1992, while the same figure for the first five ones was 60–85% (Fig. 4).

The pioneer communities of 1990 were poor in species therefore could be represented with extremely steep dominance–diversity curves demonstrating

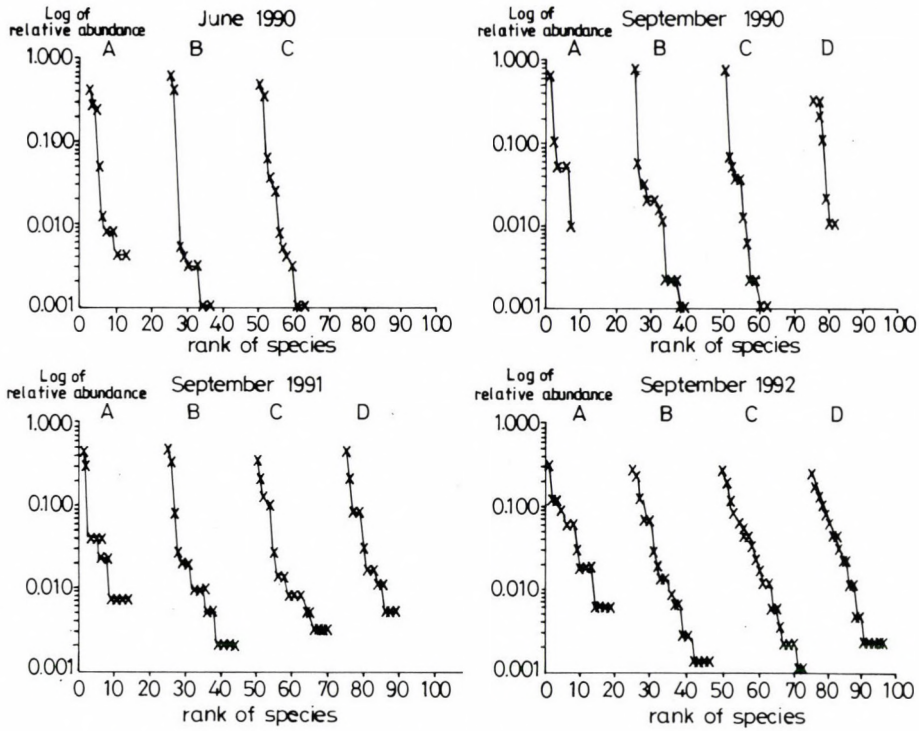


Fig. 5. Dominance-diversity curves of the weed assemblages based on cover

hardly organized, unstructured assemblages of one dominant and some insignificant satellite species. It is worth to note that the mid-region of the curve is practically missing thus there are still no subordinated species present.

Most of the second year, 1991, can also be described in the same way. In certain plots, however, different species were dominating. The last date to detect dominant controlled hierarchies is June 1991 when dominants except plot D lastly reached top relative covers of 65-85%. Some subdominants appeared in September 1991 and growth of species richness was recorded therefore dominance-diversity curves became less steep attesting to a somewhat more balanced community structure (Fig. 5). Average number of frequents per plot increased from 2.5 at June 1990 to 6.5 by autumn 1992.

We have also found a slight seasonal rearrangement in community hierarchy. In summer aspects curves developed more steep especially in their upper parts while the relative cover of the dominant reached higher figures. On the other hand spring and autumn aspects can be characterized with less

steep curves and lower performances of the dominants. The above description fits the best for 1991 but not so well for 1992 when the summer aspects of plots B and D are much more similar to those surveyed in April and September, respectively. We think that this type of behaviour unfamiliar to the pioneer phase might be regarded as a sign of further promotion in succession of these two plots.

Vegetation dynamics

During the three growing seasons 32 relevés were made and 17 different species were recorded as dominants but their number per plot was only 5.75 as an average. From a certain date of sampling to the next the actual dominant was also replaced averagely 5.75. The dominant's turnover was maximal in plot D where there were 7 changes between the 8 dates of samplings. 1.75 species per plot were dominating the vegetation more than once (usually twice and not in the same year) while only 1.00 species per plot was able to stay dominant in consecutive dates of sampling. Most of species being short-lived annuals were neither able to maintain their dominating position for more than some months nor to become a dominant repeatedly later.

Changes of life-form composition

We have found three life-form classes to compound most of the vegetation. These were according to Raunkiaer's system therophytes, hemicryptophytes and geophytes. We have not recorded obligate biennials and those species which are reported to be facultative ones (such as Matricaria inodora) were covering their life-cycle within 12 months so behaved clearly as annuals.

Therophytes played the most important role in first three year's vegetation development. From the beginning to later phases their role, however, has continuously been decreasing and significance of their life-cycle groups changed repeatedly.

Pioneer phases in June 1990 could exclusively be described with T_4 plants (summer annuals germinating in late spring, flowering and setting seed by late summer or autumn such as Amaranthus albus, A. retroflexus, Portulaca oleracea and Polygonum aviculare).

By the autumn cover was hared with T_2 winter annuals which are germinating in autumn and/or early spring and dry by midsummer (Sisymbrium

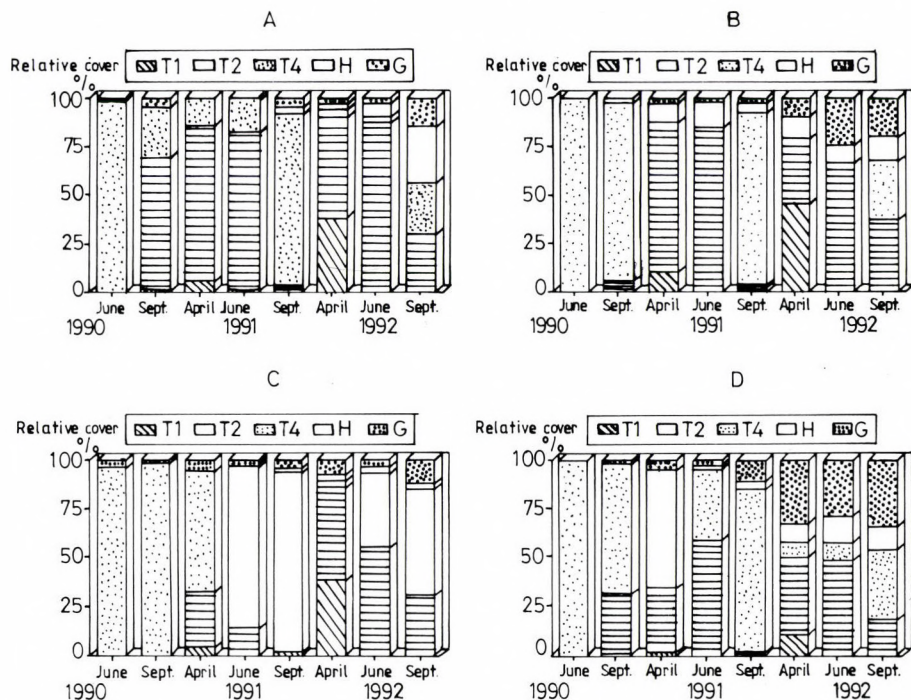


Fig. 6. Distribution of life-form categories. Annuals are categorized by the life-cycle system of UJVÁROSI

altissimum, *Anthemis ruthenica*, *Bromus tectorum*, *Apera spica-venti* and *Crepis tectorum*).

By spring 1991 some T_1 species were also present but have become more abundant a year later. The germination of these species takes place at late autumn and their development is finished by mid-spring. Plants belonging to this group were *Cerastium semidecandrum*, *Stellaria media* and *Capsella bursa-pastoris*. In the second summer coexistence of winter and summer annuals was typical while the autumn aspect of 1991 was has brought again the sole reign for summer annuals.

In the third year a gradual decline of annuals has been found but the rate of it was greatly different in plots. In April T_1 annuals reached significant covers in each plot and after their disappearance both T_2 and T_4 annuals have persisted until the autumn. As a rule no aspect of 1992 can be described with the domain of a single life-form class (Fig. 6).

Four groups of perennials were mainly present two of which were hemi-cryptophytes and two others geophytes, respectively.

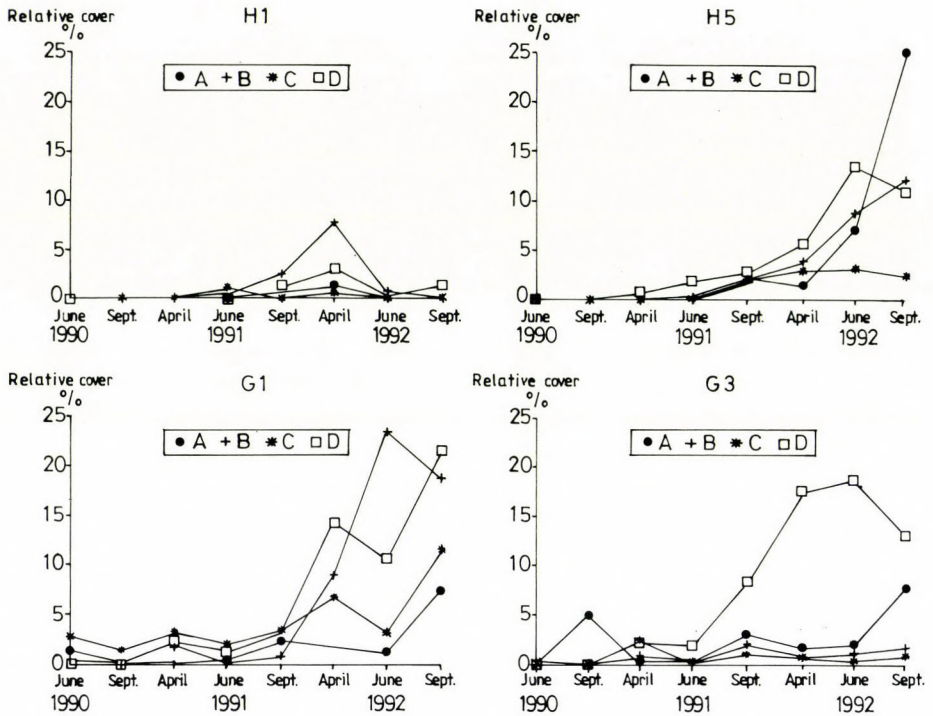


Fig. 7. Changes of relative cover of main groups of perennials

A moderate success of spread is attributed to H_1 perennials with relative covers usually under 5%. These plants are climax tussock grasses which possess no effective means of vegetative invasion. Such species are Festuca pseudovina and Corynephorus canescens.

Members of H_5 class have shown more efficient performances except plot C. Potentilla argentea, Plantago lanceolata, Hypochoeris radicata are dicots with inclined subterranean stem which enables them for occasional ramification.

A similarly powerful strategy was that of G_1 plants which are rhizomatous, stoloniferous geophytes such as Agropyron repens, Cynodon dactylon, Poa angustifolia and Achillea cf. millefolium. Their relative cover by the autumn of 1992 reached at most cases 10%.

G_3 species except plot D have accomplished less spread. Geophytes forming long roots running shallowly parallel with the soil surface like Rumex acetosella belong to this group. Their success was probably enhanced

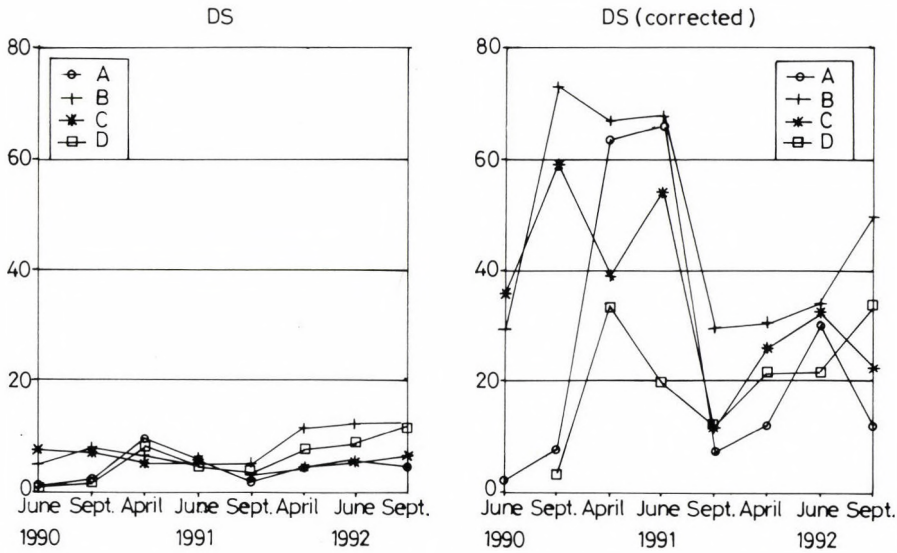


Fig. 8. Degree of succession and the corrected version of it. Cover values were used to calculate the effective number of species in the corrected form

by the dry faeces layer in plot A or by the loose moving sand in plots B and C (Fig. 7).

Degree of succession

It showed no general progression of plots neither in its original form nor in the corrected one. Calculation of the original form expressed advance in plots B and D by September 1992 while values of the corrected form for all plots were higher in at least one of 1991 surveys. In both cases irregular fluctuations of cover are reflected rather than any seasonal pattern or trend in longer terms (Fig. 8).

A more satisfactory results was gained through displaying relative cover of perennials. A non-monotonous but well expressed development can be detected from September 1991 which is continued in the following year (Fig. 9).

Phytosociological changes

The first and second year were dominated by species of division Chenopodio-Scleranthea and these elements were still rather abundant by the end of

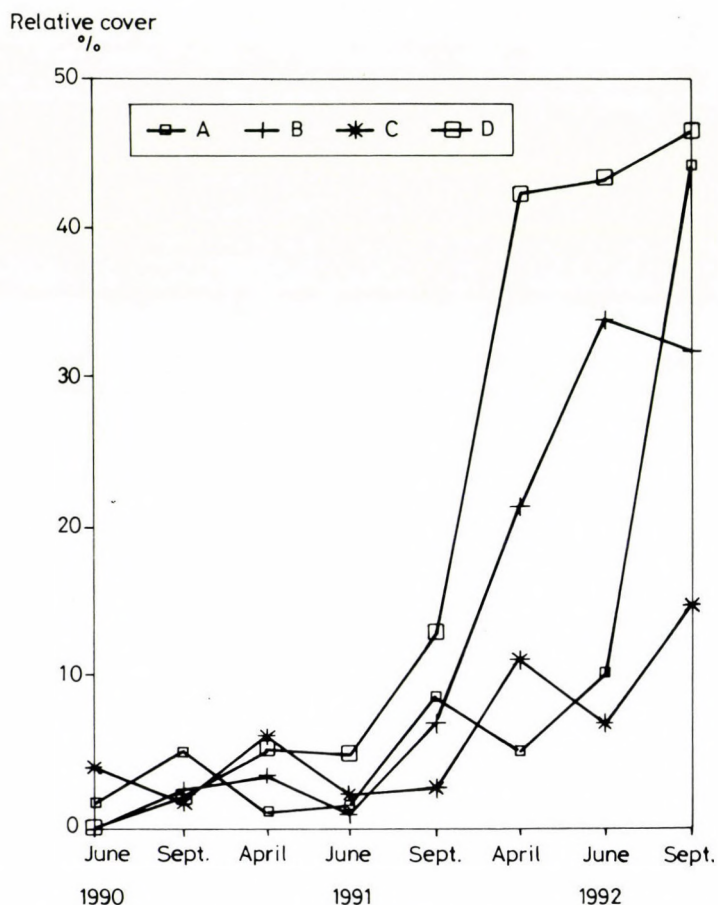


Fig. 9. Increase of the relative cover of perennials

the third growing season after disturbance. Since September 1991 the group of coenologically indifferent species became the most represented syntaxon. Sedo-Corynephorea elements were not present at the start but gained significant importance by June 1992. Most of the cover of this group was that of Anthemis ruthenica a T_2 annual perishing by mid-summer thus dominance of this group was greatly reduced in autumn relevés. Appearance of Festuco-Bromea species is confined almost exclusively to the spring aspect consisting of T_1 annuals mainly Cerastium semidecandrum. Extremely low cover of this group in the autumn reflects to the lack of perennial climax grasses (Fig. 10).

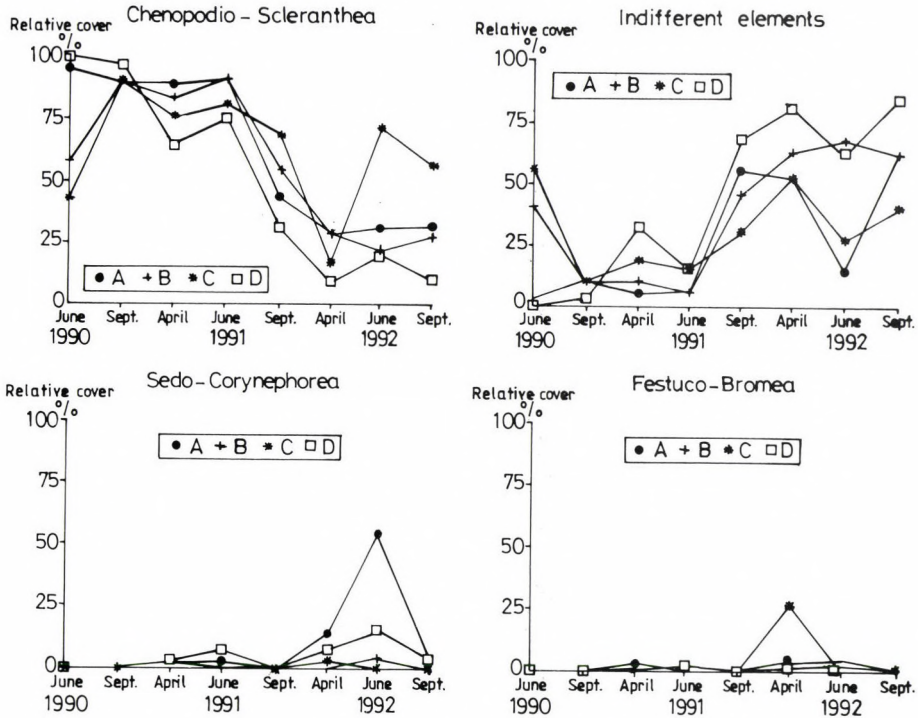


Fig. 10. The changes of relative cover of phytosociological groups

Discussion

Common conclusions of vegetation development

Successions are said to have a lot of common characteristics indicating progression. The aim of this paper was to deal with some basic features of this multi-sided process at one of the possible scales. The attributes studied are neither in strict coincidence nor in contradiction with each other but reflect to different aspects of vegetation development.

An inevitable progression was found in species richness and a clearly changing floristic and phytosociological composition was detected (Fig. 11). Regular shift in life-form composition was recorded. Subsequent domain of summer and winter annuals and later the appearance of perennials (Table 1) can be considered as a basic rule in secondary succession (HAYASHI and NUMATA 1967). Signs of emerging organization are apparently expressed in de-

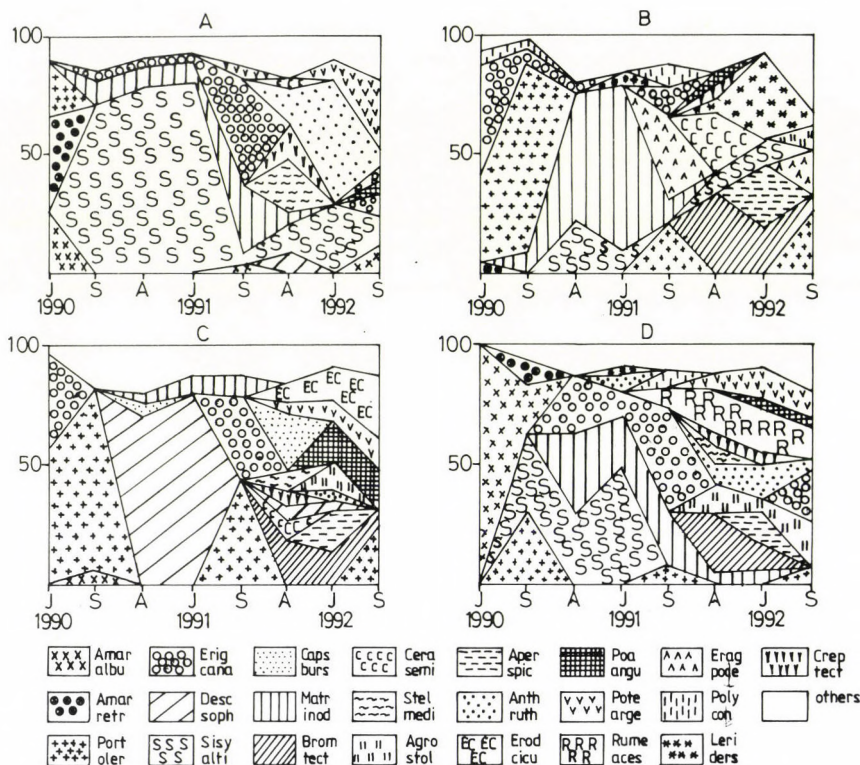


Fig. 11. Changes of the relative cover of frequent species (cover > 5%). Names are abbreviated by getting the first four characters of genus and species, respectively

veloping aspects and we found, in accordance with others (NUMATA 1982), seasonal rearrangement of the dominance structure. The often cited shift from dominant controlled communities to ones with more balanced species hierarchy (BAZZAZ 1975) was also detected. The vegetation after the short period of development cannot be described with one or a few species any longer.

There are attributes, however, which do not suggest development. Cover of vegetation and degree of succession are far from expressing progression. Broad fluctuations of cover might be partly dependent on climatological factors.

In spite of evident signs of progression the regeneration of the perennial *Cynodonto-Festucion* pasture is in a preliminary phase and a relatively small part of the species set makes up most of cover even by the end of the third growing season after disturbance. The study period is charac-

Table 1

Changes of summed cover of frequent species according to life-form classes.
Cover was summed for all plots

	Dates of sampling							
	1990		1991			1992		
	June	Sept.	April	June	Sept.	April	June	Sept.
ANNUALS								
T ₄								
<u>Amaranthus albus</u>	125	26			5			12
<u>A. retroflexus</u>	45	10						
<u>Portulaca oleracea</u>	116	188			72			30
<u>Polygonum aviculare</u>	6	5			18			
<u>Erigeron canadensis</u>	88	10	34	13	137			34
<u>Matricaria inodora</u>		16	133	107	71	10	5	
<u>Lepidium densiflorum</u>						5	37	6
<u>Digitaria sanguinalis</u>								8
<u>Eragrostis poaeoides</u>		5			33			11
<u>Fallopia convolvulus</u>				6				
T ₂								
<u>Descurainia sophia</u>			71	79		12	5	
<u>Sisymbrium altissimum</u>		100	128	137	5	21	38	12
<u>Anthemis ruthenica</u>				7		23	74	10
<u>Bromus tectorum</u>						75	44	14
<u>Apera spica-venti</u>							56	
<u>Erodium cicutarium</u>						7	14	27
<u>Crepis tectorum</u>						33	5	
T ₁								
<u>Cerastium semidecandrum</u>						39		
<u>Capsella bursa-pastoris</u>			5					
PERENNIALS								
Hemicryptophytes								
<u>Potentilla argentea</u>						10	28	52
Geophytes								
<u>Rumex acetosella</u>					8	18	18	19
<u>Agrostis stolonifera</u>						21	21	21
<u>Poa angustifolia</u>						5	20	27
<u>Agropyron repens</u>								5

terized with the overwhelming dominance of a limited number of species and their rapid turnover.

Most of the studied characteristics show significant change between June and September of the second year, 1991. These are the enormous loss in cover of vegetation, fast decline of dominants' relative cover, appearance

of a less extreme dominance hierarchy, increased establishment of perennials. We suppose that coincidence of these events indicates that the first phase of vegetation development ended, and a new one commenced. Phytosociologically the first one was ruled by elements of Chenopodio-Scleranthea while the second one by coenologically indifferent species. The process can also be interpreted as a change between two of the basic plant strategy types; ruderals and stress-tolerants (GRIME 1979). In this context species of Sedo-Corynephorrea and Festuco-Bromea as ones attributed to climax grass-land communities can be regarded as competitors to become abundant in later phases.

Effects of management

Vegetation of plot D where goose droppings were removed bears some outcomes of management but its succession was not deeply altered. The highest possible turnover of dominants is accompanied with development of a relatively even dominance structure. Cover of the dominants was usually the lowest compared with untreated plots. Since the autumn of the second growing season the largest relative cover of perennials especially that of geophytes was recorded here. This is the plot where the lowest dominance of Chenopodio-Scleranthea species and the highest one of indifferents has been recorded since April 1991. Divergences indicate that development was more expressed and progression was faster than in untreated plots.

Acknowledgements

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PHYTOSOCIOLOGICAL STUDIES OF THE CLIFF FEHÉR-SZIRT, NEAR KESZTÖLC, HUNGARY

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The coenological data were collected on the Fehér-szirt, near Kesztlőc, Hungary, during 1990 to 1991. The following associations were examined according to the method of Braun-Blanquet: Asplenio rutae-murariae-Melicetum ciliatae Soó 1962, Chrysopogono-Caricetum humilis (Soó 1930) Zólyomi 1958, Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958 festucetosum valesiaca Soó 1959, Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958 festucetosum rupicolae Soó 1959. Among above-mentioned phytocoenoses the last one — contrasted with others — to be found on cooler and more humid territories. The proportion of chamaephyton species is very low in this subassociation while the number of hemicryptophyton species is the greatest among life forms of plants. European flora elements are presented at a relatively high percentage and occurrence of Eurasian elements is the most frequent in the mentioned subassociation.

Introduction

The species of Festuca valesiaca and Festuca rupicola were not distinguished in the coenological sample taken on rocky grasslands, on grassland slope steppes by above-mentioned authors. This separation was taken into consideration on grasslands of Fehér-szirt by authors. The aim of this paper is to compare two species with each other according to their ecological requirements and their ecological parameters.

Kétágú-hegy geographically belongs to the westernmost part of Pilis-hegység and is situated between Cserepes and Dorogi Valleys (BULLA 1967; LÁNG 1953) (Fig. 1). It is mainly formed by Triassic Dachstein limestone, and red Liassic limestone occurring in some places on its northeast slope (LÁNG 1953).

The study area, Fehér-szirt is located in north-east part of Kétágú-hegy. Some floristic data about Fehér-szirt and its surrounding were published earlier (KERNER 1857; FEICHTINGER 1864, 1899; JÁVORKA 1904; DOMOKOS 1934; BOROS 1946; FEKETE and JAKUCS 1957; PENKSZA 1991, 1992).

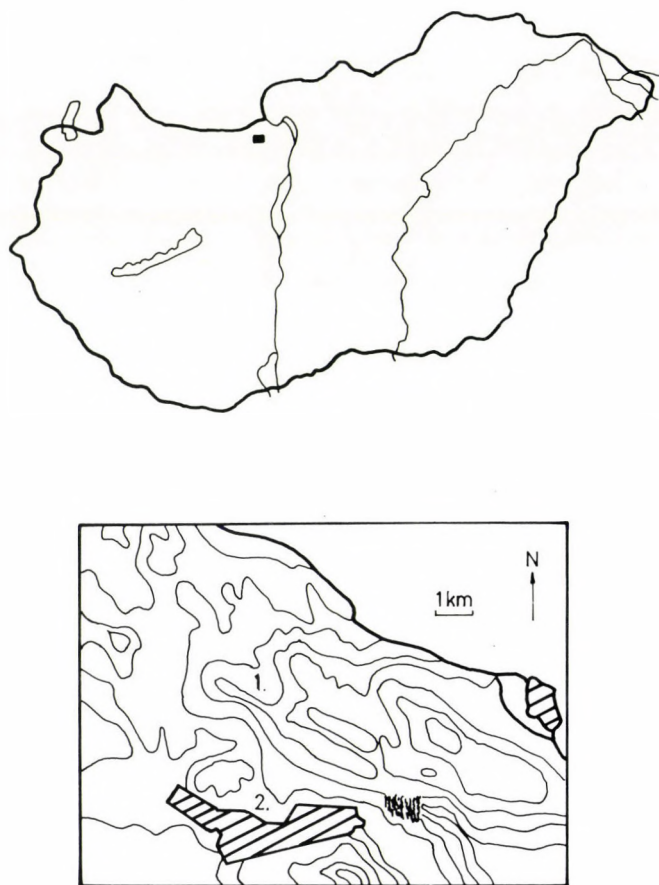


Fig. 1. Location of the study area (1. Fehér Szirt; 2. Kesztlőc)

Vegetation of Pilis-hegység and its district was surveyed by BOROS (1953). BORHIDI (1956) elaborated the sandy vegetation in Kisalföld and at the same time he dealt with area near Kesztlőc. The degrees of degradation of rocky grasslands were compared in case of Üreg Hill and Csévi Cliff by SZERDAHELYI (1988, 1989).

Taxonomic investigations of *Festuca* species were carried out in this territory by CSÁNYI-KOVÁCS and HORÁNSZKY (1973). Comparative analyses were treated on the soil-vegetation relationship by KOVÁCS-LÁNG (1966, 1971). Microclimatic conditions of the district was examined by DRASKOVITS and KOVÁCS-LÁNG (1968). The plant communities of rocky grasslands were systematized by ZÓLYOMI (1966).

Table 1

Asplenio rutae-murariae—Melicetum ciliatae Soó 1962

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	A-D	K
Cover %	20	30	25	25	25	30	35	35	30	35	35	35	40	35	45	20	30	25	25	25		
Asplenio-Festucion pallentis species																						
<i>Festuca cinerea</i> ssp. <i>pallens</i>	+1	+1	1	1	1	1	+1	3	1	+	1-2			1-2	3	+	+	2	2-3	1	+3	V
<i>Sedum album</i>	+	+	+	+		+	+	+1	+	+	+	1	1	1	+1	+		+1	+		+1	V
<i>Sempervivum hirtum</i>	+		+	+	+	+1	1-2		+1	+			1	1	+	+					+2	III
<i>Sempervivum marmoreum</i>							+		+1		1	+1	+1	+1	+1	+		+	+	+	+1	III
<i>Asplenium ruta-muraria</i>			+		+		+			+				+							+	II
Brometalia species																						
<i>Sanguisorba minor</i>	+	+	+	+	+	+	+	+		+	+	+1			1	+	+	+	+1	+	+1	V
<i>Cleistogenes serotina</i>		+	+	+	+	+	1-2		+	+	+1		+1	+					+	+	+2	IV
<i>Bromus erectus</i>														+							+	I
<i>Bromus squarrosus</i>													+								+	I
<i>Chrysopogon gryllus</i>			1		+													3		1	+3	I
<i>Dorycnium germanicum</i>																	+				+	I
<i>Linum tenuifolium</i>																				+	+	I
<i>Minuartia fastigiata</i>								+			+		+								+	I
Festuco-Brometea species																						
<i>Potentilla arenaria</i>	+1	+	+	+	+		+1	1	+1	+	1	+1	+1	1-2	1-2	+	+	1	1		+2	V
<i>Andropogon ischaemum</i>	1-2	1	1	1-2	1-2	+		1-2		+	+1				+	1-2	+1	+1	1	1	+2	IV
<i>Anthericum ramosum</i>	+	+	+	1-2	1	+			+			+				1	1	+	+	2	+2	IV
<i>Stipa eriocalis</i>	+	+		+	+			+	+	+1	+1	1		+	+	2			+		+2	IV
<i>Thymus glabrescens</i>	+	+	+	+	+	+1	+	+1	+	+	+1		+		+	+	+	+			+1	IV
<i>Sedum sexangulare</i>								+			+1	+	2	+	+			+	+	+	+2	III
<i>Calamintha acinos</i>				+	+	+													+	+	+	II
<i>Koeleria cristata</i>								+		+	+				+				+		+	II
<i>Poa bulbosa</i>												+	+	+	+	+					+	II

Table 1 (cont.)

Number plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	A-D	K
Cover %	20	30	25	25	25	30	35	35	30	35	35	35	40	35	45	20	30	25	25	25		
<i>Salvia pratensis</i>						+				+	+								+	1	+1	II
<i>Teucrium chamaedrys</i>					+		1				+	+1	+1		+						+1	II
<i>Alyssum alyssoides</i>													+						+		+	I
<i>Asperula cynanchica</i>										+									+		+	I
<i>Eryngium campestre</i>								+											+		+	I
<i>Linaria genistifolia</i>								+							+						+	I
<i>Medicago falcata</i>														+							+	I
<i>Medicago minima</i>													+								+	I
<i>Scabiosa ochroleuca</i>									+					+							+	I
<i>Tragopogon dubius</i>											+		+								+	I
<i>Verbascum lychnitis</i>						+								+							+	I
<i>Veronica spicata</i>						+											+				+	I
<i>Festucion rupicolae; Festucetalia valesiaca; Festucetalia vaginatae species</i>																						
<i>Seseli osseum</i>	+	+	+	+	+	+	+	+	+	+		+		+	+	+	+	1	+	+	+1	V
<i>Melica ciliata</i>	+		+		+	+	1	+	+	+	+	+	+	+	+				+	+	+1	IV
<i>Centaurea micranthos</i>								+	+		+	+	+	+	+		+	+		+	+	III
<i>Euphorbia seguierana</i>	+	+	+	+	+							+	+	+	+		+	+		+	+	III
<i>Stachys recta</i>						+	+	+	+	+	+	+	+	+	+						+	III
<i>Allium flavum</i>						+		+			+	+	+	+	+						+	II
<i>Fumana procumbens</i>		1-2	1-2		1-2				+	1						+	+1				+2	II
<i>Scorzonera austriaca</i>	+								+	+	+				+		+		+		+	II
<i>Teucrium montanum</i>	1	+	1	1	+					+						1-2	1				+2	II
<i>Agropyron intermedium</i>								+				+1									+1	I
<i>Allium montanum</i>														+							+	I
<i>Campanula rotundifolia</i>									+												+	I
<i>Carduus collinus</i>													+								+	I
<i>Carex liparicarpos</i>					+																+	I
<i>Festuca valesiaca</i>												+1	1	+					1		+1	I

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	A-D	K
Cover %	20	30	25	25	25	30	35	35	30	35	35	35	40	35	45	20	30	25	25	25		
<i>Galium glaucum</i>						+	+	+	+												+	I
<i>Hieracium auriculoides</i>			+	+			+						+								+	I
<i>Hieracium baohini</i>																	+				+	I
<i>Inula ensifolia</i>										+											+	I
<i>Iris pumila</i>													1								1	I
<i>Lactuca perennis</i>										+		+	+	+							+	I
<i>Lactuca viminea</i>								+													+	I
<i>Lappula heteracantha</i>											+										+	I
<i>Minuartia glomerata</i>																+			+	+	+	I
<i>Orlaya grandiflora</i>												+	+	+							+	I
<i>Scabiosa canscens</i>							+		+								+				+	I
<i>Stipa capillata</i>																		+	+	+	+	I
<i>Vinca herbacea</i>					+														+		+	I
<i>Xeranthemum annuum</i>													+								+	I
Quercetea pubescentis-petraeae species																						
<i>Asparagus officinalis</i>												+									+	I
<i>Cardaminopsis arenosa</i>							+														+	I
<i>Coronilla varia</i>													+								+	I
<i>Geranium sanguineum</i>						+															+	I
<i>Prunus mahaleb</i>									+												+	I
Other species																						
<i>Euphorbia cyparissias</i>					+		+	+	+		+	+	+		+		+	+	+		+	III
<i>Crataegus monogyna</i>																	+	1	+		+-1	I
<i>Diplotaxis tenuifolia</i>	+	+																			+	I
<i>Echium vulgare</i>											+			+							+	I
<i>Fraxinus ornus</i>	+								+												+	I
<i>Lithospermum arvense</i>													+								+	I
<i>Rosa canina</i>								+													+	I

Date: 1-8: 31.05.1990. — 9-15: 20.06.1990. — 16-20. 28.05.1990.

Table 2

Chrysopogono-Caricetum humilis (Soó 1930) Zólyomi 1958

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	30	40	30	60	75	55	60	70	50	20	30	25	40	60	65		
Asplenio-Festucion pallentis species																	
<i>Sedum album</i>				+	+											+	I
<i>Sempervivum hirtum</i>																+	I
Brometalia species																	
<i>Dorycnium germanicum</i>	1-2	1			1-2		2-3	1	1	1	1	+	1	+		+-3	IV
<i>Chrysopogon gryllus</i>										2	1-2	+	2			+-2	II
<i>Sanguisorba minor</i>										+	+	+	1	+		+-1	II
<i>Cleistogenes serotina</i>													+	+		+	I
<i>Globularia aphyllanthes</i>							+									+	I
Festuco-Brometea species																	
<i>Botriochloa ischaemum</i>	2	2-3	2	3	2	2	3	2	2-3	+	1	1	1	1-2		+-3	V
<i>Eryngium campestre</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	V
<i>Linaria genistifolia</i>		+	+	+	+	+	+	+	+	+		+				+	IV
<i>Potentilla arenaria</i>	+	+	+-1	+	+	+-1		1	+		+			+	2	+-2	IV
<i>Thymus glabrescens</i>	+		+		+			+	+-1	+	+	+-1	1	+		+-1	IV
<i>Achillea pannonica</i>	+	+				1	+	+		1		+	+			+-1	III
<i>Asperula cynanchica</i>		+	+	+	+	+	+	+								+	III
<i>Carex humilis</i>	1	+	+-1			1				1	1		+			+-1	III
<i>Koeleria cristata</i>		+	+	+	1				+		+		+	1	1	+-1	III
<i>Picris hieracioides</i>	+	+	+		+		+	+	+			+				+	III
<i>Scabiosa ochroleuca</i>	+	+				+		+		+	+	+	+	+		+	III
<i>Teucrium chamaedrys</i>	+	+	1	1	+	+	+	1							+	+-1	III
<i>Anthericum ramosum</i>						+			+	+	+	+				+	II
<i>Cuscuta epithymum</i>							+			+		+		+		+	II
<i>Galium verum</i>	+	+	+					+	+							+	II

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	30	40	30	60	75	55	60	70	50	20	30	25	40	60	65		
<i>Hieracium pilosella</i>	+	+	+1					+	+							+1	II
<i>Sedum sexangulare</i>				+	+			+						+		+	II
<i>Tragopogon dubius</i>				+	+		+	+			+	+				+	II
<i>Agrimonia eupatoria</i>							+									+	I
<i>Alyssum alyssoides</i>															+	+	I
<i>Calamintha acinos</i>					+										+	+	I
<i>Carex caryophylla</i>				+1												+1	I
<i>Filipendula vulgaris</i>									+				+			+	I
<i>Hypericum perforatum</i>				+						+		+				+	I
<i>Hypochoeris maculata</i>									+	+			+			+	I
<i>Medicago falcata</i>			+		+											+	I
<i>Medicago lupulina</i>		+	+													+	I
<i>Muscari comosum</i>												+				+	I
<i>Potentilla recta</i>										+						+	I
<i>Salvia pratensis</i>						+				+						+	I
<i>Sedum acre</i>				+												+	I
<i>Stipa eriocalis</i>													1		1-2	1-2	I
<i>Verbascum lychnitis</i>			+													+	I
<i>Veronica spicata</i>	+	+	+					+								+	I
<i>Festucion rupicolae; Festucetalia valesiaca; Festucetalia vaginatae species</i>																	
<i>Festuca valesiaca</i>	+	+	+	1-2	1-2	1-2	1-2	2-3	1-2	2	1	2	1	3-4	3	+4	V
<i>Agropyron intermedium</i>	+	+		+		+	+		1	1		+		+	1	+1	IV
<i>Astragalus onobrychis</i>	+	+	+	+		+	+	1		+			+	+		+1	IV
<i>Seseli osseum</i>	+	+		+	+	1-2	+		+		+	+		+	+	+2	IV
<i>Thymus marschallianus</i>	+	+	+	+	1	+1	1	+1	+	+			1			+1	IV
<i>Adonis vernalis</i>		+1	+				+		+	+	+	+	1			+1	III
<i>Euphorbia seguieriana</i>	+1	1	+1			+1	+				+	+	+	+		+1	III
<i>Inula ensifolia</i>			+			+	+	1-2	+		+	+				+2	III
<i>Lotus borbasii</i>	+	+	+	+				+				+	+			+	III

Table 2 (cont.)

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	30	40	30	60	75	55	60	70	50	20	30	25	40	60	65		
<i>Ononis pusilla</i>		+	+	+	+	+	+	+	+							+	III
<i>Stipa capillata</i>		+1				+1				+1	2-3	1	1	+		+3	III
<i>Campanula rotundifolia</i>	+	+	+	+		+										+	II
<i>Carlina intermedia</i>			+				+	+	+							+	II
<i>Centaurea micranthos</i>		+	+						+		+		+	+	+	+	II
<i>Chondrilla juncea</i>	+		+	+					+	+						+	II
<i>Dianthus pontederiae</i>							+			+	+		+			+	II
<i>Erysimum diffusum</i>		+	+	+	+				+							+	II
<i>Inula oculus-christi</i>			+	+							2	3-4				+4	II
<i>Silene otites</i>	+	+	+				+	+	+							+	II
<i>Vinca herbacea</i>					+					+	+	+	+			+	II
<i>Allium flavum</i>													+	+	+	+	I
<i>Cynoglossum officinale</i>			+													+	I
<i>Cytisus austriacus</i>								1								1	I
<i>Festuca wagneri</i>									+							+	I
<i>Galium glaucum</i>								+			+	+				+	I
<i>Helianthemum ovatum</i>											+					+	I
<i>Helichrysum arenarium</i>			+		+											+	I
<i>Herniaria incana</i>									+							+	I
<i>Lactuca perennis</i>				+												+	I
<i>Lactuca viminea</i>				+												+	I
<i>Melica ciliata</i>										+					1	+1	I
<i>Orlaya grandiflora</i>															+	+	I
<i>Oxytropis pilosa</i>						+		1-2				+				+2	I
<i>Sideritis montana</i>				+												+	I
<i>Stachys recta</i>			+			+								+		+	I
<i>Taraxacum laevigatum</i>			+	+												+	I
<i>Taraxacum serotinum</i>		+					+1		+1							+1	I

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	30	40	30	60	75	55	60	70	50	20	30	25	40	60	65		
<i>Teucrium montanum</i>											+					+	I
<i>Veronica prostrata</i>				+												+	I
<i>Viola ambigua</i>			+													+	I
<i>Viola rupestris</i>								+								+	I
Quercetea pubescentis-petraeae species																	
<i>Fragaria viridis</i>	+1	1	1	+		+1	1	+	+1	+		+	+	+		+1	IV
<i>Anthemis tinctoria</i>						+			+							+	I
<i>Asparagus officinalis</i>			+						+							+	I
<i>Betonica officinalis</i>													+			+	I
<i>Cardaminopsis arenosa</i>			+													+	I
<i>Carex michelii</i>													+			+	I
<i>Coronilla varia</i>											+					+	I
<i>Euonymus verrucosus</i>									+							+	I
<i>Genista tinctoria</i>												+				+	I
<i>Quercus pubescens</i>											+		+			+	I
<i>Rhamnus catharticus</i>									+							+	I
<i>Rosa hungarica</i>									+							+	I
<i>Rosa rubiginosa</i>			+	+												+	I
<i>Sedum maximum</i>														+		+	I
<i>Verbascum austriacum</i>	+			+	+											+	I
<i>Viola hirta</i>													+			+	I
Quercu-Fagetea species																	
<i>Campanula rapunculoides</i>									+							+	I
<i>Cornus sanguinea</i>								+1								+1	I
<i>Fraxinus excelsior</i>			+													+	I
Other species																	
<i>Pimpinella saxifraga</i>	+	+	+	+	+	1	+1	+	+	+	+	+	+	+		+1	V
<i>Crataegus monogyna</i>	+	+	+		+	+	+1			+	+	+	+	+		+1	IV

Table 2 (cont.)

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	30	40	30	60	75	55	60	70	50	20	30	25	40	60	65		
<i>Euphorbia cyparissias</i>		+	+	+	+	+	+	+1		+	+	+	+		+	+1	IV
<i>Plantago lanceolata</i>	+	+	+				+	+	+							+	II
<i>Prunus spinosa</i>	+	+			+		+		+							+	II
<i>Allium vineale</i>								+								+	I
<i>Cirsium arvense</i>													+			+	I
<i>Convolvulus arvensis</i>				+1												+1	I
<i>Crepis rheoadifolia</i>			+													+	I
<i>Echium vulgare</i>				+												+	I
<i>Falcaria vulgaris</i>											+	+		+		+	I
<i>Melandryum album</i>	+															+	I
<i>Poa pratensis</i>							+		+							+	I
<i>Rosa canina</i>					+			+	+							+	I
<i>Rumex acetosella</i>		+														+	I
<i>Senecio jacobaea</i>						+										+	I
<i>Stachys annua</i>													1			1	I
<i>Verbascum phlomoides</i>				+												+	I

Date: 1-5: 31.05.1990. — 6-8: 21.06.1990. — 9: 22.07.1990. — 10-24: 20.05.1990. — 15: 31.05.1990.

Table 3

Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958; festucetosum valesiacae Soó 1959

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	60	65	70	45	60	60	70	55	50	55	65	55	55	50	60		
Asplenio-Festucion pallentis species																	
<i>Festuca cinerea</i> ssp. <i>pallens</i>	3	1	1	1	1	1	1		1	1		2	1-2	+	-	+-3	V
<i>Sedum album</i>	+	+	1	+	+	+			1	+		+	+	+	+	+-1	IV
<i>Sempervivum hirtum</i>	+	+	+	+	+			+	+			+	1	1		+-1	IV
<i>Sempervivum marmoreum</i>						+								+	1-2	+-2	I
Brometalia species																	
<i>Sanguisorba minor</i>	2	1	+	+	+	1	+	+	1	+	+	+	+	1	+	+-2	V
<i>Cleistogenes serotina</i>			1	1-2	1-2		+	+	2	+	+	+	+			+-2	IV
<i>Dorycnium germanicum</i>		1	1		+					+	+					+-1	II
<i>Minuartia fastigiata</i>	+					+			+			+		+		+	II
<i>Chrysopogon gryllus</i>												1	2-3			1-3	I
<i>Linum tenuifolium</i>											+					+	I
Festuco-Brometea species																	
<i>Botriochloa ischaemum</i>	+-1	1	3-4	2	3	1	3	2-3		+-1	1	1-2	+			+-4	IV
<i>Calamintha acinos</i>	+	+	+	+		+			+			+	+	+	+	+	IV
<i>Potentilla arenaria</i>	1	+		1	1	1	1			+	+	+	+	1	1-2	+-2	IV
<i>Sedum sexangulare</i>	+		+	+-1			+	+	1-2	+		+	+	+	+	+-2	IV
<i>Thymus glabrescens</i>	+	1	+		+			+		+	+	+	+	+		+-1	IV
<i>Koeleria cristata</i>	1			+		1	1	+	+					+	+-1	+-1	III
<i>Salvia pratensis</i>			+	+	+	+	+	+			+				+	+	III
<i>Teucrium chamaedrys</i>	1		1	1		+	2	1			1	+			1-2	+-2	III
<i>Asperula cynanchica</i>				+			+	+		+	+					+	II
<i>Carex humilis</i>		2								2	3	1-2	2	1-2		1-3	II
<i>Eryngium campestre</i>			+		+		+				+	+			+	+	II
<i>Linaria genistifolia</i>	+		+		+			+	+						+	+	II

Table 3 (cont.)

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	60	65	70	45	60	60	70	55	50	55	65	55	55	50	60		
<i>Medicago minima</i>	+					+			+						1	+1	II
<i>Stipa eriocalis</i>	+	+						1-2	2	1-2			+			+3	II
<i>Thesium linophyllum</i>	1												+	1-2	1	+2	II
<i>Tragopogon dubius</i>			+	+		+		+	+		+					+	II
<i>Veronica spicata</i>	+				+									+	1-2	+2	II
<i>Achillea pannonica</i>							+	+								+	I
<i>Alyssum alyssoides</i>			+													+	I
<i>Aster linosyris</i>													1-2	1	1-2		I
<i>Campanula glomerata</i>			+									+				+	I
<i>Medicago falcata</i>						+								+		+	I
<i>Muscari racemosum</i>														+		+	I
<i>Orobancha alba</i>						+										+	I
<i>Phleum phleoides</i>	+															+	I
<i>Poa bulbosa</i>						+								+		+	I
<i>Scabiosa ochroleuca</i>	+															+	I
<i>Thlaspi perfoliatum</i>						+			+							+	I
<i>Verbascum lychnitis</i>				+					+							+	I
<i>Festucion rupicolae; Festucetalia valesiacae; Festucetalia vaginatae species</i>																	
<i>Stachys recta</i>	+	+	+	+	+	+1	+	+	+	+	+	+	+	+	+	+1	V
<i>Centaurea micranthos</i>	+	+	+	+	+	+		+	+	+	+			+	+	+	IV
<i>Melica ciliata</i>	1	+	+		+	+		+	1-2	+	+	1	+		+	+2	IV
<i>Seseli osseum</i>	+	+	+	+	+	+		+		+		+	+	+	+	+	IV
<i>Allium flavum</i>	+	+	+	+		+	+		+							+	III
<i>Festuca valesiaca</i>	+					2	1		+1					+1	1-2	+2	III
<i>Helianthemum ovatum</i>	1		1				+			+	+	+	+	+	+	+1	III
<i>Hieracium bauhini</i>	+			+	+	+	+			+	+	+	+			+	III
<i>Lactuca perennis</i>			+	+				+	+	+		+	+	+		+	III
<i>Scabiosa canescens</i>		+			+			+		+				+	+	+	III

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	60	65	70	45	60	60	70	55	50	55	65	55	55	50	60		
<i>Agropyron intermedium</i>			+	+		+	+	+								+	II
<i>Carex liparicarpus</i>						+					+	+	+1	+	+	+1	II
<i>Dianthus pontederæ</i>	+												+	+	+	+	II
<i>Galium glaucum</i>	+	+					+	+								+	II
<i>Inula oculus-christi</i>				+			+	+1		+		1				+1	II
<i>Scorzonera austriaca</i>		1	+				+			+	+					+1	II
<i>Stipa capillata</i>	+1			1-2					1			+	+	2		+2	II
<i>Vinca herbacea</i>			+	+1						+	+					+1	II
<i>Adonis vernalis</i>							+					1				+1	I
<i>Allium montanum</i>					+											+	I
<i>Astragalus onobrychis</i>							+	+								+	I
<i>Carduus collinus</i>				+				+								+	I
<i>Centaurea triumfetti</i>							+1	+1								+1	I
<i>Erysimum odoratum</i>															+	+	I
<i>Euphorbia seguierana</i>										+						+	I
<i>Festuca rupicola</i>															+	+	I
<i>Fumana procumbens</i>			+	+					1							+1	I
<i>Hieracium auriculoides</i>	+															+	I
<i>Inula ensifolia</i>	+															+	I
<i>Iris pumila</i>	1					2										1-2	I
<i>Lactuca viminea</i>						+										+	I
<i>Ononis pusilla</i>							+									+	I
<i>Polygala major</i>													1	+1	+1	+	I
<i>Scorzonera hispanica</i>									+							+	I
<i>Sideritis montana</i>							+									+	I
<i>Teucrium montanum</i>										1	1		+			+1	I
<i>Thymus marschallianus</i>							+1									+1	I
<i>Xeranthemum annuum</i>						+										+	I
<i>Quercetea pubescentis-petraeae</i> species																	
<i>Anthemis tinctoria</i>			+		+					+1	1	1	+	+		+1	III

Table 3 (cont.)

Plot number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	A-D	K
Cover %	60	65	70	45	60	60	70	55	50	55	65	55	55	50	60		
<i>Cardaminopsis arenosa</i>		+	+	+		+										+	II
<i>Geranium sanguineum</i>		1-2		+	2		1-2							+	+	+2	II
<i>Bupleurum praealtum</i>									+							+	I
<i>Coronilla varia</i>		+		+								+				+	I
<i>Cynanchum vincetoxicum</i>															+	+	I
<i>Echinops sphaerocephalus</i>				+												+	I
<i>Polygonatum odoratum</i>		+									1					+1	I
<i>Quercus pubescens</i>	+				+			+								+	I
<i>Sedum maximum</i>							+		+						+	+	I
<i>Viola hirta</i>							+		+	+						+	I
Querco-Fagetea species																	
<i>Cornus sanguinea</i>		+														+	I
<i>Viola odorata</i>			+													+	I
Other species																	
<i>Euphorbia cyparissias</i>	+		+	+	+	+		+	+		+				+	+	III
<i>Bromus squarrosus</i>						+			+							+	I
<i>Caucalis platycarpus</i>			+													+	I
<i>Convolvulus arvensis</i>							+									+	I
<i>Crataegus monogyna</i>					+		+				+					+	I
<i>Echium vulgare</i>											+		+			+	I
<i>Fraxinus ornus</i>				+	+					1						+1	I
<i>Myosotis arvensis</i>						+										+	I
<i>Prunus fruticosa</i>							+									+	I
<i>Prunus spinosa</i>							+									+	I
<i>Rosa canina</i>							+	1								+1	I

Date: 1-5: 18.06.1990. — 6-9: 21.06.1990. — 10: 22.07.1990. — 11-15: 20.06.1991.

Table 4

Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958;
festucetosum rupicolae Soó 1959

Plot number	1	2	3	4	5	5	A-D	K
Cover %	100	85	75	90	80	95		
Asplenio-Festucion pallentis species								
<i>Sedum album</i>	+	1	+	+			+-1	IV
<i>Polypodium vulgare</i>					+	+	+	II
<i>Asplenium ruta-muraria</i>					+		+	I
<i>Asplenium trichomanes</i>					+		+	I
<i>Sempervivum hirtum</i>		+					+	I
Brometalia species								
<i>Bromus erectus</i>	1			+	3	3	+-3	IV
<i>Sanguisorba minor</i>	+	+		+			+	III
Festuco-Brometea species								
<i>Hypericum perforatum</i>	+			+		+	+	III
<i>Linaria genistifolia</i>			+	+	+		+	III
<i>Orobancha alba</i>		1	+	+			+-1	III
<i>Sedum sexangulare</i>		+	+	+			+	III
<i>Teucrium chamaedrys</i>	1			+		+	+-1	III
<i>Thesium linophyllum</i>	1			1		+	+-1	III
<i>Anthericum ramosum</i>		+		+			+	II
<i>Aster linosyris</i>					1	+	+-1	II
<i>Filipendula vulgaris</i>					+	+	+	II
<i>Muscari comosum</i>		+		+			+	II
<i>Salvia pratensis</i>					1	+	+-1	II
<i>Scabiosa ochroleuca</i>	+			+			+	II
<i>Achillea pannonica</i>	+						+	I
<i>Agropyron repens</i>		+					+	I
<i>Eryngium campestre</i>				+			+	I
<i>Koeleria cristata</i>	+-1						+-1	I
<i>Medicago falcata</i>				+			+	I
<i>Potentilla arenaria</i>					+		+	I
<i>Verbascum lychnitis</i>				+			+	I
Festucion rupicolae; Festucetalia valesiacae; Festucetalia vaginatae								
<i>Allium montanum</i>		3		3-4	1	1-2	1-4	V
<i>Festuca rupicola</i>		3-4	3-4	3	3	3	3-4	V
<i>Stachys recta</i>		1	+		+	+	+	IV
<i>Seseli osseum</i>			+	+	+		+	III
<i>Agropyron intermedium</i>					+-1	+	+-1	II
<i>Carduus collinus</i>		+		+			+	II
<i>Centaurea micranthos</i>					+	+	+	II
<i>Centaurea sadleriana</i>				+	+		+	II
<i>Centaurea trimfetti</i>					+	+	+	II
<i>Dianthus pontederiae</i>		+	+	+			+	II
<i>Galium glaucum</i>				+	+		+	II

Table 4 (cont.)

Plot number	1	2	3	4	5	6	A-D	K
Cover %	100	85	75	90	80	95		
<i>Helianthemum ovatum</i>				+	+		+	II
<i>Hieracium bauhini</i>	+			+			+	II
<i>Iris pumila</i>	+				+		+	II
<i>Lactuca perennis</i>	+	+					+	II
<i>Allium flavum</i>		+					+	I
<i>Thymus marschallianus</i>		+					+	I
<i>Veronica austriaca</i>					+	+	+	I
Quercetea pubescentis-petraeae species								
<i>Fragaria viridis</i>	+		1	+	1	1	+1	V
<i>Sedum maximum</i>	+	+	+	+	+		+	V
<i>Valeriana officinalis</i>	1	1		1	+	+	+1	V
<i>Arabis turrita</i>		+	+	+			+	III
<i>Cardaminopsis arenosa</i>	+				+	+	+	III
<i>Coronilla varia</i>	+	+		+			+	III
<i>Galium mollugo</i>		1-2	1	1-2			1-2	III
<i>Silene nutans</i>	+				+	+	+	III
<i>Trifolium alpestre</i>				1	+	+	+1	III
<i>Bupleurum praealtum</i>				+		+	+	II
<i>Chrysanthemum corymbosum</i>				+	+		+	II
<i>Cynanchum vincetoxicum</i>				1		+	+1	II
<i>Euonymus verrucosus</i>		+				+	+	II
<i>Polygonatum odoratum</i>			+		+		+	II
<i>Silene vulgaris</i>					+	1	+1	II
<i>Pumonia molissima</i>						+	+	I
<i>Veronica teucrium</i>				+			+	I
Querceto-Fagetea species								
<i>Primula veris</i>				+	+	+	+	III
<i>Geum urbanum</i>			+		+		+	II
<i>Melica uniflora</i>	+				+		+	II
<i>Veronica chamaedrys</i>	1	1		+			+1	II
<i>Viola odorata</i>				+		+	+	II
<i>Acer campestre</i>	+						+	I
<i>Alliaria petiolata</i>		+					+	I
<i>Campanula persicifolia</i>		+					+	I
<i>Cornus sanguinea</i>			+				+	I
<i>Dactylis glomerata</i>			+				+	I
<i>Dactylis polygama</i>						+	+	I
<i>Fraxinus excelsior</i>						+	+	I
<i>Lilium martagon</i>				+			+	I
<i>Poa nemoralis</i>			+				+	I
<i>Viburnum lantana</i>						1	1	I
Other species								
<i>Euphorbia cyparissias</i>	+		1		+	+	+1	IV

Table 4 (cont.)

Plot number	1	2	3	4	5	6	A-D	K
Cover %	100	85	75	90	80	95		
<i>Stellaria holostea</i>		+	+	+		+	+	IV
<i>Fraxinus ornus</i>		+		+			+	II
<i>Myosotis arvensis</i>			+	+			+	II
<i>Poa pratensis</i>		+			+		+	II
<i>Polygonum convolvulus</i>				+	+		+	II
<i>Rosa canina</i>		+			+		+	II
<i>Ballota nigra</i>			+				+	I
<i>Crataegus monogyna</i>				+			+	I
<i>Rosa spinosissima</i>						+1	+1	I
<i>Spiraea media</i>						+	+	I

Date: 1-4: 31.05.1990. — 5-6: 20.06.1991.

Material and Methods

The coenological data were collected during 1990 to 1991. The quadrates, each of them 2 x 2 m, were sampled according to the Braun-Blanquet method (1951), for the following associations and subassociations:

I. Asplenio rutae-murariae-Melicetum ciliatae Soó 1962

II. Chrysopogono-Caricetum humilis (Soó 1930) Zólyomi 1958

III. Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958 festucetosum valesiacaе Soó 1959

IV. Cleistogeno-Festucetum rupicolae (Soó 1930) Zólyomi 1958 festucetosum rupicolae Soó 1959

Coenological characters of the species were established by more authors, but we used the data as given by SIMON (1992). The flora elements and life-forms of the species were determined according to SOÓ and JÁVORKA (1951). Nine types of the flora elements were processed on the basis of DEBRECZY (1966) and VOJTKÓ (1989). The TWR spectrums of the species were carried out according to scale of ZÓLYOMI et al. (1967) and SIMON (1992). The figures show the results with the cover values. Nomenclature follow SOÓ and KÁRPÁTI (1968), SOÓ (1964, 1980).

Results

The distribution of coenological characters of the species is depicted in Fig. 1. The level of Asplenion pallentis elements is the highest in the Asplenio rutae-murariae-Melicetum ciliatae association. These elements occur in the lowest quantity in festucetosum valesiacaе subassociation of Festucetum rupicolae association. The level of Festucetalia elements can be found the lowest in Asplenio rutae-murariae-Melicetum ciliatae association and the highest in festucetosum valesiacaе subassociation of Festucetum rupicolae

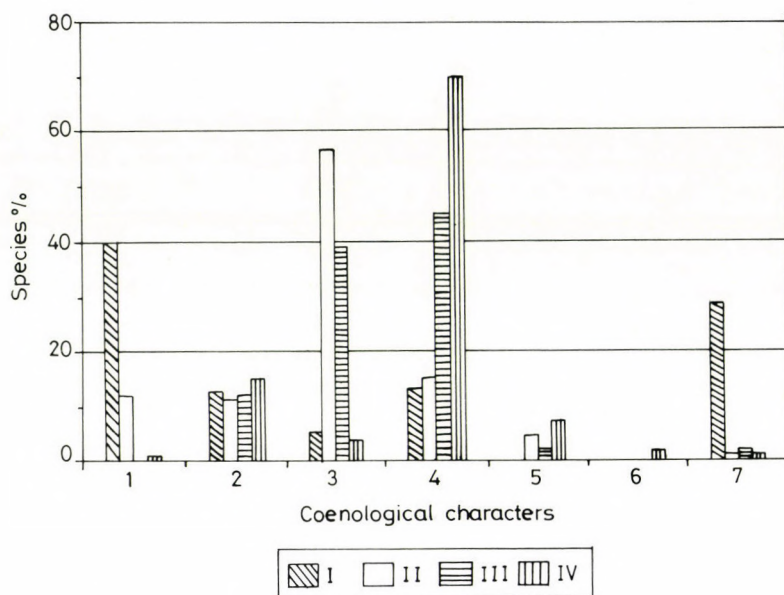


Fig. 2. The distribution of coenological characters of four association

I. *Asplenio rutae-murariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiaca* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959.

1. *Asplenio-Festuciton pallentis* species; 2. *Brometalia* species; 3. *Festuco-Brometalia* species; 4. *Festucion rupicolae*, *Festucetalia valesiaca*, *Festucetalia vaginatae* species; 5. *Quercetea pubescentis-petreae* species; 6. *Quercu-Fagetea* species; 7. Other species

association. The quantity of *Quercu-Fagea* and *Quercetea pubescentis-petreae* is the highest in *festucetosum rupicolae* subassociation.

There is no significant difference in the distribution of life-forms of the examined 4 cenotaxa (Fig. 2). Larger variation was shown by *festucetosum rupicolae* subassociation of grassland slope steppe. The level of chamaephyton species was the lowest and that of hemicryptophyton species was higher.

The quantity of Eurasian elements was the highest in the case of *festucetosum rupicolae* subassociation of grassland slope steppe (Fig. 3). The Mediterranean elements were the most frequent on *Asplenio rutae-murariae-Melicetum ciliatae*. There were differences between two subassociations of grassland slope steppe. The proportion of European elements in *Festuca rupicola* grasslands was ten times higher than in *Festuca valesiaca* communities. The percentage of continental elements in *Festuca valesiaca* communi-

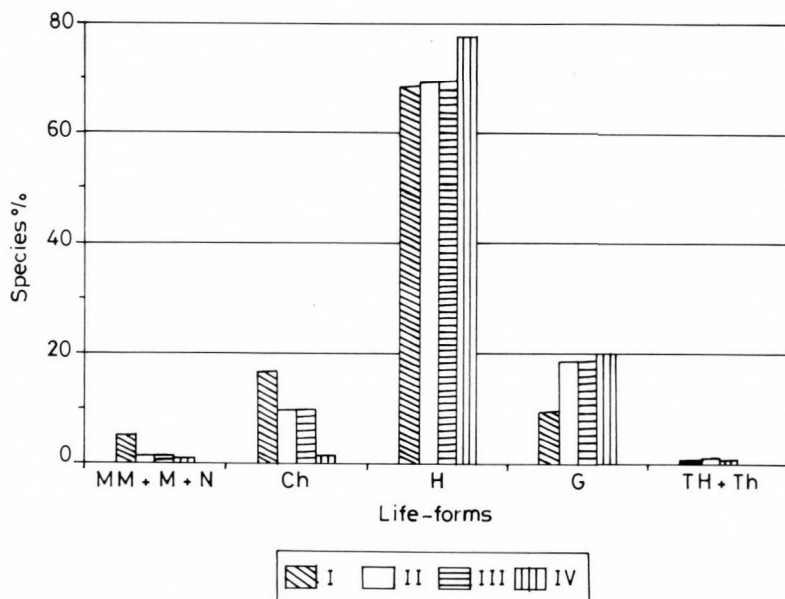


Fig. 3. The distribution of life-forms of four association

I. *Asplenio rutae-murariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiaca* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959

MM+M+N — Phanaerophyton; Ch — Chamaephyton; H — Hemikryptophyton; G — Geophyton; TH+Th — Therophyton, Hemitherophyton

ties was about twice higher then in *Festuca rupicola* communities. The Pontian, Pannonian elements are presented less then 1% in *Festuca rupicola* communities and 10% in *Festuca valesiaca* communities (Fig. 4).

The average values of T (temperature requirement), W (water requirement) and R (soil requirement) are following (I. = *Asplenio rutae-murariae-Melicetum ciliatae*, II. = *Chrysopogono-Caricetum humilis*, III. = *Cleistogeno-Festucetum rupicolae festucetosum valesiaca*, IV. = *Cleistogeno-Festucetum rupicolae festucetosum rupicolae*):

	I.	II.	III.	IV.
T	5.6	5.8	5.5	<u>6.1</u>
W	1.6	1.8	1.6	<u>2</u>
R	4.1	3.4	3.9	<u>2.8</u>

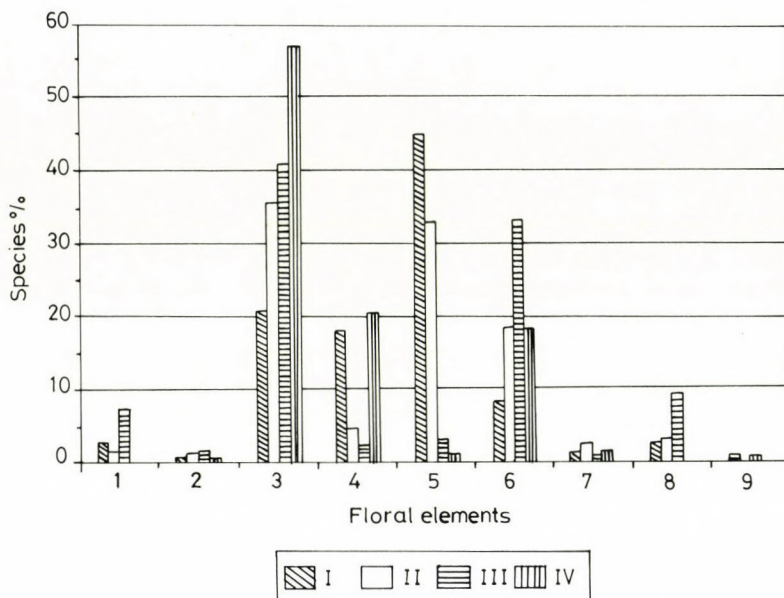


Fig. 4. The distribution of floral elements of four association

I. *Asplenio rutae-murariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiaca* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959

1. Balkan, Alpine-Balkan; 2. Circumpolar, Cosmopolitan; 3. Eurasian, Eurasian-Continental; 4. European, Central-European; 5. Mediterranean, Mediterran-European; 6. Continental; 7. Pontian, Pontian-Mediterranean; 8. Pannonian, Pontian-Pannon; 9. Endemic, Subendemic

There was no significant difference between the T values of studied four cenotaxa (Fig. 5). The lowest values could be found in the case of species requiring cooler climate in *festucetosum rupicolae* subassociation.

There is difference between the W values of communities (Fig. 6). The open rocky grassland and rocky grassland slope steppe were the driest. The species requiring more humid climate occur in *festucetosum rupicolae* subassociation of grassland slope steppe.

The R values showed a decline from the thin soil layer to the thick layer parallel with decreasing effect of limestone in the following order (Fig. 7): *Asplenio rutae-murariae-Melicetum ciliatae*, *Chrysopogono-Caricetum humilis*, *Cleistogeni-Festucetum rupicolae festucetosum valesiaca*, *Cleistogeno-Festucetum rupicolae festucetosum rupicolae*.

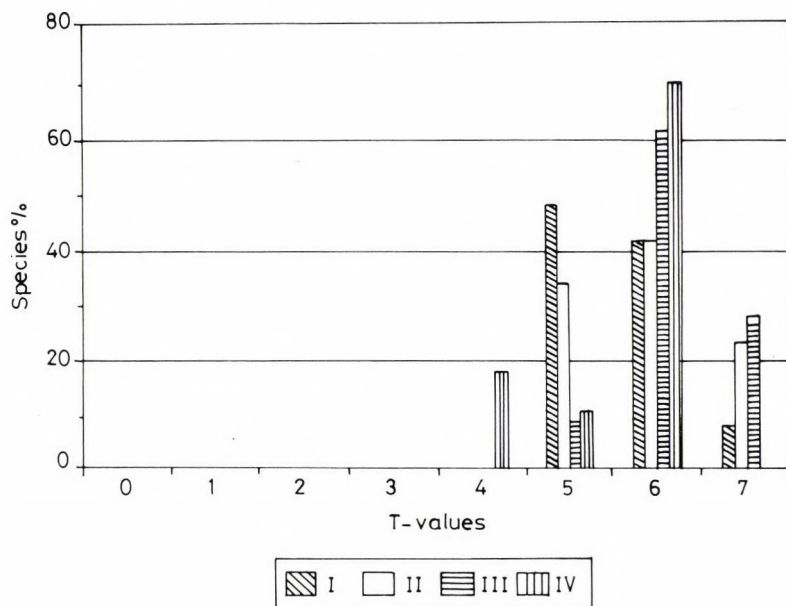


Fig. 5. The distribution of T-values of four association

I. *Asplenio rutae-murariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiaca* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959

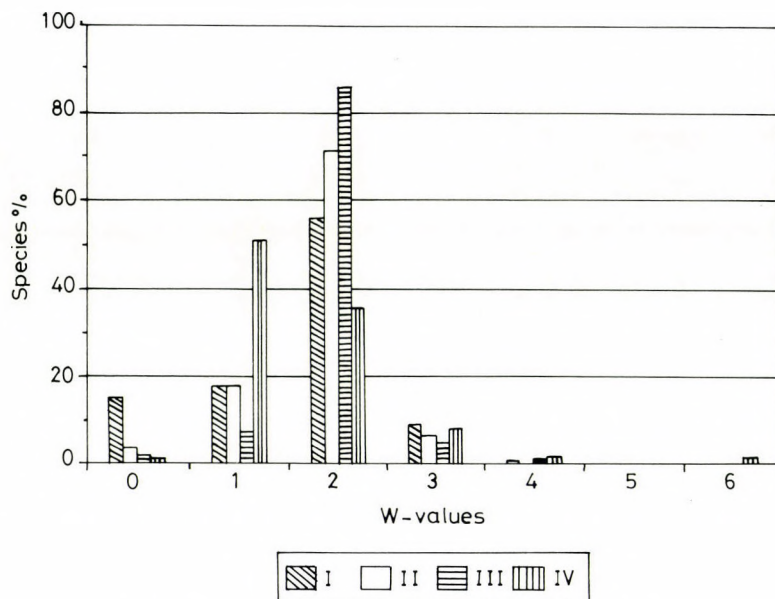


Fig. 6. The distribution of W-values of four association

I. *Asplenio rutaemurariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiacae* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959

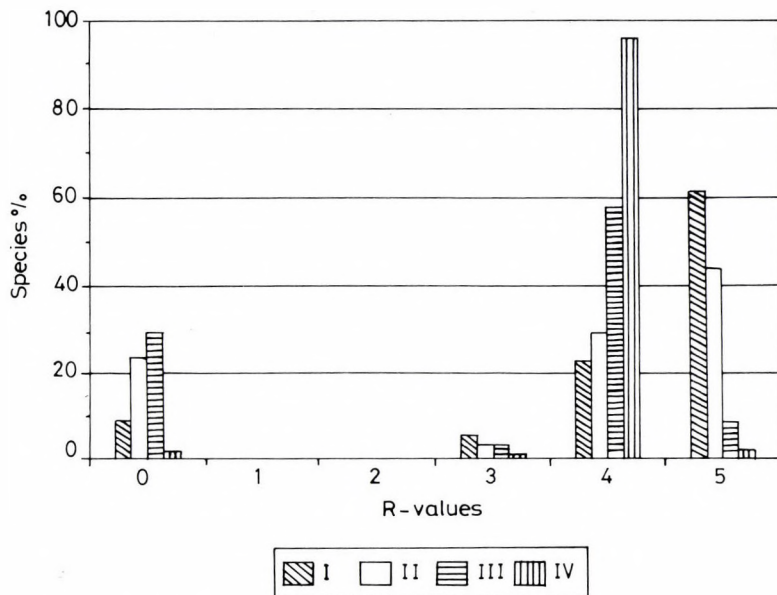


Fig. 7. The distribution of R-values of four association

I. *Asplenio rutae-murariae-Melicetum ciliatae* Soó 1962. — II. *Chrysopogono-Caricetum humilis* (Soó 1930) Zólyomi 1958. — III. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum valesiacae* Soó 1959. — IV. *Cleistogeno-Festucetum rupicolae* (Soó 1930) Zólyomi 1958, *festucetosum rupicolae* Soó 1959

Discussion

On the basis of 6 examined ecological parameters the most variation was shown by *festucetosum rupicolae* subassociation of *Festucetum rupicolae* association. There were similar values in case of open rocky grassland, rocky grassland slope steppe, grassland slope steppe of *festucetosum valesiacae* subassociation. This order corresponded to the tendency of succession and it showed the process of immigration on the surface of limestone step by step. This 3 cenotaxa can be found on south-western slope.

Festucetosum rupicolae subassociation of *Festucetum rupicolae* association is situated on north-eastern slope and it is a characteristic subassociation of more humid and cooler climate. The proportion of characteristic species of forest and shrub-forest communities is the highest in above-mentioned subassociation.

The percentage of chamaephyton species — which are characteristic of dry area — is very low in *festucetosum rupicolae* subassociation of

Festucetum rupicolae. Flora elements spectrum of this association is different from other 3 associations, because there are only few Mediterranean, Pontian and Pannonian species, however the level of Eurasian elements is high.

Results of our investigation on grasslands of Fehér-szirt showed the possibility to separate 2 associations characterized by 2 different Festuca species.

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**SOCIAL BEHAVIOUR TYPES, THE NATURALNESS AND RELATIVE
ECOLOGICAL INDICATOR VALUES OF THE HIGHER PLANTS IN THE
HUNGARIAN FLORA**

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Introduction

The Botanical Department of the Janus Pannonius University was commissioned in 1989 to make detailed comparative evaluation of nature conservation areas within the framework of the Landscape Protection Districts of SW-Hungary. For this work — as a first approach — the nature conservation rank categories of SIMON (1988) were used.

During this work various difficulties arose that we tried to eliminate in due course. Such difficulty was that in the category of "natural companions" species highly different in naturalness and nature conservation rank values were included. Other problem was that in areas worth protection had no "protected plants", while such species occurred in ecologically disturbed, secondary habitats. A third type of problem was that species placed in the category of protected plants (e.g. orchids) were determined by international agreements rather than by their importance and endangered state in the flora of Hungary.

Finally, the categories of SIMON were not ordered into a ranking order and did not allow a numerical comparative evaluation.

At the first attempt we tried to solve all these problems by extending SIMON's categories giving them relative naturalness values and ranking them according these values. During the process of forming naturalness groups we took the sociological behaviour of the species as a starting point and tried to include more and more informations accumulated by the phytosociological practice into the system. At the same time we aimed at forming wider and more generalized groups than the traditional phytosociological categories, in order to compare objectively plant communities of very different composition as well. During this process the content of the SIMON's categories

has been greatly modified, and our model gradually approached GRIME's three-way strategic model. This work has been supported with a lot of useful advices of prof. G. FEKETE, to whom we would like to express our gratitude. The system was elaborated in two different versions. The second version (BORHIDI 1991) was applied for qualifying nature protected areas, plant communities, succession stages, etc. for their naturalness in a comparative from. It was also used by J. A. KOVÁCS and B. TAKÁCS (1992) for the comparative evaluation of the actual state of the communities of a Landprotection Area in W-Hungary. The actual version has suffered some further modifications and may be these are the last ones.

A remarkable proposal was made by several experts to give a greater importance to the diversity of the native flora in respect with the indicator figures so that only the alien species would be considered as negative categories in the concept of naturalness, while disturbance tolerants and native weeds should receive low but positive values.

Another change was, that protected state as category has been left out of the model, and it was substituted by the more concrete raity values. In this respect the nature conservation groups of F. NÉMETH served with good ideas.

The process described above led to the present classification of the Hungarian flora into special categories we named: "SOCIAL BEHAVIOUR TYPES" and the relative figures correlated to them we consider as "NATURALNESS VALUES".

Social behaviour types (SBT) and naturalness values (VAL)

The social behaviour types of plants are based on the role the plant species play in the communities. They express the way the plant is linked with the habitat, and the information content and naturalness of the linkage.

From the properties of the types occurring in the community conclusion can be drawn on the richness in ecological information of the community, on its stability, and state of naturalness, on the extent to which the niches are filled up, on the regeneration ability or capacity of the community, as well as on the degree of disturbance, transoformation or deviation from the natural state.

The social behaviour types are integral parts of the C-S-R strategic model of GRIME (1979), in the following way:

Disturbance of habitat	Intensity of stress	
	low	high
low	competitors (C)	stress tolerants (ST)
high	ruderals (R)	no successful strategy

Within this model the social behaviour types (SBT) are placed as follows:

- I. Competitors (C)
- II. Stress tolerants (ST)
 - A) Stress tolerants of narrow ecology: Specialists (S)
 - B) Stress tolerants of wide ecology: Generalists (G)
- III. Ruderals (R)
 - A) Plants of habitats disturbed by natural factors: Natural pioneers (NP)
 - B) Plants of habitats disturbed by human factors
 - 1. Disturbance tolerant plants of natural habitats (DT)
 - 2. Anthropophilous elements of the native flora: native weed species (W)
 - 3. Anthropogenic elements alien to the region
 - a) Introduced crops running wild (I)
 - b) Adventitious weeds (A)
 - 4. Competitors of secondary habitats
 - a) Ruderal competitors of the natural flora (RC)
 - b) Alien competitors, aggressive invaders (AC)

Since the SBT-s express various states of naturalness or disturbances of the plant-habitat relationships, they may be supplied with relative index numbers as naturalness values and placed in the following ranking:

A) Social Behaviour Types of natural habitats

- a) Specialists, symbol: S, value: +6 point

Steno-ecological or stenotolerant stress tolerant species, mostly of low competitiveness. Sensitive indicators of certain ecological factor(s) of the habitat, and/or characteristic species of a community or a community group (alliance). Consequently they are carriers of important ecological and sociological informations. As regards the repartition of the sources of the habitat they — like the generalist species — mostly have a mere chance for

filling the gaps, but their tolerance and/or competitiveness in the given floristic environment is much lower. Therefore they response to all changes taking place in the quality, undisturbance, naturalness of the habitat much earlier than any other species and they may be considered as the most sensitive indicators of the changes of the habitat. While their role is unimportant either in the stability or in the resilience of the community, their absence or disappearance is undoubtedly an early sign of disturbance. Their reappearance, on the other hand, is the proof of a complete rehabilitation of the community.

Species considered as specialists are e.g. Dentaria enneaphyllos, Adoxa moschatellina, Seseli leucospermum, Coronilla coronata, Limonium hungaricum, Colchicum arenarium, Vicia sparsiflora, Potentilla alba etc.

b) Competitors, symbol: C, value: +5 point

Dominant species of the natural communities or in some of their layers, including the stress tolerant competitors (e.g. so-called dominance-type forming species of the herb layer in the forests). They are mostly perennial or woody species of high vegetative allocation rate K-strategists with large biomass production, and suitable to show the greatest competitiveness in the given habitat, at least in a certain period of the biotic succession. Their activity on the one hand, rectifies the material and energetic consumption, distribution and flow in the community to a considerable extent, selects and controls the possible coexisting groups of the companion species and with the biomass produced by them decisively influences the soil development processes.

Though all this they may be able to stabilize the composition and functioning of the community over a longer period. At the same time they are relatively resistant to disturbing influence and preserve the structure and basic characteristics of the communities from strange effects for the longest time.

Such species are e.g. Quercus petraea, Q. robur, Fagus silvatica, Allium ursinum, Vaccinium myrtillus, Corydalis cava, Carex pilosa, C. acutiformis, C. elata, Agrostis stolonifera, Puccinellia distans, Festuca rupicola, F. rubra etc.

c) Generalists, or companion species: symbol G, value: +4 point

Species of wide ecological range or tolerance living in the natural plant communities (so-called euryoecious species) which survive in a great

diversity of habitats and plant communities, though are not too tolerant to anthropogenic disturbance. They mostly are perennials which through their high adaptability fit well in the nutrient- and energy-chain of the communities, and by filling the repartition gaps play an important role in the balance, stability and interior dynamics of the communities. They take part in buffering minor disturbances, and are important in maintaining the genetic diversity, i.e. the homeostatic functioning.

E.g. Acer campestre, Ligustrum vulgare, Crataegus monogyna, Cornus sanguinea, Convallaria majalis, Arum maculatum, Astragalus glycyphyllos, Genista tinctoria, Dianthus pontederiae, Koeleria paniculata, Allium sphaerocephalum, Inula ensifolia, Teucrium chamaedrys, Symphytum tuberosum etc.

d) Natural pioneers, symbol: NP, value: +3 point

Species of initial stages of succession series developing on substrates maintained by various natural factors of disturbance (e.g. wind, inundation, surf erosion) or formed repeatedly. They mostly are r-strategists of high reproductive allocation rate. They are tolerant to extremities of abiotic habitat factors, but their nutrient demand and competitiveness are low. In consequence of the latter their stability preserving capacity is also low, on the other hand, they are important resilience factors, important means of the rehabilitation processes of the communities. They mostly are annuals, though the floating and submerged weeds of water communities also belong here.

Such species are: Aira caryophyllaea, Vulpia myuros, Secale sylvestre, Cerastium semidecandrum, Buglossoides arvensis, Myosotis discolor, Acinos arvensis, Cardaminopsis arenosa, Myosurus minimus, Batrachium aquatile, Lemna trisulca, Callitriche spp. etc.

B) Social Behaviour Types of plants living in disturbed, secondary and artificial habitats

Species tolerant to (anthropo-tolerant) or definitely demanding (anthropophilous) some kind, mostly anthropogenic disturbance occasionally or regularly affecting the habitats. As a common property of them, their nutrient demand and competitiveness are not in proportion to one another, so they can but to a small extent, if at all, join the "closed-circuit" system of the material and energy flow or repartition of the natural communities. They are capable of making quick and intensive use of resources released at

breaking points of the material and energy turnover chains disturbed and broken by human influences, or at empty places of the niche axes. They are specially attracted by habitats rich in nutrient due to the productive activity of man and poor in competition, as well as by artificially created habitats. The plants of these groups generally are given the comprehensive name of weed plants, which according to their origin, the time and way of immigration, and their habitat requirement can be categorized in more than one way.

The categories are given -- partly negative -- values from +2 to -3. They are:

e) Disturbance tolerants, symbol: DT, value: +2 point.

In contrast to other categorizations (e.g. SIMON) we do not classify here the natural spontaneous species of the semi-natural communities developed under the lasting human control (hay-fields, mountain meadows), where the stability and basic conditions of the habitat are regulated by the human activity (mowing, grazing). We do it therefore, because the human activity produces a similar set of conditions in extrazonal situation, which allow the development of natural zonal ecosystems in other climatic belts. This category includes the pioneer elements of the secondary successions (e.g. forest clearing plants) starting after the destruction of permanent communities (forests), which are suitable to use the nutrient surplus naturally released in the course of the disturbance (Urtica dioica, Alliaria petiolata, Geum urbanum). Perennial plants taking part in populating natural or seminatural substrates of artificial establishments or constructions -- like road cut, banks (e.g. Coronilla varia, Salvia austriaca, S. nemorosa, Vicia tenuifolia, etc.); originally they are generalists of dry grasslands but are able to make use of disturbed habitat with a higher population dynamic activity.

f) Weeds, symbol: W, value: +1 point.

Members of plant communities living on habitats artificial or heavily disturbed by frequently repeated and/or long lasting anthropogenic influence. They mostly are r-strategists annuals or ephemerals able to produce even 3-4 generations in a vegetative period. They are natural plant species of roads, roadsides, fertilized and detritic soils, crop fields, and contaminated sites, which for centuries or even thousands of years have been naturalized members of the native flora.

Such species are e.g. Papaver rhoeas, Centaurea cyanus, Stachys annua, Anthriscus cerefolium, Lamium amplexicaule, Carduus acanthoides, Cirsium lanceolatum, Arctium lappa, Onopordon acanthium, Chelidonium majus, Polygonum aviculare, Plantago major etc.

g) Introduced alien species, symbol: I, value: -1 point.

Plants alien to a region and flora, intentionally introduced and acclimatized as potential useful crops for some economic purpose. Here belong the agricultural crops of Hungary of different origin (wheat, grapevine, maize, hemp, orchard trees), useful forest trees alien to region, the so-called exotic trees (e.g. Pinus nigra, Chamaecyparis lawsoniana, Larix decidua, Picea omorica, P. pungens, Quercus rubra, etc.) ornamentals (Portulaca grandiflora, Platanus hybrida, Ginkgo biloba, Tagetes spp., Delphinium spp., etc.). These species mostly do not behave as escapes of culture, they remain on the area they have been planted for economic purposes (arable field, garden, park). Their presence or appearance in the natural flora indicates that the given habitat has long been utilized for economic purposes. Although the economic usefulness of the plants is beyond question, from the point of view of naturalness they definitely represent a negative value. Those useful plants which with their aggressive, invasive spreading go beyond the areas marked out of them, in the cultivated fields, and by occupying the natural habitats creating vegetation types or communities alien to the region do not belong here and are treated as a separate category. The number of introduced species constantly changes and mostly shows an increasing tendency.

h) Adventives, symbol: A, value: -1 point.

They are plants alien to region and flora, which are not intentionally introduced but appear accidentally as contaminants of commercial transports due to human activity (transportation, trade, travels), or show up and get acclimatized in the form of weeds spreading or settling in the course of introducing certain crops or agrotechnics. In their original habitats they mostly are species of natural communities rather than weeds. Their appearance often is only temporary, ephemeral, their occurrence is local, spot-like, and is confined to the environs of cities and/or industrial establishments, railway stations, wasteyards, etc. Of the permanent settlers only those plants are placed in this category which adapt themselves to the vegetation of the secondary habitats, but never invades massively into the natural plant communities.

Such plants are e.g. Ambrosia elatior, Xanthium spinosum, Echinochloa oryzoides, Echinocystis lobata, Ecballium elaterium, Eleusine indica, Gallinsoga ciliata, Oenothera spp. etc.

i) Ruderal competitors, symbol: RC, value: -2 point.

Dominant or type-forming weeds of the natural flora which became dominant and community-forming due to their efficient propagation strategy and/or the competition-poor environment and behaving as secondary edificators they are able to transform the habitat and modify the successional trend. They mostly produce a large amount of propagula which conserve their germinative ability for a long time, even under unfavourable conditions (Cirsium arvense, Agropyron repens). Many geophytes have become aggressive weeds owing to the wide use of herbicides (Convolvulus arvensis, Agropyron repens).

Other species belonging here: Chenopodium album, Ch. polyspermum, Amaranthus retroflexus, etc.

j) Aggressive alien species or invaders, symbol: AC, value: -3 point.

Plants alien to region and flora; they arrive by intentional introduction or by casual importation, where due to their aggressive propagation strategy and/or the less competitive environment and their independence of the local food chains they are able to invade the gaps of natural and semi-natural communities and become there dominant. They often act as secondary edificators transforming the habitats and occupying them for long time, while excluding the home competitors become the main obstacles of the processes of the natural succession.

A considerable amount of the species spread with underground vegetative shoots, stolos (e.g. Robinia, Acer negundo, Helianthus decapetalus), other produce large quantities of generative propagules (e.g. Amorpha fruticosa, Padus serotina, Prunus triloba, Solidago serotina, Rudbeckia laciniata, Ambrosia elatior).

The reason for their being treated as a separate category is that as active invasive elements they may break the stability of the natural communities and divert the process of the natural and rehabilitative succession from their progressive tendency, producing deficient, alien ecosystems, whereby they endanger the survival and regeneration of natural habitats and communities (Parthenocissus quinquefolia, Echinocystis lobata, Elodea canadensis etc.).

Rarity values

In the former version of this work (BORHIDI 1991) an attempt was made for involving protective viewpoints into the evaluation of the species by adding them supplementary points. However we found, that such principles as naturalness, social behaviour and motives of protection, like vulnerability and endangeredness, are too diversely based for being combined in one value. The aspects of protection often are not sociologically or ecologically based, but they are related to rarity, vulnerability, or to the high economic, ornamental or medicinal values of the plants.

It is obvious, that plants requiring protection belong to different social behaviour types although their great majority is specialist. At the same time, it is easy to see, that plants protected for their ornamental or medicinal values may belong to very different ecological and sociological categories. It is also obvious, that protection categories, like strictly protected, protected, endangered, vulnerable etc. are really state indicators and the state of the same species may change in space and time. The general protection of complete taxonomic groups — like orchids and cacti — reflects also a preventive purpose.

In the actual model, the complementing of the naturalness values with supplementary points does not serve for manifesting the administrative fact of the protected state of a species but emphasizing its rarity as a fundamental reason of the protection.

Two supplementary categories are suggested for rarity:

k) rare species: represented with 5 to 20 populations in the Hungarian flora. Symbol: **r**, value: **+2**, which is added to the SBT-value points.

l) unique species, represented with 1 to 5 populations in the Hungarian flora, or they are somewhat more frequent, but not occurring out of the Hungarian-Pannonian flora. Symbol: **u**, value: **+4** supplementary points.

Naturalness Values can be obtained by adding the supplementary rarity points to the basic SBT-values, and are found in the fifth column of the table under Val. Its value ranges from -3 to +10.

Some more common combinations are:

Su: 10 points, unique specialist, e.g. Linum dolomiticum, Vaccinium oxycoccos, Primula farinosa, Vincetoxicum pannonicum, Adonis hybrida.

Cu: 9 points, unique competitors, e.g. Calamagrostis stricta, Festuca wagneri, Eriophorum vaginatum.

- Gu: 8 points, unique generalist, e.g. Ophrys scolopax, Lilium bulbiferum, Liparis loeselii, Molinia microspecies.
- Sr: 8 points, rare specialist, e.g. Arnica montana, Thlaspi goesingense, Dianthus lumnitzeri, D. diutinus.
- Cr: 7 points, rare competitor, e.g. Sesleria sadlerana, Sesleria uliginosa, Festuca amethystina.
- Gr: 6 points, rare generalist, e.g. Traunsteinera globosa, Narcissus stellaris, Stachys alpina, Gymnadenia conopsea, etc.

The other points generally originate from the basic points of the SBT-categories. As a rule may be considered that species worth protection have 6 or more points.

Ecological indicator values

The expression of the ecological experiences in form of relative indicator values is not a new attempt. It was IVERSEN (1936) at first, who applied relative indicator values for characterizing salt-resistance of coastal plants, suggesting a three-grade scale. ELLENBERG (1950, 1952) worked out the ecological indicator values of a larger number of meadow plants and agricultural weeds for several ecological factors and the first experiment for applying these indicator values in characterizing plant communities. In those studies he applied 5-grade scales and the moisture scale was amplified later to a 10-grade scale (1963).

To the process of developing indicator values, an important contribution was made by ZÓLYOMI by introducing the TWR system (1964) and amplified by him and his collaborators (1967). Their TWR-system consisted of a 10-grade temperature scale (T), an 11-grade water content or soil moisture scale (W) and a 5-grade soil reaction scale (R). This TWR-system was worked out to 1400 native species of the Hungarian flora and this set was amplified with the inclusion of weeds (KÁRPÁTI 1978) and with some critical taxonomic groups (e.g. BORHIDI 1969) etc. TWR-system has been widely used for ecological analysis of plant communities and to place them into a multidimensional ecological space. More advanced numerical methods were also fitted to these analyses (PRÉCSÉNYI in: ZÓLYOMI 1964; ZÓLYOMI and PRÉCSÉNYI 1979; ZÓLYOMI 1987).

The so-called ecological behaviour indicator values were elaborated by ELLENBERG (1974) in a comprehensive synoptic form with regard to the seven

main environmental factors; three of them are climatic ones: temperature (T), light (L), and continentality (C), further three indicators related to soil factors, i.e. moisture or water supply (F), acidity or soil reaction (R) and nitrogen supply (N). Also salinity has been regarded. The system has been recently actualized (ELLENBERG et al. 1991). Almost all factors are uniformly scaled representing nine degrees, and the figure 5 represents the middle value. Two exceptions are: the moisture (F) scale with 12 degrees. The indicator values -- which reflect the 50 years field and laboratory experiences on plant ecology of generations -- are given by ELLENBERG (1974) for 1780 vascular plant species and complexes of western Central Europe; 1350 species of them are common with the Hungarian flora belonging to SE-Central Europe. Recently, a new edition of this work has appeared in the authorship of ELLENBERG and collaborators (1991). This new work includes the whole flora of the former German Federal Republik (1942 taxa with the Rubus species). As new elements, it classifies the salt tolerance of the plants also in a 9-grade scale, tries to give more correct indicator numbers to the "indifferent" taxa, and extends the indicators value system to the bryophytes and lichens as well.

The indicator values of ELLENBERG have seemingly not used in the Hungarian botany. The success of the TWR-system and the temporally declining interest in phytosociology research in the 70th and 80th took off the attention from the possibly use of the indicator values of ELLENBERG. However, in the reality the indicator values of ELLENBERG -- in modified form -- had been included into the "Synopsis" of SOÓ (1964--1980).

It is easy to see, that the T-, F-, R- and N-values in the Synopsis of SOÓ can be obtained by dividing the ELLENBERG's figures with 2. However, the figures transcribed by SOÓ do not follow consequently the ELLENBERG's values because the fitted halved scale differs from the scale of the halved figures:

ELLENBERG's scale	9	8	7	6	5	4	3	2	1
Fitted halved scale	5	4-5	4	3-4	3	2-3	2	1-2	1
Scale of halved values	4-5	4	3-4	3	2-3	2	1-2	1	1

It can be tested, that SOÓ used mixed both kinds of transcriptions and we do not know, when he applied one or another intentionally and when by mistake.

It is to be mentioned that A. J. KOVÁCS (1979) elaborated the ELLENBERG's indicator values of 1300 vascular plant species living on the montane

meadows of Roumania and a register of other biological characteristics and figures. In the mentioned work the author follows completely the original concept, e.g. the ecologically wide ranged species are not given figures, but the indifferent ecological behaviour is indicated by X in respect with the correspondent ecological factor.

In our work the columns nr. 6 to 12 of the table are found the ecological indicator values of the Hungarian flora in the following order:

TB: The relative "temperature figures" reflecting the heat supply of the habitats where the species occur (mainly based on the distribution according to the latitudinal vegetation zones and altitudinal belts). The temperature figures of ELLENBERG's 9-grade scale (T) applied by BORHIDI (B) to the Hungarian flora. The relative figures indicate the following heat-climate belts or the corresponding microclimate conditions:

1. Subnival or supraboreal belt
2. Alpine, boreal or tundra belt
3. Subalpine or subboreal belt
4. Montane needle-leaved forest or taiga belt
5. Montane mesophilous broad-leaved forest belt
6. Submontane broad leaved forest belt
7. Thermophilous forest or woodland belt
8. Submediterranean woodland and grassland belt
9. Eumediterranean evergreen belt

WB: The relative "moisture figures" (occurrence in relation to soil moisture or water table) according to the 12-grade F-scale of ELLENBERG. The scale is very similar to the W-scale of ZÓLYOMI, but the water plants have a more detailed categorization, as follows:

1. Plants of extremely dry habitats or bare rocks
2. Xero-indicators on habitats with long dry period
3. Xero-tolerants, but eventually occurring on fresh soils
4. Plants of semidry habitats
5. Plants of semihumid habitats, under intermediate conditions
6. Plants of fresh soils
7. Plants of moist soils not drying out and well aerated
8. Plants of moist soils tolerating short floods
9. Plants of wet, not well aerated soils
10. Plants of frequently flooded soils
11. Water plants with floating or partly emergent leaves
12. Water plants, most wholly submersed in water

RB: Reaction figures, according to the nine-grade ELLENBERG's scale, reflect to the occurrence of the plants in relation of the soil reaction of the habitats. In the 5-grade ZÓLYOMI's scale calciphilous and salt tolerants or even halophilous plants are equally treated as basiphilous plants. Here the two groups are differentiated by their positive or negative "salt figure" category. A comparison of the reaction value scales according to ELLENBERG's versus ZÓLYOMI's classification was carried out by PICHLER and KARRER (1991).

The correspondent degrees are:

1. Plants of extremely acidic, explicitly calciumfree sites
2. Intermediate type between 1 and 3
3. Acidifrequent plants, mostly in acid soils
4. Plants of moderately acidic soils
5. Plants of slightly acid soils
6. Mostly on neutral soils but also in acid and basic ones, generally widely tolerant, more or less indifferent plants
7. Basifrequent plants, mostly on basic soils
8. Plants of basiphilous sites
9. Plants of explicitly calcareous sites and ultrabasic specialistts

Note: This scale slightly differs from the original ELLENBERG's scale, due to the greater variety of the calci- and basiphilous habitats occurring in the warm-dry subcontinental and submediterranean climates. E.g. in the ELLENBERG's scale 7 is the figure of the neutral habitats.

NB: Nitrogen figures according to ELLENBERG's 9-grade scale, based on the occurrence in relation to the ammonia and nitrate supply of the habitats. Degrees:

1. Only in soils extremely poor in mineral nitrogen, e.g. peat bog plants
2. Plants of habitats very poor in nitrogen
3. Plants of moderately oligotrophic habitats
4. Plants of submesotrophic habitats
5. Plants of mesotrophic habitats
6. Plant of moderately nutrient rich habitats
7. Plants of soils rich in mineral nitrogen
8. N-indicator plants of fertilized soils
9. Plants only on hyperfertilized soil, extremely rich in mineral nitrogen (indicating pollution, manure deposition).

LB: "Light figures" according to ELLENBERG's 9-grade scale, based on the occurrence of plants in relation to relative light intensity during summer time. Degrees:

1. Full shadow plants, often receiving less than 1%, rarely receiving more than 30% of the full day light.
2. Very shadow-tolerant plants; photosynthetic minimum at 1 to 5% of full day light.
3. Shadow plants; photosynthetic minimum under 5% relative light intensity, but survive more illuminated places.
4. Shadow-halfshadow plants; photosynthetic minimum between 5 and 10% rel. light intensity.
5. Halfshadow plants receiving more than 10% but less than 100% rel. light intensity.
6. Halfshadow-halflight plants; photosynthetic minimum between 10 and 40% rel. light intensity.
7. Halflight plants, mostly living in full light but also shadow tolerants.
8. Light plants; photosynthetic minimum above 40% rel. light intensity, less only in exceptional cases.
9. Full light plants of open habitats not receiving less than 50% of rel. light intensity.

CB: "Continentality figures" according to ELLENBERG's nine-grade scale based on the main distribution of plants according to degree of continentality of the general climate (see MEUSEL and SCHUBERT 1972) with emphasis on maximum and minimum temperature. Degrees:

1. Eu-oceanic species, reaching Central Europe only in the extreme West, not in Hungary.
2. Oceanic species, mainly in West Europe and western Central Europe.
3. Oceanic-suboceanic species, are in whole Central Europe.
4. Suboceanic species, mainly in Central Europe but reaching to East.
5. Intermediate type with slight suboceanic-subcontinental character.
6. Subcontinental, main area in eastern Central Europe.
7. Continental-subcontinental species main area in East-Europe.
8. Continental species reaching only eastern part of Central Europe.
9. Eucontinental species, main area in Siberia and East Europe reaching scarcely the eastern part of Central Europe.

SB: "Salt figures" for indicating plant occurrence in relation to the salt concentration of the soils in a 9-grade scale, according to SCHERFOSE (1990).

0. Halophob species not occurring in salty or alkalic soils.
1. Salt tolerant plants but living mainly on non-saline soils.
2. Oligohaline plants living on soils of extremely few chloride content.
3. Beta-mesohaline plants living on soils of few chloride content.
4. Alfa/beta mesohaline plants living on soils of intermediate chloride content.
5. Alfa-mesohaline plants living on soils of middle chloride content (0.7-0.9%).
6. Alfa-mesohaline to polyhaline plants living on soils of middle to high chloride content.
7. Polyhaline plants on soils of high chloride content (1.2-1.6%).
8. Euhaline plants living on soils of very high chloride content.
9. Euhaline to hypersaline plants living on soils of extremely high chloride content.

The ecological table prepared by BORHIDI diverts in 3 aspects from the ecological figures of ELLENBERG, although methodologically and in general concept follows it completely. The indicator values of the same species are mostly the same in the two catalogues.

Some differences are the following:

1. In the present catalogue the indicator values are found for the complete Hungarian flora including more than 2500 taxa, 1000 of them not occurring in ELLENBERG's list.

2. The indicator values are different in those cases, when a species plays obviously a different role in the SE-Central European region than in the western Central European flora.

3. An important difference, that ELLENBERG does not give indicator values to the species of wide ecological range in respect of the correspondent factor indicating with "x" the "indifferent" character. In our list the middle value -- mostly 5 -- is given to the wide ranged species with respect to the corresponding factor. This decision is supported by the general rule, that extreme figures are mostly represented by species of narrow ecological range, (specialists) while intermediate values are represented by generalist taxa of wide ecological range. In the new edition (1991) a similar approach is attempted but not carried out by ELLENBERG and his collaborators.

What are the purposes of this work?

The Social Behaviour Types and the Naturalness Values may serve

1. for comparative analyses of the ecological state and the changes in quality of the concrete stands of the plant communities;
2. for establishing naturalness and nature protection values of concrete fields and territories even in those cases, when the area does not contain protected, endangered or vulnerable species;
3. for registration and monitoring of changes in the social and ecological behaviour provoked by climate change, anthropic influences or other kinds of disturbances.

What is this work good for?

The new table of the ecological indicator values offers possibilities

1. for the Hungarian botanists to describe and characterize ecologically the Pannonian plant communities in a comparable way to those of other European countries using a complete database. We have to surpass the former eastern, south-eastern European phytosociological practice delimiting plant communities at the country boarder and considering that each country has a different vegetation in a certain respect. Joining to Europe means also a methodological integration in the vegetation studies. According to my view, the reasons of the meritless undercitation of the Hungarian results and papers on geobotany may be found in methodological problems like this.

2. For the comparative evaluation of the Hungarian vegetation units in respect of several ecological parameters and for studying ecological correlations non-analysed so far.

3. This database — including the SBTs as well — may serve as a useful tool for ecologists interested in comparing different vegetation units in respect of their ecological state, naturalness or certain ecological factors using objective criteria. It may be used for monitoring studies, nature conservation purposes, analysing syndynamical processes, determining situations of the coenostates, etc.

4. The database offers informations for detecting and describing changes in the ecological and/or sociological behaviour of the species. These kinds of changes are to be expected in relation to the climate change, the increasing eutrophication process of the habitats, and other anthropic disturbances. They may be manifested in changes of the ecological preferences of the species modifying their indicator values. Among others, we

refer to the processes, when the eutrophication of soils and their nutrient surplus attract more and more native species to anthropogenic habitats.

5. The database is useful for detecting long-term environmental changes, like acidification, alkalinization, desertification, eutrophication of the habitats.

6. It is to be emphasized — that the offered database is not an alternative one, for the substitution of other evaluating systems, it may serve as a complementing tool for enriching the means available for the botany, ecology and nature conservation in SE-Central Europe.

Some advices for the user's

It is highly important to emphasize, that the ecological indicator values are based on the field experiences derived from many thousands of phytosociological samples, and from many thousands of square kilometers of vegetation mapping accumulated by several generations of geobotanists during the last 60-70 years. Several authors (WALTER and BRECKLE 1983; BÖCKER et al. 1983; KOWARIK and SEIDLING 1989; in Hungary: A. HORÁNSZKY pers. comm. and I. SZODFRIDT in litt.) claimed the attention to the possible danger of applying the indicator values in literal sense, interpreting them as ecological characterization of the plant species, or as the expression of their ecological requirement to the biotop, as it occurs sometimes in the practice of ecologically not well-trained persons. These kinds of misinterpretation are consequences of unpermitted simplifications. Indicator values cannot substitute direct ecological studies and field measurements. They do not pretend to express the ecological character or requirements of the plants which can be studied only in competition free conditions (e.g. physiological experiments in pots or in pure cultures). Indicator values are really indicator rank numbers reflecting the plant response to the different sites, i.e. the ecological behaviour of the plants. The numbers are to be considered as the place of the plants on a relative ecological axis or in a relative ecological space, where it occurs with the highest frequency, related to other species of the flora.

Indicator values derived from field experiences have their advantage and the necessary limits of application at the same time. The great advantage of ecological indication by indicator values is the quickness of the method and the possibility to bridge the historical dimension, i.e. to detect ecological changes in the past by comparing old and new field data.

Phytosociological groups

In the 13th column of the database the species of the Hungarian Flora are found classified into phytosociological (syntaxonomic) units expressed by decimal code numbers. This classification follows the chapter: Systematic Review of the Central European Plant Communities of ELLENBERG et al. (1991: 71--75), which represents a consize version of a syntaxonomic review according to the intention of the author, who suggests a certain conservative moderateness in defining phytosociological units — first of all, in respect of higher hierarchical ranks — effectuating some useful simplifications in the system.

Since our goal is to adjust our criteria to the work taken as model, the Systematic Review of the Hungarian Plant Communities is given in the same system as in ELLENBERG's work. The decimal order used in the mentioned work is maintained by us without any change and the new units occurring in the Hungarian and SE-European vegetation are additionally registered under the correspondent higher units. If a species is indicated in this database with a decimal number different from that of ELLENBERG's work, it means, that its phytosociological behaviour and role is also different in the vegetation of Hungary resp. SE-Europe. Since the syntaxonomic system of ELLENBERG uses the phytosociological units in wider sense than the actual Hungarian classifications, according the initiatives of ELLENBERG, our version contains also some simplifications and reductions of the Hungarian coenosystematic units, e.g. the Asplenio-Festucion glaucae and the Seslerio-Festucion glaucae are considered as one alliance and the same refers to the Festucion valesiacae and Festucion rupicolae alliances. The South-Hungarian limestone rock swards are considered to be separated from the Bromo-Festucion glaucae (dolomite swards) alliance and classified to the West-Balkanian Satureion montanae.

Systematic review of the Hungarian Plant Communities

1. Water, swamp and moor vegetation

1.1. Lemnetea

1.1.1. Lemnetalia

1.1.1.1. Lemnion

Lemnetum gibbae

- Lemnetum minoris
 - Lemno-Spirodeletum
 - Salvinio-Spirodeletum
- 1.1.2. Hydrocharetales
 - 1.1.2.1. Hydrocharition
 - Hydrochari-Stratiotetum
 - Lemno-Utricularietum
- 1.2. Utricularietea
 - 1.2.1. Utricularietalia
 - 1.2.1.1. Sphagno-Utricularion
 - Aldrovando-Utricularietum minoris
 - Ricciatum fluitantis
 - Spirodelo-Aldrovandetum
- 1.3. Potamogetonetea
 - 1.3.1. Potamogetonetalia
 - 1.3.1.1. Potamogetonion
 - Elodeetum
 - Myriophyllo-Potametum
 - Najadetum minoris
 - Parvipotameto-Zannichellietum
 - Potamogetonetum lucentis
 - Potamogetonetum pectinati
 - 1.3.1.2. Nymphaeion
 - Hippuridetum
 - Nymphaetum albo-luteae
 - Polygonetum natantis
 - Nymphoidetum peltatae
 - Trapaetum natantis
 - 1.3.1.3. Batrachion fluitantis
 - Callitrichetum cophocarpae
 - Elatinetum triandrae
 - Hottonietum palustris
 - Ranunculetum aquatilis
 - Ranunculetum fluitantis
 - Ranunculetum polyphylli
- 1.4. Litorelletea
 - 1.4.1. Litorelletalia
 - 1.4.1.1. Litorellion
 - Ranunculo flammulae-Gratioletum

1.5. Phragmitetea

1.5.1. Phragmitetalia

1.5.1.1. Phragmition

Acoretum
Cladietum marisci
Glycerietum maximae
Rorippo-Oenanthetum
Scirpo-Phragmitetum
Schoenoplectetum lacustris
Typhetum angustifoliae
Typhetum latifoliae

1.5.1.2. Eleochari-Sagittarion

Alismato-Eleocharitetum
Butometum umbellatae

1.5.1.3. Glycerio-Sparganion

Glycerietum plicatae
Leersietum
Rorippo-Typhoidetum
Sparganio-Glycerietum fluitantis

1.5.1.4. Magnocaricion

1.5.1.4.1. Caricenion rostratae

Calamagrostetum canescentis
Caricetum appropinquatae
Caricetum elatae
Caricetum paniculatae
Carici-Calamagrostetum neglectae
Carici-Menyanthetum
Schoenoplecto-Juncetum maritimi

1.5.1.4.2. Caricenion gracilis

Caricetum acutiformis-ripariae
Caricetum gracilis
Caricetum vesicariae
Caricetum vulpinae
Carici-Typhoidetum

1.6. Montio-Cardaminetea

1.6.1. Montio-Cardaminetalia

1.6.1.1. Montio-Cardaminion

Bryetum schleicheri
Chrysosplenio-Cardaminetum amarae

- 1.6.1.2. Cratoneurion commutati
 - Carici lepidocarpae-Cratoneuretum
- 1.7. Scheuchzerio-Caricetea nigrae
 - 1.7.1. Scheuchzerio-Caricetalia
 - 1.7.1.1. Rhynchosporion
 - Rhynchosporetum albae
 - 1.7.1.2. Caricion lasiocarpae
 - Caricetum appropinquatae-stellatae
 - Caricetum canescentis-nigrae
 - Carici echinatae-Sphagnetum
 - Carici lasiocarpae-Sphagnetum
 - 1.7.2. Tofieldietalia
 - 1.7.2.1. Caricion davallianae
 - Cladio-Schoenetum
 - Orchido-Schoenetum
 - Schoeno-Seslerietum
 - Valeriano-Caricetum davallianae
 - 1.7.3. Caricetalia nigrae
 - 1.7.3.1. Caricion nigrae (fuscae)
 - Junceto-Caricetum nigrae
- 1.8. Oxycocco-Sphagnetea
 - 1.8.1. Sphagnetalia magellanici
 - 1.8.1.1. Sphagnion magellanici (fusci)
 - Eriophoro vaginati-Sphagnetum
- 2. Coastal and salt swamp vegetation
 - 2.1. Zosteretea
 - 2.2. Ruppietea
 - 2.1.1. Ruppietalia
 - 2.1.1.1. Ruppion maritimae
 - Parvipotameto-Zannichellietum
 - Ranunculetum aquatilis-polyphylli
 - 2.3. Spartinetea
 - 2.4. Thero-Salicornietea
 - 2.4.1. Thero-Salicornietalia
 - 2.4.1.1. Salicornion dolichostachyae
 - 2.4.1.2. Salicornion ramosissimae
 - Salicornietum prostratae

Salsoletum sodae

Suaedetum pannonicae

2.4.2. Crypsidetalia

2.4.2.1. Cypero-Spergularion

Acorelletum pannonici

Chenopodietum urbici

Crypsidetum aculeatae

Heleochloetum alopecuroidis

Heleochloetum schoenoidis

2.5. Saginetea

2.6. Asteretea tripolii

2.7. Honckenyo-Elymetea

2.8. Cakiletea

2.9. Ammophiletea

2.10. Bolboschoenetea

2.10.1. Bolboschoenetalia

2.10.1.1. Bolboschoenion maritimi

Bolboschoenetum maritimi

Bolboschoeno-Phragmitetum

Polygono-Bolboschoenetum

Schoenoplectetum litoralis

Schoenoplectetum tabernaemontani

3. Disturbed and secondary vegetation

3.1. Isoëto-Nanojuncetea

3.1.1. Cyperetalia fusci

3.1.1.1. Nanocyperion

Cyperetum fusci

Cypero-Juncetum bufonii

Elatini-Lindernietum procumbentis

Eleochari-Schoenoplectetum supini

Ranunculo lateriflori-Limoselletum

3.1.1.2. Elatini-Eleocharion ovatae

Dichostyli-Gnaphalietum uliginosae

Eleochari-Caricetum bohemicae

Lindernio-Eleocharetum ovatae

3.1.1.3. Heleochloo-Cyperion

Dichostyli-Heleochloetum alopecuroidis

Lythretum hyssopifolii-tribracteati

Lythro-Gnaphalietum luteo-albi

3.1.1.4. Verbenion supinae

Astragalo-Chlorocyperetum glomerati

Centunculo-Radioletum linoidis

Heliotropio-Verbenetum supinae

Lythro-Pulicarietum

3.2. Bidentetea

3.2.1. Bidentetalia

3.2.1.1. Bidention tripartitae

Eleochoo-Bidentetum tripartitae

Polygono lapathifolio-Bidentetum

Stachydi-Bidentetum tripartitae

Xanthio strumarii-Bidentetum

3.2.1.2. Chenopodion rubri

Chenopodietum glauci-rubri

Dichostylidi-Chenopodietum rubri

Echinochloo-Polygonetum lapathifolii

Echinochloo-Setarietum pumilae

3.3. Chenopodietea

3.3.1. Polygono-Chenopodietalia

3.3.1.1. Fumario-Euphorbion

3.3.1.2. Spergulo-Oxalidion

3.3.2. Eragrostietalia

3.3.2.1. Eragrostion

Amarantho-Chenopodietum albi

3.3.2.2. Digitario-Setarion

3.3.2.3. Consolido-Eragrostion minoris

Consolido orientali-Stachyetum annuae

Convolvulo-Portulacetum

3.3.2.4. Tribulo-Eragrostion minoris

Digitario-Portulacetum

Hibisco-Eragrostietum minoris

Tribulo-Tragetum

Vicio-Eragrostietum minoris

Vicio-Polygonetum arenarii

3.3.2.5. Matricario-Chenopodion albi

Matricario-Atriplicetum litoralis

3.3.3. Sisymbrietalia

3.3.3.1. Sisymbrium officinalis

- Bromo arvensi-Hordeetum murini
- Chenopodio vulvariae-Urticetum urentis
- Descurainietum sophiae
- Lappulo-Cynoglossetum
- Malvetum neglectae
- Malvetum pusillae
- Rorippo austriacae-Hordeetum murini

3.3.3.2. Salsolion ruthenicae

- Atriplicetum tatarici

3.4. Secalietea

3.4.1. Secalietalia

3.4.1.1. Caucalion lappulae

- Setario-Stachyetum annuae

3.4.1.2. Trifolio-Medicaginion

- Plantagini-Medicaginetum

3.4.2. Aperetalia

3.4.2.1. Aphanion

- Aphani-Matricarietum chamomillae
- Rorippo-Setarietum
- Sclerantho-Trifolietum arvensis
- Setario-Digitalietum
- Spergulo-Aperetum

3.4.3. Lolio-Linetalia

3.4.3.1. Lolio-Linion

- Lolio temulenti-Linetum

3.5. Artemisietea

3.5.1. Artemisietalia

3.5.1.1. Arction lappae

- Arctio-Ballotetum nigrae
- Conietum maculati
- Lycietum barbarum
- Pruno-Ballotetum nigrae
- Sambucetum ebuli
- Tanaceto-Artemisietum

3.5.2. Calystegietalia

3.5.2.1. Calystegion sepium

Asteri-Rubetum caesii
Bidenti-Calystegietum
Cuscuta-Calystegietum
Glycyrrhizetum echinatae
Impatienti-Calystegietum
Rudbeckio-Solidaginetum

3.5.3. Glechometalia

3.5.3.1. Aegopodion podagrariae

Chaerophylletum aromatici
Chaerophylletum bulbosi
Urtico-Aegopodietum

3.5.3.2. Alliarion

Alliario-Chaerophylletum temuli
Arctietum nemorosi
Cephalarietum pilosae
Chelidonio-Alliarietum
Epilobio montani-Geranietum robertiani
Eupatorietum cannabini
Torilidetum japonicae

3.5.4. Onopordetalia

3.5.4.1. Onopordion acanthii

Onopordetum acanthii
Xanthietum spinosi

3.5.4.2. Dauco-Melilotion

Berteroetum incanae
Echio-Melilotetum albi
Lactucetum salignae

3.6. Agropyretea

3.6.1. Agropyretalia repentis

3.6.1.1. Convolvulo-Agropyrion

Agropyro-Convolvuletum arvensis
Aristolochio-Convolvuletum arvensis
Bromo japonici-Aristolochietum
Cardarietum drabae
Junco-Tussilaginetum
Stellario mediae-Mercurialietum annuae

3.6.1.2. Artemisio-Agropyrion

Artemisio absinthii-Agropyretum intermedii
Festuco-Agropyretum intermedii

3.7. Plantaginetea

3.7.1. Plantaginetalia majoris

3.7.1.1. Polygonion avicularis

Amarantho deflexo-Polygonetum

Eragrosti-Polygonetum

Euphorbio supinae-Polygonetum avicularis

Juncetum tenuis

Lolio-Plantaginetum

Poetum annuae

Sagino-Bryetum argenteae

Sclerochloo-Polygonetum avicularis

3.8. Agrostietea stoloniferae

3.8.1. Agrostietalia stoloniferae

3.8.1.1. Agropyro-Rumicion crispis

Amarantho deflexo-Polygonetum

Blysmo-Juncetum compressi

Dactylido-Festucetum arundinaceae

Juncetum effusi

Junco-Menthetum longifoliae

Lolio-Alopecuretum

Lolio-Potentilletum anserinae

Ranunculetum repentis

Rorippo austriacae-Agropyretum repentis

Rorippo sylvestri-Agrostietum stoloniferae

Rumici-Alopecuretum geniculati

Trifolio fragifero-Cynodontetum

Trifolio repenti-Lolietum

3.9. Oryzetea

3.9.1. Oryzetalia

3.9.1.1. Oryzion sativae

Echinochloo-Oryzetum sativae

4. Montane rock vegetation and alpine grasslands5. Anthropo-zoogenous heath, grasslands and pastures

5.1. Nardo-Callunetea

5.1.1. Nardetalia

5.1.1.1. Nardion

- 5.1.1.2. *Violion caninae*
- 5.1.1.3. *Juncion squarrosi*
- 5.1.1.4. *Festucion variae*
- 5.1.1.5. *Nardo-Agrostion tenuis*
 - Agrostietum strictae-tenuis*
 - Festuco ovinae-Nardetum*
 - Festuco tenuifoliae-Agrostietum tenuis*
- 5.1.2. *Calluno-Ulicetalia*
 - 5.1.2.1. *Calluno-Genistion*
 - Luzulo luzuloidis-Callunetum*
- 5.2. *Sedo-Scleranthetea*
 - 5.2.1. *Sedo-Scleranthetalia*
 - 5.2.1.1. *Sedo-Scleranthion*
 - 5.2.1.2. *Alysso-Sedion*
 - Geranio rotundifolio-Sedetum albi*
 - Grimmio-Sedetum albi-sexangularis*
 - Hypno-Sedetum*
 - Sedo sexangulari-Allietum montani*
 - 5.2.1.3. *Seslerio-Festucion pallentis*
 - Seslerio-Festucetum pallentis*
 - 5.2.2. *Corynephorotalia*
 - 5.2.2.1. *Corynephorion*
 - Thymo angustifolio-Corynephoretum*
 - 5.2.3. *Festuco-Sedetalia*
 - 5.2.3.1. *Koelerion glaucae*
 - 5.2.3.2. *Sileno conicae-Cerastion semidecandri*
 - 5.2.4. *Thero-Airetalia*
 - 5.2.4.1. *Thero-Airion*
 - Festuco ovinae-Polytrichetum*
 - Festuco ovinae-Rhacomitrietum*
 - Festuco-Thymetum serpylli*
 - Filagini-Vulpietum*
 - Melampyro-Rhacomitrietum*
 - 5.2.5. *Hypno-Polypodietalia*
 - 5.2.5.1. *Polypodion*
 - Hypno-Polypodietum*
- 5.3. *Festuco-Brometea*
 - 5.3.1. *Festucetalia valesiaca*

- 5.3.1.1. Festucion valesiacaе (incl. Festucion rupicolaе)
 - Astragalo-Festucetum rupicolaе
 - Cleistogeno-Festucetum rupicolaе
 - Cynodonto-Festucetum pseudovinaе
 - Cynodonto-Poetum angustifoliaе
 - Medicagini-Festucetum valesiacaе
 - Potentillo-Festucetum pseudodalmaticaе
 - Potentillo-Festucetum pseudovinaе
 - Pulsatillo-Festucetum rupicolaе
 - Salvio-Festucetum rupicolaе
- 5.3.1.2. Cirsio-Brachypodion
 - Lino tenuifolio-Brachypodietum pinnati
 - Polygalo-Brachypodietum pinnati
- 5.3.1.3. Asplenio-Festucion pallentis
 - Asplenio rutae-murariae-Melicetum ciliatae
 - Asplenio septentrionali-Melicetum ciliatae
 - Inulo-Festucetum pseudodalmaticaе
 - Minuartio-Festucetum pseudodalmaticaе
 - Poetum pannonicae
- 5.3.1.4. Bromo-Festucion pallentis
 - Chrysopogono-Caricetum humilis
 - Festuco pallenti-Brometum pannonici
 - Poo badensi-Caricetum humilis
 - Seseli leucospermi-Festucetum pallentis
 - Seslerietum sadlerianaе
 - Stipo-Festucetum pallentis
- 5.3.1.5. Saturejon montanae
 - Sedo sopianaе-Festucetum dalmaticaе
 - Serratulo radiatae-Brometum pannonici
- 5.3.1.6. Danthonio-Stipion tirsae
 - Campanulo macrostachyae-Stipetum tirsae
- 5.3.1.7. Artemisio-Kochion
 - Agropyro pectinati-Kochietum prostratae
 - Artemisietum ponticae-campestris
- 5.3.2. Brometalia erecti
 - 5.3.2.1. Xerobromion
- 5.3.3. Festucetalia vaginatae
 - 5.3.3.1. Festucion vaginatae

Festucetum vaginatae

Festuco vaginatae-Corynephorretum

5.3.3.2. Bromion tectorum

Brometum tectorum

5.4. Molinio-Arrhenatheretea

5.4.1. Molinietales

5.4.1.1. Molinion

Junco-Molinietum

Molinio-Salicetum rosmarinifoliae

Succiso-Molinietum

5.4.1.2. Filipendulo-Petasition

Aconitetum gracilis

Aegopodio-Petasitetum

Chaerophyllo-Petasitetum

Equiseto-Chaerophylletum hirsuti

Filipendulo-Cirsietum oleracei

Filipendulo-Geranium

Nasturtio-Petasitetum

5.4.1.3. Cnidion

5.4.1.4. Juncion acutiflori

5.4.1.5. Calthion

Aconitetum gracilis

5.4.1.6. Deschampsion caespitosae

Agrostio-Poetum trivialis

Agrostio-Typhoidetum

Carici-Alopecuretum pratensis

Cirsio cano-Festucetum pratensis

Deschampsietum caespitosae

5.4.2. Arrhenatheretalia

5.4.2.1. Arrhenatherion

Alopecuro-Arrhenatheretum

Pastinaco-Arrhenatheretum

Anthyllido-Festucetum pratensis

5.4.2.2. Polygono-Trisetion

Trisetetum flavescens

5.4.2.3. Cynosurion

Festuco rubrae-Cynosuretum

Lolio-Cynosuretum

5.5. Festuco-Puccinellietea

5.5.1. Puccinellietalia

5.5.1.1. Puccinellion limosae

Bassietum sedoidis

Camphorosmetum annuae

Chenopodio-Puccinellietum limosae

Hordeetum hystricis

Pholiuro-Plantaginetum tenuiflorae

Puccinellietum limosae

5.5.1.2. Puccinellion peisonis

Lepidio crassifolii-Camphorosmetum

Lepidio crassifolii-Puccinellietum limosae

Lepidio crassifolii-Puccinellietum peisonis

Puccinellietum peisonis

5.5.1.3. Juncion gerardii

Agrostio-Caricetum distantis

Scorzonero parviflorae-Juncetum gerardii

Trifolio-Caricetum divisae

5.5.1.4. Beckmannion eruciformis

Agrostio-Alopecuretum geniculati

Agrostio-Alopecuretum pratensis

Agrostio-Beckmannietum

Agrostio-Glycerietum poiformis

5.5.2. Artemisio-Festucetalia

5.5.2.1. Festucion pseudovinae

Achilleo-Festucetum pseudovinae

Artemisio santonici-Festucetum pseudovinae

Lepidio crassifolii-Festucetum pseudovinae

Peucedano-Asteretum sedifolii

6. Forest edge heath and forb vegetation

6.1. Trifolio-Geranietea

6.1.1. Origanetalia vulgaris

6.1.1.1. Trifolion medii

6.1.1.2. Geranion sanguinei

6.2. Epilobietea angustifolii

6.2.1. Atropetalia (Epilobietalia angustifolii)

6.2.1.1. Epilobion angustifolii

Calamagrostietum epigei

Digitali-Calamagrostietum arundinaceae
Senecioni-Epilobietum angustifolii

6.2.1.2. Atropion

Atropetum belladonnae
Molinietum arundinaceae

7. Needleleaved forests and allied communities

7.1. Erico-Pinetea

7.1.1. Erico-Pinetalia

7.1.1.1. Erico-Pinion

Chamaebuxo-Pinetum

7.2. Pulsatillo-Pinetea

7.2.1. Pulsatillo-Pinetalia

7.2.1.1. Cytiso-Pinion

Lino flavi-Pinetum

7.2.1.2. Festuco vaginatae-Pinion

Festuco vaginatae-Pinetum silvestris

7.3. Vaccinio-Piceetea

7.3.1. Piceetalia

7.3.1.1. Dicrano-Pinion

7.3.1.2. Linnaeo-Piceion

7.3.1.2.1. Vaccinio-Abietenion

Bazzanio-Abietetum

8. Broadleaved forests and woodlands

8.1. Salicetea purpureae

8.1.1. Salicetalia purpureae

8.1.1.1. Salicion elaeagni

Hippophae-Salicetum elaeagni

Myricario-Epilobietum dodonaei

8.1.1.2. Salicion albae

Salicetum albae-fragilis

Salici-Populetum

8.1.1.3. Salicion triandrae

Salicetum purpureae

Salicetum triandrae

8.2. Alnetea glutinosae

8.2.1. Alnetalia glutinosae

- 8.2.1.1. Alnion glutinosae
 - Dryopteridi-Alnetum
 - Fraxino pannonicarum-Alnetum
 - Thelypteridi-Alnetum
- 8.3. Quercetea robur-petraeae
 - 8.3.1. Quercetalia robur-petraeae
 - 8.3.1.1. Quercion robur-petraeae (incl. Castaneo-Quercion)
 - Castaneo-Quercetum
 - Chrysanthemo-Quercetum
 - Genisto tinctoriae-Carpinetum
 - 8.3.1.2. Pino-Quercion
 - Aulacomnio-Pinetum
 - Genisto nervatae-Pinetum
- 8.4. Querco-Fagetea
 - 8.4.2. Quercetalia pubescentis-petraeae
 - 8.4.2.1. Quercion pubescentis
 - 8.4.2.2. Orno-Ostryon
 - Cotino-Quercetum pubescentis
 - Cotoneastro-Amelanchieretum
 - Fago-Ornetum
 - Inulo spiraeifolio-Quercetum pubescentis
 - Orno-Quercetum pubescentis
 - 8.4.2.3. Aceri tatarico-Quercion
 - Aceri campestri-Quercetum
 - Aceri tatarico-Quercetum
 - Ceraso mahaleb-Quercetum pubescentis
 - Convallario-Quercetum
 - Corno-Quercetum
 - Dictamno-Tilietum cordatae
 - Festuco rupicolae-Quercetum
 - Galatello-Quercetum
 - Junipero-Populetum albae
 - Poo pannonicarum-Quercetum
 - Tilio-Fraxinetum excelsioris
 - Waldsteinio-Spiraeetum mediae
 - 8.4.2.4. Quercion petraeae-cerris
 - Asphodelo-Quercetum roboris-cerris

Deschampsio-Quercetum petraeae-cerris

Genisto pilosae-Quercetum

Orno-Quercetum polycarpae

Potentillo micranthae-Quercetum

Quercetum petraeae-cerris

8.4.3. Fagetalia

8.4.3.1. Fagion sylvaticae

8.4.3.1.1. Luzulo-Fagenion (incl. Deschampsio-Fagion)

Galio rotundifolio-Fagetum

Luzulo-Fagetum

8.4.3.1.2. Galio odoratae-Fagenion

Aconito-Fagetum

Cyclamini-Fagetum

Laureolae-Fagetum

Melittio-Fagetum

8.4.3.1.3. Cephalanthero-Fagenion

Seslerio hungaricae-Fagetum

Tilio-Sorbetum

8.4.3.1.4. Aceri-Fagenion

Parietario-Aceretum

Phyllitidi-Aceretum

8.4.3.1.5. Tilio-Acerenion

Mercuriali-Tilietum

8.4.3.1.6. Galio-Abietenion

Abieti-Fagetum

8.4.3.2. Carpinion betuli

Querco petraeae-Carpinetum

Querco robori-Carpinetum

Waldsteinio-Carpinetum

8.4.3.3. Alno-Ulmion

Aegopodio-Alnetum

Carici acutiformis-Alnetum

Carici brizoidis-Alnetum

Carici remotae-Fraxinetum

Fraxino pannonicae-Ulmetum

8.4.3.4. Aremonio-Fagion

8.4.3.4.1. Primulo-Fagenion

Asperulo taurinae-Carpinetum

Fraxino pannonicae-Carpinetum
Helleboro dumetorum-Carpinetum
Helleboro odori-Fagetum
Scutellario-Aceretum
Tilio tomentosae-Fraxinetum orni
Vicio oroboidis-Fagetum

8.4.3.2.4. Lamio orvalae-Fagenion

8.4.3.4.3. Lonicero-Fagenion

8.4.3.4.4. Ostryo-Fagenion

8.5. Franguletea

8.5.1. Pteridio-Rubetalia

8.5.1.1. Lonicero-Rubion silvatici

8.5.2. Salicetalia auritae

8.5.2.1. Salicion cinereae

Calamagrostio-Salicetum cinereae

Salici cinereae-Sphagnetum

Salici pentandrae-Betuletum

8.6. Rhamno-Prunetea

8.6.1. Prunetalia spinosae

8.6.1.1. Pruno-Rubion radulae

8.6.1.2. Pruno-Rubion ulmifolii

8.6.1.3. Carpino-Prunion

Coryletum avellanae

Pruno spinosae-Crataegetum

8.6.1.4. Berberidion

8.6.1.5. Prunion fruticosae

Amygdaletum nanae

Crataego-Cerasetum fruticosae

Phlomidii-Prunetum tenellae

8.6.2. Salicetalia arenariae

8.6.2.1. Salicion arenariae

8.6.3. Sambucetalia

8.6.3.1. Sambuco-Salicion capreae

Aegopodio-Sambucetum nigrae

Epilobio-Salicetum capreae

Fragario-Rubetum

Sambucetum racemosae

Solidagini-Cornetum sanguineae

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**SOCIAL BEHAVIOUR TYPES (SBT) OF THE HUNGARIAN FLORA, ITS NATURALNESS
VALUES (VAL) AND RELATIVE ECOLOGICAL INDICATOR VALUES (TB-SB)**

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Abies	alba	L.	C	5	4	6	6	6	3	4	0	7.3.1.2.
Abutilon	theophrasti	Medik.	W	1	8	4	6	4	7	7	0	3.3.
Acer	campestre	L.	G	4	7	5	7	5	5	6	0	8.4.
Acer	negundo	L.	AC	-3	6	6	7	7	5	7	0	8.1.1.2.
Acer	platanoides	L.	G	4	6	6	7	6	5	4	0	8.4.3.
Acer	pseudo-platanus	L.	S	6	5	6	6	7	4	4	0	8.4.3.1.
Acer	tataricum	L.	S	6	7	4	7	4	5	8	1	8.4.2.3.
Achillea	asplenifolia	Vent.	DT	2	6	6	7	3	8	7	2	5.5.
Achillea	collina	J.Beck	DT	2	6	2	7	2	9	6	3	5.5.
Achillea	crithmifolia	W. & K.	G	4	8	4	5	3	8	6	0	8.4.2.
Achillea	distans	W. & K.	G	4	7	4	7	4	7	7	0	8.4.2.
Achillea	horanszkyi	Ujh.	Su	10	8	2	7	1	8	7	0	5.3.1.3.
Achillea	millefolium	L.	DT	2	5	6	5	5	8	5	1	5.4.
Achillea	nobilis	L.	G	4	7	3	8	1	8	7	0	5.3.1.
Achillea	ochroleuca	Ehrh.	S	6	7	2	8	1	9	8	0	5.3.3.1.
Achillea	annonica	Scheele	DT	2	7	4	6	2	8	6	0	5.3.
Achillea	ptarmica	L.	Sr	8	4	8	4	3	8	3	0	5.4.1.
Achillea	setacea	W. & K.	G	4	7	2	7	1	9	8	3	5.5.2.
Acinos	arvensis	(Lam.)Dandy	NP	3	5	2	7	1	9	3	0	5.2.
Aconitum	anthora	L.	S	6	6	4	8	5	6	6	0	8.4.2.
Aconitum	moldavicum	Hacq.	Sr	8	4	6	6	6	4	6	0	8.4.3.1.
Aconitum	x stoerckianum	Rchb.	I	-1								
Aconitum	variegatum	L.	Sr	8	5	5	9	6	5	7	0	8.4.3.1.
Aconitum	vulparia	Rchb.	S	6	5	7	7	7	3	4	0	8.4.3.
Acorellus	pannonicus	(Jacq.)Palla	NP	3	7	8	8	1	9	8	5	2.4.2.1.
Acorus	calamus	L.	S	6	7	10	7	7	8	5	0	1.5.1.1.
Actaea	spicata	L.	G	4	5	6	6	7	2	4	0	8.4.3.
Adenophora	liliifolia	(L.)Bess.	Gr	6	6	6	6	4	6	6	0	5.4.2.
Adonis	aestivalis	L.	W	1	6	3	7	3	6	7	0	3.4.1.
Adonis	flammea	Jacq.	W	1	6	3	8	2	6	6	0	3.4.1.
Adonis	transsylvanica	Simonovich	su	10	7	3	9	1	9	8	0	5.3.1.1.
Adonis	vernalis	L.	S	6	7	3	8	1	8	7	0	5.3.1.
Adoxa	moschatellina	L.	S	6	5	6	7	8	4	5	0	8.4.3.2.
Aegilops	cylindrica	Host.	DT	2	7	2	6	2	9	7	0	3.3.
Aegopodium	podagraria	L.	C	5	5	7	6	8	4	3	0	8.4.3.
Aesculus	hippocastanum	L.	I	-1	6	7	6	7	5	5	0	
Aethionema	saxatile	(L.)R.Br.	S	6	8	1	9	1	9	5	0	5.3.1.4.
Aethusa	cynapium ssp. c. & agr.	L.	DT	2	5	6	7	7	6	3	0	3.5.2.
Aethusa	cyn. ssp. cynapioides	(M.B.)Nym.	G	4	5	7	7	6	6	4	0	8.4.
Agrimonia	eupatoria	L.	DT	2	6	4	7	4	7	4	0	Indiff.
Agrimonia	procera	Wallr.	G	4	5	5	6	5	6	3	0	5.4.2.
Agropyron	caninum	(L.)P.B.	G	4	5	6	7	7	5	3	0	8.4.3.
Agropyron	intermedium	(Host.)P.B.	DT	2	7	3	8	3	7	6	0	5.3.
Agropyron	pectinatum	(M.B.)R. & Sch.	C	5	7	1	8	1	8	8	0	5.3.1.
Agropyron	repens	(L.)P.B.	RC	-2	5	5	5	7	7	7	1	Indiff.
Agrostemma	githago	L.	W	1	6	5	6	5	7	5	0	3.4.
Agrostis	canina	L.	G	4	5	8	4	2	9	5	0	5.4.1.
Agrostis	stolonifera	L.	C	5	5	7	6	5	8	5	1	Indiff.
Agrostis	tenuis	Sibth.	C	5	5	4	3	3	7	3	0	Indiff.
Ailanthus	altissima	(Mill.)Swingle	AC	-3	8	5	7	8	6	3	0	Indiff.
Aira	caryophyllacea	L.	NP	3	5	2	2	1	9	2	0	5.2.4.1.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Aira	elegantissima	Schur	NP	3	6	2	2	1	9	4	0	5.2.4.1.	
Ajuga	chamaeepitys	(L.)Schreb.	W	1	8	3	8	2	8	2	0	3.4.1.	
Ajuga	genevensis	L.	G	4	6	4	7	2	8	4	0	Indiff.	
Ajuga	laxmannii	(L.)Benth.	Sr	8	8	2	8	2	8	6	0	5.3.1.1.	
Ajuga	reptans	L.	DT	2	5	6	6	5	6	2	0	Indiff.	
Alchemilla	acutiloba	Opiz	G	4	5	6	4	7	8	3	0	5.1.	
Alchemilla	crinita	Buser	Sr	8	5	6	4	7	7	3	0	5.1.1.	
Alchemilla	glabra	Neygenf.	Sr	8	4	8	3	4	8	3	0	1.7.2.1.	
Alchemilla	gracilis	Opiz	G	4	4	6	4	6	8	3	0	5.1.	
Alchemilla	hungarica	Soó	Sr	8	4	7	3	3	8	4	0	5.1.1.1.	
Alchemilla	hybrida	L. em. Rothm.	Sr	8	4	6	2	4	8	3	0	5.1.1.	
Alchemilla	monticola	Opiz	G	4	4	6	5	4	7	5	0	5.1.	
Alchemilla	xanthochlora	Rothm.	Sr	8	4	7	5	4	7	3	0	5.4.2.2.	
Alchemilla	vulgaris	L.	G	4	4	6	3	6	7	3	0	Indiff.	
Aldrovanda	vesiculosa	L.	Su	10	8	12	5	5	5	4	0	1.2.1.1.	
Alisma	gramineum	C.Gmel.	G	4	7	11	7	5	7	6	0	3.1.1.	
Alisma	lanceolatum	With.	G	4	7	10	7	5	7	2	0	1.5.	
Alisma	plantago-aquatica	L.	G	4	5	10	6	8	7	4	0	1.5.	
Alkanna	tinctoria	(L.)Tausch.	S	6	9	1	9	1	9	9	0	5.3.3.1.	
Alliaria	petiolata	(MB.)Cav. & Gr.	DT	2	6	5	7	8	5	3	0	Indiff.	
Allium	ampeloprasum	L.	I	-1									
Allium	angulosum	L.	S	6	6	8	8	3	8	7	0	5.4.1.1.	
Allium	ascalonicum	Strand	I	-1									
Allium	atropurpureum	W. & K.	W	1	8	4	7	6	7	5	0	3.4.1.	
Allium	atroviolaceum	Boiss.	W	1	8	4	6	6	7	6	0	3.4.1.	
Allium	carinatum	L.	DT	2	5	3	8	3	7	4	0	5.3.	
Allium	cepa	L.	I	-1									
Allium	fistulosum	L.	I	-1									
Allium	flavum	L.	G	4	7	2	7	1	9	5	0	5.3.1.	
Allium	montanum	F.W.Schmidt	G	4	6	2	6	2	9	5	0	5.3.1.	
Allium	moschatum	L.	G	4	8	2	9	1	9	6	0	5.3.1.	
Allium	oleraceum	L.	S	6	7	3	7	4	8	5	0	5.3.1.1.	
Allium	paniculatum	L.	G	4	8	4	8	4	8	6	0	5.3.	
Allium	porrum	L.	I	-1									
Allium	rotundum	L.	G	4	7	4	8	4	9	5	0	5.3.1.	
Allium	sativum	L.	I	-1									
Allium	schoenoprasum	L.	I	-1	7	7	7	2	7	7	0		
Allium	scorodoprasum	L.	DT	2	6	5	7	7	6	6	0	Indiff.	
Allium	sphaerocephalum	L.	G	4	8	2	8	2	9	5	0	5.3.	
Allium	suaveolens	Jacq.	Sr	8	6	8	9	2	9	5	0	5.4.1.1.	
Allium	ursinum	L.	C	5	6	6	7	8	2	2	0	8.4.3.	
Allium	victoralis	L.	Sr	8	3	6	8	7	3	4	0	8.4.3.1.	
Allium	vineale	L.	W	1	7	4	5	7	5	3	0	3.4.	
Alnus	glutinosa	(L.)Gaertn.	C	5	5	9	6	7	5	4	0	8.2.1.1.	
Alnus	incana	(L.)Moench.	G	4	4	7	8	6	6	4	0	8.1.1.2.	
Alnus	viridis	(Chaix)DC.	Sr	8	3	6	5	5	7	4	0	8.3.1.2.	
Alopecurus	aequalis	Sobol.	DT	2	5	8	7	9	9	5	1	3.2.1.	
Alopecurus	geniculatus	L.	G	4	6	9	8	7	6	3	2	5.5.1.	
Alopecurus	myosuroides	Huds.	W	1	6	6	7	7	7	3	1	3.2.	
Alopecurus	pratensis	L.	C	5	5	6	6	7	7	5	1	5.4.	
Althaea	cannabina	(Winter)Borb.	DT	2	7	3	7	4	8	6	0	3.3.	
Althaea	hirsuta	L.	DT	2	8	4	8	3	7	2	0	3.3.	
Althaea	officinalis	L.	DT	2	7	7	8	4	7	6	2	Indiff.	
Althaea	pallida	W. & K. ex Willd.	DT	2	7	4	7	4	9	7	0	5.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Althaea	rosea	(L.)Cav.	I	-1									
Alyssum	alyss. ssp. conglobatum	(Fil. & Jáv.)Jáv.	Sr	8	7	2	8	1	9	5	0	5.3.1.3.	
Alyssum	alyssoides ssp. alyss.	(L.)Nath.	NP	3	6	3	8	1	9	4	0	5.2.1.	
Alyssum	desertorum	Stapf	NP	3	6	3	8	1	9	5	0	5.3.3.2.	
Alyssum	montanum ssp. brymii	Dostal	S	6	6	3	8	2	8	5	0	5.3.1.3.	
Alyssum	montanum ssp. gmelini	(Jord.)Schmid ex Hegi	S	6	7	2	8	1	9	6	0	5.3.3.1.	
Alyssum	montanum ssp. mont.	L.	G	4	7	2	7	1	9	4	0	5.3.	
Alyssum	saxatile	L.	Sr	8	8	2	7	1	9	6	0	5.3.1.	
Alyssum	tort. ssp. heterophyllum	Nyárády	S	6	9	2	9	1	9	7	0	5.3.1.3.	
Alyssum	tortuosum ssp. tort.	W. & K. ex Willd.	S	6	9	2	9	1	9	7	0	5.3.3.1.	
Amaranthus	albus	L.	RC	-2	8	4	6	8	9	6	1	3.3.	
Amaranthus	blitoides	S.Wats.	W	1	7	3	7	8	9	7	1	3.3.	
Amaranthus	caudatus	L.	I	-1									
Amaranthus	chlorostachys	Willd.	A	-1	9	4	7	7	9	7	1	3.3.	
Amaranthus	crispus	(Les. & Th.)Ter.	A	-1	7	5	7	8	9	7	1	3.3.	
Amaranthus	deflexus	L.	A	-1	9	4	7	7	8	7	1	3.3.	
Amaranthus	graecisans	L.	W	1	8	4	7	8	9	5	0	3.3.	
Amaranthus	hypochondriacus	L.	I	-1	9	4	7	7	9	7	1	3.3.	
Amaranthus	lividus	L. em. Thell.	W	1	8	4	7	8	8	3	1	3.2.	
Amaranthus	patulus	Bert.	A	-1	8	5	7	8	9	7	0	3.3.	
Amaranthus	retroflexus	L.	RC	-2	9	5	7	9	9	7	1	3.3.	
Ambrosia	artemisifolia	L.	AC	-3	8	5	7	7	9	6	0	Indiff.	
Ambrosia	elatiior	L.	AC	-3	8	5	7	7	9	6	0	Indiff.	
Amelanchier	ovalis	Medik.	Cr	7	7	3	8	3	7	4	0	8.4.2.2.	
Ammannia	verticillata	(Ard.)Lam.	A	-1	8	8	7	4	9	0	0	3.1.1.1.	
Amorpha	fruticosa	L.	AC	-3	7	5	6	6	6	8	0	3.2.	
Amygdalus	communis	L.	I	-1									
Amygdalus	nana	L.	Sr	8	8	3	8	3	7	9	0	8.6.1.5.	
Anacamptis	pyramidalis	(L.)Rich.	Sr	8	7	3	9	2	8	2	0	5.3.1.	
Anacharis	canadensis	(L.C.Rich.)Pl.	AC	-3	6	12	7	7	7	5	0	1.3.1.1.	
Anagallis	arvensis	L.	W	1	6	4	7	6	6	3	0	3.4.	
Anagallis	foemina	Mill.	W	1	7	4	8	5	7	5	0	3.4.1.	
Anchusa	barrelieri	(All.)Witm.	DT	2	8	3	9	4	9	5	0	5.3.	
Anchusa	italica	Retz	DT	2	9	3	7	4	9	5	0	5.3.	
Anchusa	ochroleuca	M.B.	S	6	9	2	9	2	9	7	0	5.3.3.1.	
Anchusa	officinalis	L.	DT	2	8	3	7	5	9	5	0	Indiff.	
Androsace	elongata	L.	NP	3	7	3	7	2	9	5	0	5.3.1.1.	
Androsace	maxima	L.	NP	3	8	4	8	3	7	7	1	3.4.1.1.	
Anemone	nemorosa	L.	S	6	5	6	6	7	3	5	0	8.4.3.	
Anemone	ranunculoides	L.	G	4	6	6	8	7	3	4	0	8.4.	
Anemone	sylvestris	L.	S	6	6	3	8	3	7	7	0	6.1.1.2.	
Anemone	trifolia	L.	Su	10	8	6	8	7	3	4	0	8.4.3.4.	
Anethum	graveolens	L.	I	-1	7	5	5	5	7	3	0	3.3.	
Angelica	archangelica	L.	I	-1	4	9	6	9	7	5	0		
Angelica	palustris	(Bess.)Hoffm.	Sr	8	6	9	6	8	7	5	0	8.5.2.1.	
Angelica	sylvestris	L.	G	4	6	8	6	6	7	5	0	Indiff.	
Antennaria	dioica	(L.)Gaertn.	NP	3	4	4	3	3	8	5	0	5.1.1.	
Anthemis	arvensis	L.	W	1	6	4	4	6	7	5	0	3.4.	
Anthemis	austriaca	Jacq.	NP	3	7	3	8	5	8	6	0	3.3.	
Anthemis	cotula	L.	W	1	7	4	7	5	7	3	0	3.4.	
Anthemis	ruthenica	M.B.	NP	3	7	2	5	2	8	7	0	5.2.2.	
Anthemis	tinctoria	L.	G	4	6	3	6	4	7	5	0	5.3.1.	
Anthericum	liliago	L.	Sr	8	7	3	7	4	6	4	0	5.3.1.1.	
Anthericum	ramosum	L.	G	4	6	3	7	4	7	4	0	6.1.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Anthoxanthum	odoratum	L.	C	5	5	5	5	5	6	3	0	Indiff.	
Anthriscus	caucalis	M.B.	W	1	7	5	6	8	7	5	0	3.5.	
Anthriscus	cerefolium	(L.)Hoffm.	W	1	7	5	6	9	6	6	0	3.5.2.2.	
Anthriscus	nitida	(Wahlb.)Hazsl.	Sr	8	4	6	8	8	4	4	0	8.4.3.1.	
Anthriscus	sylvestris	(L.)Hoffm.	DT	2	6	5	7	8	7	5	0	Indiff.	
Anthyllis	calcicola	Schur	G	4	5	1	9	1	9	3	0	5.3.1.4.	
Anthyllis	macrocephala	Wender	G	4	6	3	8	2	8	5	0	Indiff.	
Anthyllis	vulneraria	L.	G	4	6	4	7	4	8	4	0	5.3.	
Antirrhinum	majus	L.	I	-1	7	5	7	6	7	2	0		
Antirrhinum	orontium	L.	W	1	7	5	5	6	7	4	0		
Apera	interrupta	(L.)P.B.	W	1	7	4	4	1	7	3	0	3.4.2.1.	
Apera	spica-venti	(L.)P.B.	W	1	5	4	5	4	6	4	0	3.4.2.	
Aphanes	arvensis	L.	W	1	6	6	5	5	6	4	0	3.4.2.1.	
Aphanes	microcarpa	(Boiss.)Rothm.	W	1	7	4	4	4	7	2	0	3.4.2.1.	
Apium	graveolens	L.	I	-1	6	8	7	8	9	2	0		
Apium	repens	(Jacq.)Lag.	NP	3	8	10	7	7	6	3	0	1.5.1.3.	
Aquilegia	vulgaris	L.	Sr	8	6	5	8	5	5	4	0	8.4.2.2.	
Arabidopsis	thaliana	(L.)Heynh.	DT	2	6	4	7	4	6	4	0	3.4.	
Arabis	alpina	L.	Sr	8	2	6	9	4	7	3	0	8.4.3.1.	
Arabis	hirsuta ssp. gerardii	(Bess.)Hartm.	G	4	6	8	8	5	8	5	0	5.4.1.	
Arabis	hirsuta ssp. hirsuta	(L.)Scop.	G	4	6	3	8	4	7	3	0	5.3.	
Arabis	hirsuta ssp. sagittata	(Bert.)Rchb. in Sturm	G	4	6	4	8	4	7	4	0	5.3.	
Arabis	recta	Vill.	G	4	7	4	8	4	7	5	0	5.3.1.	
Arabis	turrita	L.	G	4	7	3	7	3	6	4	0	8.4.2.	
Arachis	hypogaea	L.	I	-1									
Arctium	lappa	L.	W	1	5	6	7	9	8	4	0	3.5.1.1.	
Arctium	minus	(Hill)Bernh.	W	1	5	5	7	9	8	5	0	3.5.1.1.	
Arctium	nemorosum ssp. nemor.	Lej. & Court.	DT	2	5	7	6	8	5	4	0	6.2.1.	
Arctium	nemorosum ssp. pubens	(Bab.)Rothm.	DT	2	6	6	6	9	7	4	0	6.2.1.2.	
Arctium	tomentosum	Mill.	W	1	5	5	8	9	8	7	0	3.5.1.1.	
Aremonia	agrimonioides	(L.)DC.	S	6	7	6	8	5	4	4	0	8.4.3.4.	
Arenaria	leptoclados	(Rchb.)Guss.	NP	3	8	2	7	2	9	7	0	5.3.1.	
Arenaria	micradenia	Smim.	S	6	6	3	8	2	9	8	0	5.3.1.1.	
Arenaria	serpyllifolia	L.	NP	3	4	3	7	4	9	5	0	Indiff.	
Aristolochia	clematitis	L.	W	1	7	4	8	7	6	4	0	Indiff.	
Armeria	alpina	(DC.)Willd.	I	-1	2	4	5	1	9	3	0		
Armeria	elongata	(Hoffm.)Koch	Su	10	6	3	6	2	8	3	0	5.2.3.1.	
Armoracia	lapathifolia	Gilib.	I	-1	6	5	6	9	8	3	0	Indiff.	
Armoracia	macrocarpa	(W. & K.)Baumg.	S	6	5	10	7	7	7	1	1.5.1.1.		
Arnica	montana	L.	Sr	8	4	5	4	3	9	4	0	5.4.2.2.	
Arrhenatherum	elatius	(L.)Presl	DT	2	5	5	7	7	8	3	0	5.4.	
Artemisia	abrotanum	L.	I	-1	8	3	7	3	9	6	0		
Artemisia	absinthium	L.	W	1	6	4	7	7	9	7	0	3.5.	
Artemisia	alba	Turra	S	6	9	1	9	2	9	7	0	5.3.1.5.	
Artemisia	annua	L.	W	1	7	4	7	6	8	7	0	3.4.	
Artemisia	austriaca	Jacq.	S	6	9	1	9	1	9	8	0	5.3.1.1.	
Artemisia	campestris	L.	G	4	6	3	6	2	9	5	0	5.3.	
Artemisia	dracunculus	L.	I	-1									
Artemisia	pontica	L.	S	6	8	2	8	2	9	9	0	5.5.2.1.	
Artemisia	santonicum	L.	C	5	7	3	7	4	9	8	5	5.5.2.1.	
Artemisia	scoparia	W. & K.	S	6	6	4	7	2	9	7	0	5.3.1.1.	
Artemisia	vulgaris	L.	W	1	6	5	6	8	7	5	0	3.5.	
Arum	maculatum	L. em. Mill.	G	4	6	6	7	8	3	2	0	8.4.3.	
Arum	orientale	M.B.	G	4	7	6	8	7	3	6	0	8.4.3.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Aruncus	sylvester	Kostel.	S	6	5	7	6	8	4	4	0	8.4.3.1.	
Asarum	europaeum	L.	G	4	5	6	7	7	3	5	0	8.4.3.	
Asclepias	syriaca	L.	AC	-3	7	4	6	4	7	6	0	3.5.2.	
Asparagus	officinalis	L.	G	4	7	3	7	4	8	7	0	5.3.	
Asperugo	procumbens	L.	W	1	6	3	8	8	7	6	0	3.3.3.1.	
Asperula	arvensis	L.	W	1	8	5	9	4	7	3	0	3.4.1.1.	
Asperula	cynanchica ssp. cyn.	L.	G	4	7	3	8	3	8	5	0	5.3.	
Asperula	cyn. ssp. montana	(W. & K.)Simk.	S	6	7	2	8	2	8	5	0	5.3.1.1.	
Asperula	orientalis	Boiss. & Hohen.	I	-1	9	4	9	4	7	5	0	3.4.1.	
Asperula	taurina	L.	Sr	8	8	6	8	6	4	4	0	8.4.3.4.	
Asperula	tinctoria	L.	G	4	6	3	8	3	6	6	0	5.3.	
Asphodelus	albus	Mill.	Sr	8	8	5	4	5	6	2	0	8.4.2.4.	
Asplenium	adiantum-nigrum	L.	S	6	7	4	3	3	6	2	0	5.3.1.3.	
Asplenium	fontanum	(L.)Bernh.	Su	10	7	6	9	7	3	2	0	5.3.1.4.	
Asplenium	ruta-muraria	L.	G	4	5	2	8	2	8	3	0	5.3.1.3.	
Asplenium	septentrionale	(L.)Hoffm.	G	4	5	1	3	2	8	4	0	5.3.1.3.	
Asplenium	trichomanes ssp.t.	L.	G	4	5	3	5	4	5	3	0	5.3.	
Asplenium	t. ssp. quadrivalens	D.C.Meyer	G	4	6	2	8	2	7	4	0	5.3.	
Asplenium	viride	Huds.	S	6	4	6	9	1	4	3	0	5.3.1.3.	
Aster	amellus	L.	G	4	5	4	8	3	7	6	0	5.3.1.	
Aster	ericoides	L.	I	-1									
Aster	x lanceolatus	Willd.	A	-1	7	6	7	8	7	6	0	3.5.	
Aster	linosyris	(L.)Bernh.	G	4	7	3	8	3	8	6	0	5.3.	
Aster	novae-angliae	L.	I	-1	6	7	7	9	7	5	5	3.5.	
Aster	novi-belgii	L.	I	-1	6	6	7	9	9	3	0	3.5.2.	
Aster	oleifolius	(Lam.)Wagen.	Su	10	7	3	8	2	9	7	3	5.5.2.	
Aster	sedifolius ssp. canus	(W. & K.)Merxm.	C	5	8	3	8	2	9	7	3	5.5.2.	
Aster	sedifolius ssp. sedifolius	L.	C	5	8	4	8	3	9	9	3	5.5.2.1.	
Aster	pannonicus	Jacq.	S	6	7	2	8	3	9	9	7	5.5.	
Aster	tradesantii	L.	A	-1	6	7	8	9	7	2	0	3.5.2.	
Aster	x versicolor	Willd.	A	-1									
Astragalus	asper	Wulf.	S	6	7	3	9	2	9	8	0	5.3.1.1.	
Astragalus	austriacus	Jacq.	S	6	8	2	8	1	7	8	0	5.3.1.1.	
Astragalus	cicer	L.	G	4	6	4	7	3	7	6	0	5.3.1.	
Astragalus	contortuplicatus	L.	Sr	8	6	8	6	4	8	6	0	3.2.1.2.	
Astragalus	dasyanthus	Pall.	Sr	8	8	3	8	1	9	8	0	5.2.1.1.	
Astragalus	exscapus	L.	S	6	7	2	9	1	9	6	0	5.3.3.1.	
Astragalus	glycyphyllos	L.	G	4	6	5	7	4	6	4	0	8.4.	
Astragalus	onobrychis	L.	G	4	7	2	9	1	9	6	0	5.3.1.	
Astragalus	sulcatus	L.	Su	10	6	3	8	1	9	4	0	5.3.1.1.	
Astragalus	varius	Gmel.	S	6	8	1	9	1	9	7	0	5.3.3.1.	
Astragalus	vesicarius	L.	S	6	8	1	9	1	9	6	0	5.3.1.4.	
Astrantia	major	L.	S	6	4	6	8	5	6	4	0	8.4.3.	
Asyneuma	canescens	(W. & K.)Gr. & S.	S	6	8	2	8	1	8	5	0	5.3.1.	
Athyrium	filix-femina	(L.)Roth	G	4	5	7	6	6	4	3	0	Indiff.	
Atriplex	hastata	auct.	W	1	6	6	6	6	9	5	2	3.3.	
Atriplex	hortensis	L.	I	-1	6	5	7	8	7	5	0	3.3.	
Atriplex	litoralis	L.	NP	3	7	5	7	9	9	8	7	5.5.1.	
Atriplex	nitens	Schkuhr.	W	1	7	5	7	6	9	3	0	3.3.	
Atriplex	oblongifolia	W. & K.	W	1	7	4	7	6	9	6	1	3.3.	
Atriplex	patula	Sm.	W	1	5	5	7	4	7	4	1	Indiff.	
Atriplex	rosea	L.	W	1	6	5	7	7	9	5	0	3.3.3.	
Atriplex	tatarica	L.	DT	2	7	4	8	6	9	8	1	3.3.	
Atropa	bella-donna	L.	DT	2	6	6	6	8	6	2	0	6.2.1.2.	
Avena	fatua	L.	W	1	7	5	7	4	7	6	0	3.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Avena	nuda	Hoejér	A	-1									
Avena	sativa	L.	I	-1									
Avenella	flexuosa	(L.)Drejer	S	6	4	5	2	3	5	2	0	8.3.1.	
Avenula	compressa	(Heuff.)Holub	S	6	7	3	8	3	8	6	0	5.3.1.6.	
Avenula	praeusta	(Rchb.)Holub	G	4	4	4	5	2	8	4	0	5.1.1.	
Avenula	pratensis	(L.)Dum.	G	4	5	3	6	2	7	4	0	5.3.	
Avenula	pubescens	(Darre)Dum.	G	4	6	4	6	4	6	3	0	5.4.2.	
Azolla	caroliniana	Willd.	A	-1	7	11	6	7	7	2	0	1.1.1.1.	
Baldingera	arundinacea	(L.)Dum.	(L.)Dum.									1.5.1.	
Ballota	nigra	L.	W	1	6	5	7	8	6	5	0	3.5.1.1.	
Barbarea	stricta	Andrz. ex Bess.	W	1	6	7	7	6	8	7	0	3.5.2.	
Barbarea	vulgaris	R.Br.	W	1	6	6	6	6	8	3	0	Indiff.	
Bassia	sedoides	(Pall.)Aschers.	NP	3	6	3	8	2	9	8	2	5.5.1.1.	
Batrachium	aquatile	(L.)Dum.	NP	3	5	11	5	6	7	2	0	2.2.1.	
Batrachium	baudotii	(Godr.)F.Schlz.	NP	3	7	11	8	4	7	6	6	2.2.1.1.	
Batrachium	circinatum	(Sibth.)Spach.	NP	3	6	11	7	5	7	5	0	1.3.1.1.	
Batrachium	fluitans	(Lam.)Wimm.	NP	3	6	11	7	8	8	2	0	1.3.1.3.	
Batrachium	radians	(Rev.)Rev.	NP	3	7	11	7	6	7	6	1	2.2.1.1.	
Batrachium	rhipiphyllum	(Bast.)Dum.	NP	3	6	11	7	6	7	6	2	2.2.1.1.	
Batrachium	rionii	(Lagger)Nym.	NP	3	7	11	7	6	7	7	0	2.2.1.1.	
Batrachium	trichophyllum	(Chaix)Bosch	NP	3	5	11	6	6	7	3	0	1.3.	
Beckmannia	eruciformis	(L.)Host	C	5	7	8	9	3	7	8	6	5.5.1.4.	
Bellis	perennis	L.	DT	2	5	5	5	5	8	2	0	5.4.2.	
Berberis	vulgaris	L.	G	4	7	4	8	3	6	4	0	8.6.1.	
Berteroa	incana	(L.)DC.	W	1	6	3	7	4	9	7	0	Indiff.	
Beta	vulgaris	L.	I	-1	6	6	7	9	9	4	5		
Betonica	officinalis	L.	G	4	6	4	6	3	6	5	0	8.4.2.	
Betula	pendula	Roth.	C	5	4	5	4	4	7	3	0	8.3.	
Betula	pubescens	Ehrh.	Su	10	3	9	3	3	7	4	0	8.5.2.1.	
Bidens	cernua	L.	W	1	5	9	5	9	8	5	0	3.2.1.1.	
Bidens	tripartita	L.	W	1	5	8	6	8	8	5	0	3.2.	
Bifora	radians	M.B.	W	1	7	3	8	5	7	4	0	3.3.2.2.	
Biota	orientalis	(L.)Endl.	I	-1									
Biscutella	laevigata	L.	S	6	7	2	9	1	9	4	0	5.3.1.4.	
Blackstonia	serotina	(Koch)Beck	G	4	7	7	7	4	8	3	0	3.1.1.	
Blechnum	spicant	(L.)Roth	Sr	8	3	6	3	3	3	2	0	7.3.1.2.	
Blysmus	compressus	(L.)Panzer	G	4	5	9	6	3	8	5	0	3.8.1.	
Bolboschoenus	maritimus	(L.)Palla	C	5	6	10	8	5	8	7	3	2.10.1.1.	
Botriochloa	ischaemum	(L.)Keng	DT	2	7	3	8	3	9	6	0	5.3.	
Botrychium	lunaria	(L.)Sw.	Sr	8	4	4	5	2	6	3	0	5.1.1.	
Botrychium	matricariifolium	(Retz)A.Br.	Sr	8	3	4	3	1	7	4	0	5.1.1.	
Botrychium	multifidum	(Gmel.)Rupr.	Sr	8	4	6	4	2	6	4	0	5.1.1.	
Botrychium	virginianum	(L.)Sw.	Su	10	3	5	4	1	6	4	0	8.4.2.3.	
Brachypodium	pinnatum	(L.)P.B.	C	5	5	4	7	4	6	5	0	5.3.	
Brachypodium	sylvaticum	(Huds.)R. & Sch.	G	4	5	5	6	5	5	5	0	Indiff.	
Brassica	elongata	Ehrh.	S	6	8	3	9	1	9	8	0	5.3.1.7.	
Brassica	x juncea	(L.)Czern.	W	1	7	4	6	6	8	6	0	3.3.	
Brassica	x napus	(L.)Metzger	A	-1									
Brassica	nigra	(L.)Koch	A	-1	7	8	8	7	8	5	0	3.3.	
Brassica	oleracea	L.	I	-1	7	5	6	8	8	2	3		
Briza	media	L.	G	4	5	6	5	3	8	3	0	5.4.	
Bromus	arvensis	L.	W	1	6	4	8	5	7	4	0	Indiff.	
Bromus	benekenii	Trimen	G	4	5	5	7	5	5	4	0	8.4.3.	
Bromus	commutatus	Schrad.	DT	2	7	4	7	3	6	4	0	3.3.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Bromus	erectus	Huds.	C	5	6	3	8	3	8	2	0	5.3.
Bromus	hordeaceus	L.	DT	2	6	5	6	5	7	3	0	Indiff.
Bromus	inermis	Leyss.	C	5	6	4	8	5	8	7	0	5.3.
Bromus	japonicus	Thunb.	DT	2	8	3	8	5	8	7	0	5.3.1.
Bromus	mollis	L.	DT	2	6	5	6	5	7	3	0	Indiff.
Bromus	pannonicus	Kumm. & Sendt.	C	5	8	3	8	3	8	4	0	5.3.1.4.
Bromus	racemosus	L.	DT	2	6	8	5	5	6	2	0	5.3.1.5.
Bromus	ramosus	Huds.	G	4	6	5	7	6	6	2	0	8.4.
Bromus	rigidus	Roth. ex Roem.	G	4	8	2	8	3	8	6	0	5.3.1.1.
Bromus	secalinus	L.	DT	2	7	4	6	5	6	3	0	3.4.2.
Bromus	squarrosus	L.	NP	3	8	2	7	3	9	7	0	5.3.3.2.
Bromus	sterilis	L.	RC	-2	7	4	6	5	7	4	0	Indiff.
Bromus	tectorum	L.	DT	2	6	3	8	4	8	7	0	Indiff.
Broussonetia	papyrifera	(L.)L'Hérit.	I	-1								
Bryonia	alba	L.	W	1	6	5	7	6	7	5	0	3.5.1.
Bryonia	dioica	L.	W	1	7	6	8	6	8	3	0	3.5.1.
Bulbocodium	versicolor	(Ker-Gawl.)Spr.	Su	10	6	3	7	3	6	7	0	8.4.2.3.
Buglossoides	arvensis	Johnston	NP	3	5	2	7	5	7	5	0	3.4.
Buglossoides	purpureo-coerulea	L.	S	6	7	4	8	4	5	4	0	8.4.2.
Bunias	orientalis	L.	W	1	6	4	7	5	7	5	0	3.5.1.1.
Buphtalmum	salicifolium	L.	G	4	5	4	8	3	7	4	0	Indiff.
Bupleurum	affine	Sadler	S	6	7	2	9	3	7	6	0	5.3.1.1.
Bupleurum	falcatum	L.	G	4	6	3	8	3	6	6	0	6.1.1.2.
Bupleurum	longifolium	L.	G	4	5	4	9	5	5	6	0	8.4.2.
Bupleurum	pachnospermum	Panc.	S	6	7	3	8	4	7	7	0	5.3.1.1.
Bupleurum	praealtum	Nath.	G	4	8	4	8	3	6	7	0	8.4.2.3.
Bupleurum	rotundifolium	L.	DT	2	7	3	8	4	8	4	0	3.4.1.
Bupleurum	tenuissimum	L.	G	4	7	7	8	3	9	4	3	5.5.1.
Butomus	umbellatus	L.	G	4	6	10	6	7	6	5	0	1.5.1.1.
Buxus	sempervirens	L.	I	-1	8	4	8	4	5	2	0	
Calamagrostis	arundinacea	(L.)Roth	G	4	5	5	4	5	6	4	0	8.3.1.
Calamagrostis	canescens	(Weber)Roth	C	5	4	10	5	5	6	5	0	8.5.2.1.
Calamagrostis	epigeios	(L.)Roth	RC	-2	5	5	7	7	7	7	0	Indiff.
Calamagrostis	pseudophragmites	(Hall.)Koel.	G	4	6	9	7	3	8	6	0	8.5.2.1.
Calamagrostis	stricta	(Timm.)P.B.	Cu	9	4	9	6	2	9	5	0	1.7.1.2.
Calamagrostis	varia	(Schrad.)Host	Cr	7	3	5	8	3	7	4	0	8.4.2.2.
Calamintha	menthifolia	Host	G	4	6	5	7	4	5	3	0	8.4.
Calamintha	subisodonta	Borb.	Gr	6	6	5	7	4	5	3	0	8.4.3.
Calamintha	thymifolia	(Scop.)Rchb.	Su	10	9	1	9	1	9	4	0	5.3.1.3.
Caldesia	parnassifolia	(Bassi)Parl.	Su	10	7	10	5	6	7	4	0	1.5.1.1.
Calendula	officinalis	L.	I	-1	8	5	6	6	7	3	0	3.3.
Calepina	irregularis	(Asso)Thell.	W	1	9	3	8	4	8	3	1	3.4.
Callitriche	cophocarpa	Sendtn.	NP	3	5	10	8	5	8	4	0	1.3.1.
Callitriche	palustris	L. em. Druce	NP	3	4	11	5	4	6	4	0	1.3.1.
Calluna	vulgaris	(L.)Hull.	S	6	3	5	1	1	8	3	0	8.3.1.2.
Caltha	palustris ssp. pal.	L.	G	4	5	9	5	5	7	4	0	Indiff.
Caltha	pal. ssp. laeata	(Sch.N. & Ky)Hegi	G	4	4	9	5	3	8	4	0	1.7.
Calystegia	sepium	(L.)R.Br.	DT	2	6	9	7	8	8	5	0	3.5.2.
Camelina	allyssum	(Mill.)Thell.	W	1	6	5	6	4	7	6	0	3.4.3.
Camelina	microcarpa	Andrz. ex DC.	W	1	6	4	8	4	7	7	0	3.4.
Camelina	rumelica	Velen.	W	1	6	4	8	4	7	8	0	3.3.2.3.
Camelina	sativa	(L.)Cr.	W	1	7	4	7	6	7	6	0	3.4.
Campanula	bononiensis	L.	G	4	6	3	8	2	7	6	0	8.4.2.
Campanula	carpatica	Jacq.	I	-1								

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Campanula	cervicaria	L.	G	4	6	4	8	4	6	6	0	8.4.2.	
Campanula	glomerata	L.	G	4	6	5	7	5	7	7	0	5.3.	
Campanula	latifolia	L.	Su	10	5	6	8	8	4	5	0	8.4.3.1.	
Campanula	macrostachya	Kit. ex Willd.	Sr	8	7	4	7	3	8	8	0	5.3.1.6.	
Campanula	media	L.	I	-1									
Campanula	patula	L.	G	4	5	6	6	4	7	4	0	5.4.	
Campanula	persicifolia	L.	G	4	6	5	7	4	5	4	0	8.4.	
Campanula	rapunculoides	L.	DT	2	6	5	7	4	6	4	0	8.4.	
Campanula	rapunculus	L.	G	4	7	4	6	4	7	2	0	8.4.2.	
Campanula	rotundifolia	L.	G	4	5	4	7	2	6	3	0	Indiff.	
Campanula	sibirica	L.	G	4	7	3	8	3	8	7	0	5.3.1.	
Campanula	trachelium	L.	G	4	5	6	7	8	4	3	0	8.4.3.	
Camphorosma	annua	Pall.	NP	3	8	2	8	1	9	9	9	5.5.1.	
Cannabis	sativa	L.	A	-1	7	6	6	7	7	7	0	3.6.	
Capsella	bursa-pastoris	(L.)Medik.	W	1	6	5	0	7	8	4	0	Indiff.	
Capsicum	annuum	L.	I	-1									
Cardamine	amara	L.	G	4	5	9	6	4	7	4	0	1.6.1.	
Cardamine	flexuosa	With.	DT	2	5	8	5	5	6	2	0	1.6.1.	
Cardamine	hirsuta	L.	DT	2	6	5	5	7	6	3	0	3.5.2.	
Cardamine	impatiens	L.	G	4	5	7	7	8	5	4	0	8.4.3.	
Cardamine	matthioli	Moretti	G	4	4	9	3	2	7	5	0	5.4.1.	
Cardamine	parviflora	L.	NP	3	6	8	8	6	8	5	3	5.5.1.4.	
Cardamine	pratensis ssp. dentata	(Schult.)Celak.	G	4	4	7	6	5	6	4	0	8.1.	
Cardamine	pratensis ssp. pratensis	L.	G	4	5	8	6	6	7	4	0	5.4.	
Cardamine	trifolia	L.	Su	10	4	6	8	7	3	4	0	8.4.3.4.	
Cardaminopsis	arenosa	(L.)Hay.	NP	3	6	4	6	2	9	4	0	Indiff.	
Cardaminopsis	petraea	(L.)Hit.	Sr	8	3	3	9	1	9	2	0	5.3.1.4.	
Cardaria	draba	(L.)Desv.	W	1	7	3	7	4	8	7	1	3.3.3.	
Carduus	acanthoides	L.	W	1	6	3	6	8	9	6	0	3.5.4.	
Carduus	collinus	W. & K.	S	6	8	4	7	5	8	8	0	5.3.1.	
Carduus	crispus	L.	DT	2	5	7	7	9	7	4	0	3.5.2.	
Carduus	glaucus	Holub	Sr	8	4	4	9	2	7	5	0	5.3.1.4.	
Carduus	hamulosus	Ehrh.	S	6	8	3	8	2	9	7	0	5.3.1.1.	
Carduus	nutans	L.	DT	2	7	3	8	6	8	5	0	Indiff.	
Carex	acutiformis	Ehrh.	C	5	5	9	7	5	7	3	0	Indiff.	
Carex	alba	Scop.	S	6	5	5	8	2	5	7	0	8.4.2.2.	
Carex	appropinquata	Schuhmach.	C	5	5	9	8	4	8	5	0	1.5.1.4.	
Carex	bohemica	Schreb.	Sr	8	5	9	8	4	8	5	0	3.1.1.1.	
Carex	brevicollis	DC.	S	6	6	5	7	6	6	8	0	8.4.2.3.	
Carex	brizoides	Jusl.	C	5	5	7	5	4	6	4	0	8.4.3.	
Carex	buekii	Wimm.	S	6	5	9	6	4	8	6	0	1.5.1.3.	
Carex	caespitosa	L.	Sr	8	5	8	5	4	8	3	0	1.7.2.1.	
Carex	canescens	L.	Sr	8	4	9	3	2	7	4	0	1.7.1.2.	
Carex	caryophyllea	Latour	DT	2	5	5	5	2	8	3	0	Indiff.	
Carex	cuprina	(Sándor)Nendtw.	G	4	6	8	6	5	8	5	0	Indiff.	
Carex	davalliana	Sm.	S	6	5	9	8	2	9	4	0	1.7.2.1.	
Carex	diandra	Schrank	S	6	4	9	6	3	8	7	0	1.5.1.4.	
Carex	digitata	L.	G	4	5	6	6	4	3	4	0	8.4.3.	
Carex	distans	L.	C	5	7	7	8	3	9	3	5	Indiff.	
Carex	disticha	Huds.	G	4	5	9	7	5	8	4	0	1.5.1.4.	
Carex	divisa	Huds.	G	4	6	8	8	3	8	6	2	5.5.1.	
Carex	divulsa	Stok. ex With.	DT	2	6	5	5	6	6	3	0	Indiff.	
Carex	elata	All.	C	5	5	10	6	4	8	2	0	1.5.1.4.	
Carex	elongata	L.	S	6	5	9	6	6	4	3	0	8.2.1.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Carex	ericetorum	Poll.	G	4	5	3	5	2	8	7	0	5.2.2.	
Carex	flacca	Schreb.	G	4	5	7	8	3	7	3	1	Indiff.	
Carex	flava	L.	S	6	5	9	8	4	8	2	0	1.7.2.1.	
Carex	fritschii	Waisb.	S.	6	7	4	4	4	6	4	0	8.3.1.2.	
Carex	gracilis	Curtis	C	5	5	9	6	4	7	7	0	1.5.1.4.	
Carex	hallerana	Asso	S	6	8	3	9	3	7	2	0	8.4.2.2.	
Carex	hartmannii	Cajander	Su	10	4	8	5	5	8	7	0	1.5.1.4.	
Carex	hirta	L.	DT	2	6	7	6	5	7	3	0	Indiff.	
Carex	hordeistichos	Vill.	G	4	7	8	7	4	9	6	2	5.5.1.3.	
Carex	hostiana	DC.	S	6	5	9	7	2	8	2	0	1.7.2.1.	
Carex	humilis	Leyss.	C	5	6	3	9	3	7	5	0	5.3.1.	
Carex	lasiocarpa	Ehrh.	Cu	9	4	9	4	3	9	3	0	1.8.1.1.	
Carex	lepidocarpa	Tausch.	G	4	5	9	8	2	9	2	0	1.7.2.	
Carex	leporina	L.	DT	2	4	7	5	4	7	3	0	5.4.	
Carex	limosa	L.	Su	10	3	9	2	2	9	3	0	1.7.1.1.	
Carex	liparicarpos	Gaudin	G	4	8	2	8	2	9	7	0	5.3.3.	
Carex	melanostachya	Willd.	G	4	6	9	7	4	7	7	1	1.5.1.	
Carex	melchii	Host	G	4	7	4	7	4	7	5	0	8.4.2.	
Carex	montana	L.	S	6	5	5	6	3	5	4	0	8.4.2.4.	
Carex	nigra	(L.)Reichb.	G	4	5	9	6	2	8	3	0	1.7.1.	
Carex	oederi	Retz	G	4	5	9	7	2	8	3	2	1.7.	
Carex	pairae	F. Schultz	DT	2	5	5	6	4	6	3	0	Indiff.	
Carex	pallescent	L.	DT	2	5	6	5	4	7	3	0	Indiff.	
Carex	panicea	L.	G	4	5	8	6	3	8	3	0	5.4.1.	
Carex	paniculata	Jusl. ex L.	C	5	5	9	8	4	7	3	0	1.5.1.	
Carex	pendula	Huds.	S	6	6	8	6	5	4	2	0	8.4.3.1.	
Carex	pilosa	Scop.	C	5	6	5	6	5	4	5	0	8.4.3.	
Carex	pilulifera	L.	Sr	8	5	4	3	5	6	2	0	8.3.1.2.	
Carex	praecox	Schreb.	G	4	6	3	7	3	9	6	1	Indiff.	
Carex	pseudocyperus	L.	S	6	6	10	6	5	7	3	0	1.5.1.4.	
Carex	remota	Jusl. ex L.	C	5	5	8	6	6	4	3	0	8.4.3.3.	
Carex	repens	Bell	Su	10	5	9	7	4	7	6	0	1.5.1.4.	
Carex	riparia	Curt.	C	5	7	10	7	4	7	3	0	1.5.1.4.	
Carex	rostrata	Stok. in With.	C	5	4	10	3	3	9	4	0	1.7.1.	
Carex	secalina	Wahlbg.	G	4	7	7	7	4	8	8	2	Indiff.	
Carex	serotina	Merat.	G	4	5	8	7	4	8	6	1	5.4.1.	
Carex	spicata	Huds.	DT	2	5	5	6	4	7	3	0	Indiff.	
Carex	stellulata	Good.	S	6	5	9	3	2	8	3	0	1.7.1.2.	
Carex	stenophylla	Wahlbg.	G	4	6	3	7	3	9	5	1	5.5.2.	
Carex	strigosa	Huds.	S	6	6	7	5	6	3	1	0	8.4.3.3.	
Carex	supina	Wahlbg.	G	4	6	2	7	2	7	7	0	5.3.1.	
Carex	sylvatica	Huds.	G	4	5	6	7	5	3	3	0	8.4.3.	
Carex	tomentosa	L.	G	4	5	6	8	5	6	5	0	Indiff.	
Carex	umbrosa	Host	Gr	6	5	5	5	4	5	4	0	8.3.1.2.	
Carex	vesicaria	L.	C	5	5	9	6	5	7	3	0	1.5.1.4.	
Carex	vilpina	L.	DT	2	5	8	6	5	9	5	0	Indiff.	
Carlina	acaulis	L.	S	6	5	5	6	2	7	4	0	5.1.1.3.	
Carlina	intermedia	Schur	DT	2	6	4	7	3	7	3	0	5.3.	
Carlina	vulgaris ssp. longifolia	(Rchb.)Nym.	G	4	5	4	6	3	6	4	0	8.3.1.	
Carlina	vulgaris ssp. vulgaris	L.	DT	2	6	4	8	3	7	3	0	Indiff.	
Carpesium	abrotanoides	L.	Gr	6	8	7	7	4	5	3	0	8.4.3.	
Carpesium	cernuum	L.	DT	2	7	7	7	7	5	4	0	3.5.2.	
Carpinus	betulus	L.	C	5	6	6	6	5	4	4	0	8.4.3.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Carpinus	orientalis	Mill.	Su	10	9	4	8	4	6	6	0	8.4.2.2.	
Carthamus	lanatus	L.	DT	2	8	3	8	4	8	5	0	5.3.1.1.	
Carthamus	tinctorius	L.	I	-1									
Carum	carvi	L.	DT	2	5	7	6	6	8	5	1	5.4.	
Carya	alba	(L.)C.Koch	I	-1									
Castanea	sativa	Mill.	S	6	8	5	4	4	5	2	0	8.3.1.	
Catabrosa	aquatica	(L.)P.B.	G	4	5	9	7	8	8	5	1	1.5.1.3.	
Catalpa	bignonioides	Walt.	I	-1									
Caucalis	latifolia	(L.)L.	W	1	8	4	9	4	7	6	0	3.4.1.1.	
Caucalis	platycarpus	L.	W	1	6	4	9	4	6	5	0	3.4.1.1.	
Celosia	argentea	L.	I	-1									
Celtis	australis	L.	I	-1									
Celtis	occidentalis	L.	I	-1									
Cenchrus	incertus	M.A.Curtis	W	1	8	2	8	2	9	3	0	3.5.4.1.	
Centaurea	arenaria	MB. ex Willd.	G	4	8	1	7	1	9	4	0	5.3.3.	
Centaurea	banatica	Roch. ex Rchb.	G	4	7	5	6	4	7	5	0	5.4.	
Centaurea	calcitrapa	L.	W	1	8	4	6	6	9	6	0	3.5.4.	
Centaurea	cyanus	L.	W	1	7	4	6	7	7	5	0	4.2.	
Centaurea	diffusa	Lam.	A	-1	7	3	7	4	9	6	0	3.5.4.	
Centaurea	fritschii	Hay.	S	6	5	6	4	4	6	2	0	8.3.1.2.	
Centaurea	indurata	Janka	G	4	7	4	6	4	7	8	0	8.4.2.	
Centaurea	jacea	L.	G	4	5	5	6	4	8	3	0	5.4.	
Centaurea	micranthos	S.G.Gmel.	DT	2	7	2	8	1	9	7	0	Indiff.	
Centaurea	mollis	W. & K. ex Bess.	Sr	8	4	6	7	6	5	5	0	8.4.3.1.	
Centaurea	nigrescens	Willd.	G	4	6	6	6	8	3	0	1	7.1.	
Centaurea	pannonica	(Heuff.)Simk.	DT	2	7	5	7	4	7	6	1	Indiff.	
Centaurea	pseudo-phrygia	C.A.Mey.	G	4	4	6	5	4	7	5	0	5.4.2.	
Centaurea	rhenana	Bor.	G	4	7	2	8	3	8	4	0	5.3.	
Centaurea	sadleriana	Janka	G	4	8	3	7	2	8	6	0	5.3.1.	
Centaurea	salonitana	Vis.	A	-1									
Centaurea	scabiosa	L.	G	4	5	3	8	3	7	2	0	Indiff.	
Centaurea	solstitialis	L.	W	1	8	4	6	6	9	4	0	3.3.2.	
Centaurea	spinulosa	Roch. ex Spr.	DT	2	7	2	8	3	8	3	0	5.4.	
Centaurea	stenolepis	Kern.	G	4	6	5	4	3	7	5	0	8.3.1.	
Centaurea	triumfetti	All.	S	6	7	2	8	1	9	5	0	5.3.1.	
Centaurea	vochinensis	Bern. ex Rchb.	G	4	6	6	6	4	8	5	0	5.4.	
Centaurium	erythraea	Rafn.	G	4	6	5	6	5	8	5	0	Indiff.	
Centaurium	pulchellum	(Sw.)Druce	DT	2	6	7	8	4	9	7	1	Indiff.	
Centaurium	uliginosum	(W. & K.)Beck	G	4	7	6	7	2	8	6	0	5.4.1.	
Centunculus	minimus	L.	NP	3	6	6	4	3	7	3	0	3.1.1.1.	
Cephalanthera	damasonium	(Mill.)Druce	G	4	6	4	7	4	4	2	0	8.4.	
Cephalanthera	longifolia	(Huds.)Fritsch	G	4	5	4	6	4	5	3	0	8.4.	
Cephalanthera	rubra	(L.)Rich.	G	4	5	3	8	3	4	4	0	8.4.2.	
Cephalaria	pilosa	(L.)Gren. & Gord.	DT	2	7	6	7	6	7	5	0	3.5.2.	
Cephalaria	transsylvanica	(L.)Schrader	DT	2	8	3	8	3	9	3	0	3.3.2.	
Cerastium	arvense	L.	G	4	6	2	6	4	8	5	0	5.3.	
Cerastium	brachypetalum	Desp. ex. Pers.	NP	3	7	3	7	2	9	4	0	5.2.	
Cerastium	dubium	(Bast.)Guepin	NP	3	8	5	8	1	9	6	3	5.5.	
Cerastium	fontanum	Baumg.	DT	2	4	5	6	5	7	4	0	Indiff.	
Cerastium	glomeratum	Thuill.	G	4	6	5	5	5	7	3	0	5.3.1.	
Cerastium	pumilum	Curt.	NP	3	7	2	8	2	8	4	1	5.3.1.	
Cerastium	semidecandrum	L.	NP	3	7	2	6	2	9	3	0	Indiff.	
Cerastium	sylvaticum	W. & K.	G	4	7	7	6	4	4	5	0	8.4.3.	
Cerastium	subtetrandrum	(Lange)Murb.	S	6	6	6	8	2	9	5	3	5.5.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Cerasus	avium	(L.)Mönch	S	6	6	6	7	5	4	4	0	8.4.3.2.	
Cerasus	fruticosa	Pall.	G	4	7	3	8	4	8	8	0	8.6.1.	
Cerasus	mahaleb	(L.)Mill.	C	5	5	3	8	2	7	8	0	8.4.2.	
Cerasus	vulgaris	Mill.	I	-1									
Ceratocephalus	testiculatus	(Cr.)Roth	NP	3	9	2	8	2	9	8	0	5.2.1.2.	
Ceratophyllum	demersum	L.	C	5	7	12	8	8	6	4	0	1.3.1.	
Ceratophyllum	submersum	L.	C	5	8	12	8	7	5	5	0	1.3.1.	
Ceratostigma	plumbaginoides	Bunge	I	-1									
Cercis	siliquastrum	L.	I	-1									
Cerinth	minor	L.	W	1	8	4	7	4	8	5	0	3.4.	
Ceterach	javorkaeum	(Vida)Soó	S	6	9	2	8	2	9	3	0	5.3.1.	
Ceterach	officinarium	DC.	S	6	9	2	8	2	9	2	0	5.3.1.	
Chaenorhinum	minus	DC.	W	1	6	5	8	5	8	4	0	3.7.1.	
Chaerophyllum	aromaticum	L.	G	4	5	7	6	8	6	5	0	8.4.3.	
Chaerophyllum	aureum	L.	Gr	6	7	6	8	8	6	4	0	8.4.	
Chaerophyllum	bulbosum	L.	W	1	6	7	8	8	7	5	0	3.5.2.	
Chaerophyllum	hirsutum	L.	Gr	6	3	8	6	7	6	4	0	5.4.1.	
Chaerophyllum	temulum	L.	DT	2	5	5	5	7	5	3	0	3.5.3.1.	
Chamaecytisus	albus	(Jacq.)Rothm.	G	4	8	3	9	1	8	7	0	5.3.1.	
Chamaecytisus	austriacus	(L.)Link	G	4	8	3	9	1	8	8	0	5.3.1.	
Chamaecytisus	ciliatus	(Wahlbg.)Rothm.	G	4	5	1	9	1	9	7	0	5.3.1.3.	
Chamaecytisus	heuffelii	(Wierzb.)Rothm.	Gu	8	8	3	6	2	7	6	0	8.3.1.1.	
Chamaecytisus	hirsutus ssp. hirsutus	(L.)Link	G	4	6	4	5	2	7	7	0	8.3.1.	
Chamaecytisus	hirs. ssp. leucotrichus	(Schur.)A. & D. Löve	G	4	7	3	8	2	8	7	0	5.3.1.	
Chamaecytisus	ratisbonensis	(Schaeff.)Roth	G	4	7	2	8	1	7	6	0	5.3.1.	
Chamaecytisus	sup. ssp. pseudo-rochelii	(Sink.)A. & D. Löve	G	4	7	4	7	2	7	6	0	8.4.2.	
Chamaecytisus	supinus ssp. supinus	(L.)Link	G	4	7	4	6	1	7	4	0	5.4.2.	
Chamaenerion	angustifolium	(L.)Scop.	DT	2	4	5	5	9	8	5	0	6.2.1.	
Chamaenerion	angustissimum	(Gau.)Sosn.	NP	3	6	4	8	1	9	5	0		
Chamaespartium	sagittale	(L.)Gibbs	S	6	5	4	4	2	7	5	0	5.1.2.1.	
Cheilanthes	marantae	(L.)Dom.	Su	10	9	1	7	1	9	3	0	5.3.1.3.	
Chelidonium	majus	L.	W	1	6	5	7	9	6	5	0	3.5.3.1.	
Chenopodium	album	L.	RC	-2	6	4	6	7	7	5	0	3.3.	
Chenopodium	ambrosioides	L.	W	1	6	5	6	7	8	5	0	3.3.	
Chenopodium	aristatum	L.	W	1	6	3	8	4	9	6	0	3.3.2.4.	
Chenopodium	bonus-henricus	L.	W	1	5	5	6	9	8	2	0	3.3.	
Chenopodium	botryodes	Sm.	DT	2	8	6	8	9	9	7	2	5.5.1.	
Chenopodium	botrys	L.	W	1	9	4	6	6	8	2	0	3.3.	
Chenopodium	ficifolium	Sm.	W	1	7	6	6	7	7	7	0	3.2.	
Chenopodium	foliosum	(Mönch)Asch.	W	1	6	5	6	8	8	8	0	3.3.	
Chenopodium	glaucum	L.	DT	2	7	6	8	9	8	7	3	Indiff.	
Chenopodium	hybridum	L.	W	1	6	6	8	8	7	7	0	3.3.	
Chenopodium	multifidum	L.	AC	-3									
Chenopodium	murale	L.	W	1	7	5	8	9	8	6	0	3.3.	
Chenopodium	opulifolium	Schrad.	W	1	6	5	6	6	8	6	0	3.3.	
Chenopodium	polyspermum	L.	RC	-2	6	6	8	8	6	4	0	3.3.1.	
Chenopodium	pumilio	R.Br.	A	-1									
Chenopodium	rubrum	L.	DT	2	7	6	8	9	8	5	1	3.2.	
Chenopodium	schraderanum	Schult.	A	-1	8	6	7	7	8	6	0	3.3.	
Chenopodium	strictum	Roth.	A	-1	6	6	7	6	7	5	0	3.4.	
Chenopodium	suecicum	J.Murr.	A	-1	6	5	7	8	8	4	0	3.3.	
Chenopodium	urbicum	L.	W	1	7	4	7	7	7	7	1	3.1.1.	
Chenopodium	vulvaria	L.	W	1	7	4	7	9	7	4	0	3.7.	
Chimaphila	umbellata	(L.)Barton	Sr	8	4	5	4	3	4	6	0	8.3.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Chlorocyperus	glaber	(L.)Palla	Cu	9	8	9	6	4	9	5	0	3.1.1.1.	
Chlorocyperus	glomeratus	(Torn.)Palla	Sr	8	7	9	6	6	8	4	0	3.1.1.1.	
Chlorocyperus	longus	(L.)Palla	S	8	7	9	6	6	8	4	0	3.1.1.1.	
Chondrilla	juncea	L.	DT	2	7	2	8	5	8	5	0	Indiff.	
Chrysopogon	gryllus	(Torn.)Trin.	C	5	8	3	7	2	9	6	0	5.3.	
Chrysosplenium	alternifolium	L.	S	6	5	7	7	4	4	4	0	8.4.3.3.	
Cichorium	intybus	L.	W	1	6	6	8	5	8	5	0	Indiff.	
Cicuta	virosa	L.	S	6	5	9	6	7	7	7	0	1.5.1.4.	
Cimicifuga	europaea	Schipcz.	Sr	8	5	5	8	7	5	4	0	8.4.3.1.	
Circaea	alpina	L.	Su	10	4	7	5	5	6	3	0	8.4.3.3.	
Circaea	x intermedia	Ehrh.	S	6	5	6	7	6	4	2	0	8.4.3.3.	
Circaea	lutetiana	L.	G	4	5	6	7	7	4	3	0	8.4.3.	
Cirsium	arvense	(L.)Scop.	RC	-2	5	4	6	7	8	5	0	Indiff.	
Cirsium	brachycephalum	Jur.	S	6	7	9	7	4	8	7	5	5.5.1.4.	
Cirsium	canum	(L.)All.	G	4	6	8	6	5	8	7	0	5.4.	
Cirsium	eriphorum	(L.)Scop.	W	1	6	4	8	5	9	3	0	3.5.4.	
Cirsium	eristihales	(Jacq.)Scop.	S	6	5	6	8	5	6	3	0	5.4.1.2.	
Cirsium	furiens	Gr. & Sch.	W	1	7	4	7	7	9	8	0	3.5.4.1.	
Cirsium	oleraceum	(L.)Scop.	G	4	5	7	8	5	6	3	0	5.4.1.	
Cirsium	palustre	(L.)Scop.	G	4	5	8	5	3	7	3	0	Indiff.	
Cirsium	pannonicum	(L.f.)Link	G	4	7	4	7	3	8	7	0	5.3.	
Cirsium	rivulare	(Jacq.)All.	G	4	5	8	8	4	9	4	0	5.4.	
Cirsium	vulgare	(Savi)Ten.	W	1	6	5	7	8	8	3	0	3.5.	
Citrullus	colocynthis	(L.)Schrad.	I	-1									
Citrullus	lanatus	(Thunb.)Mans.	I	-1									
Cladium	mariscus	(L.)Pohl	C	5	6	9	9	3	9	3	0	1.5.1.1.	
Cleistogenes	serotina	(L.)Keng	S	6	8	2	8	2	9	6	0	5.3.1.1.	
Clematis	alpina	(A.)Mill.	Sr	8	3	6	8	5	4	7	0	8.4.3.1.	
Clematis	integrifolia	L.	G	4	6	6	8	5	8	6	0	5.4.	
Clematis	recta	L.	G	4	7	3	8	3	6	5	0	6.1.1.2.	
Clematis	vitalba	L.	DT	2	7	5	6	7	7	3	0	8.4.	
Clematis	viticella	L.	A	-1	8	4	7	6	8	3	0	3.3.	
Clinopodium	vulgare	L.	G	4	6	5	7	3	6	3	0	8.4.	
Cnicus	benedictus	L.	I	-1									
Cnidium	dubium	(Schk.)Thell.	G	4	7	8	6	4	7	6	0	5.4.1.	
Coeloglossum	viride	(L.)Hartm.	S	6	4	4	5	4	8	3	0	5.4.2.2.	
Colchicum	arenarium	W. & K.	S	6	8	2	9	1	9	7	0	5.3.3.1.	
Colchicum	autumnale	L.	G	4	5	6	7	4	6	2	0	5.4.	
Colchicum	hungaricum	Janka	Su	10	8	1	9	1	9	5	0	5.3.1.5.	
Colutea	arborescens	L.	G	4	8	3	8	2	6	3	0	8.4.2.	
Comarum	palustre	L.	Sr	8	3	10	3	1	8	3	0	1.5.1.4.	
Conium	maculatum	L.	RC	-2	6	5	6	8	8	5	0	3.5.1.1.	
Conringia	austriaca	(Jacq.)Sweet	NP	3	8	3	9	3	8	7	0	5.3.1.1.	
Conringia	orientalis	(L.)Dum.	W	1	6	3	9	4	7	5	0	3.4.1.1.	
Consolida	orientalis	(J.Gay.)Schroe	W	1	8	4	8	4	7	8	0	3.3.2.3.	
Consolida	regalis	S.F.Gray	W	1	7	4	8	5	6	6	0	3.4.1.	
Convallaria	majalis	L.	G	4	5	5	6	4	5	3	0	8.4.	
Convolvulus	arvensis	L.	RC	-2	6	4	8	4	7	4	0	3.6.1.1.	
Convolvulus	cantabrica	L.	S	6	9	1	8	2	9	6	0	5.3.1.5.	
Conyza	canadensis	(L.)Cronq.	AC	-3	6	4	6	4	8	4	0	Indiff.	
Corallorhiza	trifida	Chatel.	Sr	8	4	6	3	5	2	7	0	8.3.1.	
Coreopsis	grandiflora	Hoog ex Sweet	I	-1									
Coreopsis	tinctoria	Nutt.	I	-1									
Coriandrum	sativum	L.	I	-1									
Corispermum	canescens	Kit. ex Schult.	S	6	8	1	8	1	9	8	0	5.3.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Corispermum	nitidum	Kit. ex Schult.	NP	3	8	1	8	1	9	8	0	5.3.3.1.
Cornus	mas	L.	G	4	7	4	8	4	6	4	0	8.4.2.
Cornus	sanguinea	L.	G	4	5	4	8	5	7	4	0	Indiff.
Coronilla	coronata	Nath.	S	6	6	4	9	1	7	4	0	8.4.2.2.
Coronilla	elegans	Panc.	Sr	8	6	5	5	4	5	6	0	8.4.3.2.
Coronilla	emerus	L.	Sr	8	6	3	9	2	7	3	0	8.4.2.2.
Coronilla	vaginalis	Lam.	S	6	5	2	9	1	8	4	0	5.3.1.4.
Coronilla	varia	L.	DT	2	5	4	8	3	7	5	0	Indiff.
Coronopus	squamatus	(Forsk.)Ascher	W	1	7	5	7	6	8	3	1	3.7.1.1.
Corydalis	cava	(L.)Schw. & K.	C	5	6	6	8	8	3	4	0	8.4.3.
Corydalis	intermedia	(L.)Merat	G	4	5	6	7	7	3	4	0	8.4.3.
Corydalis	pumila	(Host)Rchb.	G	4	6	6	8	8	3	5	0	8.4.3.
Corydalis	solida	(L.)Clairv.	C	5	7	5	7	7	3	5	0	8.4.
Corylus	avellana	L.	G	4	5	5	6	7	5	5	0	8.4-8.6.
Corylus	colurna	L.	I	-1								
Corylus	maxima	Mill.	I	-1								
Corynephorus	canescens	(L.)P.B.	C	5	6	2	4	2	9	5	0	5.2.2.1.
Cosmos	bipinnatus	Cav.	I	-1								
Cotinus	coggygria	Scop.	S	6	8	3	8	2	7	4	0	8.4.2.2.
Cotoneaster	integerrimus	Medik.	Sr	8	6	3	7	2	8	4	0	8.4.2.2.
Cotoneaster	niger	(Thunb.)Fr.	G	4	6	3	8	2	8	6	0	8.4.2.
Cotoneaster	tomentosus	(Ait.)Lindl.	C	5	8	3	9	2	7	6	0	8.4.2.2.
Cotoneaster	x matrensis	Domokos	G	4	6	3	8	2	8	4	0	8.4.2.3.
Crambe	tataria	Sebeök	Su	10	7	3	8	1	8	9	0	5.3.1.1.
Crataegus	monogyna	Jacq.	G	4	6	4	7	4	7	4	0	Indiff.
Crataegus	nigra	W. & K.	Sr	8	7	7	8	4	6	6	0	8.4.3.3.
Crataegus	oxyacantha	L. em. Jacq.	G	4	6	6	7	5	6	4	0	8.4.
Crepis	biennis	L.	DT	2	5	5	6	5	6	3	0	5.4.
Crepis	capillaris	(L.)Wallr.	NP	3	7	4	7	3	7	2	0	5.2.2.
Crepis	niccaensis	Balb. ex Pers.	NP	3	8	3	8	2	8	4	0	5.3.1.
Crepis	paludosa	(L.)Mönch	S	6	5	7	7	4	7	3	0	5.4.1.1.
Crepis	pannonica	(Jacq.)C.Koch	G	4	7	4	9	3	8	6	0	5.3.1.
Crepis	polymorpha	Thuill.	I	-1	8	6	8	4	8	7	0	5.4.
Crepis	praemorsa	(L.)Tausch.	G	4	6	5	9	3	6	6	0	8.4.2.
Crepis	pulchra	L.	DT	2	8	4	8	5	7	3	0	3.3.
Crepis	rheoadifolia	M.B.	W	1	7	5	6	5	9	3	0	Indiff.
Crepis	setosa	Hall.f.	W	1	8	4	8	3	9	4	1	5.4.
Crepis	tectorum	L.	W	1	6	3	6	6	8	7	0	Indiff.
Crocus	albiflorus	Kit. ex Schult.	Su	10	3	5	7	4	7	4	0	5.4.2.2.
Crocus	heuffelianus	Herbert	Su	10	4	6	7	4	7	6	0	8.4.3.2.
Crocus	reticulatus	Stev. ex Adam	Sr	8	7	4	8	3	8	6	0	5.3.3.1.
Crocus	sativus	L.	I	-1								
Crocus	tommasinianus	Herbert	Gu	8	6	6	6	4	7	4	0	8.4.3.2.
Cruciata	glabra	(L.)Ehrend.	G	4	6	6	6	6	6	4	0	8.4.
Cruciata	laevipes	Opiz em. Ehrend	DT	2	6	6	6	7	7	5	0	Indiff.
Cruciata	pedemontana	(Bell.)Ehrend.	G	4	8	3	7	1	9	6	0	5.3.1.
Crupina	vulgaris	Pers. ex Cass.	NP	3	8	2	8	2	9	7	0	5.3.1.4.
Crypsis	aculeata	(L.)Ait.	C	5	8	4	8	1	9	8	3	2.4.2.1.
Cucubalus	baccifer	L.	G	4	6	7	8	7	7	4	0	8.4.3.3.
Cucumis	melo	L.	I	-1								
Cucumis	sativus	L.	I	-1								
Cucurbita	ficifolia	Bouche	I	-1								
Cucurbita	maxima	Duch. ex Lam.	I	-1								
Cucurbita	pepo	L.	I	-1								
Cuscuta	australis	R.Br.	G	2	7	7	8	1	6	4	0	3.3.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Cuscuta	campestris	Yuncker	W	1	7	4	6	1	6	4	0	3.4.1.2.	
Cuscuta	epilinum	Weihe	W	1	6	4	0	1	6	4	0	3.4.3.1.	
Cuscuta	epithymum	(L.)Nath.	G	4	6	3	7	2	7	5	0	5.3.	
Cuscuta	europaea	L.	W	1	6	6	0	7	6	5	0	3.5.2.1.	
Cuscuta	lupuliformis	Krock.	W	1	6	8	6	3	6	6	0	3.5.2.	
Cuscuta	trifolii	Bab.	W	1	8	4	6	4	6	6	0	3.4.1.2.	
Cyclamen	purpurascens	Mill.	S	6	6	6	6	5	4	4	0	8.4.3.4.	
Cydonia	oblonga	Mill. em. Beck	I	-1	6	4	8	4	8	3	0		
Cymbalaria	muralis	G.M.Sch.	A	-1	7	2	8	3	7	4	0	5.2.1.2.	
Cynodon	dactylon	(L.)pers.	RC	-2	7	3	7	5	8	3	0	Indiff.	
Cynoglossum	hungaricum	Sink.	G	4	8	3	7	1	8	7	0	5.3.1.	
Cynoglossum	officinale	L.	W	1	7	3	7	7	8	5	0	3.5.4.1.	
Cynosurus	cristatus	L.	C	5	5	5	6	4	8	3	0	5.4.2.3.	
Cynosurus	echinatus	L.	A	-1									
Cyperus	diformis	Torn. ex L.	A	-1	8	8	6	6	7	5	0	3.9.1.1.	
Cyperus	fuscus	L.	NP	3	6	9	8	6	9	4	0	3.1.1.	
Cypripedium	calceolus	L.	Su	10	6	4	8	3	5	5	0	8.4.2.1.	
Cystopteris	fragilis	L.	G	4	5	7	8	5	5	3	0	Indiff.	
Cytisus	procumbens	(W. & K.)Spr.	S	6	8	3	8	3	8	6	0	5.3.1.4.	
Dactylis	glomerata	L.	DT	2	5	6	4	6	7	4	0	Indiff.	
Dactylis	polygama	Horvatov.	G	4	5	5	5	5	5	4	0	8.4.	
Dactylorhiza	fuchsii	(Druce)Soó	G	4	6	6	5	5	5	5	0	8.4.3.	
Dactylorhiza	incarnata	(L.)Soó	S	6	4	8	7	2	8	3	0	5.4.2.	
Dactylorhiza	maculata	(L.)Soó	Gr	6	4	7	4	2	7	2	0	5.4.	
Dactylorhiza	majalis	(L.)Soó	S	6	5	8	7	2	8	3	0	5.4.1.	
Dactylorhiza	sambucina	(L.)Soó	G	4	5	4	5	2	7	4	0	8.3.1.	
Dahlia	pinnata	Cav.	I	-1									
Dahlia	x variabilis	(Willd.)Desf.	I	-1									
Danae	cornubiensis	(Torn.)Burn.	Su	10	8	5	6	4	7	6	0	8.4.2.4.	
Danthonia	alpina	Vest	S	6	7	4	6	3	8	7	0	5.3.1.6.	
Danthonia	decumbens	(L.)Lam. & DC.	S	6	5	5	5	2	8	2	0	5.1.1.	
Daphne	cn. ssp. arbusculoides	(Tuzson)Soó	S	6	5	5	5	3	6	5	0	8.3.1.2.	
Daphne	cneorum ssp. cn.	L.	Sr	8	6	2	9	2	8	4	0	5.3.1.4.	
Daphne	laureola	L.	S	6	7	5	8	3	6	2	0	8.4.3.1.	
Daphne	mezereum	L.	S	6	5	6	6	5	4	4	0	8.4.3.	
Datura	stramonium	L.	W	1	7	4	6	8	8	4	1	3.3.	
Daucus	carota	L.	DT	2	6	4	7	4	8	5	0	Indiff.	
Dentaria	bulbifera	L.	G	4	5	5	7	6	4	4	0	8.4.3.	
Dentaria	enneaphyllos	L.	S	6	5	6	7	7	3	4	0	8.4.3.1.	
Dentaria	glandulosa	W. & K. ex Willd.	Sr	8	4	6	5	7	4	6	0	8.4.3.1.	
Dentaria	trifolia	W. & K.	Su	10	7	5	6	6	4	5	0	8.4.3.4.	
Deschampsia	caespitosa	(L.)P.B.	C	5	6	7	6	3	7	5	0	5.4.1.6.	
Descurainia	sophia	(L.)Webb	W	1	6	4	7	6	8	7	0	3.4.	
Deutzia	scabra	Thunb.	I	-1									
Dianthus	arenarius	L.	S	6	6	2	5	1	9	4	0	5.2.2.1.	
Dianthus	armeria	L.	D/	2	6	5	5	3	6	3	0	5.4.	
Dianthus	armeriastrum	Wolfner	G	4	7	4	5	2	8	5	0	5.2.2.1.	
Dianthus	barbatus	L.	S	6	6	6	5	4	6	5	0	8.4.3.4.	
Dianthus	carthusianorum	L.	G	4	5	3	6	2	8	7	0	5.3.	
Dianthus	caryophyllus	L.	I	-1									
Dianthus	chinensis	L.	I	-1									
Dianthus	collinus	W. & K.	S	6	7	4	8	3	7	7	0	5.3.1.	
Dianthus	deltoides	L.	DT	2	5	4	5	4	8	4	0	Indiff.	
Dianthus	diutinus	Kit. ex Schult.	Sr	8	8	2	8	1	8	7	0	5.3.3.1.	
Dianthus	giganteiformis	Borb.	S	6	8	3	8	2	8	6	0	5.3.1.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Dianthus	lumnitzeri	Wiesb.	Sr	8	7	2	9	1	9	6	0	5.3.1.4.	
Dianthus	pontederae	Kern.	G	4	7	3	8	2	8	6	0	5.3.	
Dianthus	praecox	Kit. ex Schult.	Sr	8	7	2	9	1	9	6	0	5.3.1.3.	
Dianthus	regis-stephani	Rapcs.	S	6	8	2	9	1	9	7	0	5.3.1.4.	
Dianthus	serotinus	W. & K.	S	6	7	2	8	1	9	7	0	5.3.3.1.	
Dianthus	superbus	L.	Sr	8	5	8	8	2	7	7	0	5.4.1.1.	
Dichostylis	miceliana	(L.)Nees	NP	3	7	9	6	5	8	7	0	3.1.1.1.	
Dictamnus	albus	L.	S	6	8	3	8	2	7	7	0	6.1.1.2.	
Digitalis	ferruginea	L.	Gu	8	8	3	7	2	7	7	0	8.4.1.	
Digitalis	grandiflora	Mill.	G	4	5	5	6	5	6	4	0	8.4.	
Digitalis	lanata	Ehrh.	Gu	8	8	3	8	2	8	7	0	8.4.1.	
Digitalis	purpurea	L.	I	-1	5	5	3	6	7	2	0	Indiff.	
Digitaria	ischaemum	(Schreb.)Muhl.	W	1	6	5	4	3	7	4	0	3.4.2.1.	
Digitaria	sanguinalis	(L.)Scop.	AC	-3	7	3	5	4	7	3	0	3.4.2.	
Diphasium	complanatum	(L.)Rothm.	Sr	8	4	4	2	2	6	7	0	8.3.1.2.	
Diphasium	issleri	(Rouy)Holub	Su	10	3	6	2	1	8	5	0	5.1.1.3.	
Diphasium	tristachyum	(Pursh)Rothm.	Su	10	6	5	1	1	8	5	0	5.1.1.3.	
Diploxaxis	muralis	(L.)DC.	W	1	8	4	8	5	8	3	0	3.3.	
Diploxaxis	tenuifolia	(Jusl.)DC.	W	1	7	3	6	4	8	3	0	3.3.3.	
Dipsacus	fullonum	L.	W	1	5	7	7	6	7	5	0	3.7.	
Dipsacus	laciniatus	L.	W	1	6	7	8	5	9	3	0	3.7.	
Doronicum	austriacum	Jacq.	Sr	8	3	6	6	7	5	4	0	8.4.3.3.	
Doronicum	hungaricum	(Sadl.)Rchb.	S	6	8	4	7	3	7	7	0	8.4.2.3.	
Doronicum	orientale	Hoffm.	Sr	8	8	5	8	4	6	8	0	8.4.3.4.	
Dorycnium	germanicum	(Grem.)Rikli	G	4	6	3	8	2	8	4	0	5.3.	
Dorycnium	herbaceum	Vill.	G	4	7	2	9	1	8	4	0	5.3.1.	
Draba	lasiocarpa	Roch.	S	6	8	1	9	1	8	7	0	5.3.1.4.	
Draba	muralis	L.	NP	3	6	4	8	2	7	2	0	5.3.1.	
Draba	nemorosa	L.	NP	3	8	4	8	3	8	7	0	5.3.	
Dracocephalum	austriacum	L.	Su	10	7	2	9	1	9	7	0	5.3.1.1.	
Dracocephalum	ruyschiana	L.	Su	10	4	4	8	2	9	8	0	5.3.1.3.	
Drosera	anglica	Huds.	Su	10	4	9	3	2	9	3	0	1.7.1.1.	
Drosera	rotundifolia	L.	Su	10	4	9	1	1	8	3	0	1.8.1.1.	
Dryopteris	assimilis	S. Walker	G	4	6	4	5	3	6	4	0	8.2.	
Dryopteris	carthusiana	(Vill.)Fuchs	S	6	4	7	4	3	5	3	0	8.2.1.	
Dryopteris	cristata	(L.)A.Gray	Su	10	4	9	5	5	5	5	0	8.2.1.1.	
Dryopteris	dilatata	(Hoffm.)A. Gray	Sr	8	3	6	4	7	4	3	0	8.2.1.1.	
Dryopteris	filix-mas	(L.)Schott	G	4	5	5	6	6	4	3	0	8.4.	
Dryopteris	pseudo-mas	(Woll.)Hol. & P.	G	4	6	5	5	4	5	3	0	8.4.3.	
Ecballium	elaterium	(L.)Rich.f.	A	-1	9	5	8	7	8	5	0	3.3.3.	
Echinochloa	crus-galli	(L.)P.B.	AC	-3	7	7	7	8	8	5	0	3.9.1.	
Echinochloa	oryzoides	(Ard.)Fritsch.	A	-1	8	6	6	7	8	6	0	3.9.1.1.	
Echinochloa	phyllopogon	(Stapf)Carv.	A	-1	8	6	6	6	8	6	0	3.9.1.1.	
Echinochloa	spiralis	Vasinger	A	-1	8	6	6	6	8	6	0	3.9.1.1.	
Echinocystis	lobata	(Michx.)T. & Gr.	AC	-3	8	8	8	8	7	5	0	3.5.2.1.	
Echinops	ruthenicus	(Fisc.)M.B.	S	6	8	2	8	3	9	8	0	5.3.3.1.	
Echinops	sphaerocephalus	L.	DT	2	7	3	7	5	8	6	0	8.4.2.	
Echium	italicum	L.	DT	2	9	4	8	4	9	6	0	5.3.1.1.	
Echium	ruscicum	J.F.Gmel.	S	6	8	2	8	1	9	8	0	5.3.1.1.	
Echium	vulgare	L.	W	1	7	3	6	4	9	3	0	3.3.	
Elaeagnus	angustifolia	L.	I	-1									
Elaeagnus	argentea	Pursh	I	-1									
Elatine	alsinastrium	L.	NP	3	7	10	6	5	8	5	1	3.1.2.	
Elatine	hydropiper	L.	NP	3	7	10	5	4	8	4	0	3.1.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Elatine	macropoda	Guss.	NP	3	7	10	5	4	8	4	0	3.1.1.2.	
Elatine	triandra	Schkuhr	NP	3	7	10	4	4	8	4	0	3.1.1.2.	
Eleocharis	acicularis	(L.)R. & Schult.	NP	3	5	10	6	2	7	3	0	3.1.1.1.	
Eleocharis	carniolica	Koch	C	5	7	9	6	2	7	5	0	1.4.1.1.	
Eleocharis	ovata	(Roth.)R. & Sch.	NP	3	7	9	8	5	8	4	0	3.1.1.2.	
Eleocharis	palustris	(L.)R. & Schult.	C	5	6	10	7	5	8	5	1	Indiff.	
Eleocharis	quinqueflora	(Harm.)Schwrtz.	S	6	6	9	8	2	8	3	1	1.7.2.1.	
Eleocharis	uniglumis	(Link)Schult.	G	4	6	9	8	5	7	7	4	1.7.2.	
Eleusine	indica	(L.)Gaertn.	I	-1	9	4	6	6	8	6	0	3.7.1.1.	
Elodea	canadensis	Rich. ex Mich.	AC	-3	6	12	8	7	7	5	0	1.3.1.	
Ephedra	distachya	L. em. Stapf.	Sr	8	9	1	9	1	9	7	0	5.3.3.1.	
Epilobium	adenocaulon	Haussk.	A	-1	6	5	7	8	7	4	0	Indiff.	
Epilobium	collinum	C.C. Gmel.	DT	2	5	5	4	5	7	5	0	6.2.1.	
Epilobium	hirsutum	L.	DT	2	5	9	8	7	7	5	0	Indiff.	
Epilobium	lamyi	F. Schulz	G	4	6	8	6	6	7	2	0	8.1.1.	
Epilobium	lanceolatum	Seb. & M.	DT	2	7	6	6	3	8	3	0	8.4.3.	
Epilobium	montanum	L.	G	4	6	5	6	5	4	3	0	8.4.3.	
Epilobium	obscurum	Schreb.	G	4	5	9	5	4	7	2	0	1.5.1.	
Epilobium	palustre	L.	G	4	4	9	5	3	7	4	0	1.7.	
Epilobium	parviflorum	Schreb.	G	4	5	9	7	5	7	3	0	1.5.1.	
Epilobium	roseum	Schreb.	G	4	6	8	7	7	7	4	0	1.5.1.3.	
Epilobium	tetragonum	L. em. Leyss.	G	4	7	9	5	5	7	4	0	1.5.1.	
Epipactis	atrorubens	(Hoffm.)Schult.	G	4	6	3	8	2	6	3	0	8.4.2.	
Epipactis	helleborine	Cr.	G	4	5	5	7	5	4	3	0	8.4.	
Epipactis	leptochila	(Godr.)Godf.	G	4	6	6	7	6	4	3	0	8.4.	
Epipactis	microphylla	(Ehrh.)Sw.	S	6	6	5	8	4	3	4	0	8.4.3.2.	
Epipactis	muelleri	Godf.	G	4	7	6	7	4	5	2	0	8.4.	
Epipactis	palustris	(Mill.)Cr.	S	6	5	8	8	2	8	3	0	1.7.2.1.	
Epipactis	purpurata	Sw.	S	6	6	6	8	6	3	4	0	8.4.3.	
Epipogium	aphyllum	(F.W.Schm.)Sw.	Su	10	4	6	5	5	3	6	0	8.4.3.2.	
Equisetum	arvense	L.	DT	2	5	6	6	3	6	5	0	Indiff.	
Equisetum	fluviatile	L.em.Ehrh.	G	4	4	10	6	6	8	4	0	1.5.	
Equisetum	hyemale	L.	G	4	5	7	7	6	5	5	0	8.4.3.	
Equisetum	x moorei	Newman	G	4	7	8	7	4	7	6	0	8.4.3.	
Equisetum	palustre	L.	S	6	4	9	6	3	7	5	0	5.4.1.	
Equisetum	ramosissimum	Desf.	S	6	7	2	7	1	8	7	0	5.3.3.1.	
Equisetum	sylvaticum	L.	S	6	4	7	4	4	4	5	0	8.4.3.3.	
Equisetum	telmateia	Ehrh.	C	5	6	8	6	5	5	2	0	8.4.3.3.	
Equisetum	variegatum	Schleich.	S	6	3	9	8	2	8	7	0	1.7.2.1.	
Eragrostis	megastachya	(Koel.)Link	W	1	7	3	6	3	7	5	0	3.3.2.4.	
Eragrostis	minor	Host	W	1	7	3	6	4	8	5	0	3.3.2.	
Eragrostis	pilosa	(L.)P.B.	W	1	7	4	6	5	8	3	0	3.4.	
Eranthis	hyemalis	(L.)Salisb.	Gr	6	9	6	8	5	4	6	0	8.4.3.	
Erechtites	hieraciifolia	(L.)Rafin.	AC	-3	8	5	6	6	7	6	0	6.2.	
Erigeron	acris	L.	DT	2	5	4	8	5	9	7	0	5.3.	
Erigeron	podolicus	Bess.	S	6	4	7	4	3	9	8	0	5.1.1.3.	
Eriophorum	angustifolium	Honck.	C	5	4	9	5	2	8	3	0	1.7.1.	
Eriophorum	gracile	Koch ex Roth	Su	10	4	10	4	2	8	5	0	1.7.1.2.	
Eriophorum	latifolium	Hoppe	S	6	5	9	8	2	8	3	0	1.7.2.1.	
Eriophorum	vaginatum	L.	Cu	9	3	8	2	1	7	5	0	1.8.1.1.	
Erodium	ciconium	(Jusl.)L'Hér.	W	1	8	4	8	5	9	7	0	3.3.3.1.	
Erodium	cicutarium	(L.)L'Hér.	W	1	6	4	7	4	8	5	0	Indiff.	
Erodium	neilreichii	Janka	Gr	6	8	2	8	1	8	8	0	5.3.3.1.	
Erophila	praecox	(Stev.)DC.	NP	3	6	2	8	1	8	7	0	5.2.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Erophila	spathulata	Lang	NP	3	6	3	9	2	8	8	0	5.2.1.
Erophila	verna	(L.)Bess.	NP	3	6	3	6	2	6	3	0	Indiff.
Eruca	sativa	Mill.	I	-1	8	4	8	6	8	6	0	3.4.3.1.
Erucastrum	gallicum	(Willd.)Schulz	I	-1	6	4	8	4	8	4	0	3.3.
Erucastrum	nasturtiifolium	(Poir.)Schulz	W	1	7	6	8	7	8	3	0	3.5.2.1.
Eryngium	campestre	L.	DT	2	8	2	8	2	9	5	0	Indiff.
Eryngium	planum	L.	DT	2	6	6	8	4	7	7	0	3.5.2.
Erysimum	cheiranthoides	L.	DT	2	6	6	6	7	7	3	0	3.5.2.1.
Erysimum	crepidifolium	Rchb.	G	4	7	3	7	1	9	5	0	5.3.1.
Erysimum	diffusum	Ehrh.	NP	3	7	1	8	1	9	6	0	5.3.3.
Erysimum	hieracifolium	Jusl. ex L.	DT	2	7	5	8	5	7	7	0	3.5.2.1.
Erysimum	odoratum	Ehrh.	G	4	7	2	8	2	9	5	0	5.3.1.
Erysimum	pallidiflorum	Szépl. ex Jáv.	Su	10	6	2	8	1	8	6	0	5.3.1.3.
Erysimum	repandum	Hoejer ex L.	W	1	8	4	7	6	8	6	0	3.3.
Erythronium	dens-canis	L.	Sr	8	8	6	7	4	4	6	0	8.4.3.4.
Euclidium	syriacum	(L.)R.Br.	W	1	8	4	7	5	9	8	0	3.3.3.1.
Euonymus	europaeus	L.	G	4	5	5	6	5	6	3	0	8.4.
Euonymus	verrucosus	Scop.	G	4	7	4	8	3	6	8	0	8.4.2.
Eupatorium	cannabinum	L.	DT	2	5	7	7	8	7	3	0	Indiff.
Euphorbia	amygdaloides	L.	G	4	5	5	7	6	4	2	0	8.4.3.
Euphorbia	angulata	Jacq.	S	6	7	5	8	4	6	7	0	8.3.1.
Euphorbia	cyparissias	L.	DT	2	5	3	7	3	8	4	0	Indiff.
Euphorbia	dulcis	L.	S	6	5	6	7	5	5	2	0	8.4.3.1.
Euphorbia	esula	L.	DT	2	5	4	7	4	8	5	0	Indiff.
Euphorbia	exigua	L.	W	1	6	4	8	4	6	2	0	3.4.1.
Euphorbia	falcata	L.	W	1	7	4	8	6	8	3	0	3.4.
Euphorbia	helioscopia	L.	W	1	7	3	7	7	7	3	0	3.4.1.
Euphorbia	humifusa	Willd.	A	-1	7	4	7	6	9	5	0	3.7.1.
Euphorbia	lucida	W. & K.	G	4	6	8	9	5	7	6	0	8.6.1.3.
Euphorbia	maculata	L.	A	-1	8	3	7	5	9	6	0	3.7.1.1.
Euphorbia	nutans	Lag.	A	-1	7	3	7	2	8	7	0	
Euphorbia	palustris	L.	G	4	6	9	8	5	8	6	1	8.6.1.3.
Euphorbia	pannonica	Host.	S	6	8	3	8	1	8	7	0	5.3.1.1.
Euphorbia	peplus	L.	W	1	7	4	6	8	6	3	0	3.3.
Euphorbia	platyphyllos	L.	W	1	8	4	6	7	8	6	0	3.5.
Euphorbia	polychroma	Kern.	G	4	8	4	8	5	7	7	0	8.4.2.
Euphorbia	salicifolia	Host.	DT	2	8	3	6	5	8	6	0	3.3.
Euphorbia	seguierana ssp. minor	(Sadler)Domin	S	6	8	2	9	1	9	4	0	5.3.1.4.
Euphorbia	seguierana ssp. seg.	Necker	S	6	7	2	8	1	9	6	0	5.3.3.1.
Euphorbia	stricta	L.	DT	2	7	8	7	4	6	4	0	8.6.1.3.
Euphorbia	taurinensis	All.	A	-1	8	4	8	4	8	5	0	3.4.
Euphorbia	verrucosa	L. em. L.	G	4	7	4	8	3	8	2	0	8.4.2.
Euphorbia	villosa	W. & K. ex Willd.	G	4	8	7	6	4	7	5	0	5.4.1.
Euphorbia	virgata	W. & K.	DT	2	6	5	8	4	8	6	1	Indiff.
Euphrasia	kernerii	Wettst.	G	4	6	6	5	4	8	6	0	5.4.
Euphrasia	rostockiana	Hayne	G	4	6	6	5	4	7	3	0	5.4.1.
Euphrasia	stricta	Wolff ex Lehm.	G	4	6	5	5	2	8	4	0	5.1.1.
Euphrasia	tatarica	Fisch. ex Spr.	G	4	6	4	7	2	8	6	0	5.3.1.
Eurotia	ceratoides	(L.)C.A.Mey.	Su	10	8	2	8	3	9	9	0	3.6.1.2.
Fagopyrum	esculentum	Mönch	I	-1								
Fagus	sylvatica	L.	C	5	5	5	6	5	3	2	0	8.4.3.1.
Falcaria	vulgaris	Bern.	W	1	7	3	8	3	7	6	0	Indiff.
Fallopia	convolvulus	(L.)Löve	W	1	5	5	5	3	7	3	0	Indiff.
Fallopia	dumetorum	(L.)Holub	DT	2	5	5	6	6	5	4	0	3.5.3.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Ferula	sadlerana	Ledeb.	Su	10	8	2	8	1	8	7	0	8.4.2.3.	
Festuca	altissima	All.	S	6	5	6	7	6	3	3	0	8.4.3.1.	
Festuca	amethystina	Host	Sr	8	3	3	9	2	6	4	0	8.4.2.2.	
Festuca	arundinacea	Schreb.	DT	2	5	8	7	4	8	4	2	Indiff.	
Festuca	cinerea	Vill.	S	6	7	2	8	1	8	4	0	5.3.1.3.	
Festuca	dalmatica	(Hack.)Richt.	Cu	9	9	1	9	1	9	5	0	5.3.1.5.	
Festuca	drymeia	M. & K.	C	5	7	6	6	5	3	6	0	8.4.3.1.	
Festuca	gigantea	(L.)Vill.	G	4	5	7	6	6	4	3	0	8.4.3.3.	
Festuca	heterophylla	Lam.	C	5	5	4	5	4	5	4	0	8.4.	
Festuca	nigrescens	Lam.	C	5	5	5	4	2	7	5	0	5.1.1.	
Festuca	ovina	L.	S	6	4	4	3	5	7	3	0	5.1.1.1.	
Festuca	pallens	Host.	C	5	7	2	8	1	9	4	0	5.3.1.	
Festuca	pratensis	Huds.	C	5	5	6	7	6	8	3	0	Indiff.	
Festuca	pseudodalmatica	Kraj. & Dom.	C	5	6	3	5	2	8	6	0	5.3.1.3.	
Festuca	pseudovina	Hack. ex Wiesb.	C	5	8	3	8	3	9	6	3	5.5.2.	
Festuca	rubra	L.	C	5	5	5	5	4	8	5	0	5.4.2.3.	
Festuca	rupicola	Heuff.	C	5	7	3	8	2	9	7	0	5.3.1.	
Festuca	x stricta	Host	Cu	9	8	2	8	1	9	6	0	5.3.1.1.	
Festuca	tenuifolia	Sibth.	S	6	6	4	3	2	8	2	0	5.1.1.5.	
Festuca	vaginata	W. & K. ex Willd.	C	5	8	2	8	1	9	7	0	5.3.3.1.	
Festuca	valesiaca	Schleich.	C	5	6	2	7	2	8	6	0	5.3.1.	
Festuca	x wagneri	Deg., Th. & Flatt	Cu	9	7	3	9	2	9	7	0	5.3.3.1.	
Ficus	carica	L.	I	-1									
Filago	arvensis	L.	NP	3	7	2	5	2	8	3	0	5.2.	
Filago	germanica	(L.)L.	NP	3	7	2	5	1	9	2	0	5.2.4.1.	
Filago	minima	(Sm.)Pers.	NP	3	6	2	4	1	9	3	0	5.2.4.1.	
Filipendula	ulmaria	(L.)Maxim.	G	4	4	8	6	4	7	3	0	5.4.1.	
Filipendula	vulgaris	Moench	G	4	6	4	8	2	7	5	0	5.3.	
Foeniculum	vulgare	Mill.	I	-1									
Forsythia	suspensa	(Thunb.)Vahl	I	-1									
Fragaria	moschata	Duch.	G	4	6	5	6	6	6	4	0	8.4.	
Fragaria	vesca	L.	G	4	5	5	6	6	7	5	0	8.4.	
Fragaria	viridis	Duch.	G	4	5	3	8	3	7	5	0	6.1.1.2.	
Frangula	alnus	Mill.	G	4	6	7	5	3	6	5	0	8.2-8.5.	
Fraxinus	angustifolia	Vahl	C	5	7	8	7	4	6	6	0	8.4.3.3.	
Fraxinus	excelsior	L.	C	5	5	6	7	7	4	3	0	8.4.3.1.	
Fraxinus	ornus	L.	C	5	8	3	8	3	5	4	0	8.4.2.2.	
Fraxinus	pennsylvanica	Marsh.	AC	-3	6	8	6	7	5	3	1	8.1.1.2.	
Fritillaria	meleagris	L.	Sr	8	7	8	7	5	7	4	0	8.4.3.3.	
Fumana	procumbens	(Dun.)Gr. & Godr.	S	6	8	1	9	1	9	3	0	5.3.3.1.	
Fumaria	officinalis	L.	W	1	6	3	6	7	7	3	0	3.3.	
Fumaria	parviflora	Lam.	A	-1									
Fumaria	rostellata	Knaf.	NP	3	6	4	8	6	7	4	0	3.4.	
Fumaria	schleicheri	Soy.-Vill.	NP	3	7	2	8	6	8	4	0	3.3.	
Fumaria	vaillantii	Lois. ex Desv.	DT	2	7	3	8	5	8	5	0	3.4.	
Gagea	bohémica	(Zau.)R. & Sch.	G	4	8	2	8	1	9	5	0	5.3.1.1.	
Gagea	lutea	(L.)Ker-Gawl.	G	4	5	6	7	7	4	4	0	8.4.3.	
Gagea	minima	(L.)Ker-Gawl.	S	6	6	5	7	7	7	5	0	8.4.3.3.	
Gagea	pratensis	(Pers.)Dum.	G	4	6	4	7	6	7	5	0	8.4.2.	
Gagea	pusilla	(F.W.Sch.)R. & S.	G	4	7	2	7	4	8	5	0	5.3.1.	
Gagea	spathacea	(Hayne)Salisb.	Su	10	6	7	7	7	4	4	0	8.4.3.3.	
Gagea	villosa	(M.B.)Duby	W	1	7	3	6	4	7	5	0	3.4.	
Galanthus	nivalis	L.	S	6	7	6	7	7	5	4	0	8.4.3.	
Galega	officinalis	L.	DT	2	6	8	8	7	8	6	0	3.5.2.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Galeobdolon	luteum	(Krock.)Huds.	G	4	5	6	7	5	3	4	0	8.4.3.	
Galeopsis	bifida	Boenn.	DT	2	5	6	5	7	8	4	0	6.2.	
Galeopsis	ladanum	L.	W	1	5	4	8	3	8	5	0	3.4.	
Galeopsis	pubescens	Bess.	G	4	5	5	6	5	7	4	0	8.4.	
Galeopsis	speciosa	Mill.	G	4	6	6	7	7	7	6	0	6.2.1.	
Galeopsis	tetrahit	L.	W	1	5	5	4	7	7	3	0	Indiff.	
Galinsoga	ciliata	(Rafin.)Blake	A	-1	7	6	5	7	7	4	0	3.3.1.	
Galinsoga	parviflora	Cav.	AC	-3	6	6	6	8	7	3	0	3.3.	
Galium	abaujense	Borb.	S	6	7	4	6	4	7	6	0	8.4.2.1.	
Galium	album	Mill.	G	4	6	3	9	2	9	4	0	5.3.1.	
Galium	aparine	L.	W	1	5	7	6	9	7	3	0	Indiff.	
Galium	austriacum	Jacq.	S	6	7	3	9	1	9	4	0	5.3.1.4.	
Galium	boreale	L.	G	4	4	8	8	2	6	7	0	5.4.1.	
Galium	divaricatum	Pourr. ex Lam.	NP	3	8	2	3	2	9	2	0	5.2.4.1.	
Galium	elongatum	Presl	G	4	5	9	6	4	6	3	0	1.5.1.	
Galium	glaucum	L.	G	4	7	2	9	1	8	4	0	5.3.1.	
Galium	lucidum	All.	S	6	8	3	8	2	8	4	0	5.3.1.5.	
Galium	mollugo	L.	G	4	6	5	7	6	7	3	0	Indiff.	
Galium	odoratum	(L.)Scop.	C	5	5	5	6	5	2	2	0	8.4.3.	
Galium	palustre	L.	G	4	5	9	6	4	6	3	0	1.5.1.4.	
Galium	parisiense	L.	NP	3	8	2	3	1	9	2	0	5.2.2.1.	
Galium	pumilum	Murr.	G	4	5	5	4	2	7	2	0	5.4.	
Galium	rivale	Sibth. & Sm.	G	4	5	8	6	5	5	4	0	8.4.3.3.	
Galium	rotundifolium	L.	S	6	5	6	4	4	2	2	0	7.3.1.2.	
Galium	rubroides	L.	G	4	5	5	8	5	7	5	0	8.1.1.	
Galium	schultesii	Vest	G	4	6	4	6	4	5	5	0	8.4.	
Galium	spurium	L.	W	1	6	5	7	5	7	5	0	3.4.3.1.	
Galium	sylvaticum	L.	G	4	5	6	6	5	4	4	0	8.4.3.	
Galium	tenuissimum	M.B.	A	-1									
Galium	tricornutum	Dandy	W	1	7	3	8	3	7	3	0	3.4.	
Galium	uliginosum	L.	S	6	4	9	5	4	6	4	0	5.4.1.	
Galium	verum	L.	DT	2	5	4	7	3	7	4	0	Indiff.	
Gaudinia	fragilis	(L.)P.B.	A	-1	6	6	6	7	8	3	0	5.4.	
Genista	elata	(Mnch.)Wender.	G	4	6	4	6	3	7	4	0	Indiff.	
Genista	germanica	L.	S	6	5	4	3	3	6	4	0	8.3.1.2.	
Genista	ovata	W. & K.	S	6	7	4	4	3	6	5	0	8.3.1.2.	
Genista	pilosa	L. oecotyp. acidoph.	C	5	5	5	3	3	6	3	0	8.3.	
Genista	pilosa	L. oecotyp. basiphil.	C	5	7	3	8	1	8	5	0	5.3.1.	
Genista	tinctoria	L.	G	4	5	5	5	2	7	3	0	5.4.	
Gentiana	asclepiadea	L.	Sr	8	4	6	7	4	6	4	0	7.3.1.2.	
Gentiana	cruciata	L.	G	4	5	3	8	3	7	4	0	5.4.	
Gentiana	pneumonanthe	L.	S	6	5	8	6	2	8	3	0	5.4.1.1.	
Gentianella	austriaca	(Kern.)Dost.	S	6	5	5	6	2	8	5	0	5.4.2.1.	
Gentianella	cliata	(L.)Borkh.	Gr	6	6	4	8	2	7	4	0	5.4.	
Gentianella	livonica	(Ledeb.)Soó	Sr	8	5	5	6	1	8	6	0	5.1.1.5.	
Geranium	bohemicum	Torn.	A	-1									
Geranium	columbinum	L.	DT	2	7	3	7	4	8	6	0	3.3.	
Geranium	dissectum	Jusl.	W	1	6	5	7	5	7	3	0	3.3.1.	
Geranium	divaricatum	Ehrh.	DT	2	7	4	6	5	5	6	0	3.5.3.1.	
Geranium	lucidum	L.	S	6	7	6	7	7	5	4	0	8.4.3.1.	
Geranium	molle	L.	DT	2	6	3	6	4	7	3	0	Indiff.	
Geranium	palustre	Torn.	G	4	5	7	8	8	8	4	0	5.4.1.	
Geranium	phaeum	L.	S	6	6	6	7	7	4	6	0	8.4.3.1.	
Geranium	pratense	L.	S	6	5	6	8	7	8	5	0	5.4.2.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Geranium	pusillum	Burm.f.	DT	2	6	3	6	6	7	5	0	3.3.	
Geranium	pyrenaicum	Burm.f.	W	1	5	5	6	6	8	4	0	3.5.1.1.	
Geranium	robertianum	L.	DT	2	5	6	6	7	4	3	0	3.5.2.	
Geranium	rotundifolium	L.	W	1	6	3	7	4	7	5	0	3.3.	
Geranium	sanguineum	L.	C	5	6	3	8	3	7	4	0	6.1.1.2.	
Geranium	sibiricum	L.	A	-1	6	6	7	4	7	7	0	3.5.1.	
Geranium	sylvaticum	L.	Su	10	4	7	7	7	7	4	0	5.4.1.2.	
Geum	aleppicum	Jacq.	Sr	8	4	6	8	4	4	7	0	8.4.3.1.	
Geum	urbanum	L.	DT	2	5	5	7	7	4	5	0	6.2.	
Gladiolus	byzantinus	Mill.	I	-1									
Gladiolus	imbricatus	L.	Gr	6	4	5	6	3	8	6	0	5.4.	
Gladiolus	palustris	Gaud.	Sr	8	7	7	8	3	8	4	0	5.4.1.1.	
Glaucium	corniculatum	(L.)Rudolph	W	1	8	4	8	4	9	6	0	3.4.	
Glaucium	flavum	Cr.	A	-1	7	6	8	7	9	6	2	Indiff.	
Glaux	maritima	L.	Sr	8	6	7	8	5	8	7	3	5.5.1.3.	
Glechoma	hederacea	L.	DT	2	5	6	6	7	7	3	0	Indiff.	
Glechoma	hirsuta	W. & K.	G	4	6	4	8	5	6	6	0	8.4.	
Gleditsia	triacanthos	L.	I	-1									
Globularia	cordifolia	L.	Su	10	5	3	9	1	9	4	0	5.3.1.1.	
Globularia	punctata	Lap.	S	6	6	2	9	1	9	5	0	5.3.1.4.	
Glyceria	declinata	Breb.	Su	10	5	10	8	7	7	3	0	1.5.1.3.	
Glyceria	fluitans	(L.)R.Br.	C	5	5	9	8	5	7	3	0	1.5.1.3.	
Glyceria	maxima	(Hartm.)Holmb.	C	5	5	10	8	7	9	4	0	1.5.1.1.	
Glyceria	nemoralis	Uechtr. & Koer.	G	4	5	10	6	5	7	3	0	1.5.1.3.	
Glyceria	plicata	(Fr.)Fr.	G	4	5	10	8	8	8	3	2	1.5.1.3.	
Glyceria	poiformis	Fr.	G	4	6	8	8	4	8	6	4	5.5.1.4.	
Glycine	soja	(L.)Sieb. & Zucc.	I	-1									
Glycyrrhiza	echinata	L.	DT	2	8	7	8	5	8	7	0	3.5.2.1.	
Glycyrrhiza	glabra	L.	A	-1	7	5	8	7	8	7	0	3.5.2.	
Gnaphalium	luteo-album	L.	DT	2	6	7	5	3	7	5	0	3.1.1.	
Gnaphalium	sylvaticum	L.	DT	2	5	5	5	6	7	3	0	6.2.1.	
Gnaphalium	uliginosum	L.	DT	2	5	9	8	5	7	5	1	3.1.1.	
Gomphrena	globosa	L.	I	-1									
Goniolimon	tataricum	(L.)Boiss.	A	-1									
Goodyera	repens	(L.)R.Br.	Sr	8	4	4	4	2	5	7	0	8.3.1.2.	
Gossypium	hirsutum	L.	I	-1									
Gratiola	officinalis	L.	C	5	7	8	7	3	8	5	0	Indiff.	
Groenlandia	densa	(L.)Fourr.	Sr	8	5	12	7	4	6	4	0	1.3.1.1.	
Gymnadenia	conopea	(L.)R.Br.	Gr	6	5	7	8	3	8	2	0	Indiff.	
Gymnadenia	odoratissima	(L.)Rich.	Sr	8	5	5	9	2	7	4	0	5.4.2.1.	
Gymnocarpium	dryopteris	(L.)Newm.	G	4	4	6	4	5	3	5	0	Indiff.	
Gymnocarpium	robertianum	(Hoffm.)Newm.	G	4	5	5	8	5	4	4	0	8.4.3.	
Gymnocladus	dioica	(L.)C.Koch	I	-1									
Gypsophila	arenaria	W. & K.	S	6	7	2	8	1	8	5	0	5.3.3.1.	
Gypsophila	muralis	L.	NP	3	6	7	6	2	8	5	1	Indiff.	
Gypsophila	paniculata	L.	S	6	6	2	9	2	9	6	0	5.3.3.1.	
Haynaldia	villosa	(L.)Schur	A	-1	8	4	6	3	8	7	0	3.4.	
Hedera	helix	L.	G	4	5	5	6	5	4	2	0	8.4.	
Helenium	autumnale	L.	I	-1									
Heleochoa	alopecuroides	(Pill. & M.)Host	G	4	8	6	9	1	9	8	6	2.4.2.	
Heleochoa	schoenoides	(L.)Host	G	4	8	7	9	1	9	8	6	2.4.2.	
Helianthemum	canum	(L.)Baumg.	G	4	7	1	9	1	8	4	0	5.3.1.	
Helianthemum	nummularium	(L.)Mill.	G	4	6	2	8	1	8	4	0	5.3.1.	
Helianthemum	ovatum	(Viv.)Dun.	G	4	5	3	9	2	7	4	0	5.3.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Helianthus	annuus	L.	I	-1	7	5	8	7	8	4	0	3.4.
Helianthus	decapetalus	L.	AC	-3	6	7	7	6	6	4	0	3.5.2.
Helianthus	rigidus	(Cass.)Desf.	L	-1								
Helianthus	tuberosus	L.	AC	-3	7	6	7	8	8	3	0	3.5.2.
Helichrysum	arenarium	(L.)Mönch	S	6	6	2	8	1	9	7	0	5.3.3.1.
Heliopsis	helianthoides	(L.)Sweet	I	-1								
Heliotropium	europaeum	L.	W	1	8	4	8	6	8	5	0	3.3.2.
Heliotropium	supinum	L.	NP	3	9	8	8	3	9	7	1	3.1.1.4.
Helleborus	dumetorum	W. & K. ex Willd.	S	6	7	6	7	4	3	5	0	8.4.3.4.
Helleborus	odorus	W. & K. ex Willd.	G	4	8	4	6	4	5	6	0	8.4.
Helleborus	purpurascens	W. & K.	S	6	6	5	7	4	4	6	0	8.4.3.1.
Helminthia	echioides	(L.)Gaertn.	A	-1	7	5	6	5	7	4	0	3.4.1.2.
Hemerocallis	fulva	L.	I	-1								
Hemerocallis	lilio-asphodelus	L. em. Scop.	Sr	8	7	7	6	5	6	5	0	5.4.1.1.
Hepatica	nobilis	Mill.	S	6	6	5	7	4	4	4	0	8.4.3.
Heraclium	sphondylium	L.	G	4	5	5	6	5	5	4	0	8.4.
Herminium	monorchis	(L.)R.Br.	Gu	8	5	6	8	4	7	7	0	
Herniaria	glabra	L.	NP	3	6	2	5	4	9	5	0	5.2.2.
Herniaria	hirsuta	L.	NP	3	7	2	4	3	9	7	0	5.2.2.
Herniaria	incana	Lam.	G	4	8	2	7	2	8	7	0	5.3.1.
Hesperis	matronalis	L.	S	6	6	6	7	7	5	6	0	8.4.3.1.
Hesperis	sylvestris	Cr.	G	4	7	6	7	4	4	6	0	8.4.3.
Hesperis	tristis	L.	G	4	8	3	8	3	8	7	0	5.3.1.
Hibiscus	cannabinus	L.	I	-1								
Hibiscus	esculentus	L.	I	-1								
Hibiscus	moscheutos	L.	I	-1								
Hibiscus	syriacus	L.	I	-1								
Hibiscus	trionum	L.	W	1	7	4	6	5	8	4	0	3.3.2.
Hieracium	aurantiacum	L.	Su	10	4	5	4	2	8	5	0	5.4.2.2.
Hieracium	auriculoides	Lang	G	4	7	3	8	2	8	4	1	5.3.1.
Hieracium	bauhinii	Schult. ex Bess.	G	4	7	3	7	1	9	4	0	5.3.1.
Hieracium	bifidum	Kit. ex Homem.	G	4	5	4	8	2	8	3	0	8.4.3.
Hieracium	bifurcum	M.B.	G	4	8	2	8	2	9	4	0	5.3.1.
Hieracium	brachiatum	Bert. ex Lam.	G	4	5	4	5	2	7	3	0	Indiff.
Hieracium	bupleuroides	C. C. Gmel.	Su	10	3	3	9	2	9	4	0	5.3.1.3.
Hieracium	caesium	(Fr.)Fr.	S	6	4	4	8	2	9	3	0	5.3.1.3.
Hieracium	caespitosum	Dum.	G	4	5	7	7	3	8	6	0	5.4.1.
Hieracium	cynosum	L.	G	4	6	3	7	1	8	5	0	5.3.
Hieracium	echioides	Lummitzer	G	4	6	2	7	1	8	6	0	5.3.1.
Hieracium	floribundum	W. & Gr.	S	6	5	7	7	3	8	4	0	5.4.1.1.
Hieracium	glaucinum	Jord.	G	4	7	4	4	2	7	3	0	8.4.2.
Hieracium	hoppeanum	Schult.	S	6	4	5	5	2	8	4	0	5.3.1.1.
Hieracium	kossuthianum	Soó	S	6	6	3	8	1	8	6	0	5.3.1.4.
Hieracium	lachenalii	C. C. Gmel.	G	4	5	5	4	2	5	4	0	8.3.1.
Hieracium	lactucella	Wallr.	G	4	5	6	4	2	8	3	0	5.1.1.
Hieracium	laevicaule	Jord.	G	4	4	3	8	2	9	4	0	5.3.1.
Hieracium	laevigatum	Willd.	G	4	5	5	4	2	7	3	0	8.3.1.
Hieracium	laschii	(F. Schulz)Z.	G	4	6	2	7	1	8	5	0	5.3.1.
Hieracium	latifolium	Spreng.	G	4	6	5	4	2	6	4	0	8.3.1.
Hieracium	leptophyton	N. & P.	G	4	6	2	6	1	7	5	0	5.3.1.
Hieracium	maculatum	Schrank	G	4	7	4	4	3	5	4	0	8.3.1.
Hieracium	pilosella	L.	DT	2	5	4	4	2	7	3	0	Indiff.
Hieracium	piloselloides	Vill.	G	4	6	3	7	2	9	4	0	5.3.1.
Hieracium	praecurrens	Vukot.	G	4	5	5	5	3	4	3	0	8.3.1.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Hieracium	racemosum	W. & K. ex Willd.	G	4	6	4	5	2	7	4	0	8.4.	
Hieracium	ramosum	W. & K. ex Willd.	S	6	4	2	4	1	8	6	0	5.3.1.3.	
Hieracium	rothianum	Wallr.	S	6	8	2	6	1	9	6	0	5.3.3.1.	
Hieracium	sabaudum	L.	G	4	6	4	5	3	5	3	0	8.4.	
Hieracium	schmidtii	Tausch.	G	4	6	4	4	2	7	3	0	8.4.2.	
Hieracium	schultesii	F. Schulz	G	4	4	5	4	2	8	3	0	5.1.1.	
Hieracium	staticifolium	All.	Su	10	5	4	8	2	9	4	0	5.3.1.3.	
Hieracium	sylvaticum	(L.)Grufbg.	G	4	5	5	5	3	4	3	0	8.3.1.	
Hieracium	umbellatum	L.	DT	2	5	3	5	2	7	3	0	Indiff.	
Hieracium	wiesbaurianum	Uechtr.	S	6	6	3	6	2	7	3	0	5.3.1.3.	
Hierochloë	australis	(Schröd.)R. & S.	G	4	7	3	7	3	7	5	0	8.3.1.	
Hierochloë	repens	(Host)P.B.	G	4	6	5	7	4	6	7	0	8.4.2.	
Himantoglossum	hircinum	(L.)Spreng.	Sr	8	7	3	9	2	7	2	0	8.4.2.3.	
Hippocrepis	comosa	L.	G	4	5	2	8	2	7	2	0	5.3.1.	
Hippophaë	rhamnoides	L.	Cu	9	6	4	9	2	9	6	0	8.1.1.1.	
Hippuris	vulgaris	L.	C	5	5	11	8	5	7	3	0	1.3.1.	
Holcus	lanatus	L.	G	4	5	6	6	4	7	3	0	5.4.	
Holcus	mollis	L.	G	4	5	5	4	3	6	2	0	8.3.1.	
Holoschoenus	romanus	(L.)Fritsch	C	5	6	8	7	5	8	5	0	5.3.3.1.	
Holosteum	umbellatum	L.	W	1	6	5	8	4	8	5	0	Indiff.	
Hordelymus	europaeus	(L.)Jess.	G	4	5	5	6	5	3	4	0	8.4.3.1.	
Hordeum	distichon	L.	I	-1								3.4.	
Hordeum	hexastichon	L.	I	-1									
Hordeum	geniculatum	All.	DT	2	4	3	8	5	9	7	6	5.5.	
Hordeum	marinum	Huds.	A	-1	6	4	6	5	8	5	0	3.4.	
Hordeum	murinum	L.	W	1	7	4	8	6	8	4	1	3.3.3.1.	
Hordeum	vulgare	L.	I	-1								3.3.2.3.	
Hornungia	petraea	(L.)Rchb.	NP	3	7	1	9	1	8	2	0	5.2.1.2.	
Hottonia	palustris	L.	S	6	6	11	5	4	6	5	0	1.3.1.2.	
Humulus	lupulus	L.	DT	2	6	7	6	8	7	3	0	Indiff.	
Huperzia	selago	(L.)Bernh.	Sr	8	3	4	3	5	4	3	0	8.3.1.2.	
Hydrocharis	morsus-ranae	L.	NP	3	6	11	7	7	7	4	0	1.1.2.1.	
Hydrocotyle	vulgaris	L.	Su	10	6	8	4	4	6	2	0	8.4.3.3.	
Hyosciamus	niger	L.	W	1	6	4	7	9	8	4	0	3.5.4.1.	
Hypericum	barbatum	Jacq.	DT	2	6	5	7	4	6	5	0	6.2.	
Hypericum	calycinum	L.	I	-1									
Hypericum	elegans	Steph. ex Willd.	G	4	7	3	8	2	8	6	0	5.3.1.	
Hypericum	hirsutum	L.	DT	2	6	5	6	6	7	4	0	6.2.	
Hypericum	humifusum	L.	NP	3	6	7	4	3	7	2	0	5.2.2.	
Hypericum	maculatum	Cr.	G	4	5	5	4	2	7	3	0	8.3.1.	
Hypericum	montanum	L.	G	4	6	5	7	3	5	4	0	8.4.	
Hypericum	perforatum	L.	DT	2	5	3	6	3	7	5	0	Indiff.	
Hypericum	tetrapterum	Fr.	G	4	5	8	7	5	7	2	0	1.5.1.	
Hypochoeris	maculata	L.	G	4	5	5	6	2	8	5	0	5.3.	
Hypochoeris	radicata	L.	G	4	5	4	4	3	8	3	0	Indiff.	
Hyssopus	officinalis	L.	I	-1									
Ilex	aquifolium	L.	A	-1	5	5	4	5	4	2	0		
Impatiens	balfouri	Hoof.f.	A	-1									
Impatiens	balsamina	L.	I	-1									
Impatiens	glandulifera	Royle	AC	-3	7	8	6	7	5	2	0	3.5.2.	
Impatiens	noli-tangere	L.	G	4	5	7	7	6	4	5	0	8.4.3.	
Impatiens	parviflora	DC.	AC	-3	6	6	7	6	4	5	0	8.4.3.	
Inula	britannica	L.	DT	2	6	7	8	5	8	5	2	Indiff.	
Inula	conyza	DC.	DT	2	6	4	7	3	6	2	0	6.1.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Inula	ensifolia	L.	G	4	7	3	7	2	8	7	0	5.3.1.	
Inula	germanica	L.	S	6	7	3	8	2	8	6	0	8.4.2.3.	
Inula	helenium	L.	S	6	7	7	6	5	6	6	0	8.4.3.3.	
Inula	hirta	L.	G	4	6	3	8	3	7	6	0	5.3.1.	
Inula	oculus-christi	L.	S	6	8	2	8	2	9	7	0	5.3.1.1.	
Inula	salicina ssp. aspera	(Poir.)Hayek	G	4	6	4	7	2	7	7	0	8.4.	
Inula	salicina ssp. denticulata	(Borb.)Soó	G	4	7	3	8	2	8	7	0	5.3.	
Inula	salicina ssp. salicina	L.	G	4	5	5	6	2	7	5	0	5.4.	
Inula	spiraeifolia	L.	Sr	8	8	3	8	3	8	6	0	8.4.2.2.	
Ipomoea	purpurea	(L.)Roth	I	-1									
Ipomoea	tricolor	Cav.	I	-1									
Iris	aphylla	L.	Sr	8	7	3	6	2	8	6	0	5.3.1.1.	
Iris	arenaria	W. & K.	S	6	8	3	9	1	8	7	0	5.3.3.1.	
Iris	germanica	L.	I	-1	8	4	8	2	8	3	0		
Iris	graminea	L.	S	6	7	4	8	4	6	6	0	8.4.2.2.	
Iris	pseudacorus	L.	G	4	6	9	6	7	7	3	0	1.5.1.	
Iris	pumila	L.	S	6	7	2	9	1	9	7	0	5.3.1.	
Iris	sibirica	L.	Sr	8	6	8	8	2	8	5	0	5.4.1.1.	
Iris	spuria	L.	Sr	8	8	7	8	3	9	5	0	5.4.1.1.	
Iris	variegata	L.	G	4	7	4	7	4	6	6	0	6.1.1.2.	
Isatis	tinctoria	L.	G	4	7	3	8	3	8	7	0	5.3.1.	
Isopyrum	thalictroides	L.	S	6	7	6	6	4	4	5	0	8.4.3.1.	
Iva	xanthiifolia	Nutt.	AG	-3	8	4	7	6	9	8	0	Indiff.	
Jasione	montana	L.	S	6	6	2	4	2	7	3	0	5.2.2.1.	
Jasminum	fruticans	L.	I	-1									
Jasminum	nudiflorum	Lindl.	I	-1									
Jovibarba	hirta	(Jusl.)Opiz	G	4	6	1	7	1	9	5	0	5.3.1.	
Juglans	nigra	L.	I	-1	8	6	7	7	6	2	0		
Juglans	regia	L.	I	-1	8	6	8	4	5	5	0		
Juncellus	serotinus	(Rottb.)Clarke	NP	3	7	8	6	5	8	6	0	3.1.1.1.	
Juncus	alpinus	Vill.	G	4	5	8	8	3	8	5	0	1.7.2.	
Juncus	articulatus	L.	DT	2	5	8	6	2	8	3	1	Indiff.	
Juncus	atratus	Korcker	G	4	6	7	8	2	8	6	1	5.4.1.	
Juncus	bufonius	L.	DT	2	5	7	5	6	7	4	1	3.1.	
Juncus	bulbosus	L.	NP	3	6	8	4	3	8	5	0	3.1.1.1.	
Juncus	capitatus	Weigel	DT	2	7	7	4	2	8	3	0	3.4.2.1.	
Juncus	compressus	Jacq.	DT	2	5	8	6	5	8	3	0	Indiff.	
Juncus	conglomeratus	L.	DT	2	5	8	5	5	8	3	0	5.4.	
Juncus	effusus	L.	DT	2	5	9	6	3	8	3	0	Indiff.	
Juncus	gerardii	Lois.	C	5	6	7	7	5	8	7	5	5.5.1.3.	
Juncus	inflexus	L.	DT	2	5	8	8	4	8	3	1	Indiff.	
Juncus	maritimus	Lam.	C	5	7	6	8	2	9	3	0	1.5.1.4.	
Juncus	sphaerocarpus	Nees ex Funck	NP	3	6	7	4	3	8	5	0	3.1.1.1.	
Juncus	subnodulosus	Schrank	C	5	6	8	9	3	8	2	0	5.4.1.1.	
Juncus	tenageia	Ehrh.	NP	3	7	7	4	3	8	2	0	3.1.1.1.	
Juncus	tenuis	Willd.	W	1	5	7	5	4	5	4	0	3.7.1.1.	
Juniperus	communis	L.	DT	2	4	4	5	4	8	4	0	Indiff.	
Juniperus	sabina	L.	I	-1									
Juniperus	virginiana	L.	I	-1									
Jurinea	mollis	(Torn.)Rchb.	S	6	8	3	9	2	8	6	0	5.3.1.4.	
Kickxia	elatine	(L.)Dum.	W	1	6	4	7	3	7	2	0	3.4.	
Kickxia	spuria	(L.)Dum.	W	1	7	4	7	4	7	2	0	3.4.1.	
Kitabelia	vitifolia	Willd.	A	-1									
Knautia	arvensis	(L.)Coul.	DT	2	5	4	6	3	7	3	0	Indiff.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Knautia	dipsacifolia	(Host)Kreutzer	S	6	4	6	7	4	5	6	0	8.4.3.1.	
Knautia	drymeia	Heuff.	G	4	6	6	6	5	5	6	0	8.4.3.	
Knautia	kitaibelii	(Schult.)Borb.	Su	10	4	3	9	1	9	6	0	5.3.1.4.	
Kochia	laniflora	(Gmel.)Borb.	NP	3	8	1	8	2	9	7	0	5.3.3.2.	
Kochia	prostrata	(L.)Schräd.	S	6	8	1	8	1	9	8	3	5.3.1.7.	
Kochia	scoparia	(L.)Schräd.	W	1	7	5	6	6	8	6	0	3.3.	
Koeleria	cristata	(L.)Pers.	G	4	6	3	8	2	8	6	0	5.3.	
Koeleria	glauca	(Schkuhr)DC.	C	5	7	1	8	2	9	7	0	5.5.3.1.	
Koeleria	javorkae	Ujh.	Su	10	6	7	8	3	8	6	0	5.4.1.1.	
Koeleria	majoriflora	(Borb.)Borb.	G	4	7	3	8	2	7	7	0	5.3.1.	
Koeleria	mollis	Mann ex Opiz	G5	6	6	5	5	3	8	6	0	5.4.1.	
Koeleria	pyramidata	(Lam.)P.B.	G	4	6	3	8	2	8	4	0	8.4.2.	
Koelreuteria	paniculata	Laxm.	I	-1									
Laburnum	anagyroides	Medik.	S	6	7	4	8	2	7	3	0	8.4.2.2.	
Lactuca	perennis	L.	G	4	8	2	8	2	9	4	0	5.3.1.	
Lactuca	quercina	L.	G	4	7	4	8	5	6	5	0	8.4.	
Lactuca	saligna	L.	DT	2	8	3	8	5	8	5	0	Indiff.	
Lactuca	sativa	L.	I	-1									
Lactuca	serriola	Tom. ex L.	W	1	7	3	6	4	9	7	0	3.3.	
Lactuca	viminea	(L.)Presl.	G	4	7	2	7	3	7	5	0	6.1.1.	
Lagenaria	siceraria	(Mol.)Standl.	I	-1									
Lamium	album	L.	DT	2	5	5	5	9	6	3	0	3.5.2.	
Lamium	amplexicaule	L.	W	1	6	4	6	7	6	5	0	3.3.1.	
Lamium	maculatum	(L.)L.	DT	2	5	6	7	8	4	4	0	Indiff.	
Lamium	orvala	L.	Su	10	7	6	7	4	4	4	0	8.4.3.4.	
Lamium	purpureum	L.	W	1	5	5	7	6	7	3	0	3.3.	
Lantana	camara	L.	I	-1									
Lappula	heteracantha	(Led.)Gürcke	S	6	8	2	5	1	9	7	0	5.3.1.1.	
Lappula	patula	(Lehm.)Menyh.	A	-1									
Lappula	squarrosa	(Retz)Dum.	W	1	6	3	6	6	8	6	0	3.3.	
Lapsana	communis	L.	DT	2	6	7	6	7	5	3	0	Indiff.	
Larix	decidua	Mill.	I	-1	3	4	4	3	8	6	0		
Laser	trilobum	(L.)Borkh.	S	6	7	4	9	2	7	4	0	8.4.2.	
Laserpitium	latifolium	L.	G	4	4	5	7	4	6	2	0	8.4.2.	
Laserpitium	prutenicum	L.	G	4	6	6	6	4	7	5	0	8.4.	
Lathraea	squamaria	L.	S	6	5	6	6	6	3	3	0	8.4.3.2.	
Lathyrus	aphaca	L.	W	1	7	3	8	4	7	7	0	3.4.1.	
Lathyrus	cicera	L.	A	-1									
Lathyrus	hirsutus	L.	W	1	6	4	7	3	7	4	0	3.4.	
Lathyrus	latifolius	L.	DT	2	8	3	8	3	7	4	0	6.1.1.	
Lathyrus	linifolius	(Reich.)Bassl.	Su	10	5	5	3	2	6	2	0	8.3.1.1.	
Lathyrus	niger	(L.)Bernh.	G	4	7	5	6	3	5	4	0	8.4.2.	
Lathyrus	nissolia	L.	G	4	8	3	7	3	8	4	0	5.3.1.	
Lathyrus	pallescens	(MB.)C.Koch	S	6	8	3	8	1	8	6	0	5.3.1.1.	
Lathyrus	palustris	L.	T	4	6	9	8	3	8	4	0	1.5.	
Lathyrus	pann. ssp. collinus	(Ortman)Soó	G	4	8	4	8	2	8	6	0	8.4.2.	
Lathyrus	pannonicus ssp. p.	(Jacq.)Garcke	S	6	7	8	8	4	8	6	0	5.4.1.	
Lathyrus	pisiformis	L.	Sr	8	5	4	8	4	7	7	0	8.4.2.3.	
Lathyrus	pratensis	L.	DT	2	5	7	7	6	7	4	0	5.4.	
Lathyrus	sativus	L.	I	-1									
Lathyrus	sphaericus	Retz.	S	6	8	2	8	2	9	7	0	5.3.1.1.	
Lathyrus	sylvestris	L.	G	4	6	4	5	3	6	5	0	8.3.1.	
Lathyrus	transsylvanicus	(Spr.)Rchb.f.	Su	10	4	5	8	4	6	7	0	8.3.4.1.	
Lathyrus	tuberosus	L.	W	1	7	4	8	4	7	6	0	3.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Lathyrus	venetus	(Mill.)Wohlf.	S	6	8	5	8	4	5	6	0	8.4.3.4.	
Lathyrus	vernus	(L.)Bernh.	S	6	6	6	7	5	4	4	0	8.4.3.1.	
Lavandula	angustifolia	Mill.	I	-1									
Lavatera	thuringiaca	L.	DT	2	6	5	6	7	7	4	1	3.3.	
Leersia	oryzoides	(L.)Sw.	C	5	5	10	6	8	8	3	0	1.5.1.	
Legousia	speculum-veneris	(L.)Chaix.	W	1	7	4	8	3	8	4	0	3.4.1.1.	
Lembotropis	nigricans	(L.)Griseb.	G	4	6	4	4	2	6	5	0	Indiff.	
Lemna	gibba	L.	NP	3	6	11	7	8	7	3	0	1.1.1.1.	
Lemna	minor	L.	NP	3	5	11	7	6	7	3	0	1.1.1.1.	
Lemna	trisulca	L.	NP	3	5	11	7	6	8	3	0	1.1.1.	
Lens	culinaris	Medik.	I	-1									
Leontodon	autumnalis	L.	DT	2	5	7	6	5	8	3	1	Indiff.	
Leontodon	hispidus	L.	DT	2	5	4	6	3	8	3	0	Indiff.	
Leontodon	incanus	(L.)Schrank	S	6	5	1	9	1	8	4	0	5.3.1.4.	
Leontodon	saxatilis	Lam.	G	4	7	7	6	5	8	2	1	5.4.	
Leonurus	cardiaca	L.	W	1	6	5	8	8	7	6	0	3.5.1.1.	
Leonurus	marrubiastrum	L.	W	1	7	6	8	7	8	8	0	3.2.1.	
Lepidium	campestre	(L.)R.Br.	DT	2	6	4	8	6	9	3	1	Indiff.	
Lepidium	crassifolium	W. & K.	S	6	8	3	8	2	9	8	8	5.5.1.2.	
Lepidium	densiflorum	Schrad.	W	1	7	4	7	6	8	7	0	3.3.3.1.	
Lepidium	graminifolium	L.	W	1	8	3	6	3	9	3	0	3.5.4.1.	
Lepidium	perfoliatum	L.	DT	2	7	4	8	3	9	8	4	5.5.	
Lepidium	ruderales	L.	DT	2	7	4	8	5	9	7	4	5.5.	
Lepidium	sativum	L.	I	-1									
Lepidium	virginicum	L.	A	-1	7	4	8	5	8	6	0	3.3.3.1.	
Leucanthemum	irkutianum	DC.	G	4	5	5	6	3	7	3	0	5.4.	
Leucanthemum	margaritae	(Gáy & Jáv.)Soó	S	6	7	5	8	3	7	3	0	8.4.2.2.	
Leucanthemum	serotinum	L.	S	6	7	7	6	5	7	6	0	1.5.1.1.	
Leucanthemum	vulgare	agg.	G	4	5	7	6	4	7	3	0	5.4.	
Leucojum	aestivum	L.	S	6	8	9	7	8	7	4	0	8.1.1.2.	
Leucojum	vernum	L.	Sr	8	5	7	7	8	6	4	0	8.4.3.2.	
Levisticum	officinale	Koch	I	-1									
Ligularia	sibirica	(L.)Cass.	Su	10	3	9	5	2	7	8	0	1.5.1.4.	
Ligustrum	vulgare	L.	G	4	6	5	6	4	6	3	0	8.4.	
Lilium	bulbiferum	L.	Gu	8	7	6	8	4	7	4	0	8.4.	
Lilium	candidum	L.	I	-1									
Lilium	croceum	Chaix ex Vill.	I	-1									
Lilium	martagon	L.	G	4	5	6	7	5	5	5	0	8.4.3.	
Lilium	regale	Wilson	I	-1									
Limodorum	abortivum	(L.)Sw.	S	6	7	4	8	2	7	3	0	8.4.2.2.	
Limonium	gmelini	(Willd.)Ktze	A	6	7	6	7	5	9	5	7	5.5.2.1.	
Limonium	sinuatum	(L.)Mill.	I	-1									
Limosella	aquatica	L.	NP	3	5	9	6	6	7	3	0	3.1.1.1.	
Linaria	angustissima	(Lois.)Borb.	S	6	7	2	9	2	9	7	0	5.3.1.1.	
Linaria	arvensis	(L.)Desf.	A	-1	7	4	5	3	8	5	0	3.4.	
Linaria	genistifolia	(L.)Mill.	G	4	7	2	8	2	8	6	0	5.3.	
Linaria	kocianovichii	Asch.	Gr	6	6	2	8	1	9	7	0	5.3.1.	
Linaria	vulgaris	Mill.	W	1	5	3	6	3	8	5	0	Indiff.	
Lindernia	procumbens	(Krock.)Borb.	NP	3	7	9	8	7	9	5	0	3.1.1.1.	
Linum	austriacum	L.	G	4	8	2	8	1	9	6	0	5.3.	
Linum	catharticum	L.	G	4	5	7	6	2	7	3	0	5.4.	
Linum	dolomiticum	Borb.	Su	10	8	1	9	1	9	6	0	5.3.1.4.	
Linum	flavum	L.	G	4	7	2	8	1	8	5	0	5.3.1.	
Linum	glabrescens	Rochel	S	6	8	1	8	1	9	6	0	5.3.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Linum	hirsutum	L.	S	6	8	2	9	1	9	7	0	5.3.1.1.	
Linum	perenne	L.	Dt	2	6	5	8	3	7	6	0	Indiff.	
Linum	tenuifolium	L.	G	4	8	2	8	2	9	4	0	5.3.	
Linum	trigynum	L.	G	4	7	5	4	1	8	4	0	5.1.1.	
Linum	usitatissimum	L.	I	-1									
Liparis	loeselii	(L.)Rich.	Su	10	5	9	9	3	7	4	0	1.5.1.1.	
Liriodendron	tulipifera	L.	I	-1									
Listera	ovata	(L.)R.Br.	S	6	5	7	6	5	4	3	0	8.4.3.3.	
Lithospermum	officinale	L.	DT	2	5	4	6	6	6	5	0	6.2.1.	
Lobularia	maritima	(L.)Desv.	I	-1									
Lolium	multiflorum	Lam.	W	1	7	4	7	6	7	3	0	Indiff.	
Lolium	perenne	L.	DT	2	5	5	6	7	8	3	0	Indiff.	
Lolium	remotum	Schrank	W	1	6	4	8	3	7	5	0	3.4.3.1.	
Lolium	temulentum	L.	W	1	7	4	8	4	7	3	0	3.4.3.1.	
Lonicera	caprifolium	L.	G	4	8	5	8	4	6	4	0	8.4.	
Linicera	nigra	L.	S	6	4	6	4	4	4	4	0	8.3.1.1.	
Lonicera	periclymenum	L.	I	-1									
Lonicera	tatarica	L.	I	-1									
Lonicera	xylosteum	L.	G	4	5	5	7	5	5	4	0	8.4.	
Loranthus	europaeus	Jacq.	G	4	6	5	6	4	7	5	0	8.4.	
Lotus	angustissimus	L.	Sr	8	8	2	8	1	9	8	5	5.5.2.1.	
Lotus	borbasii	Ujh.	Sr	8	8	2	9	1	9	6	0	5.3.1.1.	
Lotus	corniculatus	L.	DT	2	5	4	7	2	7	3	1	Indiff.	
Lotus	tenuis	W. & K. ex Willd.	DT	2	7	7	8	4	8	3	4	Indiff.	
Lotus	uliginosus	Schkuhr	A	-1	6	8	5	4	7	2	0	5.4.1.6.	
Ludwigia	palustris	(L.)Ell.	S	6	7	10	6	4	8	3	0	3.1.1.1.	
Luffa	cylindrica	(L.)Roem.	I	-1									
Lunaria	annua	L.	Gu	8	7	5	7	5	5	5	0	8.4.	
Lunaria	rediviva	L.	S	6	5	7	7	8	4	4	0	8.4.3.1.	
Lupinus	albus	L.	I	-1									
Lupinus	angustifolius	L.	I	-1									
Lupinus	luteus	L.	I	-1									
Lupinus	polyphyllus	Lindl.	I	-1	6	5	4	6	8	3	0	6.2.1.	
Luzula	campestris	(L.)Lam. & DC.	DT	2	5	4	6	2	7	3	0	Indiff.	
Luzula	forsteri	(Sm.)DC.	S	6	6	5	4	2	4	2	0	7.4.3.4.	
Luzula	luzuloides	(Lam.)Dand. & W.	C	5	5	5	4	4	4	4	0	8.3.	
Luzula	multiflora	(Retz.)Lej.	G	4	5	6	5	3	7	4	0	5.1.	
Luzula	pallescent	(Whalbg.)Sw.	G	4	6	5	5	2	6	4	0	8.3.1.	
Luzula	pilosa	(L.)Willd.	G	4	5	5	5	4	3	3	0	8.4.3.	
Lychnis	coronaria	(L.)Desr.	S	6	7	4	6	3	5	5	0	8.4.2.3.	
Lychnis	flos-cuculi	L.	G	4	5	7	5	4	7	3	0	5.4.1.	
Lychnis	viscaria	L.	S	6	6	3	4	2	7	4	0	8.3.1.1.	
Lycium	barbarum	L.	AC	-3	7	6	6	5	8	5	0	3.5.1.	
Lycopersicon	esculentum	Mill.	I	-1									
Lycopodium	annotinum	L.	Su	10	4	5	3	3	3	3	0	8.3.1.2.	
Lycopodium	clavatum	L.	S	6	4	4	4	2	7	3	0	8.3.1.2.	
Lycopsis	arvensis	L.	W	1	5	3	4	2	8	5	0	3.3.2.	
Lycopus	europaeus	L.	DT	2	6	9	6	7	7	5	0	Indiff.	
Lycopus	exaltatus	L.	DT	2	6	9	6	6	7	6	0	Indiff.	
Lysimachia	nummularia	L.	DT	2	6	7	8	4	5	4	0	Indiff.	
Lysimachia	punctata	L.	G	4	6	6	6	5	5	5	0	8.3.	
Lysimachia	thyrsiflora	L.	Su	10	4	9	4	3	7	7	0	1.7.1.2.	
Lysimachia	vulgaris	L.	DT	2	5	8	6	4	6	5	0	Indiff.	
Lythrum	hyssopifolia	L.	DT	2	7	7	7	3	8	5	2	3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Lythrum	linifolium	Kar. & Kir.	NP	3	6	8	4	2	8	6	0	3.1.1.1.	
Lythrum	salicaria	L.	G	4	5	9	7	4	7	5	1	1.5.	
Lythrum	thesioides	M.B.	A	-1									
Lythrum	tribracteatum	Salmz. ex Spr.	NP	3	7	8	8	3	8	7	0	3.1.1.4.	
Lythrum	virgatum	L.	G	4	6	8	8	5	7	7	0	Indiff.	
Macleaya	cordata	R.Br.	I	-1									
Maclura	pomifera	(Raf.)Schneid.	I	-1									
Magnolia	acuminata	L.	I	-1									
Magnolia	denudata	Desr. ex Lam.	I	-1									
Magnolia	liliiflora	Desr. ex Lam.	I	-1									
Mahonia	aquifolium	(Pursh)Nutt.	I	-1									
Majanthemum	bifolium	(L.)W.F.Schm.	G	4	5	6	5	4	4	6	0	8.4.3.	
Majorana	hortensis	Mönch	I	-1									
Malcolmia	africana	(L.)R.Br.	A	-1									
Malus	domestica	Borkh.	I	-1									
Malus	sylvestris	(L.)Mill.	G	4	5	5	7	5	6	3	0	8.4.	
Malva	alcea	L.	W	1	6	3	8	8	8	4	0	3.5.4.1.	
Malva	neglecta	Wallr.	W	1	6	4	6	9	7	7	0	3.3.3.	
Malva	pusilla	Sm. ex Sow.	W	1	8	4	6	6	8	7	1	3.3.	
Malva	sylvestris	L.	W	1	6	4	7	8	8	3	0	3.3.3.	
Marrubium	peregrinum	L.	W	1	8	3	7	5	9	7	0	3.5.4.1.	
Marrubium	x remotum	Kit. ex Schult.	W	1	8	4	7	6	9	7	0	3.5.4.1.	
Marrubium	vulgare	L.	W	1	8	4	8	8	9	5	0	3.5.1.1.	
Marsilea	quadrifolia	L.	S	6	8	10	8	7	9	5	0	3.1.1.1.	
Matricaria	chamomilla	L.	G	4	5	6	8	4	8	5	6	5.5.1.	
Matricaria	discoidea	DC.	W	1	5	4	7	8	8	3	0	3.7.1.1.	
Matricaria	maritima	L.	W	1	5	5	7	7	8	3	2	3.3.	
Matricaria	tenuifolia	(Kit.)Simk.	W	1	5	4	6	6	8	3	0	3.4.2.1.	
Matteuccia	struthiopteris	(L.)Tod.	Sr	8	5	7	6	7	5	4	0	8.4.3.3.	
Matthiola	bicomis	(S. & S.)DC.	A	-1									
Matthiola	incana	(L.)R.Br.	I	-1									
Medicago	arabica	(L.)Huds.	G	4	8	3	8	3	8	4	0	5.3.1.	
Medicago	falcata	L.	DT	2	6	3	8	3	8	7	0	6.1.1.2.	
Medicago	lupulina	L.	DT	2	5	5	8	4	7	4	1	Indiff.	
Medicago	minima	(L.)Grufbg.	G	4	7	2	8	1	9	3	0	5.3.	
Medicago	nigra	(L.)Krock.	A	-1									
Medicago	orbicularis	(L.)All.	Su	10	9	1	9	1	9	5	0	5.3.1.5.	
Medicago	prostrata	Jacq.	G	4	8	1	9	1	9	6	0	5.3.1.	
Medicago	rigidula	(L.)Desr.	Sr	8	8	1	8	1	9	7	0	5.3.1.3.	
Medicago	sativa	L.	I	-1	6	5	8	5	9	6	0	3.4.1.2.	
Medicago	x varia	Martyn	DT	2	6	3	8	3	8	7	0	5.3.	
Melampyrum	arvense	L.	DT	2	6	3	8	3	7	5	0	3.4.	
Melampyrum	barbatum	W. & K.	G	4	8	4	8	5	8	7	0	3.5.1.	
Melampyrum	bihariense	Kem.	Su	10	6	5	6	5	5	8	0	8.4.2.3.	
Melampyrum	cristatum	L.	S	6	7	3	8	3	6	5	0	5.3.1.1.	
Melampyrum	nemorosum	L.	G	4	6	5	6	5	4	4	0	8.4.	
Melampyrum	pratense	L.	G	4	5	4	4	3	6	3	0	8.3.1.2.	
Melandrium	album	(Mill.)Garcke	W	1	5	4	6	7	8	4	0	Indiff.	
Melandrium	noctiflorum	(L.)Fr.	W	1	5	3	8	4	7	4	0	3.5.2.	
Melandrium	sylvestre	(Schk.)Roehl.	S	6	5	6	6	8	4	4	0	8.4.3.1.	
Melandrium	viscosum	(L.)Celak.	S	6	6	2	8	1	9	7	4	5.5.2.1.	
Melica	altissima	L.	S	6	6	4	8	4	6	7	0	8.4.2.3.	
Melica	ciliata	L.	C	5	7	1	7	2	9	4	0	5.3.1.	
Melica	nutans	L.	G	4	5	5	6	4	4	3	0	8.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Melica	picta	C.Koch	S	6	8	4	8	3	6	4	0	8.4.2.3.	
Melica	transsylvanica	Schur	G	4	8	2	6	3	8	4	0	5.3.1.	
Melica	uniflora	Retz.	C	5	5	5	6	4	4	2	0	8.4.	
Melilotus	alba	Desr. ex Lam.	W	1	6	3	7	3	9	6	0	3.5.4.2.	
Melilotus	altissima	Thuill.	W	1	6	7	7	4	8	5	2	3.5.2.2.	
Melilotus	dentata	(W. & K.)Pers.	DT	2	6	7	8	4	8	6	2	3.8.1.1.	
Melilotus	officinalis	(L.)Desr.	W	1	6	4	8	4	8	6	0	3.5.4.2.	
Melissa	officinalis	L.	S	6	8	4	8	4	6	7	0	8.4.2.2.	
Melittis	carpatica	Klok. em. Soó	G	4	6	5	7	3	5	5	0	8.4.2.	
Melittis	melissophyllum	L.	S	6	8	4	9	1	6	2	0	8.4.2.2.	
Mentha	aquatica	L.	G	4	5	9	7	4	7	3	0	Indiff.	
Mentha	arvensis	L.	DT	2	5	7	6	5	7	4	0	Indiff.	
Mentha	x carinthiaca	Host	DT	2	5	8	6	6	7	4	0	Indiff.	
Mentha	x dalmatica	Tausch	DT	2	6	8	8	7	7	4	0	Indiff.	
Mentha	x dumetorum	Schult.	DT	2	5	9	8	8	7	4	0	Indiff.	
Mentha	x gentilis	L.	DT	2	5	9	7	5	7	3	0	Indiff.	
Mentha	longifolia	(L.)Nath.	DT	2	5	9	8	8	7	4	0	Indiff.	
Mentha	x piperita	L.	I	-1	7	6	7	6	8	5	0		
Mentha	pulegium	L.	DT	2	7	7	8	4	8	3	1	Indiff.	
Mentha	spicata	L.	I	-1									
Mentha	x verticillata	L.	G	4	5	9	7	4	7	3	0	5.4.1.	
Menyanthes	trifoliata	L.	S	6	4	10	5	2	8	3	0	1.5.1.4.	
Mercurialis	annua	L.	W	1	7	4	7	8	7	3	0	3.3.1.	
Mercurialis	ovata	Stern. & Hoppe	S	6	7	3	8	4	7	4	0	8.4.2.2.	
Mercurialis	x paxii	Graebn.	S	6	8	4	8	2	7	6	0	8.4.2.2.	
Mercurialis	perennis	L.	C	5	5	6	7	7	3	3	0	8.4.3.	
Mespilus	germanica	L.	I	-1	8	4	6	4	6	6	0		
Micropus	erectus	L.	NP	3	8	1	9	1	9	3	0	5.2.1.2.	
Milium	effusum	L.	G	4	5	6	6	4	4	3	0	8.4.3.	
Minuartia	fastigiata	(Sm.)Rchb.	NP	3	8	2	7	1	9	6	0	5.3.	
Minuartia	frutescens	(Kit.)Tuzs. & Deg.	S	6	7	1	5	1	9	7	0	5.3.1.3.	
Minuartia	glomerata	(M.B.)Deg.	G	4	7	2	7	2	9	7	0	5.3.	
Minuartia	setacea	(Thuill.)Hay.	G	4	7	1	7	1	9	6	0	5.3.	
Minuartia	verna	(L.)Hiern.	G	4	5	2	7	1	9	7	0	5.3.	
Minuartia	viscosa	(Schreb.)S. & Th.	NP	3	8	2	5	1	9	6	0	5.2.2.	
Mirabilis	jalapa	L.	I	-1									
Mirabilis	nyctaginea	(Michx.)McMil.	I	-1	9	5	6	6	8	4	0		
Misopates	orontium	(L.)Raf.	W	1	7	5	5	5	7	3	0	3.4.1.	
Moehringia	muscosa	L.	Sr	8	3	7	9	2	4	2	0	8.4.3.1.	
Moehringia	trinervia	(L.)Clairv.	DT	2	5	5	6	7	4	3	0	8.4.	
Moenchia	mantica	(L.)Bartl.	G	4	6	5	6	2	7	3	0	5.4.2.	
Molinia	arundinacea	Schrank	C	5	6	5	5	2	6	3	0	8.3.1.	
Molinia	horanszkyi	Milkovits	Gu	8									
Molinia	hungarica	Milkovits	C	5	6	7	7	2	7	5	0	5.4.1.	
Molinia	litoralis	Host	C	5	6	7	5	3	6	4	0	8.2.	
Molinia	pocsi	Milkovits	Gu	8									
Molinia	simoni	Milkovits	Cu	9	5	9	6	4	7	6	0	1.5.1.3.	
Molinia	ujhelyii	Milkovits	Gu	8									
Monarda	didyma	L.	I	-1									
Molinia	fistulosa	L.	I	-1									
Moneses	uniflora	(L.)A.Gray	S	6	3	5	4	2	4	5	0	8.3.1.2.	
Monotropa	h. ssp. hypophegea	(Wallr.)Holmboe	G	4	5	4	5	3	7	6	0	7.2.1.	
Monotropa	hypopitys ssp. hypopitys	L.	G	4	4	5	4	5	5	5	0	8.3.	
Montia	fontana	L.	S	6	6	8	5	4	7	2	0	1.6.1.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Morus	alba	L.	I	-1	7	6	7	6	5	5	0	8.1.1.2.	
Morus	nigra	L.	I	-1									
Muscari	botryoides ssp. botr.	(L.)Mill.	G	4	6	5	7	4	6	4	0	8.4.	
Muscari	botr. ssp. hungaricum	Priszter	G	4	7	6	7	5	6	5	0	8.4.3.	
Muscari	botr. ssp. kernerii	(Marches.)Richter	G	4	7	5	8	4	7	4	0	8.4.	
Muscari	comosum	(L.)Mill.	DT	2	8	3	7	5	7	3	0	Indiff.	
Muscari	neglectum	Guss. ex Ten.	G	4	7	3	8	2	7	7	0	5.3.	
Muscari	racemosum	(L.)Mill.	G	4	8	2	9	2	8	3	0	5.3.	
Muscari	tenuiflorum	Tausch.	S	6	8	2	8	2	7	6	0	5.3.1.1.	
Myagrum	perfoliatum	L.	W	1	8	4	8	5	7	4	0	3.4.	
Mycelis	muralis	(L.)Dum.	G	4	5	5	6	6	4	2	0	8.4.	
Myosotis	arvensis	(L.)Hill.	DT	2	5	4	5	6	6	5	0	Indiff.	
Myosotis	caespitosa	(K.F.)Schultz	S	6	5	9	5	4	8	4	0	1.5.1.4.	
Myosotis	discolor	Pers.	NP	3	7	3	3	2	7	2	0	5.1.1.5.	
Myosotis	nemorosa	Bess.	G	4	5	8	6	4	6	3	0	1.5.	
Myosotis	palustris	(L.)Nath.	G	4	5	8	6	5	7	5	0	1.5.	
Myosotis	ramosissima	Roch. ex. Schult.	NP	3	6	3	8	4	9	5	0	5.2.3.	
Myosotis	sparsiflora	Mikan ex Pohl	G	4	6	6	8	7	5	6	0	8.4.3.	
Myosotis	stenophylla	Knaf in Opiz	Su	10	7	1	9	1	9	6	0	5.3.1.4.	
Myosotis	stricta	Link ex R. & Sch.	NP	3	6	2	6	2	9	5	0	5.2.3.	
Myosotis	sylvatica	(Ehrh.)Hoffm.	G	4	5	6	6	7	5	3	0	8.4.3.	
Myosoton	aquaticum	(L.)Mönch	DT	2	5	8	6	7	7	3	0	Indiff.	
Myosurus	minimus	L.	NP	3	7	6	7	3	8	5	1	5.5.1.1.	
Myricaria	germanica	(L.)Desf.	C	5	4	8	8	2	8	7	0	8.1.1.1.	
Myriophyllum	spicatum	L.	C	5	5	12	8	5	5	4	0	1.3.1.1.	
Myriophyllum	verticillatum	L.	NP	3	6	12	6	4	5	4	0	1.3.1.1.	
Myrrhoides	nodosa	(L.)Cannon	S	6	8	4	8	1	7	7	0	8.4.2.2.	
Najas	marina	L. em. Asch.	C	5	7	12	7	6	5	4	1	1.3.1.1.	
Najas	minor	All.	NP	3	8	12	8	4	6	4	1	1.3.1.1.	
Narcissus	x incomparabilis	Mill.	I	-1									
Narcissus	poeticus	L.	I	-1									
Narcissus	pseudonarcissus	L.	I	-1	4	6	4	4	8	2	0		
Narcissus	stellaris	Haw.	S	6	5	6	6	3	8	4	0	5.4.2.2.	
Nardus	stricta	L.	C	5	3	4	2	4	8	3	0	5.1.1.	
Nasturtium	officinale	R.Br.	NP	3	4	11	7	7	7	3	0	1.5.1.3.	
Nelumbo	nucifera	Gaertn.	I	-1									
Neottia	nidus-avis	(L.)Rich.	G	4	6	6	7	5	3	3	0	8.4.3.	
Nepeta	cataria	L.	W	1	7	4	7	7	8	3	0	3.5.1.1.	
Nepeta	pannonica	L.	S	6	8	3	7	4	8	6	0	8.4.2.3.	
Nepeta	parviflora	L.	Su	10	8	3	8	3	8	8	0	5.3.1.1.	
Neslea	paniculata	(L.)Desv.	W	1	6	4	8	4	7	5	0	3.4.1.1.	
Nicandra	physaloides	(L.)Gaertn.	W	1	8	5	6	6	7	6	0	3.3.3.	
Nicotiana	alata	Link & Otto	I	-1									
Nicotiana	rustica	L.	I	-1									
Nicotiana	tabacum	L.	I	-1									
Nigella	arvensis	L.	W	1	7	3	9	3	8	5	0	3.4.1.	
Nonea	pulla	(L.)Lam. & DC.	DT	2	6	3	7	4	8	6	0	5.3.	
Nuphar	luteum	(L.)Sm.	C	5	6	11	7	8	8	4	0	1.3.1.2.	
Nymphaea	alba	L.	C	5	7	11	7	7	8	3	0	1.3.1.2.	
Nymphoides	peltata	(Gmel.)Ktze.	C	5	8	11	8	7	8	5	0	1.3.1.2.	
Ocimum	basilicum	L.	I	-1									
Odontites	luteus	(L.)Clairv.	G	4	7	2	9	1	7	5	0	5.3.	
Odontites	vernus	(Bell.)Dum.	W	1	6	6	5	4	6	3	0	3.4.	
Odontites	vulgaris	Moench	DT	2	6	5	7	6	6	3	1	Indiff.	
Oenanthe	aquatica	(L.)Poir. ex Lam.	C	5	6	10	7	5	7	5	0	1.5.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Oenanthe	banatica	Heuff.	S	6	8	7	6	4	6	7	0	8.4.3.3.	
Oenanthe	fistulosa	L.	G	4	7	9	8	5	7	2	0	1.5.1.	
Oenanthe	silaifolia	M.B.	G	4	7	7	7	4	7	5	2	5.4.1.	
Oenothera	biennis	L.	W	1	7	3	8	4	9	3	0	Indiff.	
Oenothera	depressa	Greene	A	-1									
Oenothera	erythrosepala	Borb.	A	-1									
Oenothera	rubricaulis	Klebahn	A	-1									
Oenothera	suaveolens	Desf.	A	-1	7	6	7	5	8	4	0	3.5.	
Oenothera	syrticola	Bart. ex Greene	A	-1									
Omphalodes	scorpioides	(Hanke)Schränk	S	6	6	6	8	7	4	4	0	8.4.3.1.	
Onobrychis	arenaria	(Kit.)Ser.	S	6	7	2	9	1	7	7	0	5.3.3.1.	
Onobrychis	viciifolia	Scop.	DT	2	7	3	8	3	8	6	0	5.3.	
Ononis	arvensis	L.	G	4	6	4	7	6	8	7	0	5.4.	
Ononis	pusilla	L.	S	6	8	2	9	1	9	5	0	5.3.1.1.	
Ononis	semiturcica	Simk.	G	4	6	5	7	4	8	5	0	5.4.	
Ononis	spinosa	L.	DT	2	6	3	7	3	8	5	1	Indiff.	
Ononis	spinosiformis	Simk	Gr	6	7	3	7	4	8	6	0	5.3.1.	
Onopordum	acanthium	L.	W	1	7	4	7	8	9	6	0	3.5.4.1.	
Onosma	arenarium	W. & K.	G	4	8	3	8	1	7	6	0	5.3.1.	
Onosma	pseudarenarium	Schur	S	6	7	3	7	2	8	7	0	5.3.3.1.	
Onosma	tornense	Jav.	Su	10	8	1	9	1	9	6	0	5.3.1.3.	
Onosma	visianii	Clem.	S	6	8	1	9	1	9	5	0	5.3.1.4.	
Ophioglossum	vulgatum	L.	G	4	5	7	5	3	5	3	0	5.4.	
Ophrys	apifera	Huds.	Gu	8	6	4	9	2	7	2	0	Indiff.	
Ophrys	fuciflora	(F.Schm.)Mönch	Gu	8	7	6	8	3	7	5	0	5.4.1.	
Ophrys	insectifera	L. em. Grufbg.	Gu	8	5	4	8	1	8	4	0	5.3.1.	
Ophrys	scolopax	Cav.	Gu	8	8	4	9	2	7	6	0	5.3.1.	
Ophrys	sphegodes	Mill.	S	6	8	7	9	3	8	4	0	5.4.1.1.	
Opuntia	vulgaris	Mill.	I	-1									
Orchis	coriophora	L.	G	4	7	7	7	4	8	4	0	5.4.	
Orchis	laxiflora ssp. elegans	(Heuff.)Soó	G	4	7	8	7	4	8	6	0	5.4.1.	
Orchis	laxiflora ssp. palustris	(Jacq.)Bonn. & Lay	G	4	6	8	8	3	9	5	1	5.4.	
Orchis	mascula	(L.)L.	G	4	6	6	7	3	5	3	0	8.4.	
Orchis	militaris	L.	G	4	6	5	8	2	7	5	0	Indiff.	
Orchis	morio	L.	G	4	5	4	7	3	7	3	1	Indiff.	
Orchis	pallens	L.	S	6	5	5	7	4	4	4	0	8.4.3.1.	
Orchis	purpurea	Huds.	G	4	7	4	8	3	5	4	0	8.4.2.	
Orchis	simia	Lam.	Sr	8	8	3	9	2	8	2	0	8.4.2.2.	
Orchis	tridentata	Scop.	S	6	7	2	9	1	9	4	0	5.3.1.1.	
Orchis	ustulata	L.	G	4	5	4	7	3	7	5	0	5.4.	
Origanum	vulgare	L.	DT	2	6	3	8	3	7	3	0	6.2.1.	
Orlaya	grandiflora	(L.)Hoffm.	G	4	7	2	7	1	8	2	0	5.3.1.	
Ornithogalum	boucheanum	(Kunth)Asch.	W	1	7	4	7	6	7	5	0	3.5.	
Ornithogalum	comosum	Torn. ex L.	S	6	8	2	9	1	9	6	0	5.3.1.1.	
Ornithogalum	x degenianum	Polgar	W	1	6	3	8	5	7	6	0	3.4.1.2.	
Ornithogalum	orthophyllum	Ten.	G	4	8	3	8	2	9	6	1	5.3.	
Ornithogalum	pyramidale	L.	DT	2	7	4	6	5	8	6	0	Indiff.	
Ornithogalum	refractum	Kit. ex Willd.	S	6	7	3	8	2	8	7	0	5.3.1.1.	
Ornithogalum	sphaerocarpum	Kern.	Gr	6	7	4	6	2	8	8	0	5.3.	
Ornithogalum	umbellatum	L.	DT	2	6	2	8	5	7	4	0	Indiff.	
Ornithopus	sativus	Brot.	I	-1									
Orobanche	alba	Steph. ex Willd.	G	4	5	4	8	4	8	3	0	5.3.	
Orobanche	alsatica	Kirschl.	G	4	7	3	8	2	7	7	0	5.3.1.	
Orobanche	arenaria	Borkh.	G	4	8	3	8	2	7	5	0	5.3.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Orobanche	caesia	Rchb.	A	-1									
Orobanche	caryophyllacea	Sm.	G	4	6	3	9	2	8	5	0	5.3.	
Orobanche	coerulescens	Steph. ex Willd.	Sr	8	7	2	8	1	8	7	0	5.3.1.1.	
Orobanche	cumana	Wallr.	W	1	6	4	7	5	7	6	0	3.3.2.	
Orobanche	elatiar	Sutton	G	4	7	4	8	2	8	5	0	5.3.	
Orobanche	flava	Mart. ex Schulz	S	6	4	5	8	2	9	4	0	5.4.1.2.	
Orobanche	gracilis	Sm.	G	4	8	2	9	2	8	2	0	5.3.	
Orobanche	hederae	Duby	Su	10	8	5	6	4	5	2	0	8.4.3.2.	
Orobanche	loricata	Rchb.	G	4	8	3	8	2	8	6	0	5.3.1.	
Orobanche	lutea	Baumg.	DT	2	6	3	8	4	7	3	0	3.4.1.	
Orobanche	minor	Sutton	W	1	8	6	6	6	7	5	0	3.4.1.2.	
Orobanche	nana	Noë ex Rchb.	Gu	8	8	4	8	3	6	6	0	8.4.2.2.	
Orobanche	picridis	F.Schultz	Gr	6	7	6	8	2	7	2	0	5.3.	
Orobanche	purpurea	Jacq.	S	6	7	3	8	2	8	5	0	5.3.1.1.	
Orobanche	ramosa	L.	W	1	8	4	7	6	7	5	0	3.4.	
Orobanche	reticulata	Wallr.	DT	2	6	2	8	4	7	4	0	5.3.	
Orobanche	teucrit	Holand.	S	6	6	2	9	1	8	2	0	5.3.1.1.	
Orthilia	secunda	(L.)House	Sr	8	3	5	5	2	4	3	0	8.3.1.2.	
Oryza	sativa	L.	I	-1									
Oryzopsis	virescens	(Trin.)Beck	S	6	8	4	8	4	6	7	0	8.4.2.2.	
Osmunda	regalis	L.	Su	10	6	8	5	5	5	3	0	8.2.1.1.	
Ostrya	carpinifolia	Scop.	Su	10	8	4	7	5	5	3	0	8.4.2.2.	
Oxalis	acetosella	L.	C	5	5	7	6	7	2	3	0	8.4.3.	
Oxalis	corniculata	L.	AC	-3	7	4	5	5	7	4	0	3.3.	
Oxalis	dillenii	Jacq.	A	-1	7	5	6	5	7	3	0	3.3.1.	
Oxalis	fontana	Bunge	AC	-3	7	5	5	6	7	3	0	3.3.	
Oxytropis	pilosa	(L.)DC.	S	6	7	2	8	1	9	7	0	5.3.1.1.	
Padus	avium	Mill.	S	6	5	8	7	6	5	4	0	8.4.3.3.	
Padus	serotina	(Ehrh.)Borkh.	AC	-3	6	8	6	5	5	4	0	8.6.3.1.	
Paeonia	banatica	Rochel	Su	10	8	5	8	4	6	7	0	8.4.2.2.	
Panicum	capillare	L.	AC	-3	6	4	7	4	7	4	0	3.3.2.	
Panicum	miliaceum	L.	I	-1									
Papaver	argemone	L.	W	1	7	4	6	5	5	2	0	3.3.2.	
Papaver	dubium	L.	W	1	6	3	6	5	6	3	0	3.4.2.	
Papaver	hybridum	L.	W	1	8	4	8	5	8	5	0	3.3.2.	
Papaver	rhoeas	L.	W	1	7	4	7	4	6	3	0	3.4.	
Papaver	somniferum	L.	I	-1								3.4.	
Parietaria	erecta	M. & K.	DT	2	7	7	7	7	4	4	0	Indiff.	
Paris	quadrifolia	L.	S	6	5	6	7	6	3	3	0	8.4.3.	
Parnassia	palustris	L.	S	6	4	8	8	2	8	3	0	1.7.2.1.	
Paronychia	cephalotes	(M.B.)Bess.	S	6	8	1	9	1	9	7	0	5.3.1.4.	
Parthenocissus	inserta	(Kern.)Fritsch	AC	-3								3.5.2.	
Parthenocissus	quinquefolia	(L.)Planch.	I	-1									
Parthenocissus	tricuspidata	(S. & Z.)Planch	I	-1									
Pastinaca	sativa	L.	DT	2	6	6	8	5	8	5	0	Indiff.	
Paulownia	tomentosa	(Thunb.)S. & Z.	I	-1									
Pedicularis	palustris	L.	Sr	8	4	9	6	2	7	3	0	1.7.2.1.	
Peganum	harmala	L.	I	-1									
Peltaria	perennis	(Ard.)Markgr.	Sr	8	7	7	8	4	5	5	0	8.4.3.3.	
Penstemon	barbatus	(Cav.)Nutt.	I	-1									
Penstemon	cobaea	Nutt.	I	-1									
Penstemon	hartwegii	Benth.	I	-1									
Peplis	portula	L.	NP	3	6	7	4	3	8	3	1	3.1.1.1.	
Persica	vulgaris	Mill.	I.	-1									

Genus ,	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Petasites	albus	(L.)Gaertn.	C	5	5	7	6	4	4	2	0	8.4.3.1.	
Petasites	hybridus	(L.)G., M. & Sch.	C	5	6	8	7	8	7	2	0	5.4.1.2.	
Petrorhagia	prolifera	(L.)Ball & Hey.	G	4	6	2	7	2	8	3	0	5.3.	
Petrorhagia	saxifraga	(L.)Link	G	4	8	2	8	1	9	4	0	5.3.1.	
Petroselinum	crispum	(Mill.)A.W.Hill	I	-1									
Petroselinum	hortense	Hoffm.	I	-1									
Petunia	x atkinsiana	D.Don ex Loud.	I	-1									
Peucedanum	alsaticum	L.	G	4	7	3	8	2	7	6	0	8.4.2.	
Peucedanum	arenarium	W. & K.	S	6	8	1	9	1	9	7	0	5.3.3.1.	
Peucedanum	carvifolia	Vill.	G	4	7	5	7	4	8	6	0	8.4.1.	
Peucedanum	cervaria	(L.)Cuss.	G	4	6	2	7	3	8	4	0	6.1.1.2.	
Peucedanum	officinale	L.	C	5	7	4	8	2	7	5	2	5.5.2.1.	
Peucedanum	oreoselinum	(L.)Mönch	G	4	6	4	6	2	6	4	0	6.1.1.2.	
Peucedanum	palustre	(L.)Mönch	G	4	5	9	6	4	7	6	0	1.5.1.	
Peucedanum	verticillare	(L.)Koch	Sr	8	6	6	7	4	4	5	0	8.4.3.4.	
Phacelia	tanacetifolia	Benth.	I	-1									
Phalaris	arundinacea	L.	G	4	5	9	7	7	7	4	0	1.5.1.	
Phalaris	canariensis	L.	A	-1	8	4	6	6	7	3	0	3.3.	
Phaseolus	coccineus	L.	I	-1									
Phaseolus	vulgaris	L.	I	-1								3.4.	
Philadelphus	coronarius	L.	I	-1									
Philadelphus	microphyllus	Gray	I	-1									
Phleum	paniculatum	Huds.	A	-1	6	4	7	4	7	3	0	3.3.	
Phleum	phleoides	(L.)Karst.	G	4	5	2	8	1	8	7	0	5.3.	
Phleum	pratense	L.	G	4	5	5	6	6	7	5	0	5.4.	
Phlomis	tuberosa	L.	S	6	7	3	8	1	8	8	0	8.4.2.3.	
Pholiurus	pannonicus	(Host)Trin	S	6	8	4	8	2	9	8	8	5.5.1.1.	
Phragmites	communis	Trin.	C	5	5	10	7	5	7	4	1	1.5.	
Phyllitis	scolopendrium	(L.)Newm.	S	6	6	7	8	6	4	2	0	8.4.3.1.	
Physalis	alkekengi	L.	G	4	7	7	7	8	5	5	0	8.4.3.3.	
Phyteuma	orbiculare	L.	S	6	6	2	9	2	8	3	0	5.3.1.4.	
Phyteuma	spicatum	L.	G	4	6	6	6	5	4	4	0	8.4.3.	
Phytolacca	americana	L.	A	-1	6	5	6	5	5	3	0	3.5.2.	
Picea	abies	(L.)Karst.	I	-1	3	6	4	4	5	6	0	7.3.1.	
Picris	hieracioides	L.	DT	2	5	4	8	4	8	5	0	Indiff.	
Pimpinella	major	(L.)Huds.	G	4	5	5	6	7	7	2	0	5.4.	
Pimpinella	nigra	Mill.	DT	2	6	3	7	2	7	6	0	Indiff.	
Pimpinella	saxifraga	L.	G	4	5	3	6	2	7	5	0	Indiff.	
Pinguicula	alpina	L.	Su	10	3	9	8	3	8	5	0	1.7.2.1.	
Pinguicula	vulgaris	L.	Sr	8	4	9	7	3	8	3	0	1.7.2.1.	
Pinus	nigra	Am.	I	-1	8	4	9	2	7	4	0	7.1.	
Pinus	strobus	L.	I	-1									
Pinus	sylvestris	L.	C	5	4	4	5	2	7	7	0	7.2-8.3.	
Pisum	elativus	Stev. ex M.B.	S	6	9	3	8	2	8	7	0	5.3.1.6.	
Pisum	sativum	L.	I	-1	8	5	7	4	7	4	0	3.4.	
Plantago	altissima	L.	W	1	8	8	6	4	7	7	0	3.7.2.	
Plantago	arenaria	W. & K.	NP	3	7	1	7	3	8	5	0	5.3.3.2.	
Plantago	argentea	Chaix ex Vill.	S	6	8	1	9	1	8	6	0	5.3.1.1.	
Plantago	lanceolata	L.	DT	2	5	4	6	5	7	3	0	Indiff.	
Plantago	major ssp. intermedia	(DC.)Arc.	NP	3	5	8	8	4	9	4	3	3.1.1.	
Plantago	major ssp. major	L.	W	1	5	6	6	6	8	3	1	3.7.	
Plantago	maritima	L.	G	4	5	6	8	3	8	7	7	5.5.	
Plantago	maxima	Juss. ex Jacq.	Gu	8	6	6	6	4	8	8	0	5.4.1.	
Plantago	media	L.	DT	2	5	5	7	3	7	7	0	Indiff.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Plantago	schwarzenbergiana	Schur	Sr	8	8	4	8	2	9	9	6	5.5.2.1.	
Plantago	stepposa	Kupr.	G	4	7	3	6	3	8	7	0	5.3.1.	
Plantago	tenuiflora	W. & K.	G	4	7	5	8	2	8	7	8	5.5.1.	
Platanthera	bifolia	(L.)Rchb.	G	4	5	6	6	5	6	3	0	8.4.	
Platanthera	chlorantha	(Cust.)Rchb.	S	6	4	6	5	5	6	3	0	8.3.1.2.	
Platanus	occidentalis	L.	I	-1									
Platanus	orientalis	L.	I	-1									
Platanus	x hybrida	Brot.	I	-1									
Pleurospermum	austriacum	(L.)Hoffm.	S	6	4	6	8	4	5	5	0	8.4.3.1.	
Poa	angustifolia	L.	DT	2	5	3	8	3	7	4	0	Indiff.	
Poa	annua	L.	RC	-2	5	6	6	8	7	5	1	3.7.	
Poa	athroostachya	Oetting.	DT	2									
Poa	badensis	Haenk. ex Willd.	S	6	7	1	9	1	9	4	0	5.3.1.4.	
Poa	bulbosa	L.	NP	3	8	2	5	1	8	7	0	5.2.1.	
Poa	compressa	L.	DT	2	6	2	7	2	9	4	0	Indiff.	
Poa	nemoralis	L.	C	5	5	5	6	3	5	5	0	8.4.	
Poa	palustris	L.	G	4	4	9	7	7	7	5	0	1.5.1.	
Poa	pannonica	Kern.	C	5	6	4	5	3	7	6	0	5.3.1.	
Poa	pratensis	L.	G	4	5	6	6	5	6	4	0	5.4.	
Poa	remota	Forsell.	Su	8	6	7	6	7	5	6	0	8.4.3.3.	
Poa	supina	Schrad.	A	-1	4	6	6	8	8	4	0	3.7.1.1.	
Poa	trivialis	L.	DT	2	5	7	7	7	6	3	0	Indiff.	
Podospermum	canum	C.A.Mey.	G	4	8	4	8	2	8	7	5	5.5.	
Podospermum	laciniatum	(L.)DC.	G	4	8	3	8	2	7	6	1	5.3.	
Polemonium	coeruleum	L.	I	-1									
Polycnemum	arvense	L.	W	1	6	3	6	4	9	6	0	3.4.	
Polycnemum	heuffelii	Lang	NP	3	8	2	5	1	9	7	0	5.2.1.	
Polycnemum	verrucosum	Lang	W	1	8	4	6	5	7	5	0	3.4.	
Polygala	amara	L.	S	6	6	3	9	2	8	4	0	5.3.1.4.	
Polygala	amarella	Cr.	S	6	6	8	8	2	9	4	0	5.4.1.1.	
Polygala	carniolica	Kern.	Gu	8	6	4	6	1	8	3	0	5.4.2.	
Polygala	comosa	Schkuhr	G	4	6	4	8	2	8	6	0	5.4.	
Polygala	major	Jacq.	S	6	8	3	7	2	8	7	0	5.3.1.1.	
Polygala	vulgaris	L.	G	4	5	5	6	2	7	3	0	5.1.	
Polygonatum	latifolium	(Jacq.)Desf.	G	4	7	5	7	5	7	7	0	8.4.	
Polygonatum	multiflorum	(L.)All.	G	4	5	5	7	4	3	5	0	8.4.3.	
Polygonatum	odoratum	(Mill.)Druce	G	4	5	4	8	3	7	5	0	8.4.2.	
Polygonatum	verticillatum	(L.)All.	S	6	4	6	6	5	4	2	0	8.4.3.1.	
Polygonum	amphibium	L.	DT	2	5	11	7	7	7	4	0	Indiff.	
Polygonum	arenarium	W. & K.	NP	3	8	1	7	1	9	7	0	5.3.3.2.	
Polygonum	aviculare	L.	RC	-2	5	4	6	5	9	3	2	Indiff.	
Polygonum	bistorta	L.	Sr	8	4	7	5	5	7	7	0	5.4.2.2.	
Polygonum	graminifolium	Wierzb.	W	1	7	4	6	4	8	7	0	3.2.1.	
Polygonum	hydropiper	L.	NP	3	5	9	7	5	7	4	0	3.2.1.	
Polygonum	lappathifolium	L.	DT	2	6	8	6	8	6	4	0	Indiff.	
Polygonum	minus	Huds.	NP	3	6	8	8	8	7	3	0	3.2.1.	
Polygonum	mite	Schrank	DT	2	6	9	7	7	7	3	0	Indiff.	
Polygonum	patulum	M.B.	G	4	8	2	7	1	9	6	3	5.5.2.	
Polygonum	persicaria	L.	DT	2	5	7	6	7	6	3	0	Indiff.	
Polypodium	interjectum	Shivas	G	4	5	6	4	5	5	3	0	5.2.5.	
Polypodium	vulgare	L.	G	4	5	5	4	4	5	3	0	5.2.5.	
Polystichum	aculeatum	(L.)Roth	G	4	6	6	6	7	3	2	0	8.4.3.	
Polystichum	braunii	(Spenn.)Fee	S	6	4	6	5	7	3	2	0	8.4.3.1.	
Polystichum	lonchitis	(L.)Roth	S	6	3	6	8	5	6	3	0	8.4.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Polystichum	setiferum	(Fork.)Moore	S	6	8	6	5	5	4	2	0	8.4.3.4.	
Populus	alba	L.	C	5	8	6	8	6	5	7	0	8.1.	
Populus	angulata	Ait.	I	-1									
Populus	balsamifera	L.	I	-1									
Populus	x berolinensis	(C.Koch)Dipp.	I	-1									
Populus	x canadensis	Mönch	I	-1									
Populus	x canescens	(Ait.)Sm.	C	5	8	4	8	3	6	7	0	Indiff.	
Populus	deltoides	Marshall	I	-1									
Populus	euramericana	Guinier	I	-1									
Populus	nigra	L.	C	5	7	7	7	7	5	6	0	8.1.	
Populus	nigra cv. italica	Duroi	I	-1									
Populus	x robusta	Sim.-Louis	I	-1									
Populus	simonii	Carr.	I	+1									
Populus	tremula	L.	G	4	5	5	5	5	6	5	0	Indiff.	
Portulaca	grandiflora	Hook.	I	-1									
Portulaca	oleracea	L.	W	1	8	4	7	7	7	3	0	3.3.	
Potamogeton	acutifolius	Link ex R. & Sch.	NP	3	6	12	7	3	7	4	0	1.3.1.1.	
Potamogeton	x angustifolius	Bercht. & Presl.	NP	3	6	12	7	6	7	4	0	1.3.1.1.	
Potamogeton	coloratus	Vahl ex Horn.	NP	3	6	11	8	1	8	3	0	1.3.1.1.	
Potamogeton	crispus	L.	NP	3	5	12	7	6	6	3	1	1.3.1.	
Potamogeton	filiformis	Pers.	Su	10	5	12	6	2	7	6	0	1.3.1.1.	
Potamogeton	gramineus	L.	NP	3	4	12	7	3	8	4	0	1.3.1.	
Potamogeton	lucens	L.	C	5	5	12	7	8	6	4	0	1.3.1.	
Potamogeton	natans	L.	C	5	4	12	7	4	6	5	0	1.3.1.2.	
Potamogeton	nodosus	Poir. ex Lam.	NP	3	6	12	7	6	6	5	0	1.3.1.3.	
Potamogeton	obtusifolius	M. & K.	Sr	8	5	12	6	6	6	3	0	1.3.1.1.	
Potamogeton	pectinatus	L.	C	5	6	12	8	5	6	5	1	1.3.	
Potamogeton	perfoliatus	L.	C	5	5	12	7	4	6	4	0	1.3.1.1.	
Potamogeton	pusillus	L.	S	6	6	12	7	5	6	5	1	1.3.1.1.	
Potamogeton	trichoides	Cham. & Schlech.	Sr	8	6	11	7	6	8	5	0	1.3.1.1.	
Potentilla	alba	L.	S	6	6	4	6	5	6	5	0	8.4.2.4.	
Potentilla	anserina	L.	W	1	5	7	6	7	7	3	1	3.7.	
Potentilla	arenaria	Borkh.	G	4	7	1	8	1	9	6	0	5.3.	
Potentilla	argentea	L.	DT	2	5	2	6	1	9	3	0	Indiff.	
Potentilla	collina	Wibel	G	4	7	2	5	3	7	4	0	5.3.	
Potentilla	erecta	(L.)Raeuschel	DT	2	4	7	5	4	6	3	0	Indiff.	
Potentilla	heptaphylla	Jusl.	G	4	5	3	8	2	7	4	0	Indiff.	
Potentilla	impolita	Wahlbg. em. Soó	G	4	7	3	8	2	8	6	0	5.3.	
Potentilla	inclinata	Vill.	G	4	7	4	5	1	8	6	0	5.3.1.	
Potentilla	leucopolitana	Muell.	G	4	5	4	5	1	7	5	0	5.3.1.	
Potentilla	loczyana	Borb.	Sr	8	7	3	7	1	8	6	0	5.3.1.1.	
Potentilla	micrantha	Ramb.	G	4	6	5	6	4	5	4	0	8.4.2.	
Potentilla	neumanniana	Rchb.	Gu	8	6	3	5	2	7	4	0	5.3.	
Potentilla	patula	W. & K.	G	4	7	2	6	1	8	5	1	5.3.1.	
Potentilla	pedata	Willd.	S	6	7	2	8	2	8	6	0	5.3.1.1.	
Potentilla	pusilla	Host	G	4	6	2	8	1	8	4	0	5.3.1.	
Potentilla	recta	L.	G	4	8	3	7	1	9	5	0	5.3.	
Potentilla	reptans	L.	DT	2	6	6	7	5	6	3	1	Indiff.	
Potentilla	rupestris	L.	G	4	5	4	5	1	6	4	0	8.3.	
Potentilla	supina	L.	NP	3	7	8	6	7	7	5	0	3.1.1.	
Potentilla	thyrsiflora	Huels. in Zimm.	G	4	6	4	6	2	7	6	0	5.3.1.	
Potentilla	wiemanniana	Günth. & Schum.	Gr	6	6	4	6	2	7	5	0	5.3.1.	
Prenanthes	purpurea	L.	S	6	4	6	6	5	4	4	0	8.4.3.1.	
Primula	auricula	L.	Su	10	4	3	9	2	8	4	0	5.3.1.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Primula	elatior	(L.)Grufbg.	S	6	5	6	7	7	5	4	0	8.4.3.1.	
Primula	farinosa	L.	Su	10	4	8	8	2	8	4	0	1.7.2.1.	
Primula	veris	L. em. Huds.	G	4	6	4	7	3	7	3	0	8.4.	
Primula	vulgaris	Huds.	S	6	7	6	7	5	5	2	0	8.4.3.4.	
Prunella	grandiflora	(L.)Scholler	G	4	5	4	8	3	7	5	0	5.3.	
Prunella	laciniata	(L.)Nath.	G	4	5	3	8	2	8	6	0	5.3.	
Prunella	vulgaris	L.	DT	2	5	6	6	4	7	3	0	Indiff.	
Prunus	cerasifera	Ehrh.	I	-1									
Prunus	domestica	L.	I	-1									
Prunus	insititia	Jusl.	AC	-3									
Prunus	spinosa	L.	C	5	5	3	6	2	7	5	0	8.6.1.	
Pseudotsuga	menziesii	(Mirb.)Franco	I	-1									
Ptelea	trifoliata	L.	A	-1									
Pteridium	aquilinum	(L.)Kuhn	DT	2	5	6	3	3	6	3	0	8.3.	
Pteris	vittata	L.	I	-1									
Pterocarya	fraxinifolia	(Lam.)Spach	I	-1									
Puccinellia	distans	(Jacq.)Parl.	C	5	6	6	7	7	8	6	6	Indiff.	
Puccinellia	limosa	(Schur.)Holmb.	C	5	7	7	7	5	9	7	8	5.5.1.	
Puccinellia	peisonis	(Beck)Jáv.	S	6	8	7	7	4	9	6	7	5.5.1.2.	
Pulicaria	dysenterica	(L.)Gaertn.	DT	2	6	7	7	5	8	3	1	5.4.	
Pulicaria	vulgaris	Gaertn.	DT	2	7	8	6	6	8	4	2	Indiff.	
Pulmonaria	angustifolia	L.	S	6	7	5	6	3	5	4	0	8.4.2.4.	
Pulmonaria	mollis	Wolff ex Horn.	G	4	6	5	8	3	5	4	0	8.4.2.	
Pulmonaria	obscura	Dumort.	G	4	5	6	8	7	4	6	0	8.4.3.	
Pulmonaria	officinalis	L.	G	4	6	6	6	6	5	5	0	8.4.3.	
Pulsatilla	grandis	Wender.	S	6	7	2	8	2	9	5	0	5.3.1.1.	
Pulsatilla	hungarica	Soó	S	6	6	2	5	2	8	6	0	5.3.3.1.	
Pulsatilla	nigricans	Stoerck	G	4	6	2	6	2	8	5	0	5.3.1.	
Pulsatilla	patens	(L.)Mill.	Sr	8	6	3	6	2	8	5	0	5.3.1.1.	
Pulsatilla	zimmermannii	Soó	S	6	6	2	7	2	8	6	0	5.3.1.1.	
Pycnus	flavescens	(L.)Rchb.	NP	3	6	8	6	5	7	4	0	3.1.1.1.	
Pyracantha	coccinea	Roem.	I	-1									
Pyrola	chlorantha	Sw.	Sr	8	5	4	4	2	5	5	0	8.3.1.2.	
Pyrola	media	Sw.	Sr	8	4	4	4	2	4	4	0	8.3.1.2.	
Pyrola	minor	L.	S	6	4	5	4	2	6	3	0	8.3.1.2.	
Pyrola	rotundifolia	L.	S	6	4	6	5	3	4	5	0	8.3.1.2.	
Pyrus	austriaca	Kern.	G	4	7	4	6	3	6	5	0	8.3.1.	
Pyrus	communis	L. em. Gaertn.	I	-1									
Pyrus	magyarica	Terpó	Gu	8	6	4	8	4	6	7	0	8.4.2.	
Pyrus	nivalis	Jacq.	G	4	7	4	8	3	6	6	0	8.4.2.	
Pyrus	pyraster	(L.)Borkh.	G	4	6	4	8	3	5	5	0	8.4.	
Quercus	cerris	L.	C	5	8	5	6	4	6	4	0	8.4.2.	
Quercus	dalechampii	Ten.	C	5	7	4	6	2	6	6	0	8.4.2.	
Quercus	frainetto	Ten.	Su	10	8	5	6	4	6	6	0	8.4.2.4.	
Quercus	petraea	(Matt.)Liebl.	C	5	6	5	5	2	6	4	0	8.4.	
Quercus	polycarpa	Schur	C	5	7	4	7	2	7	7	0	8.4.2.	
Queercus	pubescens	Willd.	C	5	8	3	8	2	7	4	0	8.4.2.	
Quercus	robur	L.	C	5	6	6	6	4	6	4	0	8.3-8.4.	
Quercus	rubra	L.	I	-1									
Quercus	virgiliana	(Ten.)Ten.	S	6	8	3	8	3	7	5	0	8.4.2.2.	
Radiola	linoides	Roth	NP	3	6	7	4	2	8	3	0	3.1.1.4.	
Ranunculus	acris	L.	G	4	5	7	6	3	7	3	0	5.4.	
Ranunculus	arvensis	L.	W	1	7	4	8	5	6	3	0	3.4.	
Ranunculus	auricomus	L. em. Korsh.	S	6	5	6	6	7	5	3	0	8.4.3.2.	

Genús	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Ranunculus	bulbosus	L.	DT	2	6	3	7	3	8	3	0	Indiff.	
Ranunculus	cymbalaria	Pursh	A	-1									
Ranunculus	ficaria	L.	C	5	5	6	7	7	4	3	0	8.4.3.	
Ranunculus	flamula	L.	S	6	5	9	5	2	7	3	0	1.7.1.2.	
Ranunculus	illyricus	L.	S	6	8	2	8	2	8	6	0	5.3.1.1.	
Ranunculus	lanuginosus	L.	S	6	6	6	7	7	3	4	0	8.4.3.1.	
Ranunculus	lateriflorus	DC.	S	6	8	4	4	8	9	8	4	5.5.1.4.	
Ranunculus	lingua	L.	S	6	4	10	7	7	7	4	0	1.5.1.1.	
Ranunculus	parviflorus	L.	A	-1								3.1.1.1.	
Ranunculus	pedatus	W. & K.	S	6	7	2	8	3	8	7	5	5.5.2.1.	
Ranunculus	polyanthemos	L.	G	4	6	4	6	4	6	5	0	5.3.	
Ranunculus	polyphyllus	W. & K. ex Willd.	G	4	6	11	8	4	7	8	5	2.2.1.1.	
Ranunculus	psilostachys	Grieseb.	NP	3	8	5	8	4	7	6	0	Indiff.	
Ranunculus	repens	L.	DT	2	5	8	6	6	6	4	1	Indiff.	
Ranunculus	sardous	Cr.	DT	2	7	8	8	7	8	4	1	Indiff.	
Ranunculus	sceleratus	L.	NP	3	5	9	7	9	9	5	2	3.1.1.	
Ranunculus	strigulosus	Schur	DT	2	8	7	6	5	8	7	0	5.4.	
Raphanus	raphanistrum	L.	W	1	5	5	5	5	6	3	0	3.3.	
Raphanus	sativus	L.	I	-1									
Rapistrum	perenne	(L.)All.	G	4	7	3	8	4	8	5	0	5.3.1.	
Reseda	inodora	Rchb.	S	6	8	2	9	2	8	7	0	5.3.1.1.	
Reseda	lutea	L.	W	1	6	3	8	4	8	3	0	3.5.4.	
Reseda	luteola	L.	W	1	7	3	9	3	8	3	0	3.5.4.1.	
Reseda	phyteuma	L.	NP	3	8	1	9	1	9	6	0	5.3.1.	
Reynoutria	aubertii	(Henry)Mold.	I	-1									
Reynoutria	japonica	Houttuyn	A	-1	7	8	5	6	8	2	0	3.5.2.1.	
Reynoutria	sachalinensis	(F.Schm.)Nakai	I	-1									
Rhamnus	catharticus	L.	G	4	5	4	8	4	7	5	0	8.4.	
Rhamnus	saxatilis	Jacq.	Su	10	5	4	9	2	7	3	0	8.4.2.2.	
Rheum	palmatum	L.	I	-1									
Rheum	rhabarbarum	L.	I	-1									
Rheum	rhaponticum	L.	I	-1									
Rhinanthus	alectrolophus	Poll.	G	4	6	6	7	3	8	2	0	5.4.	
Rhinanthus	borbasii	(Doerfl.)Soó	S	6	6	3	9	1	9	6	0	5.3.3.1.	
Rhinanthus	minor	L.	G	4	5	7	7	2	7	3	0	5.4.	
Rhinanthus	rumelicus	Velen.	Gr	6	6	6	8	2	7	6	0	5.4.2.	
Rhinanthus	wagneri	Deg. em. K. Maly	Gr	6	6	6	8	2	7	8	0	5.4.2.	
Rhus	hirta	(L.)Sudw.	I	-1									
Rhus	toxicodendron	L.	I	-1									
Rhynchospora	alba	(L.)Vahl	Su	10	4	9	3	2	8	3	0	1.7.1.1.	
Ribes	alpinum	L.	Sr	8	4	6	8	5	5	4	0	8.4.3.1.	
Ribes	aureum	Pusch	I	-1									
Ribes	nigrum	L.	Su	10	5	8	6	5	4	7	0	8.2.1.1.	
Ribes	petraeum	Wulf. ex Facq.	Su	10	3	6	6	5	5	4	0	8.4.3.1.2.	
Ribes	rubrum	L.	S	6	5	8	6	6	4	7	0	8.4.3.3.	
Ribes	sanguineum	Pursh	I	-1									
Ribes	spicatum	Robson	I	-1	5	8	7	7	4	7	0		
Ribes	uva-crispa	L.	G	4	5	6	5	6	4	2	0	8.4.3.	
Ricinus	communis	L.	I	-1									
Robinia	pseudo-acacia	L.	AC	-3	7	4	7	8	5	4	0	Indiff.	
Rorippa	amphibia	(L.)Bess.	G	4	6	10	8	8	7	7	0	1.5.1.	
Rorippa	x anceps	(Wahlbg.)Fuss	DT	2	6	9	9	8	7	4	1	Indiff.	
Rorippa	x amoracioides	(Tausch.)Fuss	DT	2	6	6	7	6	6	4	0	Indiff.	
Rorippa	x astylis	(Rchb.)Rchb.	DT	2	6	6	6	7	7	4	0	Indiff.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Rorippa	austriaca	(Cr.)Bess.	DT	2	7	8	8	8	7	4	1	Indiff.	
Rorippa	x hungarica	Borb.	DT	2	6	8	8	8	7	7	1	Indiff.	
Rorippa	kernerii	Menyh.	S	6	8	6	8	4	9	8	5	5.5.1.4.	
Rorippa	palustris	(L.)Bess.	W	1	6	9	5	6	7	3	0	3.2.1.	
Rorippa	sylvestris	(L.)Bess.	W	1	6	8	8	6	6	3	1	Indiff.	
Rosa	afzeliana	Fr. ex Liljb.	DT	2	5	4	8	4	6	3	0	6.2.	
Rosa	agrestis	Savi	DT	2	7	4	9	2	7	4	0	8.6.1.	
Rosa	arvensis	Huds.	G	4	5	5	7	5	5	2	0	8.4.3.	
Rosa	caesia	Sm. ex Sow.	DT	2	6	4	9	3	7	3	0	8.6.1.	
Rosa	canina	L.	DT	2	5	3	6	2	8	3	0	8.6.1.	
Rosa	caryophyllacea	Bess.	DT	2	7	4	9	2	7	5	0	8.6.1.4.	
Rosa	centifolia	L.	I	-1									
Rosa	chinensis	Jacq.	I	-1									
Rosa	corymbifera	Borkh.	DT	2	7	4	7	4	8	4	0	8.6.1.	
Rosa	damascena	Mill.	I	-1									
Rosa	dumalis	Bechst.	DT	2	5	5	6	3	7	2	0	8.6.1.4.	
Rosa	elliptica	Tausch.	DT	2	7	4	9	2	7	6	0	8.6.1.4.	
Rosa	foetida	Herrm.	I	-1									
Rosa	gallica	L.	G	4	7	3	8	4	8	4	0	5.3.	
Rosa	livescens	Bess.	DT	2	7	4	8	2	7	6	0	8.6.1.4.	
Rosa	micrantha	Borrer ex Sm.	DT	2	7	4	9	2	7	5	0	8.6.1.4.	
Rosa	multiflora	Thunb.	I	-1									
Rosa	obtusifolia	Desv.	DT	2	7	4	9	3	7	5	0	8.6.1.4.	
Rosa	pendulina	L.	S	6	4	5	7	5	7	2	0	8.4.3.1.	
Rosa	rubiginosa	L.	DT	2	6	3	8	3	7	2	0	8.6.1.4.	
Rosa	rugosa	Thunb.	I	-1									
Rosa	sancti-andreae	Deg. & Trautm.	Gu	8									
Rosa	spinosissima	L.	G	4	6	4	8	2	8	5	0	5.3.	
Rosa	stylosa	Desv.	S	6	7	4	8	2	8	7	0	8.4.2.1.	
Rosa	tomentosa	Sm.	G	4	6	5	8	2	7	6	0	8.6.1.	
Rosa	officinalis	L.	I	-1									
Rubia	tinctorum	L.	A	-1	9	3	8	2	8	5	0		
Rubus	bellardii	Wh. & N.	DT	2									
Rubus	bifrons	Vest ex Tratt.	CT	2	6	5	5	5	8	4	0	8.6.1.1.	
Rubus	caesius	L.	DT	2	5	7	7	9	6	4	0	Indiff.	
Rubus	candicans	Weihe ex Rchb.	DT	2									
Rubus	canescens	DC.	DT	2	8	4	6	5	9	5	0	8.4.2.	
Rubus	clusii	Borb.	DT	2	6	5	5	5	7	5	0		
Rubus	gratus	Focke	DT	2	5	6	4	4	8	2	0	8.5.1.1.	
Rubus	hirtus	W. & K.	DT	2	5	5	6	6	7	4	0	8.6.1.	
Rubus	idaeus	L.	DT	2	5	5	6	8	7	4	0	8.6.1.2.	
Rubus	koehleri	Wh. & N.	DT	2	4	5	4	5	8	3	0	8.3.1.	
Rubus	macrophyllus	Wh. & N.	DT	2	6	5	6	6	7	3	0	8.6.1.1.	
Rubus	nessensis	W. Hall	DT	2	5	6	2	3	7	3	0	8.5.1.2.	
Rubus	nitidus	Wh. & N.	DT	2									
Rubus	plicatus	Wh. & N.	DT	2	5	4	5	2	7	4	0	8.5.1.1.	
Rubus	procerus	Muell.	DT	2									
Rubus	pyramidalis	Kaltenb.	DT	2	5	5	4	4	7	2	0	8.5.1.1.	
Rubus	radula	Weihe ex Boenn	DT	2	5	5	6	5	8	2	0	8.6.1.	
Rubus	ramnifolius	Wh. & N.	DT	2	5	5	6	4	8	2	0	8.6.1.1.	
Rubus	rivularis	Muell. & Wirtg.	DT	2									
Rubus	rudis	Wh. & N.	DT	2	5	5	6	6	7	2	0	8.6.3.1.	
Rubus	saxatilis	L.	Sr	8	4	6	8	4	7	7	0	8.4.3.1.	
Rubus	silesiacus	Wh. & N.	DT	2	5	5	3	4	7	4	0	8.6.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Rubus	sulcatus	Vest	DT	2	5	6	4	7	7	4	0	6.2.	
Rubus	sylvaticus	Wh. & N.	DT	2	5	5	4	6	7	3	0	6.2.1.3.	
Rubus	tereticaulis	P.J.Muell.	S	6	5	5	5	6	4	2	0	8.4.3.1.	
Rubus	thyrsanthus	Wh. & N.	DT	2	6	4	7	8	7	2	0	Indiff.	
Rubus	vestitus	Wh. & N.	DT	2	5	5	7	6	7	2	0	8.6.1.1.	
Rudbeckia	hirta	L.	A	-1	7	8	8	5	8	5	0	3.5.2.1.	
Rudbeckia	laciniata	L.	AC	-3	7	8	7	7	7	5	0	3.5.2.1.	
Rumex	acetosa	L.	DT	2	5	5	7	5	8	3	0	Indiff.	
Rumex	acetosella	L.	NP	3	5	2	4	2	8	3	0	Indiff.	
Rumex	aquaticus	L.	G	4	4	8	7	7	7	7	0	1.5.1.	
Rumex	confertus	Willd.	DT	2	5	9	6	5	7	5	0	5.4.	
Rumex	conglomeratus	Murr.	W	1	7	7	8	8	8	3	0	3.8.	
Rumex	crispus	L.	W	1	5	6	6	7	7	3	1	3.8.1.	
Rumex	dentatus	L.	A	-1									
Rumex	hydrolapathum	Huds.	G	4	7	10	7	7	7	3	0	1.5.	
Rumex	kernerii	Borb.	W	1	8	6	6	6	7	7	0	3.3.	
Rumex	maritimus	L.	W	1	7	7	8	9	8	7	2	3.2.1.	
Rumex	obtusifolius	L.	DT	2	5	6	7	9	7	3	0	3.5.3.	
Rumex	palustris	Sm.	DT	2	6	9	7	9	7	6	0	1.5.	
Rumex	patientia	L.	W	1	7	6	6	7	8	5	0	3.3.	
Rumex	pseudonatronatus	Borb.	Su	10	5	5	7	4	8	8	6	5.5.2.1.	
Rumex	pulcher	L.	W	1	7	5	6	6	8	3	0	3.3.	
Rumex	sanguineus	L.	G	4	5	7	7	7	4	2	0	8.4.3.	
Rumex	scutatus	L.	I	-1	5	4	7	3	8	2	0		
Rumex	stenophyllus	Ledeb.	G	4	6	6	8	5	8	8	3	5.5.1.	
Rumex	tenuifolius	(Wallr.)A. & D. Löve	NP	3	5	2	4	2	9	3	0	Indiff.	
Rumex	thyrsiflorus	Fingerhut	DT	2	5	7	7	5	8	7	0	5.4.	
Ruppia	maritima	L.	NP	3	5	12	8	3	6	2	9	2.2.1.1.	
Ruscus	aculeatus	L.	G	4	9	5	8	5	3	0	8.4.		
Ruscus	hypoglossum	L.	Sr	8	9	6	6	5	3	5	0	8.4.3.4.	
Ruta	graveolens	L.	I	-1									
Sagina	apetala	Ard.	NP	3	7	6	4	5	8	2	0	5.2.4.1.	
Sagina	ciliata	Fr.	NP	3	7	6	4	3	9	3	0	5.2.4.1.	
Sagina	nodosa	(L.)Fenzl.	S	6	4	8	8	4	8	4	0	1.7.2.1.	
Sagina	procumbens	L.	DT	2	5	7	6	5	6	3	0	Indiff.	
Sagina	sabuletorum	(Gay)Lange	A	-1									
Sagina	subulata	(Sw.)Presl	NP	3	6	7	4	3	8	2	0	5.2.4.1.	
Sagittaria	sagittifolia	L.	S	6	5	10	7	6	7	4	0	1.5.1.1.	
Salicornia	prostrata	Pall.	NP	3	8	8	8	7	9	6	9	2.4.1.	
Salicornia	simonkaiana	Soó	NP	3	8	9	8	6	9	7	9	2.4.1.1.	
Salix	alba	L.	C	5	6	9	8	7	5	6	0	8.1.1.2.	
Salix	aurita	L.	S	6	4	8	4	3	7	3	0	8.5.2.1.	
Salix	babylonica	L.	I	-1									
Salix	caprea	L.	DT	2	5	5	7	5	7	3	0	8.6.3.1.	
Salix	cinerea	L.	C	5	5	9	5	4	7	5	0	8.5.2.1.	
Salix	eleagnos	Scop.	C	5	5	7	8	4	7	2	0	8.1.1.1.	
Salix	fragilis	L.	G	4	5	9	6	6	5	3	0	8.1.1.	
Salix	pentandra	L.	Su	10	4	8	6	4	7	7	0	8.5.2.1.	
Salix	purpurea	L.	C	5	5	9	8	4	8	4	0	8.1.1.	
Salix	rosmarinifolia	L.	C	5	5	7	8	4	8	6	0	5.3.3.1.	
Salix	triandra	L.	C	5	5	9	8	4	8	7	0	8.1.1.3.	
Salix	viminialis	L.	G	4	6	8	8	4	8	4	0	8.1.1.	
Salsola	kali	L.	DT	2	7	2	7	8	9	8	3	3.3.2.	
Salsola	soda	L.	NP	3	8	1	8	7	9	9	7	2.4.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Salvia	aethiopis	L.	DT	2	7	3	7	4	9	9	0	5.3.1.1.	
Salvia	austriaca	Jacq.	G	4	8	3	7	4	9	8	0	5.3.1.1.	
Salvia	glutinosa	L.	G	4	5	6	7	7	4	4	0	8.4.3.	
Salvia	nemorosa	L.	DT	2	7	3	8	5	8	6	0	5.3.	
Salvia	nutans	L.	Su	10	8	3	9	1	8	9	0	5.3.1.1.	
Salvia	officinalis	L.	I	-1									
Salvia	pratensis	L.	G	4	6	3	8	4	8	4	0	5.3.1.	
Salvia	sclarea	L.	I	-1									
Salvia	splendens	Sell. ex Nees	I	-1									
Salvia	verticillata	L.	W	1	6	4	7	5	9	6	0	3.7.1.	
Salvinia	natans	(L.)All.	NP	3	8	11	7	7	7	5	0	1.1.1.1.	
Sambucus	ebulus	L.	W	1	6	5	7	7	7	5	0	3.5.1.1.	
Sambucus	nigra	L.	DT	2	6	7	6	7	7	3	0	Indiff.	
Sambucus	racemosa	L.	G	4	4	5	5	8	6	4	0	8.6.3.1.	
Samolus	valerandi	L.	NP	3	6	8	8	6	7	3	3	3.1.1.	
Sanguisorba	minor	Scop.	G	4	6	3	8	2	7	5	0	5.3.	
Sanguisorba	officinalis	L.	S	6	5	7	7	3	7	7	0	5.4.1.1.	
Sanicula	europaea	L.	G	4	5	6	8	6	4	3	0	8.4.3.	
Santolina	chamaecyparissus	L.	I	-1									
Saponaria	officinalis	L.	DT	2	6	5	7	5	7	3	0	3.5.3.	
Sarothamnus	scoparius	(L.)Wimm.	AC	-3	6	4	4	3	8	2	0	8.3.1.	
Satureja	hortensis	L.	I	-1									
Saxifraga	adscendens	L.	NP	3	3	4	9	1	9	5	0	5.3.1.3.	
Saxifraga	bulbifera	L.	G	4	7	6	6	4	8	5	0	5.4.	
Saxifraga	granulata	L.	Gu	8	5	4	5	3	8	2	0		
Saxifraga	paniculata	Mill.	S	6	2	2	8	2	7	3	0	5.3.1.3.	
Saxifraga	tridactylites	L.	NP	3	6	2	7	1	8	2	0	5.2.1.2.	
Scabiosa	canescens	W. & K.	G	4	7	3	8	3	7	6	0	5.3.1.	
Scabiosa	columbaria ssp. colum.	L.	S	6	6	3	8	2	8	2	0	5.3.1.	
Scabiosa	c. ssp. pseudobanatica	(Schur)Jáv.	S	6	6	3	9	1	8	5	0	5.3.1.3.	
Scabiosa	gramuntia	L.	G	4	7	5	6	2	7	5	0	5.4.	
Scabiosa	ochroleuca	L.	DT	2	7	2	8	3	8	6	0	5.3.	
Scandix	pecten-veneris	L.	W	1	7	3	8	4	7	3	0	3.4.1.1.	
Schoenoplectus	americanus	(Pers.)Volk.	A	-1	6	10	7	7	8	4	0	1.5.1.4.	
Schoenoplectus	lacustris	(L.)Palla	C	5	5	10	7	7	8	3	2	1.5.1.1.	
Schoenoplectus	litoralis	(Schrud.)Palla	A	-1	9	10	8	8	8	2	1	2.10.1.1.	
Schoenoplectus	mucronatus	(L.)Palla	DT	2	8	10	7	8	8	4	0	3.9.1.1.	
Schoenoplectus	setaceus	(L.)Palla	NP	3	8	9	6	4	8	7	0	3.1.1.1.	
Schoenoplectus	supinus	(L.)Palla	NP	3	7	9	6	3	8	5	0	3.1.1.1.	
Schoenoplectus	tabernaemontani	(C.Gmel.)Palla	C	5	7	10	8	6	8	6	3	2.10.1.1.	
Schoenoplectus	triqueter	(L.)Palla	G	4	7	10	7	7	8	5	2	1.5.	
Schoenus	nigricans	L.	C	5	7	9	9	2	9	3	0	1.7.2.1.	
Scilla	autumnalis	L.	Su	10	8	2	9	2	8	7	0	5.3.1.1.	
Scilla	drunensis	Speta	Sr	8	5	6	7	6	5	5	0	8.4.3.2.	
Scilla	kladnii	Schur	Sr	8	5	6	7	6	5	7	0	8.4.3.2.	
Scilla	sibirica	Haw. ex Andrews	I	-1									
Scilla	spetana	Kereszty	Su	10	6	5	5	5	6	6	0	8.4.2.3.	
Scilla	vindobonensis	Speta	S	6	6	7	6	7	5	6	0	8.4.3.3.	
Scirpus	radicans	Schkuhr	NP	3	6	8	7	6	7	6	0	3.1.1.1.	
Scleranthus	perennis	L.	NP	3	6	2	4	1	8	4	0	5.2.2.	
Scleranthus	polycarpus	Tom. ex L.	NP	3	7	2	5	2	8	5	0	5.2.2.	
Scleranthus	verticillatus	Tausch.	NP	3	8	3	8	2	8	6	1	5.3.	
Sclerochloa	dura	(L.)P.B.	W	1	7	4	8	7	8	7	0	3.7.1.1.	
Scopolia	carniolica	Jacq.	S	6	6	7	8	8	3	7	0	8.4.3.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Scorzonera	austriaca	Willd.	S	6	7	3	8	2	7	7	0	5.3.1.4.	
Scorzonera	hispanica	L.	G	4	7	4	8	3	7	6	0	5.3.1.	
Scorzonera	humilis	L.	S	6	6	7	6	2	7	5	0	1.7.2.1.	
Scorzonera	parviflora	Jacq.	S	6	7	7	8	3	8	8	5	5.5.1.3.	
Scorzonera	purpurea	L.	G	4	7	2	8	2	8	6	0	5.3.1.	
Scrophularia	glandulosa	W. & K.	DT	2	6	7	6	7	4	5	0	3.5.2.2.	
Scrophularia	nodosa	L.	G	4	5	6	6	7	4	3	0	8.4.	
Scrophularia	umbrosa	Dum.	G	4	6	8	8	7	7	5	0	1.5.1.3.	
Scrophularia	vernalis	L.	S	6	6	6	7	5	5	5	0	8.4.3.1.	
Scutellaria	altissima	L.	S	6	8	6	8	6	5	7	0	8.4.3.4.	
Scutellaria	columnae	All.	G	4	8	4	8	4	6	6	0	8.4.2.	
Scutellaria	galericulata	L.	G	4	5	9	7	6	7	5	0	1.5.1.	
Scutellaria	hastifolia	L.	G	4	7	8	7	5	7	6	0	5.4.1.	
Secale	cereale	L.	I	-1								3.4.	
Secale	sylvestre	Host	NP	3	8	1	7	2	8	7	0	5.3.3.2.	
Sedum	acre	L.	NP	3	5	1	6	1	8	3	0	5.2.3.	
Sedum	album	L.	NP	3	7	2	8	1	9	2	1	5.2.	
Sedum	caespitosum	(Cav.)DC.	S	6	8	2	8	1	9	7	2	5.5.2.1.	
Sedum	hillebrandtii	Fenzl	S	6	8	1	9	1	9	6	0	5.3.3.1.	
Sedum	hispanicum	Jusl.	NP	3	8	1	4	1	9	4	0	5.3.1.3.	
Sedum	maximum	(L.)Hoffm.	DT	2	6	3	7	3	7	3	0	8.4.2.	
Sedum	neglectum	Ten.	S	6	8	1	8	1	9	6	0	5.3.1.5.	
Sedum	reflexum	L.	A	-1	5	2	4	2	7	5	0	5.2.3.	
Sedum	sexangulare	L. em. Grimm	NP	3	5	1	7	1	7	5	0	5.2.3.	
Sedum	spurium	M.B.	I	-1	6	3	4	2	8	4	0	5.2.	
Selaginella	helvetica	(L.)Link	Gu	8	6	6	8	2	6	4	0	8.4.3.	
Selinum	carvifolia	(L.)L.	G	4	5	7	7	2	7	5	0	5.4.1.	
Sempervivum	marmoreum	Griseb.	NP	3	8	1	6	1	9	5	0	5.3.1.3.	
Sempervivum	tectorum	L.	Gu	8	5	1	6	1	9	2	0	5.3.1.5.	
Senecio	aquaticus	Huds.	G	4	6	8	5	5	7	2	0	5.4.1.	
Senecio	aurantiacus	(Hoppe)Less.	Su	10	4	6	4	4	7	4	0	5.4.2.2.	
Senecio	doria	Nath. ex. L.	DT	2	5	7	7	5	7	6	0	5.4.1.	
Senecio	erraticus	Bert.	G	4	7	6	6	4	7	5	0	5.4.	
Senecio	erucifolius	L.	G	4	6	6	8	4	7	4	0	5.4.1.	
Senecio	fluviatilis	Wallr.	DT	2	7	9	7	8	7	5	0	3.5.2.1.	
Senecio	fuchsii	C.Gmel.	G	4	5	6	6	7	4	4	0	8.4.3.	
Senecio	integrifolius	(L.)Clairv.	G	4	6	4	7	4	7	7	0	5.3.	
Senecio	jacobaea	L.	DT	2	5	3	7	5	8	3	0	Indiff.	
Senecio	nemorensis	L.	G	4	6	6	6	7	4	4	0	8.4.	
Senecio	ovirensis	(Koch)DC.	Sr	8	4	6	6	8	8	4	0	7.1.1.1.	
Senecio	paludosus	L.	S	6	6	9	6	6	7	4	0	1.5.1.4.	
Senecio	rivularis	(W. & K.)DC.	S	6	6	7	6	4	7	6	0	5.4.1.2.	
Senecio	rupestris	W. & K.	A	-1									
Senecio	sylvaticus	L.	DT	2	5	4	5	8	8	3	0	6.2.1.1.	
Senecio	umbrosus	W. & K.	Su	10	7	8	7	4	8	6	0	1.7.2.1.	
Senecio	vernalis	W. & K.	W	1	7	4	6	5	7	6	1	3.3.	
Senecio	viscosus	L.	DT	2	6	3	4	5	8	4	0	6.2.	
Senecio	vulgaris	L.	W	1	6	4	6	8	7	4	0	3.3.	
Serratula	lycopifolia	(Vill.)Kern.	Sr	8	8	3	8	2	7	7	0	8.4.2.2.	
Serratula	radiata	(W. & K.)M.B.	Sr	8	8	2	9	1	8	7	0	5.3.1.4.	
Serratula	tinctoria	L. oecotyp sylvicola	G	4	6	5	5	4	7	5	0	8.3.	
Serratula	tinctoria	L. oecotyp. praticola	G	4	6	7	7	5	8	4	0	5.4.	
Seseli	annuum	L.	G	4	6	2	8	2	8	5	0	5.3.	
Seseli	hippomarathrum	Jacq.	S	6	7	1	9	1	9	6	0	5.3.1.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Seseli	leucospermum	W. & K.	S	6	8	1	9	1	9	6	0	5.3.1.4.
Seseli	libanotis	(L.)Koch	G	4	5	3	7	2	7	5	0	8.4.2.
Seseli	osseum	Cr. em. Simk.	G	4	8	2	7	1	8	7	0	5.3.1.
Seseli	pallasii	Bess.	G	4	8	1	8	1	9	8	0	5.3.1.
Sesleria	heuflerana	Schur	Cu	9	4	3	9	1	9	7	0	5.3.1.3.
Sesleria	hungarica	Ujh.	Cu	9	5	5	8	3	6	6	0	5.3.1.3.
Sesleria	sadlerana	Janka	Cr	7	6	3	9	1	9	6	0	5.3.1.4.
Sesleria	uliginosa	Opiz	Cr	7	5	8	8	2	8	4	0	1.7.2.1.
Sesleria	varia	(Jacq.)Wettst.	Cr	7	3	4	8	2	7	2	0	5.3.1.3.
Setaria	x decipiens	Schimp.	W	1	8	6	7	7	8	4	0	3.3.1.
Setaria	italica	(L.)P.B.	I	-1	8	4	7	8	8	5	0	3.3.
Setaria	lutescens	(Weigel)Hubb.	W	1	7	4	5	6	7	4	0	3.4.2.
Setaria	verticillata	(L.)P.B.	W	1	8	4	6	8	7	4	0	3.3.1.
Setaria	viridis	(L.)Pb.	W	1	6	4	7	7	7	5	0	3.4.1.
Sherardia	arvensis	L.	W	1	6	5	8	5	6	3	0	3.4.1.
Sicyos	angulatus	L.	A	-1	7	6	6	5	8	3	0	3.5.2.1.
Sideritis	montana	L.	NP	3	8	2	9	2	9	6	0	5.3.1.5.
Silaum	peucedanoides	(M.B.)Kern.	Sr	8	7	3	8	1	8	7	0	5.3.1.1.
Silaum	silaus	(L.)Sch. & Th.	G	4	6	7	8	3	7	5	0	5.4.1.
Silene	armeria	L.	DT	2	7	4	5	2	7	4	0	
Silene	borysthénica	(Grun.)Walters	S	6	6	2	9	1	9	8	0	5.3.3.1.
Silene	conica	L.	NP	3	7	1	8	2	9	4	0	5.3.3.2.
Silene	dichotoma	Ehrh.	W	1	8	4	8	4	7	5	0	3.4.1.2.
Silene	flavescens	W. & K.	Su	10	9	1	9	1	9	7	0	5.3.1.4.
Silene	gallica	L.	W	1	7	4	4	4	9	2	0	3.4.2.1.
Silene	longiflora	Ehrh.	S	6	8	2	8	1	9	7	0	5.3.1.1.
Silene	multiflora	(Ehrh.)Pers.	G	4	8	5	8	3	8	6	2	5.5.1.
Silene	nemoralis	W. & K.	G	4	7	2	8	2	7	5	0	5.3.1.
Silene	nutans	L.	G	4	5	5	6	3	7	5	0	8.4.2.
Silene	otites	(L.)Wibel	G	4	7	2	8	2	8	7	0	5.3.
Silene	viridiflora	L.	G	4	8	5	7	4	6	5	0	8.4.2.
Silene	vulgaris	(Mönch)Garcke	DT	2	6	5	7	2	8	4	0	Indiff.
Sinapis	alba	L.	W	1	7	4	8	6	8	5	0	3.4.
Sinapis	arvensis	L.	W	1	5	4	8	6	7	3	0	3.4.
Sinapis	dissecta	lag.	W	1	7	4	8	6	7	4	0	
Sisymbrium	altissimum	L.	W	1	6	3	6	6	8	7	0	3.3.3.
Sisymbrium	loeselli	Jusl. ex L.	W	1	7	3	7	5	7	7	0	3.3.3.1.
Sisymbrium	officinale	(L.)Scop.	W	1	6	5	7	7	8	5	0	3.3.3.1.
Sisymbrium	orientale	Torn. ex L.	W	1	8	5	7	6	8	8	0	3.3.
Sisymbrium	polymorphum	(Murr.)Roth	S	6	7	3	8	1	9	8	0	5.3.1.1.
Sisymbrium	strictissimum	L.	DT	2	7	6	8	7	7	4	0	3.5.
Sium	erectum	Huds.	G	4	5	11	7	6	7	5	0	1.5.1.
Sium	latifolium	L.	G	4	6	10	7	8	7	4	0	1.5.1.
Sium	sisaroides	DC.	S	6	6	10	7	7	7	7	0	1.5.1.1.
Smyrniun	perfoliatum	L.	DT	2	9	5	8	8	6	6	0	3.5.3.
Solanum	alatum	Mönch	W	1	7	5	6	7	7	4	0	3.3.
Solanum	dulcamara	L.	DT	2	5	9	6	8	7	4	0	Indiff.
Solanum	luteum	Mill.	W	1	7	5	6	7	7	4	0	3.3.
Solanum	melongena	L.	I	-1								
Solanum	nigrum	L.	W	1	6	6	7	8	7	3	0	3.3.
Solanum	tuberosum	L.	I	-1								
Solidago	canadensis	L.	AC	-3	6	7	7	6	7	5	0	3.5.3.
Solidago	gigantea	Ait.	AC	-3	6	8	6	8	7	5	0	3.5.
Solidago	virgaurea	L.	G	4	5	5	6	5	5	5	0	Indiff.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Sonchus	arvensis	L.	W	1	5	5	7	7	7	4	1	3.3.	
Sonchus	asper	(L.)Hill	W	1	5	5	7	7	7	5	1	3.3.1.	
Sonchus	oleraceus	L. em. Gouan	W	1	5	5	8	8	7	5	0	3.3.	
Sonchus	palustris	L.	DT	2	6	8	7	7	7	6	1	3.5.3.	
Sonchus	uliginosus	M.B.	DT	2	6	9	7	7	7	6	0	5.4.	
Sophora	japonica	L.	I	-1									
Sorbaria	sorbifolia	(L.)A.Br.	I	-1									
Sorbus	adami	Kárp.	Gu	8									
Sorbus	andreanszkyana	Kárp.	Gu	8									
Sorbus	aria	(L.)Cr.	G	4	5	4	8	3	6	2	0	8.4.3.1.	
Sorbus	aucuparia ssp. a.	L.	G	4	4	5	7	5	6	3	0	8.3.1.	
Sorbus	auc. ssp. glabrata	(Warm. & Graeb.)Caj.	S	6	4	6	4	5	5	4	0	7.3.1.	
Sorbus	austriaca	(Beck)Hedlund	Gu	6	5	4	8	3	6	5	0	8.4.2.3.	
Sorbus	bakonyensis	(Jáv.)Kárp.	Gu	8									
Sorbus	balatonica	Kárp.	Gu	8									
Sorbus	barthae	Kárp.	Gu	8									
Sorbus	borosiana	Kárp.	Gu	8									
Sorbus	x danubialis	(Jáv.)Kárp.	G	4	7	4	8	3	7	5	0	8.4.2.	
Sorbus	decipientiformis	Kárp.	Gu	8									
Sorbus	degenii	Jáv.	Gu	8									
Sorbus	domestica	L.	S	6	7	4	8	3	5	4	0	8.4.2.2.	
Sorbus	eugenii-kelleri	Kárp.	Gu	8									
Sorbus	gayerana	Kárp.	Gu	8									
Sorbus	gerecseensis	Boros & Kárp.	Gu	8									
Sorbus	graeca	(Spach)Lodd.	S	6	7	5	8	3	6	4	0	8.4.2.2.	
Sorbus	karpatii	Boros	Gu	8									
Sorbus	latissima	Kárp.	Gu	8									
Sorbus	pseudobakonyensis	Kárp.	Gu	8									
Sorbus	pseudolatifolia	Boros	Gu	8									
Sorbus	pseudosemiincisa	Boros	Gu	8									
Sorbus	pseudovertesensis	Boros	Gu	8									
Sorbus	redliana	Kárp.	Gu	8									
Sorbus	semiincisa	Borb.	Gu	8									
Sorbus	torminalis	(L.)Cr.	G	4	7	4	7	4	5	4	0	8.4.	
Sorbus	vertesensis	Boros	Gu	8									
Sorghum	bicolor	(L.)Mönch	I	-1									
Sorghum	dochna	(Forsk.)Snowd.	I	-1									
Sorghum	halepense	(L.)Pers.	I	-1	8	6	7	7	7	5	0	3.4.	
Sorghum	sudanense	(Piper)Stapf	I	-1								3.4.	
Sparganium	emersum ssp. emersum	Rehmann	S	6	5	11	6	5	8	3	0	1.3.1.3.	
Sparganium	emersum ssp. simplex	(Huds.)Soó	G	4	5	10	6	5	7	4	0	1.5.	
Sparganium	erectum ssp. erectum	L.	C	5	6	10	6	5	7	5	0	1.5.	
Sparganium	erectum ssp. neglectum	(Beeby)K.Richter	C	5	6	10	6	5	7	4	0	1.5.1.3.	
Sparganium	minimum	Wallr.	Sr	8	4	11	5	3	8	5	0	1.5.1.4.	
Spergula	arvensis	L.	W	1	5	5	4	7	6	3	0	3.4.2.1.	
Spergula	pentandra	L.	NP	3	6	2	4	2	9	4	0	5.2.2.2.	
Spergularia	marina	(L.)Griseb.	NP	3	6	5	8	5	7	8	9	2.4.2.1.	
Spergularia	media	(L.)Presl	NP	3	7	6	8	5	7	8	8	2.4.2.1.	
Spergularia	rubra	(L.)Presl	DT	3	7	5	6	4	7	6	1	Indiff.	
Sphagnum	acutifolium	Ehrh. em. Warnst.	S	6	3	9	2	1	6	6	0	1.8.	
Sphagnum	compactum	DC.	Sr	8	3	8	2	1	7	6	0	1.8.1.1.	
Sphagnum	fimbriatum	Wils.	Sr	8	3	8	2	1	7	6	0	1.8.1.1.	
Sphagnum	girgensohnii	Russow	Sr	8	2	7	2	2	6	6	0	1.8.1.1.	
Sphagnum	inundatum	Russow	Sr	8	3	9	4	1	5	6	0	1.7.1.2.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Sphagnum	magellanicum	Brid.	Sr	8	3	8	1	1	9	6	0	1.8.1.1.	
Sphagnum	obtusum	Warnst.	Sr	8	2	9	2	1	9	6	0	1.8.1.1.	
Sphagnum	palustre	L.	Cr	7	4	9	2	2	6	6	0	1.7.1.2.	
Sphagnum	platyphyllum	Sull. em. Warnst.	Sr	8	3	9	4	1	8	6	0	1.8.1.1.	
Sphagnum	plumulosum	Roell	Sr	8	4	8	2	1	8	4	0	1.8.1.1.	
Sphagnum	quinquefarium	(Lindb.)Warnst.	Sr	8	3	8	4	1	6	4	0	1.7.1.2.	
Sphagnum	recurvum	P.B.	CR	7	3	9	2	1	7	6	0	1.8.1.1.	
Sphagnum	robustum	(Russow)Roell	Sr	8	4	8	3	1	6	6	0	1.7.1.2.	
Sphagnum	squarrosus	Pers.	Cr	7	4	9	3	1	7	5	0	1.8.1.1.	
Sphagnum	subbicolor	Hampe	Sr	8	3	8	1	1	6	5	0	1.7.1.2.	
Sphagnum	subnitens	Russ. ex Warnst.	Sr	8	4	8	2	1	8	4	0	1.7.1.2.	
Sphagnum	subsecundum	Nees	Sr	8	2	8	3	1	6	6	0	1.8.1.1.	
Sphagnum	teres	(Schimp.)Angst	Sr	8	4	8	3	1	8	6	0	1.7.1.2.	
Sphagnum	warnstorffii	Russow	Sr	8	2	9	3	1	7	6	0	1.8.1.1.	
Spinacia	oleracea	L.	I	-1									
Spiraea	japonica	L.f.	I	-1									
Spiraea	media	Fr.Schm.	C	5	6	3	7	5	7	7	0	8.4.2.3.	
Spiraea	salicifolia	L.	S	6	6	9	6	6	7	7	0	8.2.1.1.	
Spiraea	x vanhouttei	Zab.	A	-1									
Spiranthes	aestivalis	(Poir.)Rich.	Su	10	6	9	7	3	8	4	0	1.7.2.1.	
Spiranthes	spiralis	(L.)Chevall.	Sr	8	6	7	7	2	8	2	0	5.4.1.1.	
Spirodela	polyrhiza	(L.)Schleiden	NP	3	6	11	7	7	7	5	0	1.1.1.1.	
Stachys	alpina	L.	Gr	6	4	6	8	6	7	2	0	8.4.3.	
Stachys	annua	(L.)L.	W	1	6	3	8	4	7	4	0	3.4.1.1.	
Stachys	byzantina	C.Koch	I	-1									
Stachys	germanica	L.	DT	2	6	3	8	4	7	4	0	5.3.	
Stachys	palustris	L.	DT	2	5	9	7	7	7	5	0	Indiff.	
Stachys	recta	L.	G	4	6	2	8	3	7	4	0	5.3.	
Stachys	sylvatica	L.	G	4	5	7	6	7	4	3	0	8.4.3.	
Staphylea	pinnata	L.	S	6	6	5	8	4	6	3	0	8.4.3.2.	
Stellaria	graminea	L.	DT	2	5	4	6	5	6	4	0	5.4.	
Stellaria	holostea	L.	C	5	6	5	6	5	5	3	0	8.4.	
Stellaria	media ssp. media	(L.)Cyr.	DT	2	5	5	7	8	6	5	0	Indiff.	
Stellaria	media ssp. neglecta	(Weihe)Gremli	G	4	5	7	7	7	6	4	0	8.4.3.3.	
Stellaria	nemorum	L.	S	6	4	7	5	7	4	4	0	8.4.3.3.	
Stellaria	palustris	Ehrh. ex Retz.	G	4	5	8	6	4	5	7	0	5.4.	
Stellaria	uliginosa	Murr.	S	6	4	8	4	4	5	3	0	1.7.1.1.	
Stenactis	annua	(L.)Nees	AC	-3	5	7	6	6	5	5	0	Indiff.	
Stenactis	strigosa	DC.	W	1	5	8	7	6	5	5	0	Indiff.	
Sternbergia	colchiciflora	W. & K.	Sr	8	8	2	9	1	9	8	0	5.3.1.1.	
Stipa	borysthenica	Klovov	S	6	7	2	8	1	9	8	0	5.3.3.1.	
Stipa	bromoides	(L.)Doerfl.	Su	10	8	4	8	2	7	6	0	8.4.2.2.	
Stipa	capillata	L.	C	5	7	2	8	2	8	8	0	5.3.1.	
Stipa	crassiculmis	Smirnow	Su	10	8	2	8	1	8	9	0	5.3.1.4.	
Stipa	dasyphylla	(Czern.)Trautv.	S	6	7	3	7	2	8	8	0	5.3.1.1.	
Stipa	eriocaulis	Borb.	S	6	8	1	8	1	9	7	0	5.3.1.4.	
Stipa	joannis	Čelak.	C	5	7	2	7	2	8	8	0	5.3.1.	
Stipa	pulcherrima	C.Koch	S	6	8	1	8	1	9	7	0	5.3.1.4.	
Stipa	tirsa	Stev. em. Čelak.	C	5	7	3	7	2	8	8	0	5.3.1.6.	
Stratiotes	aloides	L.	C	5	7	11	7	6	7	5	0	1.1.2.1.	
Suaeda	maritima	(L.)Dum.	C	5	6	8	7	7	8	8	8	2.4.1.2.	
Suaeda	annonica	Beck	S	6	7	8	8	7	9	9	9	2.4.1.2.	
Succisa	pratensis	Mönch	G	4	5	7	7	2	7	3	0	5.4.1.	
Succisella	inflexa	(Kluk)Beck.	G	4	6	8	6	2	8	4	0	5.4.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Symphoricarpus	rivularis	Suksd.	I	-1									
Symphytum	asperum	Lepech.	I	-1									
Symphytum	officinale	L.	G	4	6	8	6	8	7	3	0	Indiff.	
Symphytum	tuberosum	L.	G	4	5	5	7	5	5	4	0	8.4.2.	
Syrenia	cana	(Pill. & M.)Nei	S	6	8	1	8	1	9	8	0	5.3.3.1.	
Syringa	vulgaris	L.	AC	-3	8	4	8	3	7	7	0	8.4.2.	
Taeniatherum	asperum	(Simk.)Nevski	NP	3	8	2	8	2	9	7	0	3.3.	
Tagetes	patula	L.	I	-1									
Tamarix	gallica	L.	I	-1									
Tamarix	ramosissima	Ledeb.	I	-1									
Tamarix	tetrandra	Pall.	I	-1									
Tamus	communis	L.	G	4	8	4	8	6	5	2	0	8.4.	
Tanacetum	corymbosum	(L.)C.H.Schult.	G	4	6	5	7	4	7	5	0	8.4.2.	
Tanacetum	parthenium	(L.)C.H.Schult.	A	-1	7	5	6	6	7	4	0	3.5.1.1.	
Tanacetum	vulgare	L.	W	1	5	5	6	5	8	4	0	3.5.2.1.	
Taraxacum	bessarabicum	(Horn.)Hand.-M.	G	4	7	5	8	4	9	8	1	5.5.	
Taraxacum	laevigatum	(Willd.)DC.	G	4	7	3	8	3	8	5	0	5.3.	
Taraxacum	officinale	Weber ex Wigg.	RC	-2	5	5	5	7	7	4	1	Indiff.	
Taraxacum	palustre	(Lyons)Symons	G	4	5	8	8	5	8	2	0	5.4.	
Taraxacum	serotinum	(W. & K.)Poir.	S	6	8	2	7	2	8	7	0	5.3.1.1.	
Taxus	baccata	L.	Su	10	5	5	9	5	3	2	0	8.4.3.1.	
Teesdalia	nudicaulis	(L.)R.Br.	Su	10	6	2	2	1	8	2	0	5.2.2.1.	
Telekia	speciosa	(Schreb.)Baumg.	Su	10	6	7	8	6	7	4	0	5.4.1.2.	
Tetragonia	tetragonoides	(Pall.)Ktze.	I	-1									
Tetragonolobus	maritimus	(L.)Roth	DT	2	6	7	7	4	8	4	1	Indiff.	
Teucrium	botrys	L.	NP	3	6	2	8	1	9	4	0	5.2.1.2.	
Teucrium	chamaedrys	L.	G	4	6	3	8	2	7	4	0	5.3.	
Teucrium	montanum	L.	G	4	8	1	9	1	9	4	0	5.3.1.	
Teucrium	scordium	L.	G	4	7	9	8	3	7	5	1	5.4.1.	
Teucrium	scorodonia	L.	Sr	8	5	4	2	3	6	2	0	8.3.1.1.	
Thalictrum	aquilegifolium	L.	G	4	5	4	8	4	5	3	0	8.4.	
Thalictrum	flavum	L.	G	4	6	8	8	4	7	5	0	5.4.1.	
Thalictrum	foetidum	L.	Sr	8	4	2	9	1	9	8	0	5.3.1.3.	
Thalictrum	lucidum	L.	G	4	6	8	7	4	7	5	0	Indiff.	
Thalictrum	minus	L.	G	4	7	3	8	3	6	7	0	6.1.1.2.	
Thalictrum	pseudominus	(Borb.)Jáv.	S	6	5	1	9	1	9	5	0	5.3.1.4.	
Thalictrum	simplex ssp. simp.	L.	G	4	6	4	7	4	7	7	0	8.4.2.	
Thalictrum	s. ssp. galioides	(Nest. ex Pers.)Borza	G	4	5	8	7	5	8	5	0	5.4.1.	
Thelypteris	limbosperma	H.P.Fuchs	S	6	4	6	4	5	4	3	0	8.3.1.2.	
Thelypteris	palustris	Schott	S	6	4	9	5	5	7	4	0	8.2.1.1.	
Thelypteris	phegopteris	(L.)Slosson	G	4	4	5	4	6	3	3	0	Indiff.	
Thesium	arvense	Horvatovszky	G	4	6	2	8	1	8	6	0	5.3.	
Thesium	bavarum	Schrank	G	4	6	2	8	2	7	4	0	6.1.1.2.	
Thesium	dollineri	Murb.	W	1	6	4	8	4	7	6	0	3.4.	
Thesium	linophyllum	L.	G	4	6	2	8	1	8	5	0	5.3.	
Thladiantha	dubia	Bunge	A	-1	7	6	5	6	7	3	0	3.5.2.	
Thlaspi	alliaceum	L.	Gr	6	7	6	7	6	7	8	0		
Thlaspi	arvense	L.	W	1	5	3	7	7	6	4	0	3.4.	
Thlaspi	coerulescens	Presl	Gu	8	4	6	5	4	7	4	0	5.4.1.2.	
Thlaspi	goesingense	Hal.	Su	10	7	2	8	1	8	4	0	4.2.2.2.	
Thlaspi	jankae	Kern.	S	6	7	2	6	2	8	6	0	5.3.1.1.	
Thlaspi	montanum	L.	Su	10	5	2	9	2	8	4	0	5.3.1.4.	
Thlaspi	perfoliatum	L.	DT	2	6	2	8	2	8	5	0	Indiff.	
Thlaspi	schudichii	Soó & Kárp.	Su	10	6	5	6	3	6	6	0	8.4.2.4.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Thymelaea	passerina	L.	W	1	7	4	8	4	8	6	0	3.4.	
Thymus	austriacus	Bernh. ex Rchb.	G	4	7	1	8	1	8	5	0	5.3.	
Thymus	caespitosus	(Lyka)Ronn.	S	6	6	2	8	1	8	4	0	5.3.1.3.	
Thymus	degenianus	(Lyka)Lyka	S	6	8	1	8	1	9	6	0	5.3.3.1.	
Thymus	glabrescens	Willd.	G	4	7	1	8	1	8	5	0	5.3.	
Thymus	marshallianus	Willd.	G	4	6	2	8	1	8	6	0	5.3.1.	
Thymus	montanus	W. & K.	G	4	5	5	6	2	8	6	0	5.1.1.	
Thymus	oenipontanus	H.Br. ex Borb.	G	4	7	1	8	1	8	5	0	5.3.	
Thymus	pannonicus	All.	G	4	7	2	8	2	8	7	0	5.3.1.	
Thymus	praecox	Opiz	S	6	6	1	9	1	9	5	0	5.3.1.2.	
Thymus	pulegioides	L.	G	4	5	3	6	1	8	4	0	5.4.	
Thymus	serpyllum	L. em. Mill.	C	5	5	2	3	1	8	4	0	5.2.2.1.	
Thymus	vulgaris	L.	I	-1									
Tilia	cordata	Mill.	G	4	5	5	6	5	4	4	0	8.4.	
Tilia	platyphyllos	Scop.	C	5	5	5	7	7	3	2	0	8.4.3.	
Tilia	rubra	DC.	C	5	6	5	7	6	6	5	0	8.4.2.	
Tilia	tomentosa	Mönch	C	5	7	5	7	6	5	7	0	8.4.	
Tilia	x vulgaris	Hayne	I	-1									
Tordylium	maximum	L.	DT	2	8	2	7	2	7	4	0	6.2.1.	
Torilis	arvensis	(Hunds.)Link	W	1	7	3	7	4	7	3	0	3.4.	
Torilis	japonica	(Houtt.)DC.	DT	2	6	5	8	8	6	3	0	Indiff.	
Torilis	ucrainica	Spr.	DT	2	6	5	8	7	6	4	0	Indiff.	
Tragopogon	dubius	Scop.	DT	2	6	4	7	3	7	4	0	5.3.	
Tragopogon	floccosus	W. et K.	S	6	8	2	8	1	8	7	0	5.3.3.1.	
Tragopogon	orientalis	L.	DT	2	5	4	7	6	7	5	0	Indiff.	
Tragopogon	porrifolius	L.	I	-1									
Tragus	racemosus	(L.)Desf.	W	1	9	2	8	4	9	3	0	3.3.2.4.	
Trapa	natans	L.	C	5	7	11	6	8	8	5	0	1.3.1.2.	
Traunsteinera	globosa	(L.)Rchb.	Sr	8	4	5	6	4	7	4	0	5.4.2.2.	
Tribulus	terrestris	L.	NP	3	9	1	8	2	9	9	0	5.3.3.2.	
Trichophorum	alpinum	(L.)Pers.	Su	10	4	10	3	2	8	4	0	1.7.1.2.	
Trichophorum	caespitosum	(L.)Hartm.	Su	10	4	9	2	2	8	3	0	1.7.1.2.	
Trifolium	alpestre	L.	G	4	5	3	7	3	7	4	0	6.1.1.2.	
Trifolium	angulatum	W. & K.	S	6	8	2	6	1	8	6	4	5.5.2.1.	
Trifolium	arvense	L.	DT	2	5	2	4	1	8	3	0	Indiff.	
Trifolium	aureum	Poll.	G	4	5	3	6	2	7	4	0	8.4.2.	
Trifolium	campestre	Schreb.	DT	2	5	4	7	3	8	3	0	Indiff.	
Trifolium	diffusum	Ehreh.	S	6	7	3	6	2	7	7	0	5.5.2.1.	
Trifolium	dubium	Sibth.	G	4	6	5	6	4	6	3	0	5.4.2.	
Trifolium	fragiferum	L.	DT	2	6	7	8	7	8	5	4	Indiff.	
Trifolium	hybridum	L.	DT	2	5	8	7	5	7	5	1	Indiff.	
Trifolium	incarnatum	L.	I	-1	6	5	5	5	8	2	0	3.4.	
Trifolium	medium	Grufbg. ex L.	G	4	5	5	6	3	6	4	0	8.4.	
Trifolium	micranthum	Viv.	S	6	8	2	8	2	9	3	4	5.5.2.1.	
Trifolium	montanum	L.	G	4	5	3	8	2	7	4	0	6.1.1.2.	
Trifolium	ochroleucum	Huds.	G	4	5	4	8	2	7	4	0	8.4.2.	
Trifolium	ornithopodioides	(L.)Sm.	Gr	6	8	1	8	1	8	2	7	5.5.1.	
Trifolium	pallidum	W. & K.	Gr	6	8	1	7	2	8	7	0		
Trifolium	pannonicum	L.	G	4	8	3	8	4	7	8	0	8.4.2.	
Trifolium	patens	Schreb.	G	4	6	6	7	5	8	5	0	5.4.	
Trifolium	pratense	L.	DT	2	5	6	6	5	7	3	0	Indiff.	
Trifolium	repens	L.	DT	2	5	5	6	7	8	3	1	Indiff.	
Trifolium	resupinatum	L.	NP	3	8	5	8	5	8	3	2	3.1.1.4.	
Trifolium	retusum	Hoejer	S	6	7	2	7	1	8	7	3	5.5.2.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Trifolium	rubens	L.	G	4	6	3	8	3	7	5	0	6.1.1.2.
Trifolium	striatum	L.	NP	3	8	2	4	2	8	3	1	5.2.2.
Trifolium	strictum	Jul. ex L.	S	6	8	2	7	1	8	8	3	5.5.2.1.
Trifolium	subterraneum	L.	Sr	8	9	1	8	1	9	9	5	5.5.2.1.
Trifolium	vesiculosum	Savi	S	6	7	3	8	2	8	7	5	5.5.2.1.
Triglochin	maritimum	L.	S	6	5	7	7	3	8	7	6	5.5.1.3.
Triglochin	palustre	L.	G	4	5	9	7	1	8	4	3	5.4.1.
Trigonella	caerulea	(L.)Ser. ex DC.	I	-1	8	4	8	4	7	5	0	3.4.
Trigonella	foenum-graecum	L.	I	-1								
Trigonella	gladiata	Stev. ex. M.B.	Su	10	9	1	9	1	9	5	0	5.3.1.5.
Trigonella	monspeliaca	L.	G	4	9	1	8	1	8	6	0	5.3.1.
Trigonella	procumbens	(Bess.)Rchb.	DT	2	8	4	7	4	8	6	0	
Trinia	glauca	(L.)Dum.	G	4	8	1	8	1	9	5	0	5.3.
Trinia	ramosissima	(Fisch.)Koch	S	6	8	3	8	1	8	7	0	5.3.1.1.
Trisetum	flavescens	(L.)P.B.	S	6	5	6	6	5	7	5	0	5.4.2.2.
Triticum	aestivum	L.	I	-1								
Triticum	durum	Desf.	I	-1								
Triticum	turgidum	L.	I	-1								
Trollius	europaeus	L.	Sr	8	3	7	7	6	9	5	0	5.4.1.1.
Tulipa	gesnerana	L.	I	-1								
Tulipa	sylvestris	L.	I	-1								
Turritis	glabra	L.	G	4	5	3	6	3	7	6	0	8.4.2.
Tussilago	farfara	L.	DT	2	5	5	8	6	9	3	0	Indiff.
Typha	angustifolia	L.	C	5	7	10	7	7	8	5	1	1.5.1.1.
Typha	latifolia	L.	C	5	6	10	7	8	8	5	1	1.5.1.1.
Typha	laxmannii	Lepech.	A	-1	6	10	8	6	8	7	0	3.9.1.1.
Typha	minima	Funck ex Hoppe	Sr	8	5	9	8	2	8	7	0	1.7.2.1.
Typha	schuttletworthii	Koch & Sond.	A	-1	3	10	8	3	8	4	0	1.5.1.
Ulmus	glabra	Huds.	G	4	5	7	6	7	4	3	0	8.4.3.
Ulmus	laevis	Pall.	S	6	6	8	7	7	4	5	0	8.4.3.3.
Ulmus	minor	Mill.	G	4	7	7	8	6	5	5	0	8.4.3.3.
Ulmus	procera	Salisb.	G	4	7	6	8	6	5	6	0	8.4.2.
Urtica	dioica	L.	DT	2	6	7	6	9	6	4	0	Indiff.
Urtica	kioviensis	Rogov.	Sr	8	6	9	7	7	7	6	0	1.5.1.1.
Urtica	urens	L.	W	1	6	5	6	8	7	4	0	3.3.
Utricularia	australis	R.Br.	NP	3	6	12	5	3	9	2	0	1.1.2.
Utricularia	bremii	Heer ex Koell.	Sr	8	7	12	4	2	8	4	0	1.2.1.1.
Utricularia	minor	L.	Sr	8	6	12	6	1	8	4	0	1.2.1.1.
Utricularia	vulgaris	L.	NP	3	6	12	7	5	7	5	0	1.1.1.
Vaccaria	hispanica	(Mill.)Rausch.	W	1	6	4	9	5	7	6	0	3.4.1.
Vaccinium	myrtillus	L.	S	6	3	4	2	2	5	5	0	8.3.1.
Vaccinium	oxycoccos	L.	Su	10	3	9	2	1	8	3	0	1.8.1.1.
Vaccinium	vitis-idaea	L.	Sr	8	3	5	2	2	5	5	0	8.3.1.
Valeriana	dioica	L.	G	4	5	8	6	2	7	2	0	5.4.1.
Valeriana	excelsa	Poir.	Su	10	6	7	6	6	4	5	0	8.4.3.1.
Valeriana	officinalis	L.	G	4	6	8	7	5	7	5	0	Indiff.
Valeriana	stolonifera	Czern. em. Soó	G	4	7	4	7	4	7	4	0	8.4.2.
Valeriana	tripteris	L.	Sr	8	3	6	8	2	7	2	0	8.4.3.1.
Valerianella	carinata	Lois.	NP	3	8	3	8	3	7	3	0	5.3.1.1.
Valerianella	coronata	(L.)DC.	NP	3	8	1	8	1	8	7	0	5.3.1.1.
Valerianella	dentata	(L.)Poll.	W	1	6	3	7	2	7	2	0	3.4.1.1.
Valerianella	locusta	(L.)Latter.	DT	2	6	4	7	3	7	3	0	Indiff.
Valerianella	pumila	(L.)DC.	NP	3	8	2	8	1	8	6	0	5.3.1.1.
Valerianella	rimosa	Bast. ex Desv.	W	1	7	4	7	3	6	2	0	3.4.1.

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Vallisneria	spiralis	L.	A	-1	8	12	6	4	6	5	0	1.3.1.1.	
Ventenata	dubia	(Leers)Coss.	DT	2	7	3	4	4	8	4	0	Indiff.	
Veratrum	album	L.	S	6	4	7	8	6	7	4	0	5.4.1.1.	
Veratrum	nigrum	L.	S	6	6	5	7	5	6	6	0	8.4.2.4.	
Verbascum	austriacum	Schott	G	4	7	3	7	5	7	7	0	6.1.1.2.	
Verbascum	blattaria	L.	DT	2	6	3	7	6	8	7	1	Indiff.	
Verbascum	densiflorum	Bert.	W	1	6	4	8	5	8	5	0	3.3.	
Verbascum	lychnitis	L.	G	4	6	3	7	8	7	5	0	5.3.	
Verbascum	nigrum	L.	DT	2	5	4	7	7	7	5	0	6.2.	
Verbascum	phlomoides	L.	W	1	6	4	6	6	8	5	0	Indiff.	
Verbascum	phoeniceum	L.	G	4	7	2	8	2	8	6	0	5.3.1.	
Verbascum	pulverulentum	Vill.	DT	2	8	4	8	4	8	4	0	3.4.	
Verbascum	speciosum	Schrad.	DT	2	8	3	8	5	8	7	0	5.3.	
Verbascum	thapsus	L.	W	1	5	3	6	7	8	3	0	Indiff.	
Verbena	officinalis	L.	W	1	6	4	8	6	9	3	0	3.3.	
Verbena	rigida	Spr.	I	-1									
Verbena	supina	L.	NP	3	8	8	8	2	9	8	3	3.1.1.4.	
Veronica	acinifolia	L.	G	4	9	7	4	3	7	2	0	5.5.	
Veronica	agrestis	L.	W	1	6	6	7	7	5	2	0	3.4.	
Veronica	anagallis-aquatica	L.	S	6	6	9	7	7	7	3	0	1.5.1.3.	
Veronica	anagalloides	Guss.	DT	2	7	8	8	6	7	5	0	Indiff.	
Veronica	arvensis	L.	DT	2	6	5	6	5	5	3	0	Indiff.	
Veronica	austriaca	L.	G	4	7	2	8	1	8	6	0	5.3.1.	
Veronica	beccabunga	L.	S	6	5	10	7	6	7	3	0	1.5.1.3.	
Veronica	catenata	Penn.	S	6	7	9	7	7	7	6	0	1.6.1.3.	
Veronica	chamaedrys	L.	DT	2	5	5	7	5	6	3	0	Indiff.	
Veronica	dillenii	Cr.	NP	3	6	2	4	1	9	6	0	5.2.2.	
Veronica	hederifolia	L.	W	1	6	4	7	7	6	3	0	3.4.	
Veronica	jacquinii	Baumg.	S	6	7	2	8	1	8	7	0	5.3.1.3.	
Veronica	longifolia	L.	G	4	5	8	7	7	7	7	0	Indiff.	
Veronica	montana	Jusl.	S	6	5	6	6	6	4	2	0	8.4.3.1.	
Veronica	officinalis	L.	G	4	5	4	4	3	5	3	0	8.3.1.	
Veronica	opaca	Fr.	W	1	5	4	8	6	5	4	0	3.4.	
Veronica	orchidea	Cr.	G	4	7	3	8	3	8	6	0	5.3.1.	
Veronica	pallens	Host	Sr	8	6	2	5	1	8	7	0	5.3.1.1.	
Veronica	paniculata	L.	S	6	7	4	8	3	6	8	0	8.4.2.3.	
Veronica	peregrina	L.	A	-1	7	8	8	6	8	5	0	3.1.1.1.	
Veronica	persica	Poir.	W	1	6	5	7	7	6	3	0	3.3.	
Veronica	polita	Fr.	W	1	6	4	8	7	5	3	0	3.4.	
Veronica	praecox	All.	NP	3	8	2	8	1	8	5	0	5.2.	
Veronica	prostrata	L.	G	4	7	2	8	1	8	6	0	5.3.1.	
Veronica	scardica	Griseb.	S	6	7	9	6	4	6	6	0	1.5.1.3.	
Veronica	scutellata	L.	G	4	5	9	6	3	8	3	1	5.4.1.	
Veronica	serpyllifolia	L.	DT	2	5	6	6	5	7	3	1	Indiff.	
Veronica	spicata	L.	G	4	7	2	7	2	8	6	0	5.3.	
Veronica	teucrium	L.	G	4	6	3	8	2	7	5	0	6.1.1.2.	
Veronica	triphyllous	L.	NP	3	7	3	5	4	6	3	0	Indiff.	
Veronica	verna	L.	NP	3	6	1	4	1	8	5	0	5.2.	
Viburnum	lantana	L.	G	4	7	4	8	3	6	2	0	8.4.2.	
Viburnum	opulus	L.	G	4	5	7	7	6	6	3	0	8.1-8.2.	
Vicia	angustifolia	Grufbg.	DT	2	7	3	8	5	7	5	0	Indiff.	
Vicia	biennis	L.	DT	2	7	8	8	7	7	7	0	3.5.2.	
Vicia	cassubica	L.	S	6	6	5	6	3	5	4	0	8.4.2.4.	
Vicia	cracca	L.	DT	2	5	4	6	4	7	4	0	Indiff.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.	Chr.
Vicia	dumetorum	L.	G	4	6	5	6	4	6	4	0	6.1.1.2.	
Vicia	faba	L.	I	-1									
Vicia	grandiflora	Scop.	DT	2	7	4	6	4	7	6	0	Indiff.	
Vicia	hirsuta	(L.)S.F.Gray	DT	2	6	3	8	5	7	5	0	Indiff.	
Vicia	lathyroides	L.	NP	3	7	2	6	2	8	4	0	5.2.	
Vicia	lutea	L.	W	1	7	4	5	4	7	3	0	3.4.2.1.	
Vicia	narbonensis	L.	S	6	8	3	8	2	7	3	0	5.3.1.1.	
Vicia	oroboides	Wulf. ex Jacq.	S	6	6	6	7	5	5	4	0	8.4.3.4.	
Vicia	pannonica	Cr.	W	1	7	4	7	4	7	6	0	3.4.	
Vicia	peregrina	L.	A	-1									
Vicia	pisiformis	L.	G	4	7	4	8	3	7	4	0	8.4.2.	
Vicia	sativa	L.	W	1	7	5	7	6	7	6	0	3.4.	
Vicia	sepium	L.	DT	2	5	5	6	5	7	5	0	Indiff.	
Vicia	sparsiflora	Ten.	S	6	8	4	8	4	6	8	0	8.4.2.2.	
Vicia	striata	M.B.	W	1	7	4	7	4	7	7	0	3.4.	
Vicia	sylvatica	L.	G	4	5	6	8	5	6	4	0	8.4.3.	
Vicia	tenuifolia	Roth.	DT	2	6	3	8	2	8	6	0	Indiff.	
Vicia	tenuissima	(M.B.)Sch. & Th.	DT	2	8	4	6	5	7	6	0		
Vicia	tetrasperma	(L.)Schreb.	DT	2	6	5	6	4	6	5	0	Indiff.	
Vicia	villosa	Roth	W	1	6	3	5	5	7	5	0	3.4.	
Vinca	herbacea	W. & K.	S	6	8	2	8	1	8	7	0	5.3.1.1.	
Vinca	minor	L.	C	5	6	5	6	6	4	2	0	8.4.3.2.	
Vincetoxicum	hirundinaria	Medik.	G	4	5	3	7	3	6	5	0	Indiff.	
Vincetoxicum	pannonicum	(Borhidi)Holub	Su	10	8	2	9	2	8	7	0	5.3.1.4.	
Viola	alba	Bess.	G	4	8	5	6	4	5	3	0	8.4.	
Viola	ambigua	W. & K.	G	4	7	4	7	1	8	6	0	5.3.1.	
Viola	arvensis	Murr.	W	1	5	4	6	6	5	3	0	3.4.	
Viola	biflora	L.	Su	10	3	7	7	6	3	4	0	8.4.3.1.	
Viola	canina	L.	G	4	5	4	4	2	7	3	0	5.1.1.	
Viola	collina	Bess.	Sr	8	5	2	8	2	7	7	0	5.3.1.1.	
Viola	cornuta	L.	I	-1									
Viola	cyanea	Celak.	G	4	7	4	7	4	5	8	0	8.4.	
Viola	elatior	Fr.	G	4	6	7	8	4	7	6	0	8.4.1.	
Viola	hirta	L.	G	4	5	3	8	2	6	5	0	6.1.1.	
Viola	kitaibeliana	Roem. & Schult	NP	3	7	3	7	4	7	6	0	5.2.	
Viola	mirabilis	L.	G	4	5	5	8	6	4	4	0	8.4.3.	
Viola	montana	L.	G	4	5	4	4	4	6	5	0	8.3.1.	
Viola	odorata	L.	G	4	6	5	8	8	5	3	0	8.4.	
Viola	pumila	Chaix ex Vill.	G	4	7	7	6	4	8	7	2	5.5.	
Viola	riviniana	Rchb.	G	4	5	5	6	5	5	3	0	8.4.3.	
Viola	rupestris	F.W.Schm.	S	6	6	2	8	2	8	7	0	5.3.3.1.	
Viola	stagnina	Kit. ex Schult.	S	6	6	7	6	6	6	5	0	5.4.1.1.	
Viola	suavis	M.B.	S	6	7	5	6	4	5	8	0	8.4.2.3.	
Viola	sylvestris	Lam.	G	4	5	5	7	6	4	4	0	8.4.	
Viola	tricolor ssp. polychroma	(Kern.)J.Murr	S	6	4	3	7	2	8	4	0	5.3.1.3.	
Viola	tricolor ssp. subalpina	Gaud.	S	6	4	3	8	2	8	5	0	5.3.1.3.	
Viola	tricolor ssp. tricolor	L.	G	4	4	2	5	2	7	2	0	5.3.1.	
Viscum	album	L.	G	4	5	7	5	6	7	3	0	8.4.	
Vitis	vulpina	L.	A	-1	7	8	6	6	6	4	0	8.1.1.2.	
Vitis	rupestris	Scheele	A	-1								8.6.1.	
Vitis	sylvestris	C.Gmel.	S	6	8	8	8	6	6	4	0	8.1.1.2.	
Vitis	vinifera	L.	I	-1	8	4	6	4	8	4	0	8.6.1.	
Vulpia	bromioides	(L.)S.F.Gray	NP	3	8	2	3	2	9	2	0	8.2.4.1.	
Vulpia	myuros	(L.)C.Gmel.	NP	3	8	1	4	1	8	3	0	5.2.4.1.	

Genus	Species	Auctor	SBT	Val	TB	WB	RB	NB	LB	KB	SB	Soc.Chr.
Waldsteinia	geoides	Willd.	G	4	8	4	8	6	6	8	0	Indiff.
Wolffia	arrhiza	(L.)Horkel	NP	3	6	11	7	5	8	7	0	1.1.1.1.
Woodsia	alpina	(Bolt.)S.F.Gray	Su	10	2	2	5	1	9	4	0	5.3.1.3.
Woodsia	ilvensis	(L.)R.Br.	Sr	8	3	2	6	1	7	5	0	5.3.1.3.
Xanthium	italicum	Moretti	W	1	7	8	6	7	8	4	0	3.2.
Xanthium	saccharatum	Wallr.	A	-1								3.2.
Xanthium	spinosum	L.	W	1	8	4	6	5	8	5	1	3.3.
Xanthium	strumarium	L.	W	1	7	6	7	6	8	5	1	3.3.3.
Xeranthemum	annuum	L.	NP	3	8	2	6	2	8	7	0	5.3.1.
Xeranthemum	cyllindraceum	Sibth. & Sm.	NP	3	8	2	8	1	8	8	0	5.3.1.
Yucca	filamentosa	L.	I	-1								
Zannichellia	palustris	L.	C	5	6	12	8	8	6	5	5	2.2.1.1.
Zea	mays	L.	I	-1								

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The author is grateful to Prof. G. FEKETE for his theoretical advices. Dr. Ing. D. BARTHA of the University of Forestry and Wood Industry gave valuable suggestions for the phytosociological characters of many tree and shrub species. My colleagues, Mr. T. MORSCHHAUSER and Mrs. É. SALAMON-ALBERT made also some useful remarks for improving the ecological characterization of some critical plants. The study was supported by the Hungarian Scientific Research Fund (OTKA) No. 1298.

BOOK REVIEWS

Editor: K. T. KISS

NABHAN, G. P.: *Gathering the Desert*. Illustrated by P. MIROCHA. The University of Arizona Press, Tucson, AZ, USA 1987, 209 pp.

Desertification has become a global problem. The arable land in 99 countries is slowly turning into desert — 900 million people is affected in all continents. Deserts account for 7% of earth's land surface, while 38% is considered dryland. Of the world's 5200 million hectares of agriculturally used dryland, 69% is degraded or subject to desertification, according to UNEP.

One of the world's five main desert zones is the Sonoran Desert of North-West Mexico and its continuation in the desert zone of the South-West United States. It may seem to be harsh and sterile, but Sonoran Desert has yielded food, fiber, and home for the cultures dwelling within it. Now, with the man-made changes, like lowering the water-tables throughout the Southwest of USA, folk wisdom about native plants is fading among American Indian and Mexican alike. In "Gathering the Desert" from the University of Arizona Press, naturalist Gary Paul NABHAN and artist Paul MIROCHA look the past to recapture knowledge and practices of native Indian tribes, concerning the opportunities for gathering and agriculture in the desert. Yes, for agriculture, too — because these tribes (Papago, Yuma, Pima, Seri, Opata and others) have had a very ancient agriculture. They domesticated many plant species and developed local varieties of the introduced ones. But this book is not only about the past, the authors have the significant message for the future, too. These are many lessons to learn from these tribes, how to grow crops in arid lands.

Each chapter is dealing with a group of native plants or cultivated crops: wild chiles, amaranths, cactus, palms, panicgrass, gourds, tepary beans, etc. Only a dozen from the cca. 2500 native plants, and roughly 25 crops cultivated here. But through these few and the stories attached to them one can see the living desert and its people dwelling in it. These plants have a great significance for the native tribes whose ancient wisdom of desert agriculture can be a great help for those who live under similar conditions and struggle with the desert.

There is an argument in this book which deserves highly the readers' attention. The modern food production in half-desert environment is based on human-adapted crops that consume 20-30 percent more water in the desert than they do if cultivated in the more temperate zones where they originated. This is "extra" water which costs lots of energy and exhausts of our resources. Instead, we should learn more from the desert plants, the people living here and their agricultural practices. This book is a beautiful combination of botanical, ecological and ethnobotanical observations, spiced with humor and folklore.

It includes a dozen stylized pencil drawings by P. MIROCHA, an artist with the University of Arizona Office of Arid Lands Studies.

G. P. NABHAN, the author, a research botanist at the same institution, is also a founder of NATIVE SEED/SEARCH, a conservation organization devoted to save by propagation of rare but useful desert plants.

I can wholeheartedly recommend this masterpiece of American Naturalist literature to both professionals (botanists, ecologists, conservationists, plant breeders, etc.) and the interested public.

Z. SZŐCS

READ, D. J.—LEWIS, D. H.—FITTER, A. H.—ALEXANDER, I. J. (eds): *Mycorrhizas in Ecosystems*. C.A.B. International, Wallingford 1992, 419 pp.

In nature the roots of different plants are infected by fungi forming mycorrhizas. This symbiotic co-existing of fungi and plants plays a central role in the capture of the nutrients.

Mycorrhizas are also having an important role in the ecosystems and the Third European Symposium on Mycorrhizas was addressed to this theme. Contributions of this symposium are edited in this book, including the abstracts of posters, too.

The papers of 48 chapters are divided into six parts, which deal with different aspects of the role of mycorrhizas. The first nine chapters are given under title "Status and Function of Vesicular-Arbuscular (VA) Mycorrhiza in Ecosystems". In this we could read about so important aspects of VA-mycorrhizas as the nutrient dynamics at soil-root interface, the transport of phosphorus, the effects of plants in low nutrient environment, etc.

Parts Two, Three, Four and Five present contributions on role of mycorrhizas in the different ecosystems. They consist papers on Temperate and Boreal Forests, Disturbed, Agricultural and Successional Ecosystems, Heathland Ecosystems and Tropical Ecosystems, respectively. The sixth part is addressed to physiological ecology, while the seventh one is containing the poster abstracts.

All of the papers given in this volume contract the most important informations about the mycorrhizas representing the different types of the co-existing of the different organisms, ways of investigations and roles in ecosystems including effects on plant associations. These make the book very important for a wide range of research workers in mycology, plant ecology and soil biology.

E. I. SIMAY

REHM, S.—ESPIG, G.: *The Cultivated Plants of the Tropics and Subtropics. Cultivation, Economic Value, Utilization.* Weikersheim, Margraf 1991, 552 pp.

The aim of the international organization CTA (Technical Centre for Agriculture) is to collect, disseminate and facilitate the exchange of information on agricultural and rural research as well on training and innovation between the countries of the European Community on the one hand and the African, Caribbean and Pacific Countries on the other. The growth both of the world population and the famine on the Southern continents require an effectual increase in agricultural production and a better utilization of potential agronomical sources. The wealth of useful plants is far from being fully exploited for industry or feeding CTA activity is promoted by a special book series dealing with the most timely economic problems in the world. The original German edition of the above work (1984) was based on the research of the senior author S. REHM (Göttingen University) and on the documentation on tropical crop collection by G. ESPIG. The great demand and interest result in the edition of the English translation. The most important 1000 crop plant species are discussed in this pocket manual, facilitated by 101 figures and 55 tables. The treatment is along economic groups. Each chapter starts with a description as to the particular properties of the group, giving then a survey on the economy, the production trends, nutritional aspect, chemistry and technological features. Only the major crops could be treated in detail, concentrating on the essential points: botany, production, breeding, ecophysiology, cultivation, diseases and pests, and utilization. In most chapters appears a large table indicating the botanical and vernacular names, the distribution, economic importance and uses of each plant species, as well as a diagram illustrating world — production during the last 10 years. The drawings between the text are helpful in identifying the species; they depict the significant morphological characteristics. Research are assisted by a large bibliography 74 pages all species included. All information on the plants is available off-line from a continuously updated data bank for cultivated plants and relevant literature at the Institute of Agronomy at Göttingen University. The booklet is completed by a detailed index including the most important notions mentioned in the text, and both the scientific and local plant names. The manual is intended for all educated people, teacher and scientist working or interested in any kind of tropical vegetation, especially in agronomy.

Z. KERESZTY

REISSER, W. (ed.): *Algae and Symbioses: Plants, Animals, Fungi, Viruses, Interactions Explored*. Biopress Limited, Bristol, England 1992, 746 pp.

The aim of this book is written most correctly in its preface: "The intention of this book is to give an insight into the state of the art of modern symbiosis research with algae. Accordingly, it covers a wide range of topics and techniques and reflects quite different ways of thinking about algae and their interactions. But what is common to all authors is their devotion to learn more about those fascinating organisms and their place in the biosphere."

The extent of the book is 746 pages. To make the book easy to understand there are many figures, tables and photos. Because in Hungary the algological investigations are focused mainly taxonomical and ecological aspects, this book fills in the gap of our algological knowledge about the symbioses. It includes the newest results of algal symbiosis research.

In the first chapter we can read about symbiotic interactions separated the cellular and subcellular level. Within the cellular level the symbiotic interactions are separated into the freshwater, marine and terrestrial habitats, altogether in 26 subchapters.

In the second chapter we can read about epi- and endobiotic interactions. It consists of five subchapters.

In the last chapter is discussed the basic mechanisms of symbioses, including basic mechanisms of signal exchange, recognition, specificity and regulation in endosymbiotic systems and lichens, and the role of symbiosis formation in algal evolution.

Within almost every subchapter is given a short review about the taxonomy, morphology, physiology and ecology of symbiont living creatures. Every subchapter of the book is finished with long and detailed references including from oldest to newest literature.

At the end of the book there are 12 pages index including the list of the taxa and the most important notions, which are in the book.

In my opinion the most interesting part of the book is the interactions of eucaryotic algae and viruses, but this subchapter is very short, indicate our little knowledge about his topic. Probably because the phytopathology is a rather neglected field of science.

Because of the topic of this book is very special, I can recommend mainly the researchers dealing with algal physiology, but I think, this book is also very important and useful for professors and those who want to write botanical or algological textbooks for the students.

É. ÁCS

REYNOLDS, D. R.—TAYLOR, J. W. (eds): *The Fungal Holomorph: Mitotic, Meiotic and Pleomorphic Speciation in Fungal Systematics*. C.A.B. International, Wallingford 1993, 375 pp.

This book covers the Proceedings of an International Symposium founded by U.S. National Science Foundation, Newport, Oregon, 4—7 August 1992. The symposium was focused on a particularly vexy aspect of biological aspect of biological systemaics pointing out the dual system of classification of fungi. Under the dual system, fungi having structures of sexual reproduction are classified in the kingdom fungi, while fungi lacking these structures are classified in the form taxon Deuteromycotina. So, this taxon became a highly variant one containing fungi similar to anamorphs of both Ascomycotina and Basidiomycotina.

The papers of books are selected into six part. An overview of different aspects is given in the first one including the role of nucleic acid sequence-analysis in change of fungal classification or the status of mitosporic fungi (Deuteromycetes in the Dictionary of the fungi). The second part of the book deals with the morphological and molecular studies of fungi for integration of mitotic and meiotic ones. The problems are demonstrated through different fungal groups belong to different genera. There is a Group Discussion, too, with the possibilities of classification together the mitotic, meiotic and pleomorphic species.

The asexual reproduction could serve a rapid spread of genetic changes. This aspect and its evolutionary questions are demonstrated in the third part. The most of papers presented in the book deal with ascomycetous fungi and their anamorphs, while some Basidiomycotina also have

asexual forms. Two types of these are given in the fourth part. These are Peridermium forms of Cronartium rust and the basidiomycetous yeasts.

There are taxonomical and nomenclatural questions about acceptance and integration of results of molecular genetics beside the morphological taxonomy. These are presented in the next two parts of these book. The fifth one is addressed to taxon definition connecting with molecular systematics, while the sixth deals with the nomenclature including the perspectives to give a natural classification of the fungi.

The papers of this book give valuable information about morphological and developmental systematics, molecular systematics, and contribution where attempts were made to develop syntheses between these. The book therefore represents an important addition to the mycological literature, but it will also be interest for taxonomists and biologists working with other organisms.

E. I. SIMAY

ROMO, A. M.: Flora i vegetacio del Montsec (Pre-Pirineus catalans). Institut d'Estudis Catalans, Barcelona 1989, 534 pp.

The study of the flora and vegetation of the Mountain Montsec is a part of the systematic, thorough and detailed investigations started by the Catalan botanical school. The book was published under the auspices of the Catalan Institute of Sciences and, as several other books dealing with botanical investigations of Catalan lands, was given the award named after the great Catalan botanist Pius Font i Quer, who lived in the middle of this century. Although the book was written in Catalan, its style makes it easy to understand for readers familiar with either French or Spanish.

The Montsec was quite unexplored botanically. This chain of mountains which lies South and not far from the axis of the Pyrenees, with its severe climate did not attract the attention of botanists, although it is an important biogeographic borderland and bridge between the Ebre plane, and the Pyrenees. The Montsec is the greatest and highest mountain in the Catalan Pre-Pyrenees. Its surface is varied. The height difference between its highest and lowest points is 1350 m. The difference in level is remarkable even within short ranges. The highest points are around 1600 m. The mountain is crossed by two rivers in the N-S direction, and they divide the mountain in three separate blocks.

The base rocks are limestone and dolomite. It is a climatic and biogeographical borderland. Going towards the South in the mountain precipitation decreases, while average temperature rises. The northern part of the mountain belongs to the sub-mediterranean climate, while the southern part is in the continental mediterranean zone. Its vegetation is mixed accordingly. The flora consist of mainly sub-mediterranean elements, but the ratio of mediterranean species is quite high.

The author prepared the flora catalogue of this mountain, in which the precise locations of species are given by the codes of UTM screens. He collected earlier, sporadic herbarium data, as well as trying to check on the old data. Almost 1100 plants got into the catalogue. In the further chapters he gives flora analysis regarding the different parts of the mountain. He describes the composition of the communities of the different habitats with tables showing abundance relations. He also discusses the vegetation degradation which is the result of silvicultural exploitation and increasing inhabitation, and describes the relations of vegetation dynamics following degradation.

The book is an excellent review about the vegetation of this mountain, which is a biogeographical border between sub-mediterranean and mediterranean areas. It is a useful book for every botanist dealing with vegetation of the sub-mediterranean and mediterranean areas.

B. PAPP

SACHS, T.: Pattern Formation in Plant Tissues. Cambridge University Press, Cambridge, New York 1991, 234 pp.

It is obvious, that living organisms have a predictable form, a patterned structure. This patterned structure is characteristic to the morphological units, and to the arrangement of cells and tissues as well. We could simply state, that genes specify the structure. From this statement arises the central problem of this book: How the structure of macromolecules (nucleic acids and proteins) could be causally related to the pattern of cells tissues and organs of vascular plants.

The aim is not to understand the molecular mechanisms, but to define general principles concerning the specification of biological form and to develop a new theory on it. New concept however needs factual approach. The chapters of this book shows a series of topics related the discussion of the above-mentioned problem. These are:

- Interactions of developing organs
- Hormones as correlative agents
- Callus and tumour development
- The polarization of tissues
- The canalization of vascular differentiation
- Cell lineages
- Stomata as an example of meristemoid development
- Expression of cellular interaction
- Apical meristems
- The localization of new leaves
- A temporal control of apical differentiation

The last chapter of the book involves the generalizations of the tissue patterning. The formerly used theories, rely on early chemical plans (pre-patterns) are parts of the new concept, but to explain all developmental events they are not suffice. An examination of the patterning principles of the former chapters suggests way for extending the hypothesis with the involvement of the following phenomenons: cell orientation and polarization, the existence and activity of different gradients and signals in tissues, local interactions between cells, the stochastic character of cell differentiation etc. The existence of random elements at a cellular level results the possibility of choice. It bears the question: How could a definite patterning emerge if the early stage of development is not strictly specified? The answer is that the choice would be between structures, that differs in gene expression but not in genetic traits. The phenomenon gives the name of this type of patterning: epigenetic selection.

Though the existence of some obscure question is not to be denied, the hypothesis of epigenetic selection provides new possibilities in understanding the development of plant form.

This book will be of interest to advanced undergraduates and graduate students, and to biologists who are interested in new theories and experimental evidences that support them.

E. MIHALIK

SAKAI, A.—LARCHER, W. (eds): Frost Survival of Plants. Springer-Verlag, Berlin, Heidelberg, New York, London, Paris, Tokyo 1987, 321 pp.

Combining information on several aspects of frost on plants at different structural levels the authors have successfully compiled a well-balanced, yet interesting book for different research areas. From cellular to whole plant responses and from the arctics to the tropic zone it covers a wide range of ecophysiological and ecological considerations in viewing phenomena of frost resistance, acclimation, tolerance and adaptation in plant kingdom. From characterizing large-scale temperature changes to that of expected in a plant's microclimate the authors outline at first the possible mechanisms affecting distribution of frost events in space and time with no implications deriving from physiological reactions modifying the energy balance. The value of this clear distinction becomes apparent in later sections as sequences of phenomena and their relationships are overviewed. A short, nevertheless comprehensive

description of physical phenomena of freezing is very useful in avoiding confusions in terminology and makes it valuable tool in education, too. The histological and physiological considerations of freezing process in plants is the determining part of the book and it serves as a background for understanding the mechanism — including resistance, acclimation, tolerance and adaptation — by the means of which plants are able to survive successfully under the variety of stress conditions imposed by frost. Within these frost mitigation, possibilities and value of deep supercooling are discussed as well as extracellular and extraorgan freezing. The role of compartmentalization of these processes between different levels of organization and plant parts is discussed. One can get a clear idea, how a twig could survive after being placed in liquid helium, and can see a photograph of this twig grown for an eight year old tree after this treatment. Detailed descriptions of freezing injuries and possible alterations accompanying low and subfreezing temperatures are given, immediate injury of sensitive cells and dehydration induced damages in tolerant cells are discussed separately. Consequences of equilibrium and non-equilibrium freezing and their implications in further events are described. Thermodynamical explanations of processes involved elucidates general phenomena which can be seen otherwise in research of drought stress from different point of view. Phase transitions of biomembranes receives special attention in discussing reasons of damages by freezing as well as implications by changes in composition and permeability of membranes. Freezing damages peculiar to trees are mentioned, too. Possible consequences of freezing and chances of recovery are discussed in relation to damages in different organs in several types of plants. Mechanisms of frost mitigation and resistance and their ecological significance are outlined. Possibilities deriving from supercooling of different organs and its implications in extratissue and extraorgan freezing gives a frame in which a variety of plant responses to freezing can be viewed. The annual course of frost resistance, induction of cold acclimation, stages in the hardening process are discussed with coincident shifts in metabolic pathways. Changes in sugars, amino acids, nucleic acids and proteins and lipids are detailed. Structural and composition changes in plasma membrane deriving from metabolic shifts during cold acclimation, role of abscisic acid and cytological changes, too, are elaborated. Differences in frost resistance between plant taxa and within populations are extensively described together with peculiarities in relation to inheritance and ontogenetic variation in frost resistance. Discussing regional distribution of plants in relation to low temperatures the authors addresses the adaptive responses by woody plants in the tropics, evergreen trees and shrubs in Mediterranean, deciduous plants and conifers in the temperate zone and separately discuss phenomena of altitudinal origin. Adaptive improvements of low temperature resistance in plants are outlined, with special attention to adaptation at the plasma membrane level.

Complex reasons for winter damages in plants are discussed in a separate chapter elucidating problems about winter desiccation and compact and/or long-lasting snow cover. The book with many of its first published figures and tables is not only a comprehensive textbook in plant ecophysiology but an extensive tool of information on frost effects on plants from various origin and in this quality it may serve as a valuable composition of references for further investigations in the topic. For the same reason parts of it should be incorporated in education of ecophysiology and ecology.

Z. NAGY

SEITZ, A.—LOESCHKE, V. (eds): *Species Conservation: A Population-Biological Approach*. Birkhauser Verlag, Basel—Boston—Berlin 1991, 281 pp.

Nowadays we have to face more and more frequently the drastic changes in our environment caused by the human activities. As a result of destructive changes the survival of more and more species has been threatened. "Extinction rates have increased considerably and biological diversity has decreased accordingly." As species extinction and habitat destruction are global problems, it is impossible to solve them without collaboration among scientists, politicians and general public.

This book contains the contributions of the symposium "Populationsbiologische Aspekte des Artenschutzes" held in 1989 in Mainz, FRG. It is devoted to different studies of population

biological viewpoint which are considered a starting point to the effective conservation. The book focuses mainly on the problems of conservation in Europe (a few non-European cases of general issues are also involved).

In his introductory remark A. SEITZ outlines the importance of population biology in the conservation biology. He demonstrates the effect of stochasticity of environment to the population structure and dynamics (e.g. plankton population), the space-dependence of genotypic and phenotypic variability in locally instable populations, the importance of maintenance of genetic variation and the application of new genetic tools in population analyses.

Four major application areas of genetics in conservation biology are illustrated by A. R. Templeton (conservation forensics, systematics, hybridization and genetic management). The genetic techniques (especially DNA fingerprinting) contribute to the effective enforcement of conservation laws, by identification of individuals, tissues. They are essential in systematics in identifying taxa, genetic lineages.

H. R. GREGORIUS gives a good survey about the possibilities of preservation of adaptability, which is based on the dynamic gene conservation. He demonstrates that the environmental heterogeneity how effects the genetic load and variation, the effective population size.

W. GABRIEL et al. deal with the risk of population extinction applying different models for asexual and sexual populations. The models are based on the interaction of mutational effects, population size and demographic stochasticity.

H.-J. RENNAU try to answer the question to what degree the stability of population may be affected by different spatial heterogeneity of supplied resources. Simulation models based on population dynamics processes are successfully validated by an experimental acarine predator-prey system.

H. R. ADCAKAYA and L. R. GINZBURG focus on the assessment of extinction risk for single and multiple populations of species. They present three computer programs (RAMAS library) based on population dynamics for the determination of risk assessment. The application of the models is illustrated by the Mountain Gorilla population.

R. BIJLSMA et al. report on the deleterious consequences of habitat destruction. Two plant populations are used to illustrate the changes in genetic and morphological variation caused by the fragmentation of habitats.

G. BAUER analyses in detail the plastic reactions in life history traits of freshwater pearl mussel influenced by environmental factors. On the basis of the results he gives the strategies for the conservation.

R. A. MENZIES presents the usefulness of allozyme technique in conservation biology in order to identify the geographic domains of breeding units and establish the possible management units.

R. S. OLDHAM and M. J. S. SWAN using as example two amphibian populations, demonstrate the exact knowledge (e.g. distribution, habitat requirements, dispersal, survival...) and methods which are necessary for the effective conservation.

S. VOGEL and C. WESTERKAMP deal with the role of pollination in the survival of biocenoses.

U. STARFINGER discusses exhaustively the population biology of an invading tree species comparing its demographic parameters in native and new habitats. He presents the prerequisites for a successful colonization.

J. P. HENRY et al. perform experiments with the metapopulations of a cultivated plant sown in several localities to test different management methods and to establish how the genetic diversity can preserve.

D. RISTOV et al. examine the population dynamics of two bird species living on an archipelago to establish the degree of genetic isolation and speciation.

C. SCHONEWALD-COX and M. BUECHNER give a detailed report on the requirements of genetic and demographic viability of mammalian carnivores. They focus mainly on the space usage on large (geographic) and small scale, and on the consequences of habitat fragmentation from the viewpoint of protection.

M. MÜHLENBERG et al. answer the interesting question whether there are minimal areas for animal populations. Two aspects are examined in detail, the area requirement of reproductive units and the viable population size.

H-J. MADER reviews the aspects for nature conservation strategies in Europe.

In their epilogue V. LOESCHKE and J. TOMIUK summarize and evaluate the content of the whole book.

The book containing mainly case studies gives a good survey of genetic and population-biological approach to species conservation and provides useful knowledge not only for conservation biologists but also for everybody who is interested in this topic.

E. MOLNÁR

SIVER, P. A.: The Biology of Mallomonas. Morphology, Taxonomy and Ecology. Kluwer Academic Publishers, Dordrecht, Boston, London 1991, 230 pp.

In the last decades there are few studies on the taxonomy and ecology of the Synuraceae (Chrysophyceae) in different countries, though this family is distributed widely in the whole world. They represent in general the freshwater phytoplankton populations as dominant and abundant species under such conditions as low water temperature, acid water or high nutrient concentration. The growing interest in the study of chrysophytes resulted this book about Mallomonas species. The first samples were taken (1983) in the frame of a special project as the Connecticut Chrysophyte Survey.

The author set out to accomplish three primary goals in completing this work. "First, I wanted to provide a compendium of scanning electron micrographs of the more common taxa of Mallomonas which would complement works consisting primarily of transmission electron micrographs. Second, I tried to summarize morphological characteristics of taxa within the genus. This was done in a comparative way for scales, bristles and whole cells. Third, I wanted to characterize each taxon according to its ecological traits."

After the short introduction showing the general characteristics and taxonomic position of Mallomonas genus, the structure of cell covering like scale and bristle morphology, arrangement of scales on the cell surface are discussed. In the third (main taxonomic) chapter 57 Mallomonas taxa are described in detail showing the cell morphology, the microstructure of scales, bristles, with discussion of similarities and differences of scale' structure in different species. There are also some tables with summary of the major diagnostic features of scale and bristles as seen with SEM and used to distinguish between several closely related taxa. In the fourth chapter (Morphology: Quantitative features of the siliceous cell coat) "Over 10 000 images from more than 2000 SEM micrographs were traced using a digitizer in order to determine the morphometric dimensions of scale, bristle and cell characters for individual taxa." The results of these analysis are useful to distinguish different taxa. In the fifth chapter we can find the ecological description (autecology — on the basis of seasonality, temperature, pH, conductivity, total p) of 28 taxa. "In summary, the environmental variables pH and specific conductance had a greater influence in determining the number of taxa of Mallomonas found in waterbody at a given point in time." The book finishes by the list of 188 references.

This excellent book would be useful if more lightmicroscopic, and transmission electron-microscopic investigations and micrographs had been used in discussion of taxonomic results. In many cases TEM micrographs are essential in determination of Mallomonas taxa. Fortunately there are a lot of superb SEM micrographs and drawings of three-dimensional reconstruction of the whole cell of many species.

This book is useful not only for algologists, but we can recommend it without hesitation to hydrobiologists, taxonomists both to zoologists and university teachers. I hope that all specialists find the information contained within this book informative and useful in their work.

K. T. KISS

SLAYTER, E. M.—SLAYTER, M. S.: *Light and Electron Microscopy*. Cambridge University Press, Cambridge 1992, 312 pp.

Taking into hands the microscopy guide-book of the late Elisabeth S. SLAYTER and Henry S. SLAYTER, a non-devoted microscopist would put it back onto the shelf after a short, superficial glance: too many complicated formulas, diagrams, charts. However no one should make the mistake not to read this bright compendium. While going through the text the reviewer became convinced, that every microscope user should read this book to get a committed microscopist, with a knowledge in the basic theory of light and electron optics. Naturally every day practice, and experiments with microscopes remain basic requirements.

Following the short introductory notes, four chapters are devoted to the nature and characteristics of light and the principles of optical or electron imaging. It is worth mentioning at this point, that the brief history of microscopes outlined in the first initial chapter seems to be incomplete. Although important dates appear in the text, the significant persons behind remain hidden (1590 e.g. indicates Zacharias Jansen, etc.). Basic optics are dealt adequately. The clear and precise draft of these chapters makes the complicated topics comprehensible for a nonprofessional biologist too. Lens characteristics are discussed in the next chapter. The comparison of optical and magnetic lenses is an interesting reading. Imaging is summarized in only six printed pages, however the problems of imaging in special optical apparatus is dealt separately. Similarly the problems conferred in "Contrast" and "Resolution" or "Imaging of phase objects", etc. chapters are naturally connected to image formation. As compared to the chapters reviewed as far, the pages devoted to the light microscope seem to be wiry. More information on bright field microscopy, condensers (e.g. pancreatic systems), objectives and eyepieces, etc. is needed. A slightly practical approach seems to be missing here. Similar inwardness is missing for the reviewer in most of other parts describing different optical systems. Certain inconsistencies are also detectable: polarizing microscopy is summarized in full details, whereas the DIC technique, fluorescence and epifluorescence microscopy are just mentioned, or even missing. X-ray microscopy is picked out in a separate chapter, whereas the rapidly spreading confocal scanning microscopy seems to be neglected.

Naturally TEM and SEM cannot be reviewed in detail, and even less the practical aspects of EM, like specimen preparation, etc. The four chapter (Chapters 14-17) compendium is however adequate and to the point. As it is mentioned before the survey of innovations in microscope development are partly incomplete. The reviewer especially objects to the real lack of overview of video micrography.

Most of the deficiencies outlined are estimated as conceptional differences, even if some of the new methods, coming into general use in microscopy are not discussed. I can only recommend again to biology students and researchers in the field too read and absorb this clear, up-to-date book.

K. MÁRIALIGETI

SZABÓ, A. S.: *Radioecology and Environmental Protection*. Coedition between Ellis Horwood/New York and Akadémiai Kiadó/Budapest 1993, 258 pp.

This book reviews the occurrence of varying concentrations of different radio-isotopes in successive steps of biological chain processes. It considers the factors which affect the transfer of these radio-isotopes, their changes on concentration, and the possibilities for preventing or decreasing the level of contamination. The material covers a wide range of topics and emphasizes environmental protection, giving useful information regarding the relationship between radiation protection, agricultural practices and dietary intakes. The book contains detailed data accrued from the Chernobyl disaster, as well as other important Eastern European literature, to illustrate points made in the text. The book covers entire biological chain of radioecology, stressing the interactions between different parts of the biosphere experiencing radioactive contamination.

In his preface, the author emphasizes that the task of ecologists — who know the changes in the different elements of the biological chain process — is to call the attention of

people to any danger and to form the right attitude. The responsibility of ecologists, and among them, radioecologists, is to use atom as a worker, not to use as a soldier, to bring about an earthly paradise on our planet instead of hell.

The book comprises four chapters:

Chapter 1. The subjects of radioecology and the development of radioactivity in the biosphere

In this first chapter, radioecology as a special field of ecology is presented and the buildup of radioactivity of the biosphere, both natural and artificial in origin, is analyzed. The author believes that it is essential, or at least advisable to read this chapter in order to understand the following parts.

Chapter 2. Factors influencing the radioactivity of the biosphere

The bulk of the book is contained in this chapter, which deals with the radioactivity of the different elements of the biosphere, and the analysis of different factors (climatic parameters, configurations of the terrain and amelioration) affecting the radioactive level. Here, the different components of the biosphere (atmosphere, hydrosphere, etc.) are discussed separately, naturally pointing out the permanent and dynamic relationships among the individual elements, the interdependence of the air-water-soil-plant-animal-man biological chain, and the necessity of analyzing the ecological processes in such a complete system.

In the subchapters the following topics are discussed:

- 2.1. — the buildup of radioactivity of the atmosphere as a consequence of natural radioactivity as well as of nuclear tests and emission from nuclear power plants,
- 2.2. — the natural radioactivity of the hydrosphere as well as the process of the buildup of radioactive contaminations,
- 2.3. — the process of natural radioactivity buildup and radioactive contamination of the soil, mechanical and chemical structure of the soil, agrotechnical and agromechanical methods, amelioration of which has influence on the level of radioactivity,
- 2.4. — the buildup radioactivity in plants caused by radionuclides of both natural and artificial origin,
- 2.5. — the buildup of natural and artificial radioactivity in animals and the level of radiation pollution in fodder-animal system,
- 2.6. — the sources of the radiation load on the human organisms, the possibilities of decreasing the radiation load and the essence, and rather the danger of the somatic and genetic radiation damages.

Naturally — since the final component of the above-mentioned biological chain is Man — the most important question ultimately raised is: How do the different ecological factors, with the interposition of the different components of the biological chain, affect man? Therefore the sixth subchapter, which deals with the problem of radiation load affecting the human organism, is of primary importance. The author believes that the Chernobyl disaster — in negative sense of the word — will be considered a milestone in the history of nuclear technology, one which serves as an eternal memento for later generations as well.

Chapter 3. Radioecological research and organizations carrying out radioecological research in Hungary

In the field of ecology — and within that also in radioecology — there are still a lot of blank areas, there are a number of questions which are waiting not only to be answered, but also to be raised. Thus, similarly to the other fields of science, coordination of research is also indispensable in radioecology. In the third part of the book the author gives a very short coverage of the research programmes in Hungary that are of radioecological nature, or closely connected with the subject.

For example there are two programmes within the National Plan for Medium-term Research and Development, as follows:

- research and development priorities for safe operation of nuclear power plants,
- research on regional environment protection of Lake Balaton.

A list of the institutes participating in radioecological research is supplied, and a brief analysis is given also on the activity of the radiometrical monitoring network of the Ministry of Agriculture and Food in Hungary.

Chapter 4. What is the future is store for us?

The fourth part calls attention to the dangers which threaten mankind if nuclear power — the second lighting fire — is not used for the sake of mankind, but the contrary. Finally answers are sought to two exciting questions, whether nuclear technology power plants are dangerous to the environment, and whether nuclear technology is a blessing or a curse for mankind.

At the end of the book a bibliography is given, including a separate list of Russian publications. Evidently the explanation of concepts and measuring methods is necessary, therefore a brief Glossary of all radioecological terms used in the book is provided. There is also an Appendix where information of prime importance is provided, a useful guide to the theoretical basis of the phenomenon of radioactivity, and also to the analysis and measurement of radioactive isotopes. All these are very useful, because this book was in the first place written for those interested in topics of an ecological nature, and not for experts engaged in radioanalysis.

N. OERTEL

TOMAS, C. M. (ed.): Marine Phytoplankton. A Guide to Naked Flagellates and Coccolithophorids. Academic Press, Inc. London 1993, 263 pp.

The knowledge published in this nice book was partially as class notes and handouts for the Advanced International Course for the Identification of Marine Phytoplankton, held in Oslo, and later in Naples. The contributors and the editor continuously revised and updated the material synthesising the latest information about these delicate plankton organisms.

The book is oriented toward the use of light microscopy, because it is the routine way to investigate these organisms. Advances in electron microscopy are included, however, and they are presented here where appropriate, but this manual serves the person working in routine, using light microscope for routine investigation of marine phytoplankton.

We have to mention that this book is a guide not a complete taxonomical manual. THRONSEN, who is the contributor of the second chapter of the book, writes in his foreword: "My account of marine planktonic flagellates (excluding dinoflagellates) is an introductory guide to this group and is based primarily on observations using the light microscope. The number of species illustrated for each genus is limited to presumably the most characteristic ones. Within genera such as Chrysochromulina (Prymnesiophyceae) and Pyramimonas (Prasinophyceae) large numbers of species need electron microscopy for reliable identification. In these cases, reference to features observed using both light and electron microscopy is given. Whenever possible the original description should be consulted, as all later ones depend on the interpretation of the first. Emended diagnoses and descriptions, however, are very important for an up-to-date identification. The variation in morphology, common within one flagellate species makes it desirable to give several illustrations, but for practical reasons only one illustration for each species is included here."

The result of THRONSEN's effort is very good. All common or dominant species of marine naked flagellates are found here, with good drawings and a short description of them. A really useful guide or key shows us the main characteristics of naked flagellates, which are important during the determination ("What to look for"). A complete glossary helps those who want to use the book. Unfortunately a key of divisions, classes, orders or families is lacking. It could be very useful for algologists without long expert.

A good summary of morphology, classification, systematic description of modern Coccolithophorids was written by HEIMDAL in the third chapter of the book. The structure, the quality of this chapter is the same as that of second one, with a complete glossary and references. The chapter ended with a special glossary where we can find the more important terms concerning on Coccolithophor species in English, French, German, Italian, Russian, Spanish. It can be very useful to read and understand the literature.

We can recommend this well-illustrated introductory guide for serious plankton workers who wish to develop their skills in identifying marine flagellate species. It can be useful not only for marine phytoplanktonologists but for specialist working by freshwater phytoplankton,

because a lot of genera and species are shown here living in brackish-water, in estuaries of rivers. It can be essential for algologists, botanists, biologist as an introductory manual on the subject. We recommend it also in university education.

K. T. KISS

VAVILOV, N. I.: *Origin and Geography of Cultivated Plants*. Translated by Doris LÖVE. Cambridge University Press 1992, 498 pp.

The book is a first hand information source for botanists, dealing with plant genetic resources and the relation between man and plant. This is the first almost complete selection of VAVILOV's works on the subject. Instead of a content review of the papers, we will focus here on the Vavilovian idea regarding the relations between plant variability and ethnic diversity.

Even if VAVILOV himself did not create a separate scientific term for the correlation between the plant variability, the ethnic characters of a traditional human community exploring (maintaining or destroying) this variability, we can consider him as one of the founders of the concept of ethnobiodiversity: "Recessive characteristics are not always inferior to the dominant ones ... and during our investigatory work we paid great attention to this fact. ... Concerning animals and Man himself, I pointed out that during the evolution of its laws, the recessive characteristics of plants are, to a certain degree, also applicable to humans and that the historical process of isolating recessives was positive from the point of view of the main historical civilisations, since it gave rise to the great northern civilisations..." Here VAVILOV advocated implicitly also for the African cradle of the humanity, well in advance of the LEAKY's discoveries (VAVILOV 1939, cf. 419). If this statement seems to be debatable for conservative-minded biologists, let us look on the paper regarding the "Plant resources of the world and their utilisation for plant breeding": the maximum plant genetic diversity and the ethnic diversity areas seem to overlap in Alp — Carpath — Balkan area, Syria, Transjordan, Palestina, Anatolia, Armenia, Georgia, Aserbadjian, Turkestan, Iran, Afghanistan, Tadzhigistan, Pakistan, India, Indonesia, China, Central- and South-America etc. These are, at the same time hot spots of the biosphere — and not only from a genetic point of view.

The Vavilovian remarks regarding the genetic diversity of the wheats cultivated by Finno-ugric tribes may be of importance, especially if we take seriously his statements that the "Banatka" type wheats (Banat was the most important wheat-growing area of the historical Hungary) emerged originally in the mountain and steppe areas of Armenia and southern Georgia (cf. op. cit. p. 387). Unfortunately VAVILOV neglected the Carpathian centre of plant genetic diversity (his fatal last expedition was organized in this area) and his statements regarding this zone are sometime out of date e.g. when speaking about *Haynaldia* as belonging to genus *Secale* according to Linne and about dozens of species of *Haynaldia* (an vero: *Aegilops*?, SzTA) accumulated in Palestinian territories (cf. p. 377).

Fortunately the editor and translator of the English version compiled an excellent index with synonymies and nomenclatural rectifications, which are of great help for the user. There are very few printing errors (perhaps the consequent misspelling of the genus *Lithonia* is one of them), and as compared with the former English editions (*The Origin, Variation, Immunity and Breeding of Cultivated Plants*, *Chronica Botanica*, 1949–50) the present translation seems to be better, at least for the Hungarian reader.

The book also reflects the heroic struggle of an energetic scientist with drastic intellectual limitations of the communism. The editors of the volume vividly avoided politics (e.g. the name of LYSENKO is mentioned only once and in almost positive context). We can just contemplate, why one of the basic texts of VAVILOV entitled "*The Linnean Species as a System*" was omitted also from this new English edition. This paper is one of the few works of VAVILOV translated in Hungarian (SZABÓ 1976), and may be included among the evergreens of the biological literature.

VAVILOV presents for example an early Russian scientist (VELIKOV 1810) interested for heredity, dealing with the emergence of new varieties (somewhat similarly to the Hungarian count I. FESTETICS who formulated in 1819 first "The Gentic Laws of Nature" in a scientific

society where G. MENDEL became later also a member. The role of Ch. DARWIN, A. DE CANDOLLE, C. BATESON and others in the emergence of the theory of the Vavilovian Centres of Origin, or the influence of a popular science book of HARWOOD ("New Creations in Plant Life") on LENIN's decision regarding the organisation of the All Union Institute of Plant Industry are important for all those interested in the history of botany, too.

A. T. SZABÓ

VENKATACHALA, B. S.—SINGH, H. P. (eds): Four Decades of Indian Palaeobotany (Birbal Sahni Birth Centenary Tribute). The Palaeobotanist, Vol. 40, 1991. Issued: Nov. 14. 1992. Lucknow, 1—545 pp.

The volume contains — with the Preface — 34 articles. In the introduction B. S. VENKATACHALA, at that time director of Birbal Sahni Institute, summarises the chief lines and results of four decades in Indian palaeobotany.

Very significant articles deal with Precambrian metaphyte and metazoan fossils (Mukund SHARMA, Manoj SHUKLA and B. S. VENKATACHALA, respectively P. K. MAITHY).

From the vegetation of Gondwana are 8 articles (172 pages). Shaila CHANDRA in the article titled "Changing patterns of the Permian Gondwana vegetation" leads along the Permian the Glossopteris — vegetation types, with excellent coloured reconstruction of the supposed palaeoenvironments. — Hari K. MAHESHWARI's article — with the help of palaeobotany — have drawn the boundaries, palaeogeographical divisions of Gondwana. — Usha BAJPAL writes about the morphological change of the vegetation in the different region of Gondwana territories. — A. K. SRIVASTAVA examined the alien elements in the Gondwana flora and their connections. — VIJAYA and R. S. TIWARI deduce the morpho-evolutionary biohorizon stratigraphy and cladistics in saccat pollen through Gondwana sequences. — R. S. TIWARI and Archana TRIPATHI studied the marker Assamblage-zone of spores and pollen species through Gondwana Palaeozoic and Mesozoic sequences. — Both articles are illustrated also with grandiose photo-material. — Suresh C. SRIVASTAVA writes about Permian palynological assemblages in Godavari Graben, which is the major coal producing area. — Shyam C. SRIVASTAVA and S. R. MANIK's lecture is a recension: "The transitional Triassic flora of India".

The subject of the next three articles is the very important constituent of the Jurassic-Cretaceous time the Williamsonia (Jayasri BANERJII), respectively an overview of the Indian Williamsoniaceae family (B. D. SHARMA), as well as the volutionary reproductive biologies in the Mesozoic plants of India (Sukh - Dev).

M. B. BANDE summarises the knowledge of Indian Palaeogene vegetation with the help of plant megafossils. — J. S. GULERIA summarises the knowledge of Neogene megafossils: the Neogene vegetation in peninsular India was characterised by rich tropical vegetation and torpical climate. They were influenced by the orogenesis of Himalya. — N. AWASTHI writes about this vegetation change in the Siwalik succession. — H. P. SINGH writes also from the floral changes in the Cenozoic, connected with the Himalayan orogeny in particular consideration of the climatic changes.

R. K. KAR describes on stratigraphical implication of Tertiary palynological successions in north-eastern and western India.

R. K. SAXENA gives account from Neyveli lignites and associated sediments — their palynology, palaeoecology, correlation and age.

H. P. GUPTA's article deals with the change of the Upper-Tertiary — Quaternary vegetation in the intermontane basin of Kashmir.

Chhaya SHARMA with the support of palynology determinated the palaeoclimatic oscillations since the last deglatiation in western Himalaya.

Asha KHANDELWAL gives a palynological interpretation from the Holocene history of mangrove vegetation in India.

D. P. AGRAVAL's abstract deals with the climatic changes of the last 20000 years.

R. R. YADAV article gives an overview about the tree ring research in India.

Rockbuilding Cretaceous — Tertiary alge from India is the subject of A. RAJANIKANTH article.

S. B. BHATIA writing of the recent advances in studies on fossil Charophyta, gives account of Mesozoic and Cenozoic research.

K. P. JAIN, R. GARG and Khawaja-Ateequzzaman stress the emerging tool of the fossile dinoflagellates in Indian biostratigraphy and and they represent also significant tables.

Anil CHANDA communicates many results of fossil diatoms, and their importance in biostratigraphy and in palaeoecology.

Three articles deal with the origin of coals in India. — G. K. B. NAVALE summarises the differences of the origin of the permina Gondwana coals. — Anand PRAKASH treats Himalayan coals: their nature, composition, formation and rank. The Permian and Upper Tertiary coals were influenced by tectonic, therefore contain very much rock-materials. The Lower Tertiary coals are only valuable in economical point of view.

Basant K. MISRA article deals with the genesis of Indian Tertiary coals and lignites in biopetrological and palaeobotanical point of view.

Finally K. S. SARASWAT writes in his article from archaeobotanical remains in ancient cultural and socioeconomic dynamics of the Indian subcontinent. He has investigated wood charcoals, carbonized seeds, fruits, cuticules, fibres and with the help of these, has described chronological framework of cultural development from the earliest Neolithic cultures around the beginning of the Christian Era.

The articles of this volume were published in very good quality, illustrated with maps, drawings, light- and electronmicroscopic pictures. They are demonstrated by evolutionary and biostratigraphical tables and by very rich material of references.

E. NAGY

WATSON, L.—DALLWITZ, J.: The Grass Genera of the World. CAB International, Wallingford 1992, 1038 pp.

This huge work is the first hard-copy verseion of the world set of descriptions of all grass genera, which have been generated by computer from taxonomic data bank.

One of the authors has been engaged for some twenty years in compiling data and making observations on grass genera, in order to investigate classificatory questions and to explore taxonomic applications of computer methods. The other has worked for a comparable time on computer key-making, and has developed the DEKTA system for comprehensive representation and manipulation of taxonomic descriptions. Since 1988, the authors have been producing a continuously updated package for the grass genera of the world, comprising floppy disks with the program INTKEY and the data in a form accessible for interactive identification and information retrieval, a booklet with illustrations of character states, and the complete descriptions. The printed keys are not included in the book, because the authors consider INTKEY to provide far better facilities for identification, and recommend it as an accompaniment to the book for persons wishing to conduct identification.

The estimated number of genera in the grass family (Poaceae, Gramineae), comprising about 10000 species, is between 650 and 785. As a result of several considerations, the authors recognize the higher generic estimation, so the present book represents the description of 785 grass genera.

The grass generic character list to cover all aspects of variation in grasses, necessary, or potentially useful, for identification and classification has continuously been extended. In the book the list consists of as many as 496 characters, dealing with nomenclature, general morphology, leaf anatomy and physiology, biochemistry, haploid and 2cDNA values, fruit and embryo structure, seedling form, cytology, intergeneric hybrids, phytogeography and distribution, ecology, pathogens, classification and economic aspects.

The enormous amount of data has been extracted from the literature, also assorted from numerous recently published papers, and in some cases checked and improved by colleagues and collaborators.

The descriptions of genera are about one page long each. The book is completed with a list of references and sources of data consisting of 673 items, an appendix including the names of the species sampled for anatomy, and the index of names.

The book is undoubtedly a definitive reference work, essential for all those with a serious research interest in grasses.

GY. SZOLLÁT

WEISS, E.: Guide to Plant Tolerant of Arid and Semiarid Conditions. Nomenclature and Potential Uses. Weikersheim, Margraf 1989, 543 pp.

The maintenance and increase of crop production had become a problem of life and death in Africa, particularly for the peoples living in the arid and semiarid deserts (ASAL conditions), covering 50 pc of tropical Africa. This area supports 35 pc of the population as also in Kenya, where this book had been made. Plants are really the central question of rural development; plants are necessary not only for the maintenance of life but also that life might continue to improve in these countries. The present conditions, the desertification and an excessive exploitation of fields are at a catastrophic level. The traditional crops cannot cope with the recent increasing arid conditions. Today, there has been a considerable interest in exploiting more deeply the renewable natural resources of the ASAL zones in order to rehabilitate these degraded areas. That is why it is so important to continue the study of the potential crops to be raised in various desert areas, and to exploit all the domestic resources in order to ensure a possibility uniform development of household farms. This book could be an excellent tool to select the most suitable crops such territories. Desertification seems to extend in the last centuries also in the temperate zone of the World. To take precautions against this continuous process one has to introduce more effective production forms by using new drought resistant plants which utilize possibilities of the harsh environmental conditions maximally.

The author attempts to compile a summary of plants reported to tolerate ASAL conditions while referring to their principle uses; giving a basis list from which the user can select a certain number of plants according to his own criteria which he believes to be worth to experiment further; quick references and assistance are given to identify and select crop plants wild or cultivated in East-Africa, especially in Kenya and its surroundings; many kinds of common (ca. 160 species) and rare or "luxury" crops are enumerated. In order to facilitate the use of the references, the nearly 800 species are listed in alphabetical order and the information are presented in tabulated form containing the botanic name, the common names, the plant family name and the principal uses. The uses are coded with six digits according to industrial, food, fodder and forage uses; possibilities for uses as firewood, timber, afforestation; for ornamental and amenity purposes; soil improvement and erosion control. The points of view of the choice of the listed plant species are: the new results of their investigation; assessment of their cultivation value.

The contents is divided in three parts after the introduction. The first part is the alphabetic list of botanic names and the above-mentioned information in tabulated form. It is followed by the list of the references used to compile this synopsis. The major part as an excellent illustrated identification book contains the figures of all enumerated plants. The line drawings have been graphically improved, redrawn and/or re-arranged from the sources mentioned on each sheet. Their numbers correspond to those in the list of references. The figures have been catalogued in alphabetical order of the botanical names of the plants. The detailed line drawings are often provided with the necessary morphological explications. Prominent drawing-key groups facilitate the identification for the drought resistant Acacia, Albizia, Combretum, Gossypium and Terminalia species. It is unfortunate that the author names in the botanical names and the botanical family names by the side of the figures are missing.

The work of a large size is co-published with the Ministry of Livestock Development, the Range Management Division German Agricultural team and the Republic of Kenya as a piece of the "Range Management Handbook" series. This current trade book is recommended to every experts or plant-fans dealing with tropical or crops plants; to the botanical gardens for an identifying book and above all to the colleagues and teams involved in research and cultivation of drought resistant crops. This activity has a remarkable actuality also in our country having an arid continental climate, especially because the aridity is increasing significantly in the last decade. It can be an information base for all researchers working on new plant resources.

Z. KERESZTY

MAGYAR
TUDOMÁNYOS AKADÉMIA
KÖNYVTÁRA

PRINTED IN HUNGARY

Akadémiai Kiadó és Nyomda, Budapest

Form of manuscript

Manuscripts should be typewritten in duplicate, double-spaced, 25 lines with 50 letters on each page. Articles should in general not exceed 25 typed pages tables and illustrations included. Acceptance depends on the opinion of one or more referees and the decision of the Editorial Board. Papers accepted for publication are subjected to editorial revision.

The papers generally have the following components, which should be presented in the order listed:

1. Title, name of the author(s), affiliation, dateline, abstract, keywords
2. Text, acknowledgements
3. References
4. Footnotes
5. Tables
6. Figure captions
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ES LA FLORA DE LAS ANTILLAS DE ORIGEN ANDINO?

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The author discusses the theses of ALWYN GENTRY published in 1982, applies them to the Antillean Flora and concludes to some new ideas about the origin and possible migration of the flora of the West Indies.

Keywords: ALWYN GENTRY, orogénesis andino, familias andinas, familias laurasiáticas, familias amazonicas, familias caribeñas, flora antillana

Introducción

Un artículo de ideas originales muy importante fue publicado por A. GENTRY (1982) sobre el origen de la flora de Centroamérica. Expuso que en la diversidad de la flora neotrópica se pueden encontrar dos dicotomías. Una es la dicotomía de las floras de Laurasia y de Gondwana respectivamente, que determinan la distribución horizontal de la flora actual de los Neotrópicos. Esta se había desarrollado durante el Cretáceo cuando América del Norte y del Sur eran directamente connados. La segunda dicotomía es el desarrollo o separación de la flora gondwánica en dos floras: la del centro amazónico y del centro andino respectivamente, que determinan la distribución vertical de la flora actual de los Neotrópicos. Esta segunda etapa del desarrollo pudo haber ocurrido durante el mediado del Terciario correlacionado con el orogénesis andino, que dió un impulso nuevo a la evolución de la flora gondwánica para especializarse y desarrollar una nueva etapa de especiación.

Para exponer y documentar su hipótesis, GENTRY clasificó las familias fanerógamas existentes en los neotrópicos en grupos según su centro de diversificación supuesto (Véase Tablas 1—9). De estas familias seleccionó 8117 especies confirmadas como válidas por las monografías modernas, aunque admitió que la flora neotrópica completa habría podido incluir unas 90 000 especies.

Tabla 1

Elementos de Laurasia en la flora neotrópica y de Cuba respectivamente

	Neotrópicos			Cuba			endem.	%
	familia	género	especie	familia	género	especie		
Aceraceae		1	5		0	0	0	0
Actinidiaceae		1	80		0	0	0	0
Aristolochiaceae		3	182		1	14	8	57
Balsaminaceae		1	2		0	0	0	0
Bataceae		1	1		1	1	0	0
Berberidaceae		2	474		1	11	0	0
Betulaceae		3	5		0	0	0	0
Boraginaceae		25	1116		8	94	51	54
Callitrichaceae		1	1		1	1	0	0
Caprifoliaceae		5	460		2	2	0	0
Caryophyllaceae		21	1466		4	5	1	20
Clethraceae		1	38		1	1	1	100
Cornaceae		3	14		1	1	0	0
Crassulaceae		7	540		0	0	0	0
Crossostomataceae		1	4		0	0	0	0
Cruciferae		35	1397		5	9	1	11
Droseraceae		1	20		1	4	0	0
Empetraceae		1	1		0	0	0	0
Ephedraceae		1	140		0	0	0	0
Fagaceae		4	160		1	1	0	0
Fouquieriaceae		2	8		0	0	0	0
Gentianaceae		19	494		9	21	9	43
Geraniaceae		6	532		0	0	0	0
Hamamelidaceae		3	5		0	0	0	0
Hippocastanaceae		2	3		0	0	0	0
Hydrophyllaceae		5	276		3	5	1	20
Illiciaceae		1	1		1	1	0	0
Juglandaceae		4	18		1	1	0	0
Krameriaceae		1	15		0	0	0	0
Lamiaceae		27	2083		8	48	18	37
Lennoaceae		4	8		0	0	0	0
Liliaceae		38	1384		4	4	0	0
Magnoliaceae		2	130		2	3	3	100
Myricaceae		1	35		1	4	3	75
Nyssaceae		1	1		0	0	0	0
Orobanchaceae		2	142		0	0	0	0
Papaveraceae		4	121		2	2	0	0
Pinaceae		4	40		1	4	3	75
Plantaginaceae		2	266		1	1	0	0
Platanaceae		1	7		0	0	0	0
Plumbaginaceae		2	7		1	1	0	0
Polemoniaceae		9	309		0	0	0	0
Primulaceae		4	214		2	3	0	0
Pyrolaceae		4	34		0	0	0	0
Rafflesiaceae		4	29		0	0	0	0
Ranunculaceae		10	1111		2	3	0	0
Rosaceae		31	2374		4	9	3	33
Salicaceae		2	30		1	1	0	0
Saxifragaceae		17	815		0	0	0	0
Scrophulariaceae		74	1038		20	55	24	44

Tabla 1 (Continuación)

	Neotrópicos				Cuba			
	familia	género	especie		género	especie	endem.	
Staphyleaceae		3	35		2	2	0	0
Styracaceae		2	133		1	1	0	0
Symplocaceae		1	160		1	8	8	100
Typhaceae		1	10		1	1	0	0
Umbelliferae		48	480		7	15	3	20
Valerianaceae		6	244		1	1	0	0
Total	58	365	18698	37	103	338	137	41

Sus conclusiones reflueraon mayormente a la flora continental de América del Sur y Central, tocando muy marginalmente a la flora de Las Antillas, cuya flora aparentemente no estaba en el enfoque de su interés. Pues algunas de sus afirmaciones relacionadas a esta flora pueden cualificarse como prematuras que requieren ciertas correcciones, tanto más porque muchos autores posteriores impresionados de la invención indiscutible del artículo han aplicado las tesis de GENTRY en forma mecanística equivocando su intención original.

Discusión

Para evaluar la flora de Las Antillas según los criterios de GENTRY vamos aplicar su método a la flora de Cuba con las modificaciones siguientes:

1) En los cálculos incluimos todas las especies registradas. Considero que la flora Neotrópica va a llegar a 100 000 especies. La cifra actual de las especies registradas es de 124 225 que sobrepasa en en 25% la cifra estimada final. GENTRY incluyó en sus calculaciones solamente 64 700 especies, el 52% de todas las especies registradas, dejando fuera de consideración 59 525 especies. De estas especies 40 366 pertenecen a 14 grandes familias siguientes: Boraginaceae, Caryophyllaceae, Compositae, Cruciferae Cyperaceae, Gramineae, Labiatae, Leguminosae, Liliaceae, Myrtaceae, Piperaceae, Ranunculaceae, Rosaceae, Rubiaceae, cuyas especies en su 76% no han sido consideradas. No puedo imaginarme que sin tomar en consideración estas familias según su importancia en cuanto a su participación en la flora y vegetación neotropicales sería posible sacar conclusiones correctas en asunto tan importante como la evolución de esta misma flora.

Tabla 2
Familias del Caribe

	Neotrópicos					Cuba		
	familia	género	especie	familia	género	especie	endem.	
Buxaceae		3	42		1	33	30	91
Cistaceae		3	120		1	1	1	100
Cneoreaceae		1	1		1	1	1	100
Cyrillaceae		2	15		2	15	14	93
Dracaenaceae		1	2		1	1	1	100
Garryaceae		1	18		1	1	0	0
Goetzeaceae		4	4		2	2	2	100
Oleaceae		8	52		4	15	8	64
Theophrastaceae		5	114		2	25	22	88
Total	7	28	368	9	15	94	79	86

2) En cuanto a las familias monografiadas y no monografiadas, GENTRY idealiza las monografías modernas. Lamentablemente en las monografías de dimensión continental, como las de La Flora Neotrópica, Flora Mesoamericana, utilizan conceptos específicos muy diferentes, mayormente demasiado bruscos para tener en consideración las formas más delicadas de la especiación (hibridación, deriva genética, apogamia) que en algunas floras aisladas y en algunos géneros son de importancia especial. Otra deficiencia de algunas monografías es que los monógrafos incluyen taxa en la sinonimia sin haber visto el tipo trazan los límites de algunas especies en forma arbitraria. Algunas monografías modernas no son modernas y resultan fracaso (p.e. Cyrillaceae).

3) No clasifico entre las familias de carácter laurasiático a las familias Aquifoliaceae, Basellaceae, Celastraceae, Chloranthaceae, Lythraceae, Rhamnaceae, Theaceae, Ulmaceae y Vitaceae (Tabla 1), estando de acuerdo con RAVEN y AXELROD (1974).

4) Se ha formado un grupo nuevo de las familias Buxaceae, Cistaceae, Cneoreaceae, Cyrillaceae, Dracaenaceae, Garryaceae, Goetzeaceae, Oleaceae, Theophrastaceae, que tienen su centro de diversificación en el área del Caribe y pueden ser consideradas como elementos de la flora Madreana-Tethyana (Tabla 2).

5) GENTRY considera (1982: 771), que la Buxaceae, la Boraginaceae y la Rhamnaceae son las familias laurasiáticas mejor representadas en la templada América del Norte que en América Central y en las Antillas. Opino lo contrario, que el género Buxus tiene su centro de diversificación más importante en México y en Las Indias Occidentales, especialmente en Cuba, siendo

representado en esta área con más de 50 especies, todas endémicas. La familia Boraginaceae no puede ser clasificada como laurasiática, solamente los géneros herbáceos. En las Antillas los géneros arbóreos y arbustivos son predominantes en la vegetación, aquellos que pertenecen a la subfamilia Ehretioideae (p.e. Cordia s.l., Ehretia, Bourreria, Rocheportia). Esta subfamilia es obviamente tropical con centro de distribución andino. La Rhamnaceae es indudablemente una familia bien representada en la región templada, sobre todo por la riqueza en especies del género Caenothus, que tiene su centro de diversificación en California. Pero la familia misma esta representada con un número más alto de géneros endémicos siguientes en el Caribe: Auerodendron, Karwinskya, Reynosia, Doerpfeldia, Sarcomphalus (no es idéntico con Ziziphus teniendo otro tipo de embrión), Krugiodendron, Rhamnidium etc.

6) En la clasificación de GENTRY no se ha dado atención al centro de distribución de la Mata Atlántica, una de las regiones más antiguas caracterizadas por muchos elementos gondwánicos.

Conclusiones

Seguido los criterios anteriormente expuestos los resultados del análisis más importantes son los siguientes:

a) A pesar de que Cuba está muy estrechamente relacionada geográficamente al continente norteamericano, y algunas familias laurasiáticas están más representadas allí que en las demás Antillas, la participación de los elementos laurasiáticos son bastante inferior a la de los elementos suramericanos. En la flora de Cuba están representados con 37 familias y 103 géneros, 338 especies y 137 endémicas de ellas. Esto significa que en la flora de Cuba los elementos laurasiáticos tienen un papel mucho más reducido que en la flora neotropical completa. Las especies de estas familias suman el 15% de la flora neotropical, mientras que solamente el 8% de la flora de Cuba. Las 137 especies endémicas de carácter laurasiático suman nada más que 4% de todos los endémicos cubanos (Tabla 10). Hay que añadir que entre estas endémicas 51 pertenecen a la subfamilia Ehretioideae de las boragináceas, que es un grupo más bien gondwánico que laurasiático.

b) De la Tabla 2 se ve que el grupo de las familias del Caribe es muy característico para su área. El grupo está bien representado en Cuba, porque todas las familias, además el 50% de los géneros y el 25% de las especies de

Tabla 3

Familias gondwánicas de centro Amazónico

	Neotrópicos			Cuba			endem.	%
	familia	género	especie	familia	género	especie		
Anacardiaceae		17	390		7	15	5	33
Annonaceae		31	805		5	27	18	67
Apocynaceae		66	812		19	58	34	59
Basellaceae		3	7		2	3	0	0
Bignoniaceae		72	631		17	86	67	78
Bixaceae		1	5		1	1	0	0
Bombacaceae		20	187		4	6	2	33
Burseraceae		7	222		4	11	8	72
Caryocaraceae		2	24		0	0	0	0
Chrysobalanaceae		8	334		1	1	0	0
Cochlospermaceae		2	8		0	0	0	0
Combretaceae		7	97		6	17	10	59
Connaraceae		5	157		3	3	1	33
Convolvulaceae		21	1000		9	93	33	35
Dialypetalanthaceae		1	1		0	0	0	0
Dichapetalaceae		3	43		1	3	3	100
Dilleniaceae		5	60		4	6	0	0
Duckeodendraceae		1	1		0	0	0	0
Ebenaceae		2	82		1	10	6	60
Elaeocarpaceae		6	132		2	3	2	66
Euphorbiaceae		92	2607		50	319	220	69
Flacourtiaceae		28	267		9	54	36	67
Gnetaceae		1	6		0	0	0	0
Hernandiaceae		3	22		1	2	1	50
Hippocrateaceae		12	114		4	5	4	80
Humiriaceae		8	46		0	0	0	0
Icacinaceae		13	56		2	3	2	67
Lacistemaceae		2	14		0	0	0	0
Lauraceae		15	1570		8	32	13	37
Lecythidaceae		11	275		0	0	0	0
Leguminosae		264	11169		76	374	140	37
Loganiaceae		14	272		5	19	12	63
Lythraceae		16	361		5	27	13	48
Malphighiaceae		44	801		10	65	30	46
Meliaceae		8	125		5	11	2	18
Menispermaceae		18	172		2	7	3	43
Moraceae		23	408		7	29	15	50
Myristicaceae		5	81		0	0	0	0
Ochnaceae		10	367		2	11	5	45
Olaceae		13	87		2	9	5	55
Palmae		55	1152		16	90	79	88
Polygalaceae		4	813		2	28	16	57
Quinaceae		4	53		0	0	0	0
Rhizophoraceae		5	24		2	2	0	0
Sabiaceae		2	47		1	2	1	50
Sapindaceae		32	922		14	55	28	51
Sapotaceae		12	442		6	36	18	50
Simaroubaceae		11	106		6	12	6	50
Sterculiaceae		16	653		9	28	14	50
Tiliaceae		20	139		6	15	4	27

Tabla 3 (Continuación)

	Neotrópicos				Cuba			
	familia	género	especie		familia	género	especie	endem.
Trigoniaceae		1	24			0	0	0
Turneraceae		4	86			3	8	2
Violaceae		13	78			1	6	4
Vochysiaceae		7	182			0	0	0
Total	54	1066	28539	42	340	1592	862	54

este grupo se encuentran en Cuba; 86% de las especies son endémicas. Algunas de las familias (Buxaceae, Cneoreaceae, Dracaenaceae) tienen una distribución muy disyunta.

c) En contraste con los elementos laurasiáticos, los de la Gondwana, es decir los elementos de origen del hemisferio Sur juegan un papel mucho más grande en la flora de Cuba y de las Antillas también. En la flora de Cuba este grupo está representado por 99 familias, 842 géneros, 4160 especies, 2509 endémicas entre ellas (60%). Ellos ocupan a nivel familiar el 55%, a nivel genérico el 63% a nivel específico el 70% y a nivel de los endémicos el 81% de la flora total (Tablas 9 y 10). Esto significa que la flora de Las Antillas tiene una flora de un origen fundamentalmente gondwánico. Esta flora gondwánica — según GENTRY (1982) puede ser dividida en dos grandes grupos, que son los elementos del centro amazónico y los del centro andino.

d) Las familias del centro amazónico ocupan una situación más notable en la flora de Cuba que los elementos laurasiáticos. Este grupo en la flora de Cuba está representado por 42 familias, 340 géneros y 1592 especies, 862 endémicas entre ellas (54%). Estas cifras significan que los elementos amazónicos están participando de la flora total del país en un 23% a nivel de las familias, en un 26% de los géneros, en un 27% de las especies y en un 28% de las endémicas. Esta participación es poco más alta que la de los elementos amazónicos en la flora neotrópica (véase Tabla 10). Sería una gran equivocación pensar que estos elementos amazónicos existentes en Las Antillas son los de la selva húmeda amazónica. La mayoría de estas familias (p.e. Annonaceae, Apocynaceae, Bignoniaceae, Bombacaceae, Burseraceae, Combretaceae, Connaraceae, Dichapetalaceae, Ebenaceae, Euphorbiaceae, Flacourtiaceae, Leguminosae, Malphigiaceae, Menispermaceae, Ochnaceae, Palmae, Sapindaceae, Sterculiaceae, Tiliaceae) están representadas por géneros y especies micrófilas, y xeromorfas, muchas de ellas en formas de bejucos, lianas y arbustos esclerófilos y/o espinosos. En los géneros del centro amazónico

Tabla 4

Familias de los Andes del Norte

	Neotrópicos			familia	género	Cuba		%
	familia	género	especie			especie	endem.	
Acanthaceae		61	1493		19	70	42	60
Aquifoliaceae		1	150		1	26	20	77
Araceae		38	1386		6	17	9	53
Araliaceae		8	553		3	5	3	60
Asteraceae		589	11066		97	362	200	55
Balanophoraceae		7	15		2	2	0	0
Begoniaceae		1	600		1	17	17	100
Bromeliaceae		46	2108		9	54	7	13
Brunelliaceae		1	51		1	1	0	0
Campanulaceae		16	1280		3	19	12	63
Cannaceae		1	55		1	1	0	0
Caricaceae		3	29		1	1	0	0
Celastraceae		20	463		8	33	22	67
Chloranthaceae		1	40		1	4	3	75
Columelliaceae		1	4		0	0	0	0
Cyclanthaceae		11	178		1	1	1	100
Ericaceae		37	731		6	24	22	92
Gesneriaceae		40	917		7	42	40	95
Guttiferae		24	822		8	35	25	71
Haloragidaceae		3	59		2	6	1	15
Loranthaceae		17	607		4	42	40	95
Marantaceae		10	270		2	3	1	33
Marcgraviaceae		4	125		1	4	2	50
Melastomataceae		85	3153		21	196	142	72
Monimiaceae		8	246		0	0	0	0
Musaceae		2	82		1	1	0	0
Myrsinaceae		14	911		5	18	11	61
Nyctaginaceae		30	437		8	24	10	42
Orchidaceae		306	8266		90	298	120	40
Oxalidaceae		3	878		1	9	3	33
Passifloraceae		4	362		1	21	6	28
Piperaceae		6	3025		4	82	51	62
Rhamnaceae		23	168		11	47	37	78
Rubiaceae		168	5451		74	445	322	72
Smilacaceae		1	48		1	8	4	50
Theaceae		9	214		5	24	20	83
Tovariaceae		1	2		0	0	0	0
Tropaeolaceae		2	92		0	0	0	0
Ulmaceae		6	17		4	10	2	20
Urticaceae		13	741		8	77	57	
Zingiberaceae		4	111		2	5	3	60
Total	41	1625	47206	37	419	2034	1255	62

que estan representados por árboles grandes, como p.e. el Hyeronima, las especies antillanas se separan de las demás especies por tener una reticulación de nervios muy densa y sobresaliente, que es un caracter obviamente xeromórfica.

e) GENTRY afirma que la flora de los cerrados evolucionó de la flora amazónica desarrollando arbustos, subarbustos de las familias y géneros consistiendo normalmente de árboles grandes y lianas. Él nota también que este grupo tiene una representación marcadamente pobre en las Indias Occidentales. Esta afirmación de GENTRY es una equivocación. Al contrario, los matorrales costeros y de las áreas serpentinadas, la vegetación cársica están compuestos de elementos amazónicos por lo menos en un tercio. De esta forma se puede considerar la flora de los matorrales antillanos como productos de un desarrollo paralelo con la flora de los cerrados suramericanos, ambas derivadas — al menos parcialmente — de elementos amazónicos.

f) Es indiscutible que en la flora actual de América Central y México las familias del centro andino están representadas por el mayor número de familias, géneros y especies. GENTRY opina que estos elementos tuvieron oportunidad de inmigrar a esta zona después del orogénesis andino, cuyas cordilleras centroamericanas se habían elevado durante el Terciario Superior hasta el Cuaternario, después del cierre del Istmo de Panamá, desarrollando una flora joven, que tenía más vigor para ocupar las regiones montañosas que los elementos especializados de la flora laurasiática. Al analizar la flora de Cuba, según los mismos criterios, encontramos que los elementos andinos están representados por 48 familias, 464 géneros y 2443 especies de las cuales 1572 son endémicas cubriendo el 64% de todos endémicos (véase tablas 4 y 5). La mayoría de estos taxa pertenece al grupo norteandino, participando en las cifras anteriormente enumeradas con 38 familias, 419 géneros, 2034 especies y 1255 endémicos (Tabla 4), dejando el resto al grupo surandino representado solamente por 10 familias, 45 géneros, 409 especies. En este grupo es notable, que 295 especies son endémicas, el 72% de todas las especies pertenecientes a este grupo. Taxonómicamente la gran mayoría de estas especies pertenece a no más de 3 familias: Myrtaceae, Podocarpaceae y Solanaceae.

g) Al comparar la participación de los elementos andinos en la flora neotrópica y en la flora de Cuba respectivamente, encontramos cifras muy parecidas. Las familias andinas ocupan el 28% de la flora neotrópica y el 27% en Cuba, los géneros el 44% en la flora neotrópica y el 35% en la cubana. A nivel específico, los elementos andinos cubren el 43% de la flora neotrópica y el 41% de la flora cubana, sumando el 51% de todos los endémicos.

h) Basándonos en estas cifras podemos afirmar que los elementos del centro andino juegan un papel igual de importante en la flora de las Antil-

Tabla 5

Familias de los Andes del Sur

	Neotrópicos			familia	género	Cuba		endem.	%
	familia	género	especie			especie			
Aextoxicaceae		1	1		0	0	0	0	0
Araucariaceae		1	2		0	0	0	0	0
Calyceraceae		4	46		0	0	0	0	0
Coriariaceae		1	1		0	0	0	0	0
Cunoniaceae		4	182		1	1	0	0	0
Cupressaceae		3	6		1	2	1	50	
Epacridaceae		1	1		0	0	0	0	0
Eucryphaceae		1	1		0	0	0	0	0
Frankeniaceae		3	8		0	0	0	0	0
Gomortegaceae		1	1		0	0	0	0	0
Hydnoraceae		1	6		0	0	0	0	0
Iridaceae		35	288		4	6	0	0	0
Juncaceae		6	49		1	2	0	0	0
Lardizabalaceae		2	3		0	0	0	0	0
Loasaceae		12	266		1	1	0	0	0
Malesherbiaceae		1	27		0	0	0	0	0
Myrtaceae		26	2354		17	280	252	90	
Myzodendraceae		1	11		0	0	0	0	0
Nolanaceae		1	18		0	0	0	0	0
Onagraceae		14	275		2	15	1	7	
Podocarpaceae		1	37		1	5	4	80	
Portulacaceae		10	430		3	14	3	21	
Proteaceae		3	92		0	0	0	0	0
Restionaceae		1	1		0	0	0	0	0
Santalaceae		7	43		0	0	0	0	0
Solanaceae		67	1869		14	83	34	41	
Winteraceae		1	1		0	0	0	0	0
Total	27	209	6019	10	45	409	295	72	

las, que en la flora de América Central y México. Esto significa que la flora antillana es fundamentalmente de origen andino, consecuentemente los elementos de esta flora tenían que llegar a las Antillas a través de una cordillera andina, o varias cordilleras andinas. Es posible pero no tenemos todavía las evidencias geológicas necesarias. Los geólogos tienen que encontrarlas, porque las evidencias botánicas y fitogeográficas presentan argumentos muy poderosos. No se puede olvidar que el concepto de la tectónica moderna ya fue prelegado mucho antes por la teoría de WEGENER, basado principalmente en evidencias biogeográficas. Se puede esperar que los fenómenos biogeográficos — más temprano o más tarde — reciban su justificación geológica.

i) Al mismo tiempo, tenemos que mencionar, — de acuerdo con GENTRY — que en cuanto a las formas de vida, las epífitas y las monocotiledóneas ar-

Tabla 6

Familias de las areas secas de la Gondwana

familia	Neotrópicos		familia	género	Cuba		endem.	%
	género	especie			especie			
Cactaceae	60	2000		20	55	32	58	
Capparidaceae	14	456		4	20	7	35	
Erythroxylaceae	1	180		1	19	15	79	
Koeberliniaceae	1	1		0	0	0	0	
Martyniaceae	3	13		2	2	0	0	
Velloziaceae	4	229		0	0	0	0	
Vitaceae	5	508		3	17	8	47	
Zygophyllaceae	12	62		3	4	0	0	
Total	8	100	3449	6	33	117	62	53

borescentes o palmiformes (Musaceae, Marantaceae, Zingiberaceae) están notablemente menos representadas en la flora de Cuba que en el continente, posiblemente condicionadas por una época seca durante el período temprano de la inmigración, o más tarde, durante la época de la fase adaptativa de la especiación. Las especies existentes en Cuba mayormente pertenecen a géneros más evolucionados y estan representados por endémicos locales de distribución muy limitada.

j) Por otra parte, la afirmación de GENTRY no es correcta cuando establece que las familias Piperaceae, Gesneriaceae, Acanthaceae, Melastomataceae, Myrsinaceae, Rubiaceae y Solanaceae están pobremente representadas (op. cit. 581). Aquí GENTRY cayó en la trampa del "monografismo" y de sacar conclusiones basándose en pocas especies. Según mis calculos, las familias

Tabla 7

Familias con centro de Guyana

familia	Neotrópicos		familia	género	Cuba		endem.	%
	género	especie			especie			
Burmanniaceae	13	51		3	5	0	0	
Dipterocarpaceae	1	1		0	0	0	0	
Mayacaceae	1	9		1	2	2	100	
Podostemaceae	19	151		2	2	1	50	
Rapataceae	15	79		0	0	0	0	
Saccifoliaceae	1	1		0	0	0	0	
Sarraceniaceae	1	6		0	0	0	0	
Tepuianthaceae	1	1		0	0	0	0	
Triuridaceae	4	12		0	0	0	0	
Total	9	56	311	3	6	9	3	33

Tabla 8

Familias de distribución indiferente

	Neotrópicos			familia	género	Cuba		%
	familia	género	especie			especie	endem.	
Aizoaceae		6	94		4	7	0	0
Alismataceae		2	61		3	10	3	30
Amaranthaceae		14	723		16	39	6	15
Amaryllidaceae		29	1019		7	33	16	48
Asclepiadaceae		49	1212		9	56	33	59
Butomaceae		2	7		1	1	0	0
Canellaceae		3	11		2	2	1	50
Ceratophyllaceae		1	2		1	2	0	0
Chenopodiaceae		12	48		4	10	1	10
Commelinaceae		17	163		11	14	1	7
Cucurbitaceae		55	311		9	18	1	6
Cyperaceae		26	3826		22	235	47	20
Dioscoreaceae		2	615		2	32	20	62
Elatinaceae		2	45		1	1	0	0
Eriocaulaceae		12	868		5	36	33	92
Goodeniaceae		1	2		1	2	1	50
Gramineae		207	5530		78	399	65	16
Haemodoraceae		2	4		2	3	1	33
Hydrocharitaceae		8	20		5	8	0	0
Juncaginaceae		2	5		1	1	0	0
Lemnaceae		4	12		4	6	0	0
Lentibulariaceae		3	116		3	20	10	50
Linaceae		4	250		1	1	1	100
Malvaceae		50	860		22	89	11	12
Myoporaceae		1	1		0	0	0	0
Najadaceae		1	8		1	3	0	0
Nymphaeaceae		5	27		3	9	0	0
Phytolaccaceae		15	116		6	8	0	0
Polygonaceae		15	927		3	45	31	69
Pontederiaceae		4	21		4	12	2	15
Potamogetonaceae		5	42		1	5	0	0
Rutaceae		40	546		9	59	43	73
Taccaceae		1	30		0	0	0	0
Thymelaeaceae		7	71		3	14	12	86
Verbenaceae		40	1143		16	114	64	56
Xyridaceae		3	271		1	13	8	61
Total	36	650	19007	34	261	1307	411	31

mencionadas están representadas por géneros y especies más ricamente en la flora de Cuba que en la neotrópica. Las familias enumeradas arriba aparecen a nivel de géneros con 10.6% en los neotrópicos y con 10.9% en Cuba, a nivel específico: Neotrópicos 13.6%, Cuba 16.0%, cuyo 67% son endémicos.

k) Aunque en la flora de Cuba abundan especies xeromorfas de distintos tipos, la familias clasificadas por GENTRY como características en las áreas

secas gondwánicas, son bastante pobremente representadas. Las familias Koeberliniaceae y Velloziaceae faltan completamente, de los 100 géneros y 2000 especies de cactáceas aparecen en Cuba solamente 33 géneros y 55 especies (Tabla 6). Solamente 2 familias de este grupo están merecidamente representadas en la flora cubana, la Erythroxylaceae y la Vitaceae.

Aunque GENTRY considera las vitáceas como una familia laurasiática, según mis conocimientos obtenidos en las sabanas de África suroriental, donde abundan las vitáceas de tronco succulento (especialmente del género Cissus), prefiero tratar esta familia como elemento de las áreas secas gondwánicas. En cuanto a las cactáceas existentes en las Antillas, consideramos que tuvieron que inmigrar en el Terciario temprano a través de una estribación andina, perteneciendo la mayoría de los géneros a la subfamilia Opuntioideae. Además hay en Cuba una especie relictica de las cactáceas fóliáceas (Peireskia cubensis). Al mismo tiempo, las cereoideas gigantescas no aparecen en la flora antillana. Este subfamilia está representada mayormente por géneros rastreros, lianiformes como Selenicereus, Hylocereus y Leptocereus, este último siendo endémico de las Antillas Mayores con 14 especies. Al parecer, en la época del gran desarrollo de las cactáceas mexicanas y californianas no hubo contacto inmediato entre las Antillas y América Central.

1) Al parecer, la flora de Guyana tuvo poco contacto con las Antillas. Aunque existen elementos con una distribución Antillas-Sur-América nor-oriental, estos elementos no pertenecen a las familias enumeradas en la Tabla 7. Entre las familias aquí nombradas la Mayacaceae y la Burmanniaceae están representadas, ambas con gran amplitud migratoria mediante aves acuáticas migratorias como posible agentes distribuidores.

m) Entre las familias indiferentes (Tabla 8) encontramos algunas que tienen un caracter más bien montañoso o amazónico, que indiferente, teniendo en cuenta su distribución en América de Sur. Por ejemplo, la mayoría de los géneros de la familia Rutaceae existentes en Cuba, especialmente Spathelia y Zanthoxylum, en la familia Verbenaceae los géneros Callicarpa, Vitex, Clerodendron, la familia Thymelaeaceae tienen caracter definitivamente montañoso. Las especies de Eriocaulaceae viven en Cuba en la zona oligotrófica de las arenas, pero llegaron allá por inversión y originalmente pertenecieron a una vegetación montana. Este caracter se manifiesta en la fisonomía de las plantas y en el hecho, que las formas más antiguas de la familia viven en la zona subalpina de las montañas suramericanas. En cuanto a la familia Polygonaceae los géneros herbáceos son de la región templada, los subfruticosos

Tabla 9

Sumario de las tablas 1-8

	Neotrópicos			Cuba			endem.	%
	familia	género	especie	familia	género	especie		
Familias de Laurasia	58	465	18698	37	103	338	137	41
Familias del Caribe	9	28	368	9	15	94	79	86
Fam. del centro Amazónico	54	1066	28539	42	340	1592	862	54
Fam. de los Andes del Norte	41	1625	47206	38	419	2034	1255	62
Fam. de los Andes del Sur	27	209	6019	10	45	409	295	72
Áreas secas Gondwánicas	8	100	3449	6	33	117	62	53
Familias de Guyana	9	56	311	3	6	9	3	33
Fam. de distrib. indiferente	36	650	19007	34	261	1307	411	31
Total	244	4199	123597	179	1222	5900	3104	53
Fam. de origen Gondwánico	141	3056	85524	99	843	4161	2477	60
Fam. de origen andino	70	1834	53225	48	464	2443	1550	64

y fruticosos están adaptados a las zonas subtropicales secas, pero los arbóreos, como p.e. el género Coccoloba tienen un caracter tropical, además la mayoría de sus especies son de una distribución montana.

n) Resumiendo nuestras afirmaciones podemos concluir que la flora antillana en su parte más notable está representada por familias gondwánicas, entre ellas primeramente por familias del centro andino, en menor parte por familias del centro amazónico. No se puede dejar fuera de atención, que el 81% de los endémicos pertenecen a las familias gondwánicas, y entre ellas el

Tabla 10

Participación de las diferentes familias en las floras de los Neotrópicos y de Cuba respectivamente, en el nivel de los distintos rangos taxonómicos

	familias		géneros		especies		endem.
	América	Cuba	América	Cuba	América	Cuba	
Familias de Laurasia	24	21	11	8	15	6	4
Familias del Caribe	4	5	<1	1	<1	>1	2
Familias de Amazonia	22	23	25	26	23	27	28
Fam. de Andes De Norte	17	21	39	32	38	34	40
Fam. de los Andes Sur	11	6	5	3	5	7	11
Áreas secas Gondwánicas	3	3	2	2	3	2	2
Familias de Guyana	4	2	1	<1	<1	<1	<1
Familias indiferentes	15	19	15	27	15	22	13
Total	100	100	100	100	100	100	100
Familias de Gondwana	57	55	15	27	15	22	81
Familias de los Andes	28	27	44	35	43	41	51

51% a familias del centro andino. La flora xeromorfa de las antillas se ha desarrollado de elementos andinos y amazónicos, en forma parecida a la evolución de la flora de los cerrados suramericanos. El papel de las familias de las zonas áridas gondwánicas es reducida en comparación con su abundancia en el continente. Los elementos andinos de la flora antillana tienen un carácter y evolución parecidos a los de los elementos afro-alpinos que se encuentran en el piso alpino de las altas montañas de África Oriental y en los llanos y colinas del Mediterráneo. La diferencia es, que este modelo de distribución esta representado a nivel específico en África siendo la duración del proceso evolutivo corto y la segregación de las áreas durante el Cuaternario, mientras que en las Antillas las mismas relaciones se manifiestan a niveles genéricos y familiares gracias al proceso evolutivo mucho más largo, empezado ya posiblemente en la época de las Proto-Antillas, desde la primera mitad del Terciario.

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STRUCTURE OF ELEOCHARETUM INTERSTINCTAE IN SANTA CRUZ RESERVOIR, CUBA

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Vertical and horizontal structure of Eleocharetum interstinctae Samek et Moncada were determined in Santa Cruz Reservoir during a flooded-drained-flooded cycle. Horizontal pattern and minimum area were also estimated. Height and density of shoots of Eleocharis interstincta (Vahl) R. et S. were recorded monthly in plots of 40 cm by 40 cm. Minimum area was 0.02 m^2 and from this value the shoots showed a random distribution. A strong influence of water level on density, height, phenology stage and species diversity was observed.

Keywords: community structure, helophyte stands, hydrological cycle

Introduction

Helophyte community structure depends on many abiotic factors such as soil and water qualities, and water level fluctuations (HEJNY and HUSAK 1978), although biotic ones such as number of species and its interaction should not be neglected. However, due to the tendency to form monotypic stands mainly in man-made reservoirs, density and height are the most important aspects to consider in the structural evaluation of this type of vegetation for a given ecological set.

Many studies have been carried out on helophyte stand structures although most of them have been developed under temperate weather conditions where the vegetation dies when the winter comes due to the low temperatures. However, in tropical countries, with a continuous growing season, helophyte community remains alive during the year, so the stand structures are either more complex than in temperate countries or at last quite different.

Eleocharetum interstinctae Samek et Moncada (SAMEK and MONCADA 1970) is the best represented helophyte association in Santa Cruz Reservoir where it almost covers the total of both limosal and littoral zones.

Considering that a detailed study on community structure is indispensable to carry out further investigations such as biomass and productivity (ONDOK and KVET 1978), it decided to assess Eleocharetum interstinctae vertical and horizontal structures during a flooded-drained-flooded cycle not only as a first step in the logical sequence of investigations of this association, but also to know the influence of some abiotic factors on its behaviour.

Material and Methods

Eleocharetum interstinctae structure was determined in a representative stand in Santa Cruz Reservoir during a flooded-drained-flooded cycle, from February 1990 to November 1990. This association is formed in this waterbody by three sub-associations which are distributed in regard to depth. Nevertheless, the dominant floristic element in all of them is "giant spikerush", Eleocharis interstincta (Vahl) R. et S., and accompanying species are low.

Cluster is the elemental structural unit of giant spikerush population which are constituted by shoots jointed at the cluster base. During the flooded period 50 clusters were removed and the number, height and phenology stage of shoots were recorded.

Structure at population level was determined in the middle band, Eleocharetum interstinctae-paspalidietosum geminati since it is the least influenced section by water level. Horizontal shoot distribution was analyzed according to MORISITA (1959) where a value close to one implies a random distribution. Minimum area was established by mean square (KERSHAW 1964). With this object living shoots of Eleocharis were counted in 438 basic plots of 5 cm by 5 cm, and after that, they were regrouped in plots of different sizes: 5 cm by 10 cm, 10 cm by 10 cm, 10 cm by 20 cm, 20 cm by 20 cm, 20 cm by 40 cm, and 40 cm by 40 cm.

In order to know the variability of density and height of Eleocharis in the middle band, from 3 to 5 plots of 40 cm by 40 cm were taken every 5 m following a transect chosen at random every month. Shoots were cut at bottom level and measured one by one. Living shoots were segregated in flowering and non-flowering, and the results are offered according to this division.

Some rules were established to separate living from dead shoots. It was considered dead when either a dried ring just below to the inflorescence appeared or the apical portion of at least 1 cm was dried in non-flowering shoots. Shoots without a dried segment often occurs and in that case the death was considered when 50% or more of the total shoot surface was faded.

During the drained season, May and June, the sample station was kept on the same place to assess the influence of water level descension and a new station was established in a flooded zone (water layer about 10 cm) as a control. In both stations three plots of 40 cm by 40 cm were taken as mentioned before.

Floristic composition changes during the hydrological cycle in Eleocharetum interstinctae were recorded in transects taken at random every four months.

A prolonged drained season characterized the next hydrological cycle, 1991, so a sample was made in October 1991. The samples were taken as mentioned before for both clusters and population.

Results and Discussion

Eleocharetum interstinctae is dominated floristically by giant spike-rush which grows making clusters with a large variability of number of shoots per cluster, from 1 to 15 (Fig. 1). Total living shoots per cluster recorded in June 1990 in the flooded station and October 1991 showed significant differences according to Test-T ($P < 0.01$). Contradictorily, the mean value in October was higher with a lower dispersion than those observed in June.

On the other hand, dead shoots remain attached to the cluster base. Due to their different decomposition stages it was difficult to count them. Nevertheless, the variability between clusters was large; from all dead shoots to all living shoots.

Flowering shoots were significantly higher than non-flowering ones in June (flooded zone). However, after a prolonged drained period (October 1991), this ratio changed but the difference between them continued being significantly at Test-T ($P < 0.01$) (Fig. 2).

At population level, clusters appear interlaced giving a homogeneous distribution view like a sward. According to the results, shoots have a random distribution for plots larger than 0.04 m (Fig. 3). This area is similar to those covered by clusters at 0.1 m above bottom level at which height the measurements were made.

The highest mean square was recorded in plots of 0.02 m (Fig. 3). From the practical point of view, this value means that a plot larger than 0.02 m is successful for further investigations.

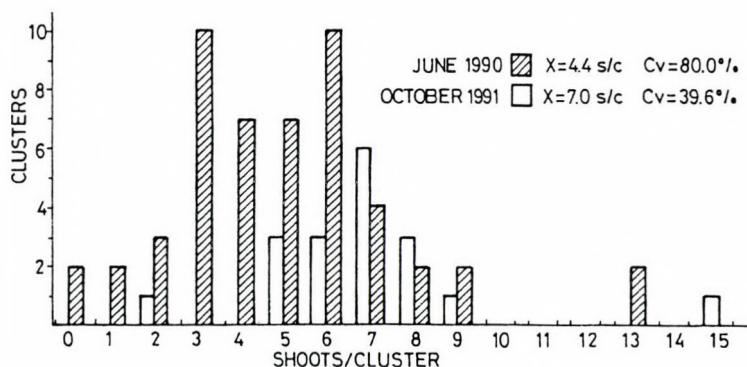


Fig. 1. Structure of Eleocharis cluster in a flooded station (June 1990) and after a prolonged drained period (October 1991)

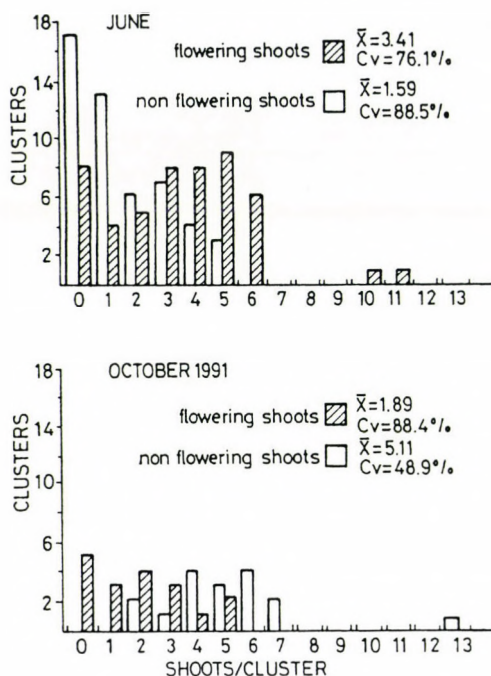


Fig. 2. Phenology stages of *Eleocharis* shoots in clusters in a flooded station (June 1990) and after a prolonged drained period (October 1991)

On the other hand, population structure of *Eleocharis interstinctae* changes according to the water level. Height and density showed a strong relation as the water level changes occurred during the hydrological cycle

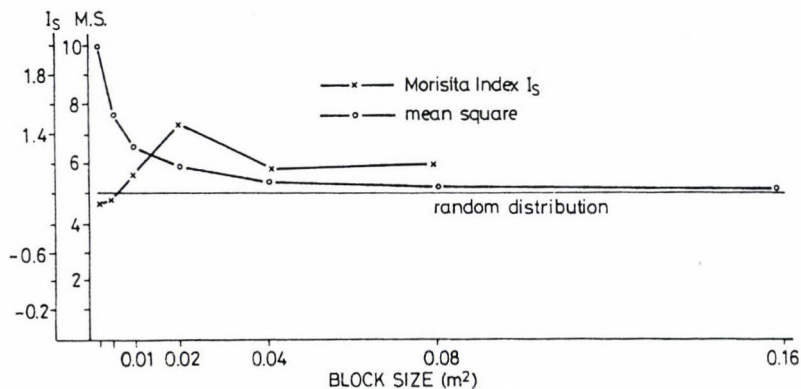


Fig. 3. Horizontal distribution pattern of *Eleocharis* shoots

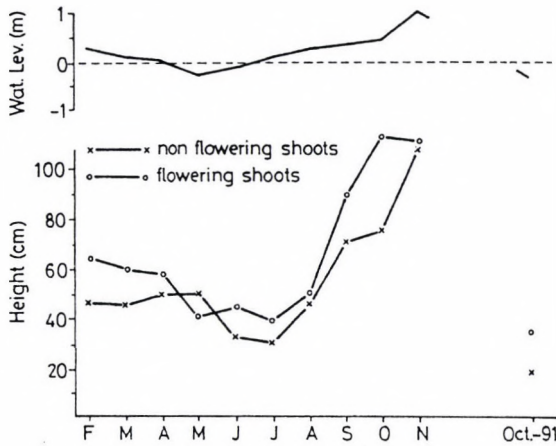


Fig. 4. Mean height of *Eleocharis* shoots during the hydrological cycle

although, a slight displacement was observed in the curves to shoot parameters.

The mean height of living shoots with and without flowers, showed the same behaviour during the cycle (Fig. 4). The lowest values were recorded during the last two months of the drained period, June and July, and those values were significantly different according to Duncan test ($P < 0.01$) from the rest, and comparable with those recorded six months after the prolonged drained period (October 1991), whilst the highest height, significantly different ($P < 0.01$), corresponded with the highest water level; November 1990.

The rest of records can be grouped according to Duncan test results. February, March, April, May and August were relatively low, significantly different ($P < 0.01$) with June and July, and September and October; this group is just below the highest.

Flowering shoots, excluding May, were higher than non-flowering ones although only in April, June, September and October 1991 were significantly different ($P < 0.01$) at Test-T. In some occasions, the variability of values had a negative influence to obtain significant differences between means.

Water level fluctuations influenced, not only on height but also on vertical pattern (Figs 5 and 6). When water level was low and soil exposed, height data had a distribution close to the normal one with a slight displacement of the most frequent value towards the class corresponding to higher heights. However, when water level began to increase, the displace-

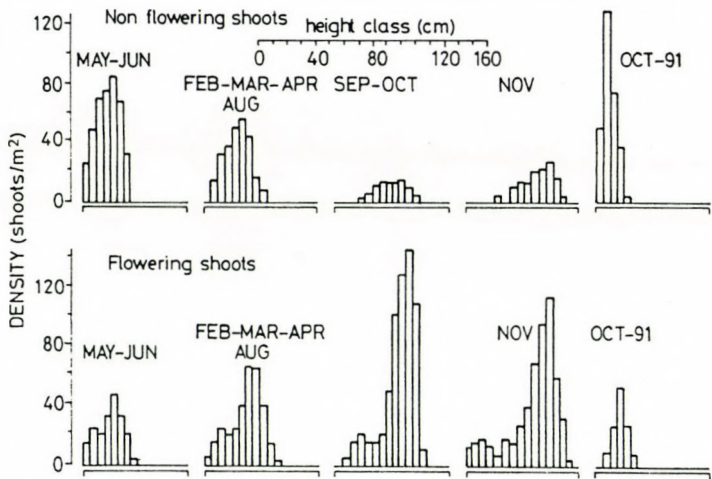


Fig. 5. Vertical structure of *Eleocharis* population during the hydrological cycle

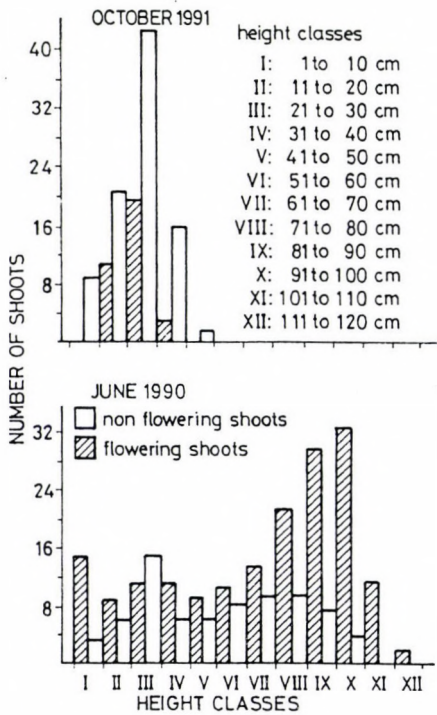


Fig. 6. Vertical structure of *Eleocharis* clusters in a flooded station (June 1990) and after a prolonged drained period (October 1991)

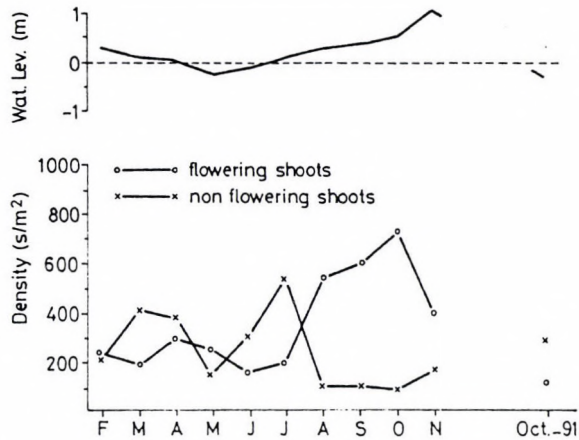


Fig. 7. Mean density of *Eleocharis* shoots during the hydrological cycle

ment was more pronounced. This larger proportion of the highest shoots has been reported for other helophyte species; HASLAM (1971a) for common reed *Phragmites communis* Trin., PLASENCIA and KVET (1993) for cat-tail *Iypha domingensis* (Pers.) Kunth.

Density was also influenced by water level fluctuations. During the hydrological cycle, total density was significantly higher ($P < 0.01$) according to Duncan test, in flooded period than in drained one (Fig. 7). However, some changes in these results were observed when total shoots are segregated.

Flowering shoots density was significantly higher ($P < 0.01$) at Duncan test in the months following the drained period: August, September and October. No statistical differences were observed in the rest of the months.

Density of both shoots types recorded in October 1991 was similar to those recorded in the drained period; May and June.

In order to eliminate the possible influence of the cycle of life at population level on the phenology stage, some samples were taken at the same time in a permanent flooded station. When comparing the results from both stations (Table 1) a significant higher density of flowering shoots ($P < 0.01$) at Duncan test, was observed in the permanent flooded station, while non-flowering shoots density was significantly higher in the drained one. These results confirmed that the ratio of both shoot types recorded monthly was strong influenced by the water level fluctuation.

Table 1

Density of E. interstincta shoots in drained and flooded stations

		Drained station	Flooded station	Significant differences*
Total living shoots	X (s/m)	421	688	++
	S.D.	109.5	87.7	
	Cv. %	36.0	12.7	
Flowering shoots	X (s/m)	192	596	++
	S.D.	65.6	276.7	
	Cv. %	34.0	46.4	
Non-flowering shoots	X (s/m)	228	93	+
	S.D.	110.5	39.9	
	Cv. %	48.5	42.9	
Significant differences**		NSD	++	

*+($P < 0.05$) ++($P < 0.01$)

**Comparison between flowering and non-flowering shoots.

NSD: No significant difference.

Water has an important role on the physiology of helophytes as well as a mechanic action supporting the shoots in stand position. For that reason, as soon as the water level begins to decrease, giant spikerush shoots fall and make up a dry matter layer above the soil, remaining in up right position shoots shorter than those fallen, according to the water level.

At the end of the drained period, a dried shoot layer appears on the bottom which is easily destroyed during the next flooded season. Nevertheless, a net organic matter accumulation was observed which can produce a negative effect on density. This has been reported for other helophyte stands (MCNAUGHTON 1968, SZCZEPANSKA 1977, PLASENCIA and KVET 1993).

At association level, Eleocharetum interstinctae is also strongly influenced by water level fluctuations which act negatively on species diversity, either in the inner band characterized by hydrophytes or in the most external one close to the terrestrial phase (Fig. 8). However, the middle band corresponding to Eleocharetum interstinctae-paspalidietosum geminati showed non-significant changes in species diversity during the hydrological cycle although, when the drained period was too long it died, and the sub-association was invaded by other species representative of either wet soil or terrestrial phase (Fig. 8).

This influence of water level fluctuations and duration of drained period have been pointed out as one of the most significant factors changing

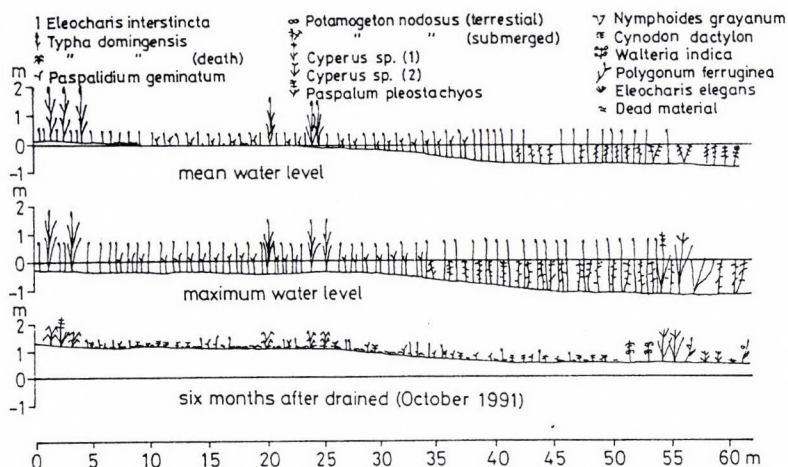


Fig. 8. Species composition in *Eleocharetum interstinctae* in regard to water level fluctuations

the helophyte stand structure (FIALA and KVET 1970, HASLAM 1971b), HOWARD-WILLIAMS 1975, HEJNY and KVET 1978).

According to the results *Eleocharetum interstinctae* structure was strongly influenced by water level fluctuations, from individual clusters to association level.

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STUDIES ON AFRICAN CALYMPERACEAE, VI
NEW DATA TO CONTINENTAL AFRICA AND MADAGASCAR*

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Syrrhopodon pottioides from Madagascar is new to science, Calymperes palisotii subsp. moluccense, C. graeffeanum, C. hispidum and C. taitense are recorded for the first time from continental Africa. Syrrhopodon pulcher is new to Madagascar and to the neighbouring islands, previously known only from Indonesia. New localities of Mitthyridium flavum, M. undulatum and Syrrhopodon lisowskii in the African continent and of S. armatissimus in Madagascar are given.

Keywords: Calymperes, Syrrhopodon, new species, new localities, Africa, Madagascar

Introduction

During the identification work of more than one thousand Calymperaceae specimens collected in Africa and in the neighbouring islands by S. Lisowski, T. Pócs, G. Kis, A. Szabó and by the author, one species proved to be new to science and several records to the bryoflora of the tropical African region. Only six species of the genus Calymperes were known before from continental Africa (cf. EDWARDS 1980). The author has found four further species, which were known earlier only in the Indo-Pacific region. Several new data are given to the flora of Africa and Madagascar from the genera Mitthyridium and Syrrhopodon. Among them Syrrhopodon pulcher is probably the most interesting, being described only five years ago from Indonesia. The data published in this article contribute to several new tropical African occurrences to the Checklist of O'SHEA (1995). All specimens referred are deposited in the Bryophyte Herbarium of the Eszterházy Károly Teacher's Training College in Eger (EGR).

*Hungarian Research Fund (OTKA, Grant No. I/3-941) and the Hungarian Ministry of Culture and Education.

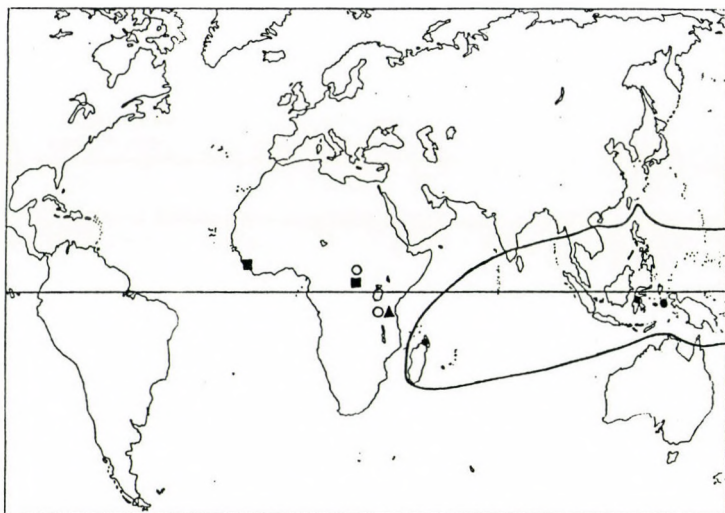


Fig. 1. The distribution of *Calymperes taiense* (○), *C. graeffeanum* (△), *C. palisotii* subsp. *moluccense* (■) and *Syrrhopodon pulcher* (●) in Indo-Pacific and African region

Calymperes Sw.

Calymperes graeffeanum C. Müll.

This species is widespread in the Indo-Pacific region (cf. ELLIS 1988) and, as the western limit of its distribution is known, the Seychelles. There a new record was found on the Kimboza Forest Reserve at the eastern foothills of Uluguru Mountains in Tanzania, where the species grows in low-land rainforest, on *Pandanus* stems, at 300 m altitude. The specimen was collected by T. Pócs in 1970, No. 6278. New to continental Africa (Fig. 1).

C. hispidum Ren. et Card.

The first record of this rare species in continental Africa was found last year in epiphyllous material from Tanzania (coll. T. Pócs, No. 87226). The second record is also from Tanzania where the specimen was found in Mahenge Plateau in Mahenge Scarp Forest Reserve in rainforest at 960 m altitude on bark of *Pandanus* (coll. Pócs et al., No. 87206/N). The species was known formerly from Madagascar and from the Seychelles (cf. ELLIS 1988, ONRAEDT 1994, ORBÁN 1995) (Fig. 2).

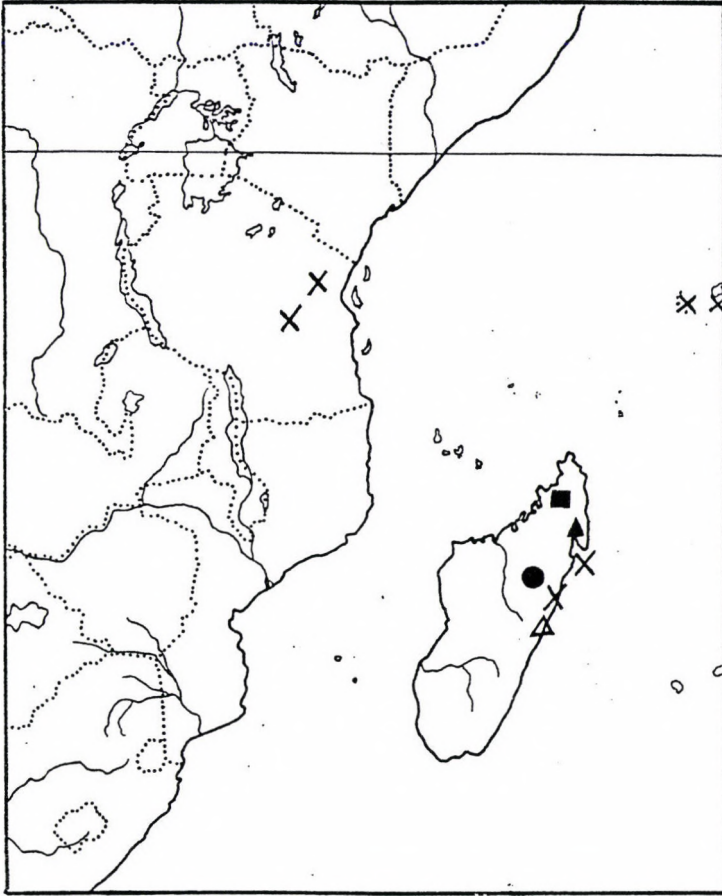


Fig. 2. The distribution of *Syrrhopodon pottioides* (●), *S. armatissimus* (new locality ▲, earlier data Δ), *S. pulcher* (■) and *Calymeres hispidum* (X)

C. palisotii subsp. *moluccense* (Schwaegr.) Menzel in Menzel & Schultze-Motel

New to continental Africa (Fig. 1). The author has found three specimens in the collections of S. Lisowski, one from Guinea: Conacry, Compagnie Minière (No. 918) and two from Zaire: Kisangani in centre of village and near Post office (No. 50255, No. 50379). All specimens were collected from tree bark. The occurrence of subsp. *moluccense* in West and East Africa show that this species has wider paleotropical distribution instead of Asian-Oceanian (cf. ELLIS 1989).

C. taitense (Sull.) Mitt.

The third Indo-Pacific species discovered in continental Africa is C. taitense. The formerly known western limit of its distribution was the Comoro and Seychelles islands (ORBÁN 1995, O'SHEA 1995). Two recently found specimens from East Africa show that the area of this species is completed with tropical Africa, hence it has a paleotropical distribution (Fig. 2). The two specimens were collected by S. Lisowski (No. 50339) in Zaire: 20 km North of Kisangani near the village Bawombi and by T. Pócs et al. (No. 6875/E) in Tanzania: Uluguru Mts on the SE slope of Mt Tumbako, where they occur in submontane rainforests at 1050—1390 m altitude and they are epiphytes (Fig. 1). According to my personal experience this species rare in Madagascar: Masoala Peninsula E of Ambanizana T. Pócs and G. Kis No. 9447/F; 9447/FA and in Reunion: Takamaka gorge W of Ste. Anna S. Orbán No. 9436/CJ and Ravine du' Étang near Annette Falls S. Orbán No. 9434/C.

Mitthyridium (Mitt.) Robins.

The species of the genus Mitthyridium are very rare in continental Africa, therefore the following new localities from Guinea and Zaire are worth mentioning:

M. flavum (C. Müll.) Robins.

Two specimens of this species were identified from Zaire where it is epiphytic in lowland rainforest. The specimens were collected by the road Kisangani-Bengamisa by S. Lisowski in 1977 (No. 12985) and in Kalamba 55 km S of Mbandaka by F. Müller in 1991 (No. Z472). M. flavum is lacking from the known checklists (BORN et al. 1993, O'SHEA 1995), however REESE (1987) published that the species known under the name of Thyridium letestui var. scalariforme Demaret et Leroy, described from "Congo Belge" is a synonym of M. flavum (Fig. 3).

M. undulatum (Dozy et Molk.) Robins.

The occurrence of M. undulatum in Africa was established by REESE in 1987 when identified is the Thyridium letestui Thér. et P. Varde as a synonym of M. undulatum. The species was described under the latter name from

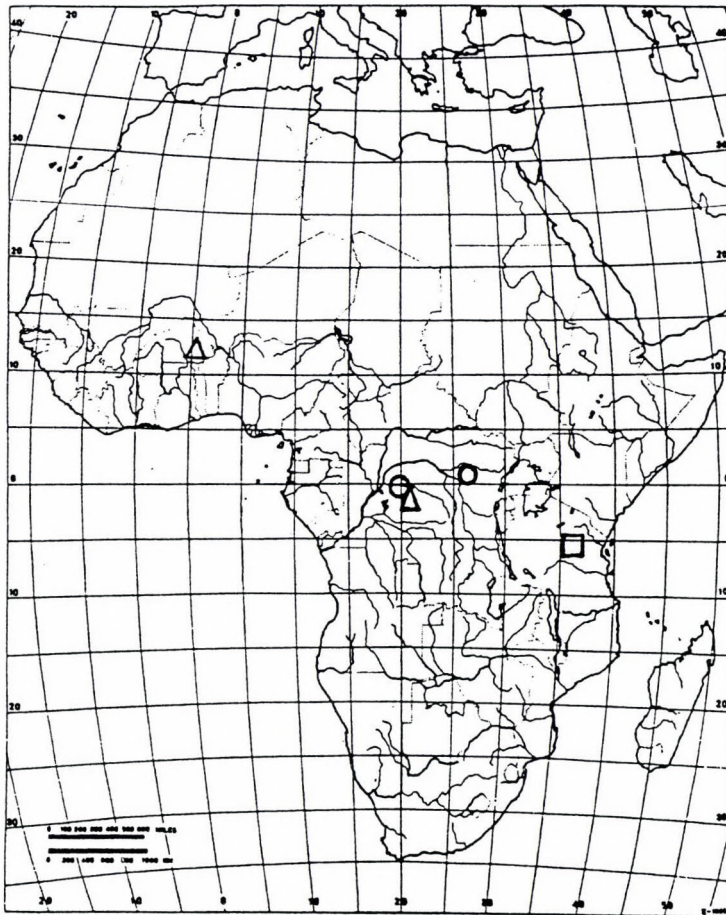


Fig. 3. The continental African distribution of *Mitthyridium flavum* (○), *M. undulatum* (Δ) and *Syrrhopodon lisowskii* (□)

Gabon but the author has found two further specimens from Guinea and one from Zaire, all of the three specimens being new to the indicated countries. *M. undulatum* is epiphytic in lowland forests and was collected in Guinea: Region Macenta near Zobrouma and Massif du Ziam S. Lisowski No. 229, No. 6074 and in Zaire: Kalamba 55 km S of Mbandaka F. Müller N. 465 (Fig. 3).

Syrrhopodon Schwaegr.S. armatissimus Reese

This species was discovered by REESE in 1991 and during our last Madagascar expedition we have found a new locality about 350 km North of Tamatave where it was collected before. The new locality is on the Mangabe island in the Antongil Bay, where this species occurs in lowland rainforest at 1--330 m altitude and the specimens were collected by G. Kis and T. Pócs (No. 9450/EA) (Fig. 2).

S. lisowskii Orbán

The species was known before from Guinea and Zaire (ORBÁN 1987, BORN et al. 1993, O'SHEA 1995). The new locality is in Tanzania in Uluguru Mts: on SE slope of Mt Tumbako NW of Kinole sawmill where the S. lisowskii is corticolous at 1300 m altitude in submontane rainforest. It was collected by T. Pócs No. 6875/M in 1973. New to Tanzania (Fig. 3).

Syrrhopodon pottioides Orbán, spec. nov. (Fig. 4)

Plantae sordidae, Pottiaceae similis; folia lingulata, 3--4 mm longa, linearia, sicca crispata, madida erecta; cellulae medio folio quadratae vel rectangulae, ca. 8--10 μ m, papillosae; margines folio denticulatae, multi-stratosae; cancellinae distinctae. Cetera ignota.

Plants in low turfs, dark green, 5--7 mm tall, with dark red rhizoids; stems simple or forked; leaves liguliform in shape, with wide apex, crispate when dry, erect when moist, 3--4 mm long with parallel sides and slightly wider shoulders; gemmae borne only on the ventral surface of costa tip; leaf margin thickened, coarsely toothed, at shoulders unistratose with sharp spreading or ascending teeth; cancellinae distinct, sharply demarcated distally from the green cells; median cells of upper lamina square, mostly ca. 8--10 μ m; dorsally papillose and ventrally papillose-mamillose, papillae tall, branched; costa ending in the leaf apex, mostly highly papillose to spinose. Gametangia and sporophytes not seen (Fig. 4a--d).

TYPE: Madagascar. Granite outcrops in secondary plateau grassland 69 km NW of Antananarivo along the Mahajanga road, N of Soaniadanana village. 18°29'54" S, 47°17'02" E. Rupicolous. 04. 09. 1994, G. Kis 9443/ED (Holotype: EGR, Isotypes: MO, TAN).

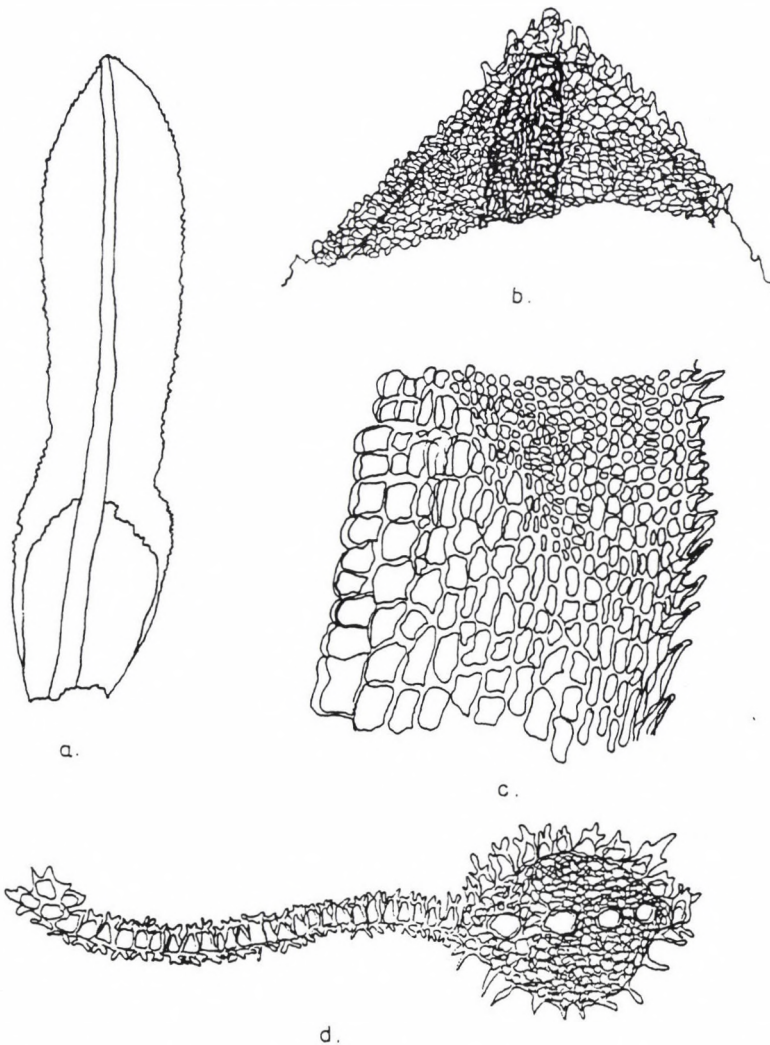


Fig. 4. *Syrrhopodon pottioides* Orbán. a. Leaf shape; b. leaf tip; c. cancellinae and margin of leaf shoulder; d. cross section of leaf (drawn by E. Nagy from the holotype)

The species belongs to Subgenus *Syrrhopodon*, Sect. *Syrrhopodon* and in several aspects is similar to *S. gardneri*, but differs in the wide ligulate leaf shape and in the tall branched papillae of the dorsal and ventral side of the leaf cells and in the highly papillose to spinose costa. Distribution: The new species seems to be endemic on the central plateau of Madagascar once covered by dry evergreen montane forests (Fig. 2).

S. pulcher Reese

Identifying the recent collections from Madagascar two specimens of pale glaucous-green plants with elongate, stiffly erect stems to 4 cm size, with erect-spreading leaves were observed. Under microscope the leaf margins proved to be entire except the toothed apex and were very heavily bordered all around with elongate hyaline cells. This species was different from all described African Syrrhopodon species. Therefore I studied the Asian and Oceanian literature and discovered the description of the S. pulcher by W. D. REESE (1991). This description matches the identity of our specimens with that of S. pulcher from Indonesia. This species occurs in the elfin forests of Marojezy Mts in northern Madagascar (Reserve Integrale Nationale de Marojezy) at 1000--1400 m on soil and tree bark, and was collected by T. Pócs, R. E. Magill and C. LaFarge-England, No. 90114/AS; 90114/AV, 26-28/3/1990. New to Madagascar and the Afr-3 region (Figs 1 and 2)!

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XYLOTOMY OF TWO ENDEMIC *SENECIO* SPECIES FROM KENYA

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Morphological and ecological characteristics, habitat and main anatomical features of the xylem of endemic *Senecio* (subgen. *Dendrosenecio*) species from Kenya, namely: *Senecio johnstonii* Oliv. subsp. *elgonensis* (T. C. E. Fr.) Mabberley and *Senecio barbatipes* Hedberg (Asteraceae, Tubuliflorae) are described.

Keywords: xylotomy, Kenya, *Senecio*

Material and Method

The samples, if not otherwise stated, were collected in western Kenya, Trans Nzoja Districts, on the SE slope of Mt Elgon, in the side valley of Kimothon River, at 3100–4000 m altitude (FODOR and PÓCS 1992).

The blocks made from the wood of diverse *Senecio* species were softened in a mixture of water and glycerin, in BRINZER's autoclave, at 1.5–2.0 atm, and then transversal, tangential and radial sections were prepared. The sections were stained with alcoholic solution of Toluidin-blue. The maceration of tissue was made by the method of Schulze (SÁRKÁNY and SZALAI 1964).

Length of fibres and vessel-elements, tangential and radial diameters of vessels, width and height of medullary rays and other characteristics were calculated by 50–100 measurements. Enlarged microphotographs were made of each section.

External morphology and distribution data are compiled by PÓCS.

External morphology and distribution

Senecio johnstonii Oliv. subsp. *elgonensis* (T. C. E. Fr.) Mabberley

(Syn.: *S. elgonensis* T. C. E. Fr.)

(Fam.: Asteraceae, subfam.: Tubuliflorae)

A 3–10 m tall pachycaul tree (giant groundsel, *Senecio* L. subgen. *Dendrosenecio* Hauman ex Hedb.) with Leeuwenberg type trichotomous branching. The large, often 1 m long leaves form rosettes at the branch endings and in open habitat after dying do not shed, but the marcescent leaves form a heat



Fig. 1. External morphology of Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.)
Mabberley. Kenya, Mt Elgon, 3100 m alt. (Photo: T. Pócs)

insulating cloak on the trunk (Fig. 1). Inflorescences develop in certain years, large, erect panicle flower heads with yellow ray florets. Fruit achene, with white pappus hairs.

Distribution: Endemic in the upper montane, in the subalpine ericaceous and in the Afroalpine belts of Mt Elgon, between 2800 and 4250 m altitude. Ecology: It occurs in smaller groups in the upper montane mist forests, especially along streamlets. Its main distribution area is in the subalpine ericaceous belt between 3200 and 3800 m, where forms larger stands on bogs and on valley bottoms. Above this altitude it becomes very scattered, giving place to Senecio barbatipes and remains restricted to the edges of Carex runssorensis bogs. Wood: As a pachycaul tree, its xylem is a relatively thin cylinder in the stem with pith inside, but old trees can develop a relatively thick stems (up to about 35 cm in diameter), in which the pith hollow remains 2--3 cm.

Senecio barbatipes Hedberg

(Syn.: S. johnstonii Oliv. subsp. barbatipes (Hedberg) Mabberley
(Fam.: Asteraceae, subfam.: Tubuliflorae)

The other endemic giant groundsel of Mt Elgon worth a bit taxonomic reconsideration. It was first described under the name of Senecio gardneri

Cotton. Later HEDBERG (1957) considered this name as illegitimate homonym and renamed the plant, as Senecio barbatipes Hedberg (HEDBERG 1957, 1964). HEDBERG also discussed the different ecology of Senecio elgonensis (now S. johnstonii subsp. elgonensis) and of S. barbatipes, describing, that the latter forms open woodlands on the dry slopes of Mt Elgon, especially in its caldera, above 3800 m altitude. In addition to the known floral characters, PÓCS and SZABÓ (1993) underline these ecological differences and the fact, that S. barbatipes has glaucous leaf colour (in contrast to the vivid green leaves of all S. johnstonii subspecies) and has naked trunk, which is not covered by marcescent leaves and hence gives a totally different appearance to S. barbatipes, from S. johnstonii subsp. elgonensis, here and there (rarely) sharing the same habitat. KNOX (1993) considers Dendrosenecio, as an independent genus, but keeps the taxon barbatipes at subspecies level.

Senecio barbatipes is a 2--6 m tall tree. We measured old specimens having trunk of 70--80 cm diameter! Even these trees do not exceed the height of 4.5--5 m, but their crown is very broad. The typical Leeuwenberg architectural model is represented by giant groundsels usually three subsequent branching (what means 27 end branches and leaf rosettes) but these very old (supposedly 250--300 years old) trees had 60--70 end branches and a very wide shaped crown. As senescent leaves do not remain on the stem, the trunk and older branches of this species are covered by very thick, corky, fissured bark, which seems to prove efficient protection against night cold and fires. According to MABBERLEY (1973) the exceptional behaviour of marcescent leaves by this species is associated with the special anatomy of leaf bases. This fact also confirms the view to consider it an independent species. The leaves are about 1 m long, forming large rosettes at branch ends (Fig. 2). Their colour is glaucous green, their lower surface is tomentose. The inflorescences are produced in certain years, when the axis terminates its life and regular, verticillate side branches (usually 3) are produced. At these branching points the remnants of marcescent inflorescence remain hanging for years. This branching type of giant groundsels is discussed by MABBERLEY (1973) in details. The composed head inflorescences are arranged in an erect panicle. The head is homogeneous, without ligulate flowers (similarly to a few other Afroalpine members of the subgenus Dendrosenecio. Distribution: Endemic to the Afroalpine belt of Mt Elgon, being restricted to its caldera at 3650--4300 m altitude. Ecology: S. barbatipes forms open woodlands on the rim and drier inner slopes of Elgon caldera, often associated with the dwarf bushes of the endemic Euryops elgonensis and Alchemilla elgonensis or with



Fig. 2. External morphology of Senecio barbatipes Hedberg.
Kenya, Mt Elgon, 4000 m alt. (Photo: F. Fodor)

some giant lobelias (Lobelia deckenii subsp. elgonensis, L. telekii). Wood: As its trunk can be the thickest among giant groundsels, in spite of its pachycaul habit is able to develop very voluminous xylem. Its wood is often used for fire by Massai pastoralists staying temporarily with their herds in the caldera.

Wood anatomy

Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.) Mabberley

Diffuse-porous wood. Its mass is composed of polygonal, thin-walled fibres. The longitudinal parenchyma is contact-vasicentric and rarely scanty (METCALFE and CHALK 1950). Wide medullary rays (Figs 3--4).

Tracheae rounded or ovate, solitary or in pairs. Radial groups of 3--5 tracheae are infrequent. Vessels are tangentially flattened. Their number is 16.0--24.4--35.0 per square mm. Tangential diameter is 32.55--68.02--79.05 μm , radial diameter is 51.15--74.78--106.95 μm . Vessel members are 135.6--247.92--395.5 μm long, with alternately set great, elongate bordered pits on the walls. Perforation plate simple.

Medullary rays 2--4-cell and 5--9-cell wide with heterogeneous structure. Their height is 79.1--542.96--1017.0 μm , width 33.9--109.89--180.8 μm (Figs 5--6).



Fig. 3. Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.) Mabberley. Cross-section x48. Diffuse-porous wood, and wide medullary rays

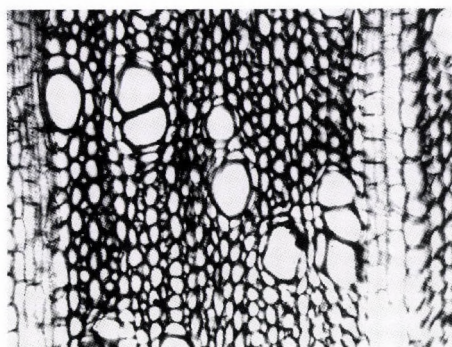


Fig. 4. Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.) Mabberley. Cross-section x120. Vessels, medullary rays, fibres. Contact-vasicentric longitudinal parenchyma

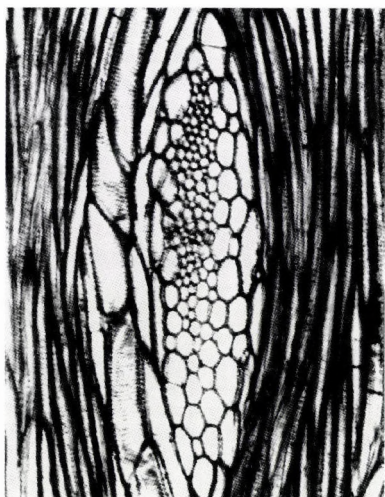


Fig. 5. Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.) Mabberley. Tangential longitudinal section x120. 8-cell wide medullary rays, vessels and fibres. Contact-vasicentric longitudinal parenchyma



Fig. 6. Senecio johnstonii Oliv. subsp. elgonensis (T. C. E. Fr.) Mabberley. Radial longitudinal section x120. Heterogeneous medullary ray, vessels, longitudinal parenchyma and fibres

Table 1
Anatomical features of the species examined

Wood elements	Features	<u>Senecio johnstonii</u> subsp. <u>elgonensis</u>	<u>Senecio barbatiipes</u>
Trachea	arrangement	diffuse, solitary and duplicate and radial groups of 3–5 members	diffuse, solitary and duplicate and radial groups of 3–4 members
	shape	oval or rounded, shaped in groups tangential direction flattened	oval or rounded, shaped in groups tangential direction flattened
	tangential diameter	32.5–68.02–79.0 μm	51.1–68.42–83.7 μm
	radial diameter	51.1–74.78–106.9 μm	60.4–82.36–103.3 μm
	length of vessels	135.6–247.92–395.5 μm	169.5–82.36–103.3 μm
	number per mm^2	16–24.24–35	16–24.0–31
	wall thickness	4.6–5.27–9.3 μm	1.8–3.79–5.5 μm
	intervascular	bordered, elongated, alternate	bordered, elongated alternate
	pitting	simple	simple
Medullary rays	plate content	rarely mastic material	—
	width	wide	narrow and wide
	number of cells	2–4, 8 (9)	1–2, 3–6
	classification	heterogeneous	heterogeneous
	height	79.1–542.96–1017.0 μm	146.9–861.05–4237.5 μm
Fibres	width	33.9–109.89–180.8 μm	33.9–110.17–226.0 μm
	content	—	—
	arrangement	radial rows	radial rows
	shape	polygonal	polygonal
	full thickness	23.0–30.77–57.6 μm	18.4–25.71–34.5 μm
	wall thickness	2.3–4.39–5.7 μm	4.0–5.74–9.2 μm
	full length	426.0–785.09–1209 μm	426.0–688.81–1065 μm
Longitudinal parenchyma	type of pitting	small, bordered	small, bordered
	other	—	—
	arrangement	contact-vasicentric, rarely scanty	contact-vasicentric, rarely scanty
	diameter	9.2–21.87–34.2 μm	6.9–17.66–27.6 μm
	height	46.0–91.82–154.1 μm	62.1–131.46–204.7 μm
	number of cells	2–6	2–4
	content	—	—
	other	—	—

Fibres arranged in radial rows, their diameter is 23.0–30.77–57.6 μm ; total length 426.0–785.09–1209.0 μm . Fibres end in smooth tips. Fibres are rarely septate.

Tangential diameter of the longitudinal parenchyma cells is 9.2–21.87–34.2 μm , their height is 46.0–91.82–154.1 μm . Number of longitudinal parenchyma cells 2–6 (Table 1).

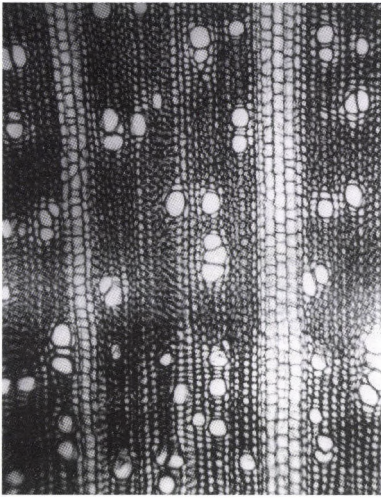


Fig. 7. *Senecio barbatipes* Hedberg. Cross-section x48. Diffuse-porous wood. Narrow and wide medullary rays

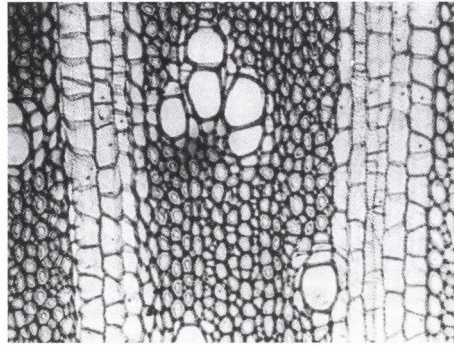


Fig. 8. *Senecio barbatipes* Hedberg. Cross-section x120. Vessels and vessels group. Medullary rays, fibres and contact-vasicentric longitudinal parenchyma

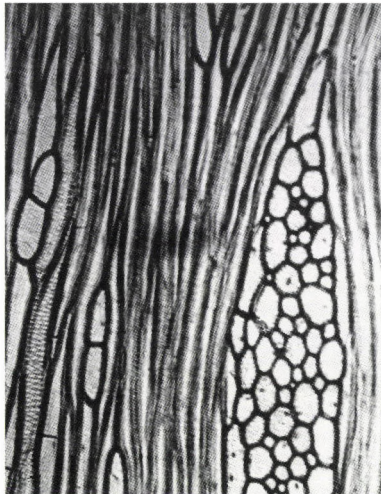


Fig. 9. *Senecio barbatipes* Hedberg. Tangential longitudinal section x120. 1-cell and 7-cell wide medullary rays, fibres. Vessels, contact longitudinal parenchyma

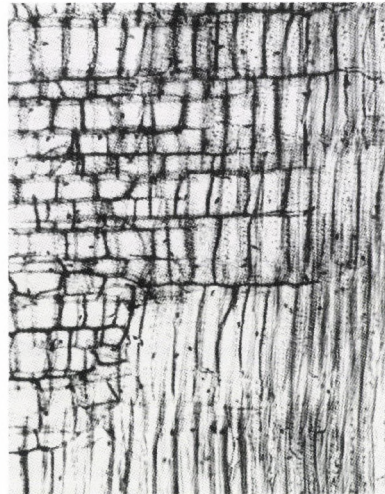


Fig. 10. *Senecio barbatipes* Hedberg. Radial longitudinal section x120. Heterogeneous medullary ray and fibres

Senecio barbatipes Hedberg

Diffuse-porous wood. The mass of wood is composed of polygonal, thin-walled fibres. The longitudinal parenchyma is contact-vasicentric and rarely scanty. Narrow and wide medullary rays (Figs 7--8).

Tracheae rounded or ovate, rarely angular. Solitary or in pairs. Radial and irregular groups of 3--4 tracheae are infrequent. Vessels are tangentially flattened. Their number is 16.0--24.0--31.0 per square mm. Tangential diameter 51.15--68.42--83.7 μm , radial diameter 60.45--82.36--103.30 μm . Vessel members are 169.5--238.28--339.0 μm , with alternately set great, elongate bordered pits on the walls. Perforation plate simple.

Medullary rays 1--2-cell and 3--6-cell (rarely 8 cell) wide with heterogeneous structure. Their height is 146.9--861.05--4237.5 μm , width 33.9--110.17--226.0 μm (Figs 9--10).

Fibres arranged in radial rows, their diameter is 18.4--25.71--34.5 μm ; total length 426.0--688.81--1065.0 μm . Fibres have smooth tips.

Tangential diameter of the longitudinal parenchyma cells 6.9--17.66--27.6 μm , their height is 62.1--131.46--204.7 μm . Number of longitudinal parenchyma cells 2--4 (Table 1).

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ASPLENIUM LEPIDUM C. PRESL IN HUNGARY*

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Asplenium lepidum is an East-Mediterranean mountain flora-element which is not a new data in the Hungarian flora but its appearance on natural habitat and surface can be considered as a novum. The distribution of this plant was justified in the Southern part of Hungary (VIDA 1963, PINTÉR 1991) but these habitats have disappeared that's why these plants were supposed distinct in Hungary (SIMON 1992). It was discovered again in the rocky grassland of Vöröskő near Ómassa in the Bükk mountains on dolomite bedrock. This area was known as the habitats of some rare species such as: Mannia triandra (SILLER 1979), Cypripedium calceolus (SÜBA et al. 1982), Ophrys insectifera (VOJTKÓ 1991).

Keywords: Asplenium lepidum, Hungary, coenology, floristics

The description of the species

Perennial; its rhizome is short, fleshy, frequently branching, the apex of the rhizome is covered by many or some black, sharp chaff scales along a straight axis. The leaves of the plant are similar to Asplenium ruta-muraria, they are very spinose, 4–9(–13) cm long, each leaf is fine, translucent; covered with single celled trichomes and they are light green. The petiole is thin, thread-like, 0.5 mm and it is as long as the lamina or longer. It is light brown only at the leaf base and on its upper part the half of the petiole is grooved. In a cross-section the vascular bundles are grooved on their ventral side with two xylem bodies at the bottom which are connected to a xylem bundle with 3–4 branches. The shape of the lamina changes from triangular to wide ovate and it is bi- or tripinnate, very thin and translucent, like grasses. There are 3–5 pinnae on the leaf, the ones at the bottom have long petioles and they are lanceolate and single or bi-

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pinnate. The pinnules and the last pinnule-parts have trapezium or wide fan shape their apex are rounded off.

The spores are base-located, long and there are 2--6 on one segment, they become settled in an acute angle and do not cover the front part of the segment even chering maturation. They are light brown and slightly granulose in optical segment. The exospores are (32--)36--40(---46) μm long. The number of chromosomes is $2n = 144$. It is allotetraploid, according to P. J. BROWNSEY this species has developed during chromosome duplication from the hybrid of Asplenium aegaeum and Asplenium ruta-muraria subsp. dolomiticum. The spore of the plant matures between the 7th and 9th months. During maturation the spores are not dispersed from the sporangium (REICHSTEIN 1984).

Variants: var. fissoides is extremely prominent which is strongly lobed and it can be easily confused with Asplenium aegaeum. From the eastern part of the island of Crete through Turkey and Caucasus to Afghanistan a relative vicarieting species substitute for Asplenium lepidum is Asplenium haussknechtii. The difference between the two species is that there are no trichomes on Asplenium haussknechtii, Asplenium lepidum as other Asplenium species hybridizes very easily. These forms have been known by the works of KÜMMERLE (1922), REICHSTEIN (1981, 1984), VIDA (1960, 1963, 1965, 1970), PINTÉR (1991).

Habitat

The habitat of Asplenium lepidum is a mesophilous relict rocky grassland which is surrounded by a forest rich in glacial relict species (Figs 1--4). The high-mountainous feature of the cliffs of Vöröskő is represented by numerous mountain-subalpine elements such as:

Aconitum moldavicum

Arabis alpina

Asplenium viride

Astrantia major

Calamagrostis varia

Centaurea mollis

Cirsium erisithales

Clematis alpina

Gymnocarpium robertianum

Moehringia muscosa

Phyllitis scolopendrium

Phyteuma orbiculare

Polystichum lobatum

Rubus saxatilis

Sesleria varia

Valeriana tripteris



Fig. 1. Asplenium lepidum C. Presl on its natural habitat



Fig. 2. The habitat of the plant rises from the dense rocky beech forest



Fig. 3. To the settlement of Asplenium lepidum the small compartments are the most ideal places



Fig. 4. The rocky beech forest (Seslerio-Fagetum) which is rich in relict species

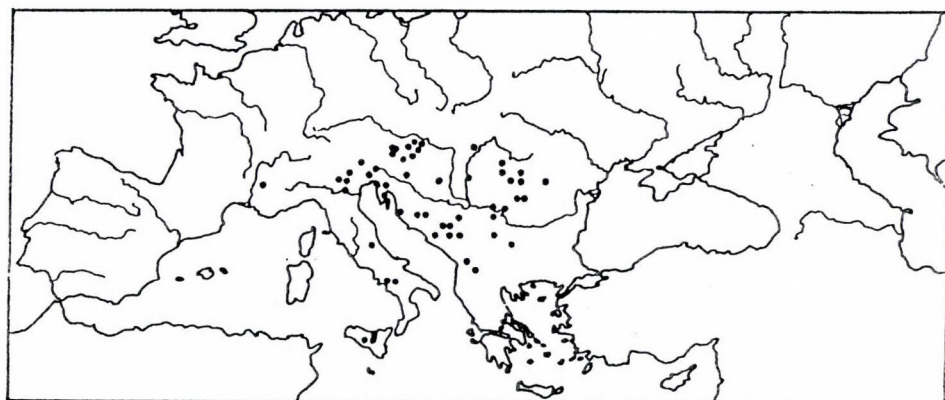
This area is one of the richest places of Hungary and the Bükk mountains in mountain-subalpine species. But on the cliffs we can find many disjunct areas of species of southern and eastern exposition, for example

<u>Aconitum anthora</u>	<u>Oryzopsis virescens</u>
<u>Carex brevicollis</u>	<u>Peucedanum cervaria</u>
<u>Cerasus fruticosa</u>	<u>Peucedanum oreoselinum</u>
<u>Cirsium pannonicum</u>	<u>Polygala major</u>
<u>Cotinus coggygria</u>	<u>Rosa pimpinellifolia</u>
<u>Cytisus albus</u>	<u>Spiraea media</u>
<u>Hesperis matronalis</u>	<u>Vinca minor</u>
<u>Iris graminea</u>	<u>Waldsteinia geoides</u>
<u>Lathyrus laevigatus</u> subsp. <u>transsylvanicus</u>	

Such unique duality of dolomite bedrock can be brought back to vegetation history (ZÓLYOMI 1942).

The coenological sampling of the rocky beech forest (Seslerio-Fagetum) on the steep slope around the rocky grassland (alt: 625 m, exposition: East):

A (cover 85%, height 18 m)		<u>Aconitum moldavicum</u>	+
<u>Fagus sylvatica</u>	4-5	<u>Actaea spicata</u>	+
<u>Acer pseudoplatanus</u>	+	<u>Ajuga reptans</u>	+
<u>Acer platanoides</u>	+	<u>Anthriscus nitida</u>	+
		<u>Aquilegia vulgaris</u>	+
		<u>Arabis turrita</u>	+
B (cover 10%, height 1.5 m)		<u>Asarum europaeum</u>	+
<u>Lonicera xylosteum</u>	+	<u>Asplenium ruta-muraria</u>	+
<u>Sorbus aucuparia</u>	+	<u>Asplenium viride</u>	+
<u>Daphne mezereum</u>	+	<u>Astrantia major</u>	+
<u>Fagus sylvatica</u>	+	<u>Bromus benekeni</u>	+
<u>Corylus avellana</u>	+	<u>Calamagrostis varia</u>	+ -1
<u>Rosa pendulina</u>	+	<u>Campanula trachelium</u>	+
<u>Staphylea pinnata</u>	+	<u>Chrysanthemum corymbosum</u>	+
<u>Viburnum lantana</u>	+	<u>Cirsium erisithales</u>	+
		<u>Clematis alpina</u>	+
C (cover 30%, height 30 cm)		<u>Convallaria majalis</u>	+
		<u>Cystopteris fragilis</u>	+
<u>Acer campestre</u>	+	<u>Daphne mezereum</u>	+
<u>Acer pseudoplatanus</u>	+		



• = *Asplenium lepidum*

Fig. 5. The distribution of *Asplenium lepidum* C. Presl

<u>Dentaria bulbifera</u>	+	<u>Phyllitis scolopendrium</u>	+
<u>Epipactis helleborine</u>	+	<u>Poa nemoralis</u>	+
<u>Euonymus verrucosus</u>	+	<u>Prenanthes purpurea</u>	+
<u>Euphorbia amygdaloides</u>	+	<u>Pulmonaria obscura</u>	+
<u>Fagus sylvatica</u>	+	<u>Senecio nemorensis</u> subsp. <u>fuchsii</u>	+
<u>Hedera helix</u>	+	<u>Sorbus aria</u> s. l.	+
<u>Heracleum sphondylium</u>	+	<u>Staphylea pinnata</u>	+
<u>Lathyrus vernus</u>	+	<u>Valeriana tripteris</u>	+
<u>Mercurialis perennis</u>	+	<u>Viburnum opulus</u>	+
<u>Mycelis muralis</u>	+	<u>Viola mirabilis</u>	+

Distribution

In order to determine the distribution of the plant I used the most important flora works, distribution data (SAVULESCU 1952, REICHSTEIN 1984, MELZER 1967, JALAS and SUOMINEN 1972).

I made exact and completed the distribution data of the plant. On the basis of these examination we can establish that *Asplenium lepidum* lives mainly in Mediterranean high mountains, it occurs in these habitats most frequently (Fig. 5). The most northern point of its Hungarian distribution is the data from the Bükk mountains.

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**LIMONIUM GMELINI, A HALOPHYTE, SPREADING ALONGSIDE MOTORWAY
M3 IN HUNGARY**

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Spreading of Limonium gmelini along the highway M3 was observed between Budapest and Kerecsend (Hungary).

Keywords: Limonium gmelini, halophyte, Hungary

Getting stuck in the traffic jam on the motorway M3 on the day of the Formula 1 car race in Hungary (which was on the 13th of August 1995) some exemplars of Limonium gmelini (Willd.) O. Kuntze were discovered in the middle green strip of the way a few kilometres before Budapest. This plant species, known as a halophyte and belonging to the Artemisio-Festucetum pseudovinae community (SÓÓ 1954), was quite unusual in the mentioned area. Some days later, between Budapest and Gyöngyös, at least 50 exemplars were counted on both sides of the hedge in the middle strip, and only a few ones were identified between Gyöngyös and Kerecsend at the edge of the road, which is the continuation of the motorway towards Miskolc.

A thorough investigation of the phenomenon is rather difficult because of the heavy traffic on the motorway and the large distances. Thus, at present, our results are based only on observations made from a moving car.

Limonium gmelini is widespread on the Hungarian salty plains (SIMON 1992). These are crossed by some roads joining the motorway M3. The distance of the salty plains from the motorway is at least 50 km. It is assumed that the seeds of the halophytic species were transported onto the motorway by the tires of vehicles. A similar spread of seeds was mentioned by LONSDALE and LANE (1994). The seeds found favourable conditions first of all in the middle strip of the motorway, which does not have any outlet and thus the de-icing salts may accumulate in its soil. A similar salt accumulation does not seem to occur at the edge of the motorway because of the presence of a

deep drainage ditch. It seems that the way of construction of the motorway also has an influence onto the accumulation of de-icing salts and the appearance of Limonium gmelini, because no exemplars of this species have been found in areas which are isolated by outstanding kerbstones from the body of the motorway.

The spread of some halophytes, like Puccinellia distans and Aster tri-polium, alongside roads as a consequence of the application of de-icing salts is a well-known phenomenon (HADAC et al. 1983, WEINERT and AL-HILLI 1987). KRIPPELOVÁ (1971) described an anthropogenic community, Puccinellio-Chenopodietum glauci, with the dominant species P. distans. It seems that in the future Limonium gmelini might also increase its area under anthropogenic impacts, and presumably a new community will also have to be described.

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NUMERICAL TAXONOMY OF THE FAMILY RANUNCULACEAE

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With the aim of determining phenetic relationships between 25 genera of the family Ranunculaceae, a numerical taxonomic analysis was carried out with 139 binary variables from the fields of anatomy, morphology, cytology, embryology and phytochemistry. Data were submitted to the cluster (product-moment correlation coefficient, UPGMA, K-means clustering) and PCO (+MST) analysis. Low correlation was recorded between data matrices from different fields. The results confirmed the isolated position of the genera Hydrastis and Glaucidium. Existence of two major clusters of genera was validated in compliance with the size and shape of chromosomes (R and T types). Genus Coptis shows a considerably closer relation to the Thalictrum group. Genera with R type chromosomes are divided into multiovular (Aconitum, Cimicifuga and Helleborus group) and the uniovular group (Ranunculus and Anemone group). Adonis and Callianthemum have an intermediate position.

Keywords: Ranunculaceae, systematics, numerical taxonomy

Introduction

The family Ranunculaceae includes about fifty genera and about 2000 species (CRONQUIST 1981) that are widely spread mainly in temperate, boreal, and especially mountainous regions of both hemispheres (ZIMAN 1985, ZIMAN and KEENER 1989). Ranunculaceae belongs to the order Ranunculales together with the families Lardizabalaceae, Sargentodoxaceae, Menispermaceae, Berberidaceae, Glaucidiaceae and Circaeasteraceae (TAKHTAJAN 1980). Though the Ranunculaceae has been thoroughly studied from different aspects, a number of classifications within the family have been proposed. The Ranunculaceae s. l. has been divided into two (SPACH 1839, LANGLET 1932), three (JENSEN 1968, BA 1981a), four (WETTSTEIN 1935, TAKHTAJAN 1980), five (EMBERGER and CHADEFAUD 1960) and six (TAMURA 1967, 1968, ZIMAN 1985) subfamilies or into three separate families (HUTCHINSON 1969). The greatest impact was made by the results of morphological (TAMURA 1966, 1967, 1968), cytological (LANGLET

1927, 1932, GREGORY 1941), phytochemical (RUJIGROK 1966) and serological (JENSEN 1968) investigations. Phylogenetic relationships between the genera of the family have been interpreted in different ways while the proposed phylogenetic trees are partly coincident (DAVEZAC 1957, ŽUKOVA 1958, KORDYUM 1959, TAMURA 1962_a, FROHNE and JENSEN 1973, ZIMMERMANN 1974, HARBORNE and TURNER 1984).

Though considerable progress has been made, it still holds that: "there is no sufficient system of the family based on the phylogeny, in other words, based on the synthetic consideration on the results of many investigations in various fields" (TAMURA 1963_a). A great advance in this respect was made by TAMURA (1990, 1991, 1992_{a,b}), LECONTE and ESTES (1989), HOOT (1991), and molecular analysis by JOHANSSON and JANSEN (1991, 1993).

The object of this paper is to put together the available data on the Ranunculaceae using numerical taxonomic approach, giving equal treatment to all types of attributes, and to produce a phenetic (STUESSY 1990) classification of the 25 major genera of the family.

Of special interest is the controversial position of the genera Hydrastis and Glaucidium, which have been allotted to the families Ranunculaceae (KUMAZAWA 1938_a, JANCHEN 1949, GREGORY 1941, TAKHTAJAN 1980, CRONQUIST 1981, TAMURA 1992_{a, b}), Berberidaceae (LANGLET 1927, 1932, WETTSTEIN 1935, ZIMMERMANN 1974) or isolated onto separate families Hydrastidaceae and Glaucidaceae (TAMURA 1963_{a, b}, 1967, TAKHTAJAN 1980). The genera Adonis and Callianthemum have also been treated differently. Thus, they have been put together into tribes Anemoneae (BENTHAM and HOOKER 1862, GREGORY 1941), Adonieae (LANGLET 1932), Ranunculeae (BUCHHEIM 1964) or subtribe Adonidinae (JANCHEN 1949, ŽUKOVA 1958, TAMURA 1967, JENSEN 1968, ZIMMERMANN 1974, ZIMAN 1985) but also into separate tribes (PRANTL 1891) or even subfamilies (LOTSY 1911). Genus Coptis has been alternately linked with the group of genera Thalictrum -- Aquilegia -- Isopyrum (BENTHAM and HOOKER 1862, HUTCHINSON 1969) and with a pair Actaea -- Cimicifuga (LOTSY 1911, JANCHEN 1949) but has also obtained separate place within the tribe Coptideae and subfamily Coptidoideae (GREGORY 1941, TAMURA 1967, JENSEN 1968, FROHNE and JENSEN 1973, HARBORNE and TURNER 1984, ZIMAN 1985). Relationships between genera Helleborus -- Nigella -- Eranthis (ZIMAN 1983, 1985) are rather undefined, as well as the relations between some major groups of genera.

Material and Methods

Data

Operational taxonomic units (OTUs) involve 25 genera which, to a large extent, present the diversity and evolution of the family. The following genera have been processed (in the parenthesis, later on used abbreviation): *Aconitum* L. (ACO), *Actaea* L. (ACT), *Adonis* L. (ADO), *Anemone* L. (ANE), *Aquilegia* L. (AQU), *Callianthemum* C. A. Meyer (CAL), *Caltha* L. (CALT), *Ceratocephalus* Moench (CER), *Cimicifuga* L. (CIM), *Clematis* L. (CLE), *Consolida* S. F. Gray (CON), *Coptis* Palisb. (COP), *Delphinium* L. (DEL), *Eranthis* Salisb. (ERA), *Glaucidium* Sieb. et Zucc. (GLA), *Helleborus* L. (HEL), *Hepatica* Mill. (HEP), *Hydrastis* L. (HYD), *Isopyrum* L. (ISO), *Myosurus* L. (MYO), *Nigella* L. (NIG), *Pulsatilla* Mill. (PUL), *Ranunculus* L. (RAN), *Thalictrum* L. (THA) and *Trollius* L. (TRO).

All data, 139 characters in all, have been taken from literature. For macro- and micro-morphological characters numerous herbarium specimens and living material was consulted. All variables are of the binary type, equally weighted. Some of variables are by its nature qualitative multistate characters with no significance to the ordering sequence (for example variables nos 9–12, 56–57, 84–89, 111–113 etc.). Because several different states could occur in the same genus and there were presence/absence polymorphism in some genera, eachy type was scored as an independent character.

All data are divided into 6 sets according to their field of origin.

On the basis of the data on the anatomy of genera from the works of SOLERDERER (1899), STERCK (1900), GOFFART (1901, 1902), LONAY (1901, 1907), SMITH (1926, 1928), KUMAZAWA (1932), TAMURA (1962b, 1964, 1965a, b), EZELARAB and DORMER (1963), PANT and MEHRA (1964), SASTRI (1969), MALYTINA (1972), DECAMPS (1974, 1975, 1979), DICKISON (1975), TRIFONOVA (1977), ZUBKOVA (1977), KASHYAP (1979), AVITA and INANDAR (1980), DUNCAN (1980), ZIMAN (1980) and BARYKINA and LUFEROV (1982), the following variables were formed: 1. root type I (primary structure): present 1, absent 0. 2. root type II (secondary structure): present 1, absent 0. 3. root type III (exofoliation): present 1, absent 0. 4. root type IV (abnormal): present 1, absent 0. 5. petiolar ventral canal + expressed: present 1, absent 0. 6. intercellular space in petiole: present 1, absent 0. 7. bundle sheaths A-type in petiole: present 1, absent 0. 8. bundle sheaths R-type in petiole: present 1, absent 0. 9. dorsiventral type of petioles vascular topography: present 1, absent 0. 10. dorsiventral-scattered type of petioles vascular topography: present 1, absent 0. 11. radial type of petioles vascular topography: present 1, absent 0. 12. radial-scattered type of petioles vascular topography: present 1, absent 0. 13. walls of endodermal cells thickened nearly equally: present 1, absent 0. 14. lignification in interfascicular petioles parts: present 1, absent 0. 15. lignification in central part of petioles: present 1, absent 0. 16. lignification in the petioles cortex: present 1, absent 0. 17. nodal structure multilacunar: present 1, absent 0. 18. nodal structure trilacunar: present 1, absent 0. 19. nodal structure unilacunar: present 1, absent 0. 20. Berberis-condition in nodal structure: present 1, absent 0. 21. branch traces from lateral gaps: present 1, absent 0. 22. more than one leaf trace in a gap: present 1, absent 0. 23. vascular bundle: amphicribal 1, amphivasal 0. 24. scalariform tracheal elements: present 1, absent 0. 25. double middle bundle of petiole: present 1, absent 0. 26. unilacunar cotyledons: present 1, absent 0. 27. trilacunar cotyledons: present 1, absent 0. 28. unilacunar sepals: present 1, absent 0. 29. multilacunar sepals: present 1, absent 0.

On the basis of the data on the morphology of genera from the works of ENDLICHER (1836–1840), PRANTL (1891), HILDEBRAND (1899), LOTSY (1911), TRAPL (1912), RASSNER (1931), SCHOEFFEL (1932), TROLL (1933), KUMAZAWA (1936, 1937), WERTH (1941), CANRIGHT (1952), SCHAEPI and FRANK (1962), ROTH (1957), SOKOLOVSKAYE (1958), EAMES (1961), ARNOTT and TUCKER (1963, 1964), TAMURA (1963a, 1963b, 1965a, 1965b, 1966, 1967, 1968), LEPPIK (1964), TUTIN (1964), HIEPKO (1965), SLAVÍKOVÁ (1965, 1968a, 1968b, 1974, 1976, 1977), ROHWEDER (1967), DAUMANN and SLAVÍKOVÁ (1968), DAUMANN (1969), ROLAND (1971), SASTRI (1969), VIJAYARAGHAVEN and MARWAH (1969), BARYKINA (1972), SMIT (1973), ZIMMERMANN (1974), HESSE (1979), GAMALEJ and PAHOMOVA (1983), ZIMAN (1980, 1985) and GAMALEJ (1988), the following variables were formed: 30. petioles in sprouting erect: present 1, absent 0. 31. petioles in sprouting nodding: present 1, absent 0. 32. polycyclic shoot: present 1, absent 0. 33. monocyclic shoot: present

1, absent 0. 34. monopodial shoot: present 1, absent 0. 35. sympodial shoot: present 1, absent 0. 36. Caltha-type of leaf vernation: present 1, absent 0. 37. Hellebrous-type of leaf vernation: present 1, absent 0. 38. Aquilegia-type of leaf vernation: present 1, absent 0. 39. Anemone-type of leaf vernation: present 1, absent 0. 40. Consolida-type of leaf vernation: present 1, absent 0. 41. Nigella-type of leaf vernation: present 1, absent 0. 42. irregular type of leaf vernation: present 1, absent 0. 43. stipule: present 1, absent 0. 44. leaf-sheath: present 1, absent 0. 45. actinomorphic flower 1, zygomorphic flower 0. 46. bisexual flowers 1, presence of imperfect flowers 0. 47. nectar secretion: present 1, absent 0. 48. free carpels 1, connation of carpels 0. 49. constant number of carpels 1, inconstant number of carpels 0. 50. one carpel: present 1, absent 0. 51. two carpels: present 1, absent 0. 52. three carpels: present 1, absent 0. 53. many secondary derived carpels: present 1, absent 0. 54. inflorescence of solitary flower: present 1, absent 0. 55. inflorescence of more than one flower: present 1, absent 0. 56. petals: present 1, absent 0. 57. secondary derived petals in some species: present 1, absent 0. 58. scale-like appendages between androecium and gynoecium: present 1, absent 0. 59. eucyclic flower: present 1, absent 0. 60. hemicyclic flower: present 1, absent 0. 61. acyclic flower: present 1, absent 0. 62. involucre: present 1, absent 0. 63. sepals persistent 1, sepals usually shed 0. 64. intermediate forms between the petal and the stamen: present 1, absent 0. 65. dilated stamen: present 1, absent 0. 66. hairiness of stamen: present 1, absent 0. 67. anther dehiscence: introrsely 1, laterally 0. 68. secondary elongation of the distal part of the carpels: present 1, absent 0. 69. not completely closed carpels: present 1, absent 0. 70. epeltate petals: present 1, absent 0. 71. peltate petals: present 1, absent 0. 72. peltate petals by its nature: present 1, absent 0. 73. sepal valvate in aestivation 1, sepal imbricate in aestivation 0. 74. rudimental petals appear: yes 1, no 0. 75. polley type I (expansion folds parallel to the major axis): present 1, absent 0. 76. polley type II (several expansion folds not parallel to each other): present 1, absent 0. 77. pollen type III (many germinating pores): present 1, absent 0. 78. fruit follicle: present 1, absent 0. 79. fruit achene: present 1, absent 0. 80. fruit berry: present 1, absent 0. 81. seed coat: thin 1, not thin 0. 82. ontogeny of leaves — eupolacron type: present 1, absent 0. 83. ontogeny of leaves — triacron type: present 1, absent 0. 84. ontogeny of leaves — complextriacron type: present 1, absent 0. 85. ontogeny of leaves — heteroacron type: present 1, absent 0. 86. ontogeny of leaves — monacron type: present 1, absent 0.

On the basis of the data on the embryology of genera from the works of ARTZ (1933), EARLE (1938), KUMAZAWA (1938b), DAVEZAC (1957), KORDYUM (1959), HACCIUS (1965), EFREMOVA (1978), BA (1974, 1981a, 1981b, 1981c) and VIJAYARAGHAVEN and MARWAH (1981), the following variables were formed: 87. multi-ovular carpel: present 1, absent 0. 88. uni-ovular carpel: present 1, absent 0. 89. bi-ovular carpel: present 1, absent 0. 90. number of integuments: one 0, two 1. 91. ovule epitropous: present 1, absent 0. 92. ovule hemitropous: present 1, absent 0. 93. arrangement of proembryo tetrad-cells, types A2, B2, C2, C1: present 1, absent 0. 94. arrangement of proembryo tetrad-cells, types A2, B2, C2: present 1, absent 0. 95. arrangement of proembryo tetrad-cells, types A2, C2: present 1, absent 0. 96. arrangement of proembryo tetrad-cells, type A2: present 1, absent 0. 97. arrangement of proembryo tetrad-cells, type B2: present 1, absent 0. 98. arrangement of proembryo tetrad-cells, type C2: present 1, absent 0. 99. endoderm haustoria: present 1, absent 0. 100. tapetal cell uninucleate: present 1, absent 0. 101. tapetal cell binucleate: present 1, absent 0. 102. ovules have: ridge of placental tissue 1, funiculus 0. 103. integuments 6–8 cell-layer thick: present 1, absent 0. 104. integuments 4 cell-layer thick: present 1, absent 0. 105. integuments about 13 cell-layer thick: present 1, absent 0. 106. intraseminary bundle: present 1, absent 0. 107. abortive ovules without vascular supply: present 1, absent 0. 108. archesporial cell: two 1, one 0. 109. large antipodal cells: present 1, absent 0. 110. antipodal cells less than usually: present 1, absent 0. 111. uninuclear antipodal cells: present 1, absent 0. 112. 2–3 nuclear antipodal cells: present 1, absent 0. 113. multinuclear antipodal cells: present 1, absent 0.

On the basis of the data on the cytology of genera from the works of LANGLET (1927, 1932), GREGORY (1941), KURITA (1956), EHRENDORFER et al. (1968), RAVEN (1975), OKADA and TAMURA (1979), the following variables were formed: 114. basic chromosome number $n=6$: present 1, absent 0. 115. basic chromosome number $n=7$: present 1, absent 0. 116. basic chromosome number $n=8$: present 1, absent 0. 117. basic chromosome number $n=9$: present 1, absent 0. 118. basic chromosome number $n=13$: present 1, absent 0. 119. basic chromosome number $n=10$: present 1,

absent 0. 120. R-type chromosomes: present 1, absent 0. 121. T-type chromosomes: present 1, absent 0. 122. C-type chromosomes: present 1, absent 0. 123. heterochromatic and euchromatic segment distribution: II-type 0, III-type 1.

On the basis of the data on the phytochemistry of genera from the works of EGGER and KEIL (1965a, 1965b), HEGNAUER (1966), RUJIGROK (1966), HOPPE (1975), RAFFAUF (1970), TJON (1979), NACHAM and OLSEN (1983), SATO and YAMADA (1984), BONORA et al. (1987) and MIZUGAKI et al. (1988), the following variables were formed: 124. diterpene alkaloids: present 1, absent 0. 125. magnoflorin: present 1, absent 0. 126. berberin: present 1, absent 0. 127. delcosin: present 1, absent 0. 128. aconitin: present 1, absent 0. 129. ajacin: present 1, absent 0. 130. jatrorrhizin: present 1, absent 0. 131. condelphin: present 1, absent 0. 132. delphinin: present 1, absent 0. 133. delsolin: present 1, absent 0. 134. hetisin: present 1, absent 0. 135. palmatin: present 1, absent 0. 136. lycocotonin: present 1, absent 0. 137. saponin: present 1, absent 0. 138. cyanogenetic compounds: present 1, absent 0. 139. ranunculin: present 1, absent 0.

Cluster analysis

The product-moment correlation coefficient for binary variables (ANDERBERG 1973) was applied as a measure of similarity. Cluster analysis was carried out using the UPGMA technique. The cophenetic correlation (r_c) was used to measure the presentation quality (SNEATH and SOKAL 1973, EVERITT 1980). Groups detected by the cluster analysis and with the ordination method are checked by K-means clustering method (k-random cluster, minimising variability within cluster and maximising variability between cluster, missing values casewise deleted (EVERITT 1980).

Principal Coordinate Analysis (PCO)

In the presence of missing values, the Principal Coordinate Analysis will give the better results than PCA — Principal Component Analysis (ROHLF 1990), so this approach was used for the final presentation of the space relationships of the genera.

The Minimum Spanning Tree was projected onto 3D results of the PCO analysis (SNEATH and SOKAL 1973, CLIFFORD and STEPHANSON 1975).

Computation

All procedures were performed using the package NTSYS-pc (ROHLF 1990). K-means clustering were performed using the package Sy-Tax-pc (PODANI 1993).

Results

Data

The data contain 8.5% of missing values. Reduction to 6% was achieved by replacement of the state of the same variable in the most similar OTU (GORDON 1981). There is high cophenetic correlation between these two matrices, $r_c = 0.98788$, the final results being almost identical, which confirms CROVELLO's (1968) conclusion that, even with a considerable quantity of missing values, phenetic analysis renders coexistent results. These data are

Table 1

Cophenetic correlation between correlation matrices derived from various sets of variables: A) anatomy, B) cytology, C) embryology, D) phytochemistry and E) morphology

	A	B	C	D	E
A	*				
B	0.3050	*			
C	0.2196	0.1375	*		
D	0.1188	0.1606	0.1621	*	
E	0.1927	0.1559	0.3363	0.2450	*

not presented and a matrix with an unreduced number of missing values was used in further analysis.

A cophenetic correlation's of the OTU correlation matrices, obtained on particular data types (i.e. anatomy, morphology, phytochemistry, cytology, embryology) are predominantly low, $0.118 < r_c < 0.336$ (Table 1).

Cluster analysis

The dendrogram (Fig. 1) shows the greatest dislocation of the genera Hydrastis and Glaucidium and group Aquilegia -- Isopyrum -- Thalictrum -- Coptis (T-type and C-type chromosomes) from the one side and all other genera form the other side (R-type chromosomes) (LANGLET 1932, GREGORY 1941). As expected, in R-type chromosome group, the following groups are also clearly separated: Aconitum -- Consolida -- Delphinium, Ceratocephalus -- Myosurus -- Ranunculus, Actaea -- Cimicifuga, Caltha -- Trollius -- Eranthis -- Nigella -- Helleborus and Anemone -- Hepatica -- Pulsatilla -- Clematis. The pair Adonis -- Callianthemum is linked to the Ranunculus group. Application of the WPGMA technique (due to its insusceptibility to the number of members in a group, which makes it convenient even having a lower cophenetic correlation than UPGMA, SNEATH 1976), indicates the relation of the Adonis -- Callianthemum pair with genus Nigella, and then with group Caltha -- Trollius -- Eranthis -- Helleborus (dendrogram is not presented). Genera Caltha -- Trollius occur as a pair in the same branch as genera Eranthis, Helleborus and the most distant genus Nigella.

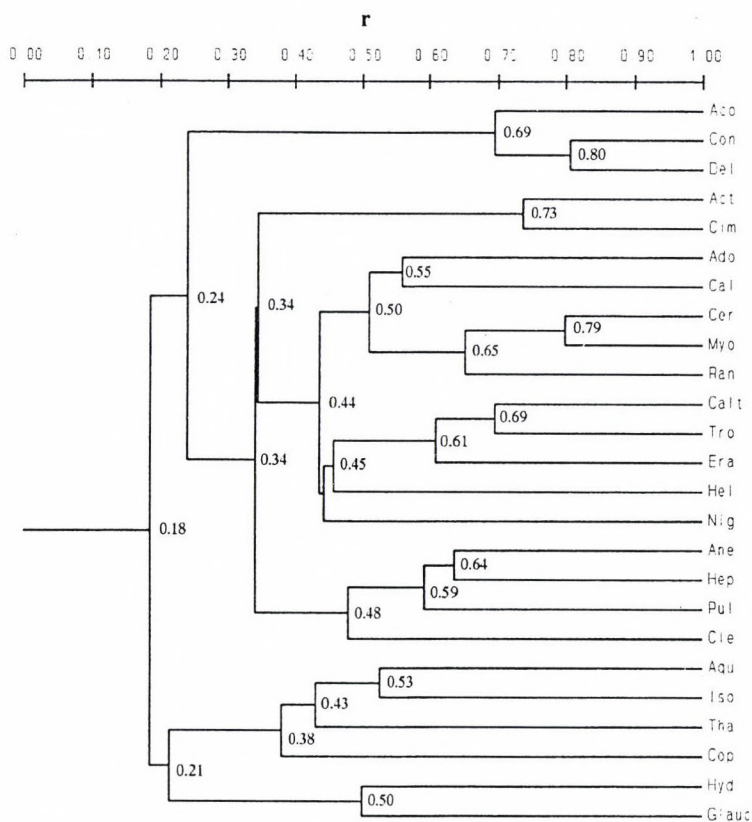


Fig. 1. Dendrogram from classification of the 25 genera of Ranunculaceae family, similarity measure — correlation coefficient, sorting strategy — UPGMA, cophenetic correlation $r_c = 0.85306$

PCO

Space relationship of the genera largely correspond to the relationships visible on the dendrogram. Genera Hydrastis and Glaucidium are clearly separated. Also, the following, mostly recognised, genera clusters are noticeable: Aconitum — Delphinium — Consolida, Actaea — Cimicifuga, Pulsatilla — Hepatica — Anemone — Clematis and Ranunculus — Ceratocephalus — Myosurus. Genera Adonis and Callianthemum take clearly intermediary position between the last mentioned cluster and the cluster Helleborus — Nigella — Eranthis — Trollius — Caltha. The Thalictrum genus is rather isolated while genus Coptis shows undubious closeness to the genera Isopyrum and Aquilegia (Fig. 2).

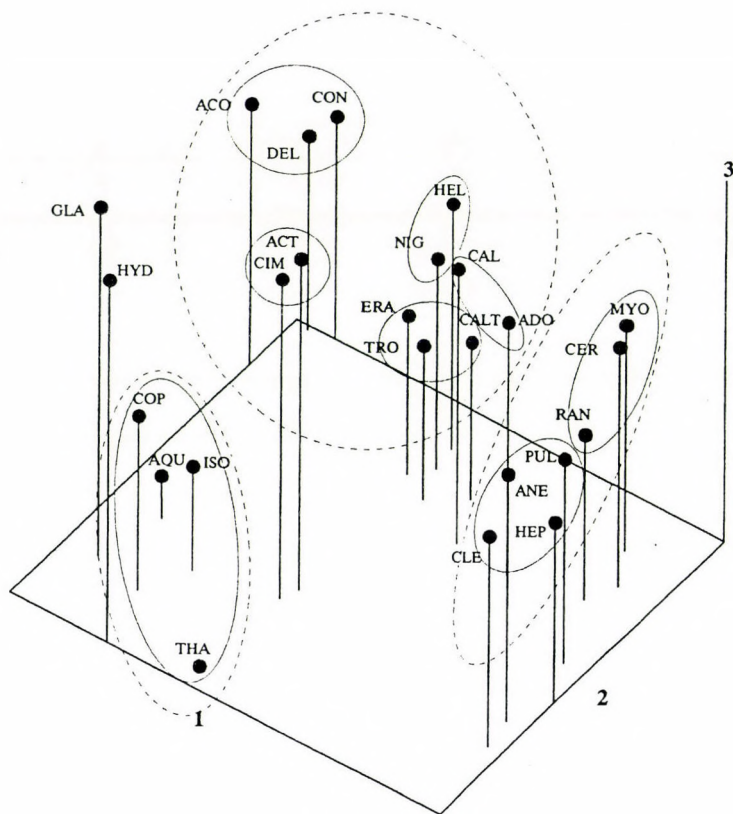


Fig. 2. 3D projection of 25 genera of Ranunculaceae family onto the first three principal coordinates. K-means clusters superimposed, dividing with three (dotted line) and eight (solid line) initial groups

MST

The MST graph projected to 3D PCO (Fig. 3) shows the interrelation of major groups. Genera Eranthis and Nigella are related mutually and with the Caltha genus, while genus Helleborus shows a direct relation to genus Trollius. Genus Callianthemum, though specially closer to the Helleborus group, is MST connected with the Ranunculus group, which also applies to the Adonis genus. Coptis is related with the Thalictrum group.

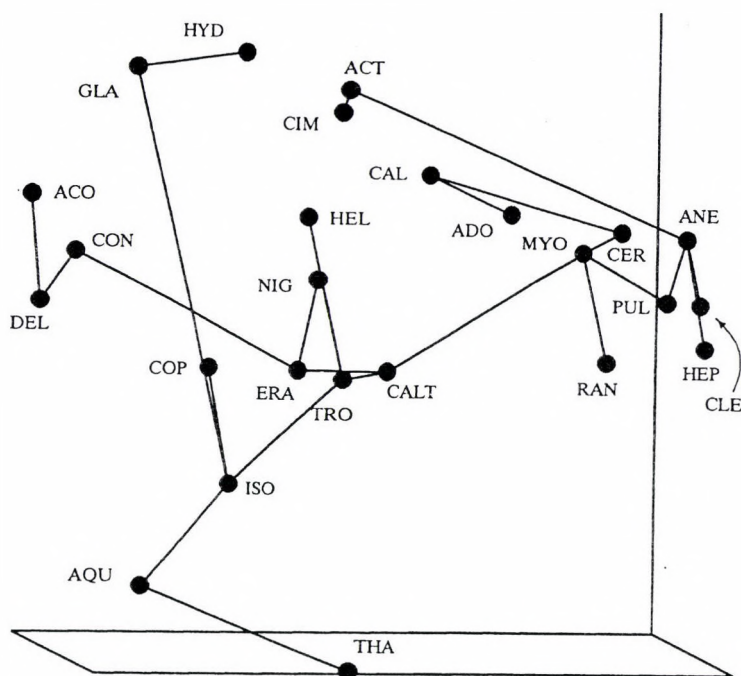


Fig. 3. 3D projection of 25 genera of Ranunculaceae family onto the first three principal coordinates with a MST superimposed upon the OTUs

K-means clustering

For resolving the intrafamilial relationships, K-means clustering is done without Hydrastis and Glaucidium. The results of clustering with three, four, five, six and eight initial groups are presented in Table 2. The dividing the genera in 3 groups shows the separation of T-chromosome genera (cluster 1) and R-chromosome group with follicles (cluster 2) and with the achenes (cluster 3). The dividing in 4 groups results in separate cluster (no. 1) with Aconitum, Delphinium and Consolida. The dividing in 5 groups results in branching the pair Actaea and Cimicifuga in separate cluster (no. 3). The dividing in 6 groups results in splitting the achene bearing genera in Ranunculus and Anemone groups. The dividing in 8 groups results in additional splitting the follicle bearing genera with R-type chromosome in 3 clusters: Adonis — Callianthemum (no. 2), Caltha — Eranthis — Trollius (no. 3) and Helleborus — Nigella (no. 5). For eight initial groups the between groups distances are shown in Table 3. This groups are presented in

Table 2

K-means clustering results with three, four, five, six and eight initial groups: members of each cluster

No. of initial cluster	3	4	5	6	8
Taxon	belonging to the cluster				
<u>Aconitum</u>	2	1	1	1	1
<u>Actaea</u>	2	3	3	4	6
<u>Adonis</u>	3	3	2	2	2
<u>Anemone</u>	3	2	4	5	7
<u>Aquilegia</u>	1	4	5	6	8
<u>Callianthemum</u>	2	3	2	2	2
<u>Caltha</u>	2	3	2	2	3
<u>Ceratocephalus</u>	3	2	4	3	4
<u>Cimicifuga</u>	2	3	3	4	6
<u>Clematis</u>	3	2	4	5	7
<u>Consolida</u>	2	1	1	1	1
<u>Coptis</u>	1	4	5	6	8
<u>Delphinium</u>	2	1	1	1	1
<u>Eranthis</u>	2	3	2	2	3
<u>Helleborus</u>	2	3	2	2	5
<u>Hepatica</u>	3	2	4	5	7
<u>Isopyrum</u>	1	4	5	6	8
<u>Myorusus</u>	3	2	4	3	4
<u>Nigella</u>	2	3	2	2	5
<u>Pulsatilla</u>	3	2	4	5	7
<u>Ranunculus</u>	3	2	4	3	4
<u>Thalictrum</u>	1	4	5	6	8
<u>Trollius</u>	2	3	2	2	3

Table 3

K-means clustering results with eight initial clusters: matrix of between groups distance, Euclidean distance below diagonal, squared distance above diagonal

Cluster No.	1	2	3	4	5	6	7	8
1	0	1388	12.00	18.00	12.30	12.05	22.84	17.74
2	3.72	0	6.11	7.33	6.75	9	9.87	12.43
3	3.46	2.47	0	10.88	5.86	7.94	11.06	9.46
4	4.24	2.70	3.29	0	8.75	12.50	8.29	16.35
5	3.50	2.59	2.42	2.95	0	8.75	13.12	12.43
6	3.47	3	2.82	3.53	2.96	0	12.87	11.94
7	4.78	3.14	3.33	2.88	3.62	3.59	0	15.06
8	4.21	3.53	3.08	4.04	3.53	3.45	3.88	0

PCO scatter shown in Fig. 3. Groups Adonis — Callianthemum, Helleborus — Nigella and Actaea — Cimicifuga are the nearest to Caltha group (no. 3, distances 4.24, 2.42 i.e. 2.82).

Discussion

Table 1 fully confirms the statement of JOHANSSON and JANSEN (1991) that one of the reasons for a large number of proposed intrafamily classification is "... the high level of character conflict in the different data sets".

The highest correlation was recorded between the embryology and morphology data ($r_c = 0.3363$). There is striking incompatibility between the matrix derived from phytochemical data with all other matrices ($0.089 < r_c < 0.245$). It generally holds that correlations between matrices derived from various data sets are expressly low ($0.077 < r_c < 0.336$) and, accordingly, it is not realistic to expect compatible classification systems from different source of data.

Generally, the results of distinct numerical technique are highly congruent.

The results of the PCO analysis indicated that the most isolated genera are Hydrastis and Glaucidium (Fig. 2). Both genera are weakly connected with Thalictrum group in cluster analysis (Fig. 1). The results do not resolve its status except to confirm this isolated position. It is beyond the scope of this paper to consider their position outside the family and whether it is common to both genera but in light of these dissimilarities, separation from the Ranunculaceae is justified, which is in agreement with some other authors (LANGLET 1932, WETTSTEIN 1935, ŽUKOVA 1958, TAMURA 1963_{a, b}, EAMES 1961, ZIMMERMANN 1974, TOBE and KEATING 1985, HOOT 1991, JOHANSSON and JANSEN 1993). However, weak connection with Thalictrum group in MST (Fig. 3) and dendrogram (Fig. 1) still leave suspicious about Hydrastis and Glaucidium position.

Other genera are clearly divided into two clusters that correspond to genera with T and R type chromosomes (LANGLET 1932, GREGORY 1941).

In the cluster with the T type chromosomes, Thalictrum is the most isolated genus which is in agreement with TAMURA (1962_a) and APARECIDA et al. (1977). It is exceptionally isolated but still related to genera Aquilegia and Isopyrum — Coptis. Genus Coptis has strong serological compatibility

with the Actaea -- Cimicifuga pair (JENSEN 1968), but the PCO (fig. 2) and cluster analysis results (Fig. 1, Table 2), however, point to its indubitable relation to the Thalictrum group, which was partly stressed by LANGLET (1932), MASCRE and DEYSSON (1951) and HUTCHINSON (1969). It seems that the treatment most compatible with the results is that of genus Coptis with a somewhat isolated position, as it is given by GREGORY (1941), in the same higher category as the "Thalictrum" group.

Genera with the R type chromosomes and multiovular ovaries form three clusters:

1) Aconitum -- Delphinium -- Consolida is a compact and mainly undisputed cluster with the genera commonly gathered in a separate subtribe (LOTSY 1911, LANGLET 1932, JANCHEN 1949, JENSEN 1968, ZIMMERMANN 1974) or tribe (PRANTL 1891, GREGORY 1941, DAVEZAC 1957, ŽUKOVA 1958, TAMURA 1967, ZIMAN 1985). This group is clearly disassociated with several specific characteristics (i.e. zygomorphic flowers, diterpene alkaloids, etc.).

2) Actaea -- Cimicifuga is a steady pair of genera, notably at manifesting strong serological equivalence (JENSEN 1968). It was only in the earliest classification that these two genera were not put together (DE CANDOLLE 1818, ENDLICHER 1836--1840). They are commonly allotted to a separate tribe (TAMURA 1967, JENSEN 1968, ZIMAN 1985) or subtribe (LOTSY 1911, LANGLET 1932, JANCHEN 1949, ŽUKOVA 1958, ZIMMERMANN 1974). Cluster analysis (Fig. 1, Table 2) shows weak connection of this pair with main part of multiovular genera, however MST (Fig. 3) connect it with Anemone group.

3) Nigella -- Helleborus -- Eranthis -- Caltha -- Trollius certainly make up a unique cluster according to the results. The results confirm the closeness of the genera Caltha -- Trollius, which refutes JENSEN's standpoint about the small importance of this relationships. Within the group, genera Helleborus, and especially Nigella, are somewhat more isolated and through MST (Fig. 3) related to the genera Trollius and Eranthis, respectively. Genus Eranthis is slightly closer to the pair Caltha -- Trollius and binds, through MST, with the former. Genera Eranthis, Helleborus and Nigella are surely a heterogeneous part of this cluster, which is in agreement with some of the so far taxonomic approaches (JENSEN 1968, ZIMAN 1985). The PCO results (Fig. 2), and especially K-means clustering (Tables 2 and 3), however, point to a more direct interrelation of the genera Helleborus and Nigella and provide the basis for a different taxonomic approach.

Genera with the R type chromosomes and uniovular ovaries form two cluster:

4) Ranunculus -- Myosurus -- Ceratocephalus is a compact and mainly undisputed cluster in the rank of subtribe or tribe (LANGLET 1932, JANCHEN 1949, TAMURA 1967, JENSEN 1968, ZIMMERMANN 1974, ZIMAN 1985).

5) Anemone -- Hepatica -- Pulsatilla -- Clematis is also a compact and undisputed cluster of close relatives. Genus Clematis is, especially according to the cluster analysis results (Fig. 1), somewhat isolated and, through MST (Fig. 3), related to the Anemone genus. The results agree with the taxonomic treatment of Anemone s. l. and Clematis in separate subtribes (LANGLET 1932, JANCHEN 1949, TAMURA 1967, 1991, JENSEN 1968, ZIMMERMANN 1974) or tribes (ZIMAN 1985). The compactness of the cluster disputes separation of Anemone s. l. and Clematis into separate subfamilies (ŽUKOVA 1958) but specific characters of genus Clematis do not comply with the treatment in the same taxonomic category (GREGORY 1941).

Genera with R type chromosomes and doubtful position:

6) Adonis -- Callianthemum hold a specific position. In cluster analysis (Fig. 1), this heterogeneous pair is related to the Ranunculus group. The PCO analysis shows a slightly closer relationships of both genera with Helleborus group, though genus Adonis is closer to the Ranunculus group (Fig. 2). The MST diagram (Fig. 3) binds both genera to the Ranunculus group. K-means clustering with six initial groups put the Adonis and Callianthemum with the Helleborus group, but with eight initial groups this pair appear like a separate cluster (Tables 2 and 3). The history of classification systems of the family Ranunculaceae is full of alternate grouping of genus Callianthemum with the multiovular group (PRANTL 1891, LOTSY 1911, WETTSTEIN 1935) or with the uniovular group (KUMAZAWA 1938^{a,b}, GREGORY 1941, JANCHEN 1949, ŽUKOVA 1958, TAMURA 1967, 1991, JENSEN 1968, ZIMMERMANN 1974, ZIMAN 1985) of genera. Some phylogenetic trees clearly point out the intermediary position of the pair Adonis -- Callianthemum between these two clusters (TAMURA 1962^a, JENSEN 1968, EFREMOVA 1978). The results, particularly PCO, indicate just such an intermediary position of the Callianthemum -- Adonis genera.

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STUDY ON NUMBER OF STOMATA AND ITS RELATION TO SOME OTHER PROPERTIES
IN A FEW NEW CROATIAN WHEAT (TRITICUM AESTIVUM L.) GENOTYPES

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The number of stomata and its relation to the length of stem, leaf surface area and yield, including the length of spike, mass of grains per a spike and mass of 1,000 grains, has been investigated in five new Croatian wheat genotypes. The quantitative data indicate a strong positive correlation between the number of stomata on the first and on the third leaf and in some genotypes between the number of stomata and the yield. The most productive genotype 5. (AG 6304-93) has been distinguished by the greatest number of stomata, shorter stem, long spike and the highest yield. Quite opposite relations were found for the least productive genotype 4 (AG 6302-93). The increase of the yield was followed by the increase of spike.

Keywords: Triticum aestivum, genotype, stomata, stem, leaf, leaf surface area, yield

Introduction

During the last thirty years the genetic investigations and breeding on the wheat (Triticum aestivum L.) in Croatia have given a relatively great number of new varieties with genetic potential for grain yield of 10 tons per acre, some of which are recognized in Europe as varieties of the first-class.

So far the biggest changes in the breeding have been made in the stem. By using the Japanese genes Rht 8 (2d) and Rht 15 (4a) Croatian selectors created the varieties which are, in comparison with those that were the leading ones in the fifties, shortened by 70 cm. The stem abbreviations were accompanied by the increase in the harvest index, from 0.20 to 0.45, and the yield. This also enabled the wheat planting in the dense folds. However, the recent selection, no matter how long the stem is, is focused on getting as long the spike as possible and consequently as big grain yield as possible.

The above-mentioned changes require the investigations regarding leaf properties, especially of stomata as a factor of great influence on the

photosynthetic capacity and because of their importance for the development of more efficient and productive wheat varieties. This, as well as the possibility to contribute to the wider knowledge of our new varieties and genotypes, has urged us to do the research presented here. The study included the research of stomata number and their relation to the length of stem, leaf surface area and the yield including the length of spike, mass of grains per a spike and mass of 1,000 grains per each genotype.

Material and Methods

Five wheat genotypes selected by M. BEDE in the agrygenetics, a company for plant breeding and nursery in Osijek, were investigated. These are as follows:

1. AG 5307-93.
2. AG 5301-93.
3. AG 5303-93.
4. AG 6302-93.
5. AG 6304-93.

The genotypes examined were obtained by crossing "Žitarka" (o), a variety of the Institute of Agriculture in Osijek, Croatia, and "Hercules" (o), a variety of the Institute in Szeged, Hungary.

Genotypes 1 and 2 closely resemble each other by phenotype, whereas the others differed mutually, although all had derived from the same crossing.

Ten plants of each genotype and two leaves of each plant, first (flag) and third, were sampled. The sampling was done on the experimental field of the Agrygenetics near Osijek in the phase of heading, on May 24th, 1995.

Microscopic preparations of stomata were done by a modified replica method. A film of the nail polish was painted directly onto small areas about 1 to 2 cm on the three leaf sites; base, middle and top. The nail polish was allowed to dry for a few minutes and then was peeled with an adhesive tape and mounted on a slide.

Stomata were counted on the ten microscopic fields per each leaf region and subsequently converted into 1 mm^2 . This parameter was obtained with the aid of a light binocular microscope and by applying a 10x ocular and a 40x objective.

The length of stem as well as the length of spike were measured with an ordinary meter and the leaf surface area with a planimeter. The yield was determined by measuring mass of grains per a spike and mass of 1,000 grains by the use of an analytical pair of scales.

The results obtained were statistically analysed with analysis of variance and "t"-test with the use of Microsoft Excel Version 5. t = test: the difference is significant at $P > 2.1009$ (*). Coefficient of correlation: $> +0.4$ (*) and $> +0.6$ (**).

Results

Number of stomata

Taking into account all leaf regions, both leaves and all genotypes examined, the average stomata number varied from 49 to 82 per sq. mm.

Table 1

Number of stomata per 1 sq. mm with respect to leaf region and position

Genotype	First leaf							Third leaf							First/Third leaf
	Region				"t"			Region				"t"			
	Top	Middle	Base	X	Top/Middle	Top/Base	Middle/Base	Top	Middle	Base	X	Top/Middle	Top/Base	Middle/Base	
1	65	74	74	71	2.024	2.534	0.134	49	61	60	57	5.068	4.950	0.278	6.852
2	71	80	81	77	2.632	6.629	0.252	54	67	66	62	3.389	4.678	0.271	6.045
3	74	76	82	77	0.461	2.545	2.273	58	68	63	63	3.130	1.879	1.835	7.743
4	73	71	75	73	0.582	0.510	0.904	57	62	58	59	1.347	0.143	1.179	6.886
5	75	77	80	77	0.532	1.181	0.627	58	72	66	65	2.970	2.176	1.409	4.557

As shown in Table 1, the smallest average number of stomata was recorded on the top of leaf, while the largest was stated either on the base (first leaf) or in the middle region (third leaf). The differences between the top and base on the first leaf were mostly statistically significant whereas those between the middle and base on the third one were insignificant (Table 1).

Concerning leaf position the data in Table 1 clearly show in all genotypes a significantly higher stomata number on the first leaf compared to the third one.

As far as the particular genotypes are concerned, the results suggest the largest number of stomata in genotype 5 (71 per sq. mm in average) and



Fig. 1. The average number of stomata per sq. mm

Table 2

Experimental values of the "t"-test for the leaf surface area, length of stem, length of spike, mass of the grains per a spike and mass of 1,000 grains between genotypes examined

	Leaf surface area	Length of stem	Length of a spike	Mass of grains per a spike	Mass of 1,000 grains
Genotype 1/Genotype 2	1.467	0.101	0.148	1.351	1.035
Genotype 1/Genotype 3	0.074	3.447	1.009	0.158	2.889
Genotype 1/Genotype 4	0.809	4.830	3.415	3.903	3.794
Genotype 1/Genotype 5	1.211	3.863	0.259	3.122	0.821
Genotype 2/Genotype 3	1.274	3.512	1.189	1.018	1.459
Genotype 2/Genotype 4	0.674	4.881	3.676	2.674	2.777
Genotype 2/Genotype 5	0.039	3.925	0.425	4.432	1.387
Genotype 3/Genotype 4	0.673	1.479	2.478	3.459	1.668
Genotype 3/Genotype 5	1.071	0.305	0.818	3.060	2.829
Genotype 4/Genotype 5	0.524	1.228	3.439	6.679	3.793

the least in genotype 1 and 4 (64 or 66 per sq. mm) in average (Fig. 1). Differences among the genotypes in this parameter, except between genotype 1 and 4, were significant (Table 2).

Leaf surface area

Leaf surface area varied from 17.75 to 44.55 cm². For the first leaf it amounted from 29.98 to 34.05 cm² and for the third from 24.89 to 27.98 cm² in average (Fig. 2). Within each genotype the values for the flag leaf were always significantly bigger in comparison with those for the third one (Table 2). Taking into account the surface of both leaves, the biggest leaf

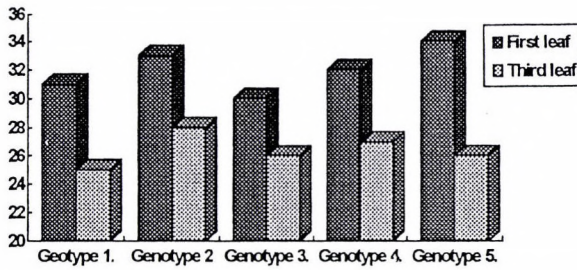


Fig. 2. The average leaf surface area in cm^2 for the first and third leaf

surface in average had genotype 5 and 2, respectively, and the smallest genotype 1. Unlike the differences between leaf surfaces within each genotype, the differences in leaf surfaces between particular genotypes were statistically insignificant.

Length of stem

The data in Fig. 3 reveal that the average length of stem was within the range from 54 to 95 cm and for particular genotypes were from 73 to 83 cm in average. The longest stem has been measured in the genotype 4 (83 cm) and the shortest in the genotype 1 and 2, respectively (73 cm). Statistically significant differences in this parameter were between genotypes 1 and 4 and genotypes 2 and 4 as well as between most of others (Table 2).

Length of spike

The length of spike ranged between 60 (Genotype 2) and 120 mm (Genotypes 2 and 3). As is seen in Fig. 4 the longest spike in average was measured in the genotype 1 or 2 and 5, respectively (96 or 97 mm) and the short-

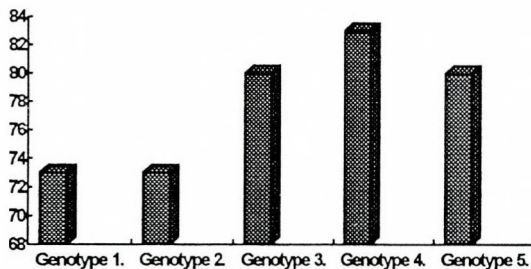


Fig. 3. The average length of stem in cm

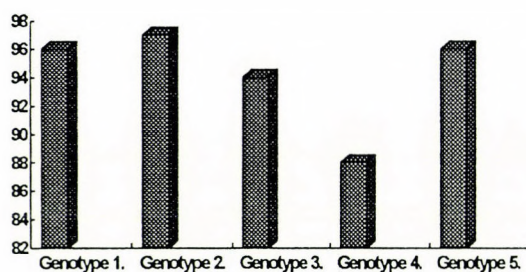


Fig. 4. The average length of spike in mm

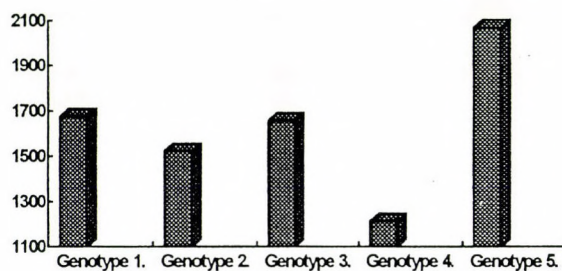


Fig. 5. The average mass of grains per a spike in mg

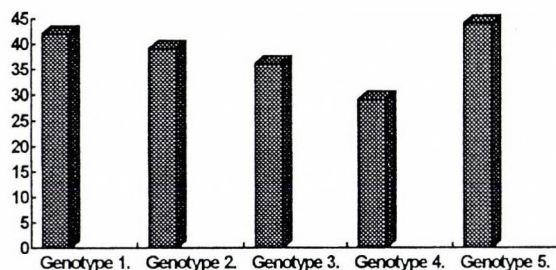


Fig. 6. The average mass of 1,000 grains in g

est in the genotype 4 (88 mm). Statistically significant differences were between genotypes 1 and 4, between 2 and 4 as well as between 5 and 4 (Table 2).

Mass of grains per a spike

This parameter had values ranging from 541 to 3,372 mg and for particular genotypes it ranged from 1,521 to 1,674 mg in average. As is seen in Fig. 5 the greatest mass of grains was measured in spikes of genotype 5 and

the least in those of genotype 4. The differences between the above two genotypes and between others were mostly significant (Table 2).

Mass of 1,000 grains

Mass of 1,000 grains varied from 14.130 to 49.984 g or in average from 29.039 to 43.502 g. Like the previous parameter, the extreme values have been stated in genotypes 5 and 4, first with the greatest and then with the least mass of 1,000 grains (Fig. 6). Except between them, significant differences were also found between genotypes 1 and 3 or 4, between 2 and 4 and between 3 and 5.

Correlations between number of stomata and other quantitative characters within genotypes

	Coefficient of correlation				
	Gen. 1	Gen. 2	Gen. 3	Gen. 4	Gen. 5
Number of stomata on the first/on the third leaf	0.996**	0.987**	0.114	-0.836**	0.472*
Number of stomata/surface area of the first leaf	-0.319	0.028	-0.165	-0.438*	-0.071
Number of stomata/surface area of the third leaf	-0.136	0.052	-0.502*	0.039	0.059
Number of stomata/length of stem	-0.671**	-0.055	-0.091	-0.059	-0.006
Number of stomata/length of spike	-0.243	-0.227	-0.734**	-0.308	-0.006
Number of stomata/mass of grains per a spike	0.211	-0.365	0.652**	-0.154	0.778**
Number of stomata/mass of 1,000 grains	0.115	0.019	0.608**	0.021	0.414*

Discussion

Although the Croatian selectors, as mentioned, have achieved considerable results in wheat breeding, there are no data in investigations of stomata number and its correlation with other parameters to follow the selection. Therefore, the discussion here is based exclusively on the results presented as well as on the data obtained from the research done abroad.

According to the data available, the number of stomata on the leaves of Triticum aestivum has been investigated by a certain number of researchers. In general, the data indicate a somewhat greater number of stomata in our genotypes in comparison with some others. ANĐELIĆ et al. (1970) e.g. found a lesser number of stomata in average, from 43.3 to 53.3 per the field of vision. The same authors (JANJATOVIĆ et al. 1972), established later from 32 to 72 stomata per sq. mm while RANJIT et al. (1983), stated from 25 to 37 per sq. mm. No data of any greater number have been found.

As far the fluctuation of stomata number with respect to leaf region there are different data in a general sense. TEARE et al. (1971) also observed the smallest number of stomata on the top and the largest on the basal leaf region, whereas JANJATOVIĆ et al. (1972), as well as, we detected the same regularity, the increasing of stomata number from the top to the base, but only the first leaf; on the third leaf a larger number was found either in the middle or on the basal part. An opposite tendency has been reported by BENKOVA et al. (1968) and GÖBÜ and KUBJATKO (1971).

Contrary to the above, the data of the fluctuation of stomata number with respect to leaf position are almost completely in accordance with our findings. The upper or youngest leaves, as a rule, have a greater number of stomata than the lower or older leaves (BENKOVA et al. 1968, TEARE et al. 1971, MISKIN and RASMUSSEN 1970). This finding indicates a more xeromorphic structure of the upper leaves in relation to the lower ones and presents the results of their development in drier conditions.

An almost identical tendency of variation of leaf surface area presented here was reported by JANJATOVIĆ et al. (1972). These authors also claim that the younger, first leaves always exceeded those of the older, third ones. Such a finding is not only unexpected but is, no doubt, in discrepancy with the data of the greater number of stomata on the first and a smaller number on the third leaves.

Although the length of stem is a parameter of great importance no data on its research could be found except that of JANJATOVIĆ et al. (1972) who detected its variation from 41 to 90 cm with a prevailing length over 70 cm in average. This occurrence can be said to be close to our findings.

The yield of our genotypes expressed just by mass of grains per a spike compared to that from the literature data (no data on yield expressed by length of spike and mass of 1,000 grains) turns out to be somewhat bigger. While JANJATOVIĆ et al. (1972) e.g. stated mass of grains per a spike ranging from 860 to 1.460 mg for a particular genotype, our findings ranged from 1.521 to 1.674 mg.

The correlation studies revealed mostly a positive and significant correlation between the number of stomata on the first and on the third leaf. The same occurrence was reported by JANJATOVIĆ et al. (1972) and YOSHIDA (1977) for barley. A strong positive correlation was also observed between the number of stomata and the yield (mass of grains per a spike and mass of 1,000 grains), but only in genotypes 3 and 5. A trend of a negative correlation was revealed between the number of stomata and surface area of the first leaf (the same was reported by JANJATOVIĆ et al. 1972). A similar trend was found between the number of stomata and length of spike as well as between the number of stomata and length of stem.

Judging by the results obtained it is evident that the genotypes presented differ from those quoted in the literature data not only in a somewhat increased number of stomata but in a higher yield, too. This is particularly evident in the most productive genotype 5. The mentioned have been achieved by increasing the length of spike while the length of stem as it seems remained the same.

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WATER BUDGET OF A LOESS GRASSLAND

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Introduction

Considerable effort has been made in the past on investigating xero-therm grasslands in Hungary (KOVÁCS-LÁNG 1971, 1974, 1992, FEKETE 1989). As part of these investigations research was carried out into the plant-water relationship in a loess grassland. First measurements were taken of different parts of the water budget during experimental conditions. Our chosen measurement site was the meeting point of the Gödöllő hills and the Great Hungarian Plain near Albertirsa. This Salvio-Festucetum rupicolae community is a diverse, multilayered loess grassland on steep slopes, influenced by climatic factors. As a consequence of the deep soil water level, the limited available soil moisture influences the dynamics of vegetation. The inner control mechanisms guiding the development of vegetation show a high level of ecological adaptation.

Not only the condition of vegetation, but water demand levels are also characteristic of the different physiological phases of the stand, and differ from the water demand of the individual species.

The stand water consumption was investigated in the vegetative period and the behaviour of association was observed with an unlimited water supply. The latter experiment provided the opportunity to determine approximately the biological factor of the stand, and using this coefficient the water demand of the stand could be calculated from the meteorological data for any period.

Theory

The water budget of any plant or association of plants can be calculated from the measured component of water budget. Generally the water balance is interpreted to a 1–2 m deep soil layer, on the presumption that the roots do not penetrate into a deeper zone.

The water budget equation, simplified for practical purposes for this layer is as follows:

$$P = I + E + F + (w_2 - w_1) \quad (1)$$

where P means the precipitation, I interception, E evapotranspiration, F runoff, and w soil moisture at two distinct times.

On plains where there is no runoff, or on slopes where rain can infiltrate into the soil: $F = 0$. This is especially true if the soil water level is deeper than 2 m, as it is presumed that the root zone keeps all the precipitation and that the water does not infiltrate into the deeper layers:

$$\Delta w = P - I - E \quad (2)$$

All components of this equation can be either measured by different methods, or calculated as a residual from the measurements of the other three parts. The methods of measurement for P and w are widely known. However, it is useful to adjust the actual precipitation equipment to the given task, because of the disturbance caused by wind and the uneven density of the falling drops (WALKOVSKY 1975). The value of w should be directly measured, or calculated daily on the basis of E_p .

Interception (I) is generally neglected in most of the cases, because its significance is usually not really acknowledged. Sometimes, it is calculated as a residue although it could be directly measured in herbaceous plant communities by appropriate methods (BURGY and POMEROY 1958, WALKOVSKY 1981).

The evapotranspiration (E) can be measured by evapotranspirometer or lysimeter. Due to the difficulties and uncertainties inherent in these measuring method, it is useful to apply theoretical-calculative or meteorological measuring methods (PENMAN 1948, DUNAY et al. 1968, SZÁSZ 1973), or some combinations of them. For example, in connection with pastures, there are well-known agrometeorological methods for calculating the water consumption of a grassland during the growing season, based on regular meteorological records (WALKOVSKY 1975).

One of these methods is included in the following, based on the formula:

$$E = k \cdot E_p \quad / \text{mm day}^{-1} / \quad (3)$$

Where E is the evapotranspiration of a certain grassland, k is a coefficient specific to the community and the site (usually $0.4 < k < 1.2$). This value is influenced by the density (cover), maturity and quality of the actual vegetation.

E_p is the potential evapotranspiration. It can be calculated by several methods usually resulting in very similar values. The simplest method (DUNAY et al. 1968) is:

$$E_p = \frac{1-f}{2-f} \cdot t \quad / \text{mm} / \quad (4)$$

where t is the daily mean air temperature and f is the daily mean air humidity. The E_p values are very close to the values of open water evaporation, measured daily in the international meteorological observation network at the regular "A" pan. Therefore one value may substitute the other.

The k values should be determined by measuring the water consumption for several years. Of course k is valid for a given type of community only at a general state of development. k can be used also for backcast calculations. The spatial variations of k have been studied by ENDRÓDI and TÓTH (1975) and has been proved to be independent of its location in Hungary.

Methods

Measurements of components of the water budget

The water budget for the loess grassland during the growing season was determined by the following method.

A piece (4 m^2) of the original grassland community was transplanted into a Thorntwaite-type evapotranspirometer at Szarvas, Hungary. $20 \times 20 \times 20$ cm cubes of soil containing vegetation were cut out of the original site, marked and carefully transported then to Szarvas. They were then assembled again in the original pattern of the 4 m^2 piece of grassland and placed in a 1 m deep container of a evapotranspirometer filled with soil. The pan was supplied with water from the bottom of the container and the water level was regulated according to the plan of the experiment. Of course, it is possible to measure the amount of water supplied externally or simply provide no water at all and leave the whole system rain-fed.

The soil moisture in the container was measured by two independent pieces of equipment.

1. High frequency soil moisture probe, developed by the MTA-TAKI, Budapest.
2. A neutron probe, made in the USSR.

The soil moisture was measured every ten days. At the same time it was also calculated, based on the daily available soil moisture (disponible water), reducing it day by day with the percent of the daily measured E_p value.

For the estimation of interception, the water retaining capacity of the dominant plant species of the grassland community was measured using a gravimetric method (WALKOVSKY 1982). These measurements were made twice in the growing season and the interception was calculated in the vegetation period by considering its linear relationship with the height of the plants.

Estimation of k values

In 1989 a 20 cm water level was provided in the container of the evapotranspirometer and in this way the transplanted vegetation had optimal soil moisture conditions. The whole soil profile contained moisture up to the surface level due to capillarity action. It is true, these conditions were not exactly the same as in the original site, but in this way the k value could be estimated, which would not have been possible at the site. Then k values were given as a ratio between measured evapotranspiration and "A" pan data.

Results

First experiment in 1988

In the first year, there was no irrigation so as to simulate the natural conditions. In the first month, May 1988, precipitation and temperature were above average. The transplantation caused a little stress to the plants, but the favourable weather conditions regenerated them quickly, and after 7--8 days transpiration was observed to have taken place (Fig. 1).

As the plant cover was 85--90% the bare soil evaporation was neglected and only water loss from the evapotranspirometer due to transpiration was measured. In the last ten days of May and in the first twenty days of June,

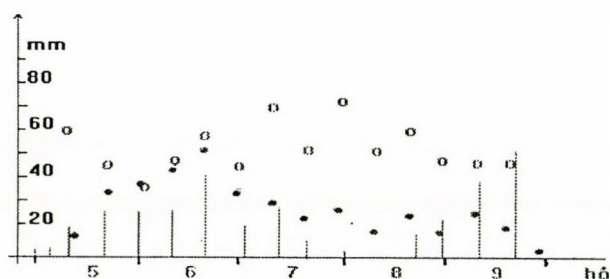


Fig. 1. P (vertical lines), E_p (o), E (●), of the model grassland community without irrigation. Szarvas, 1988

the soil moisture was high enough to cause the transpiration rate to reach the potential. The mean temperature and precipitation in June was very close to the average, therefore the transpiration could cope with the potential evapotranspiration till the end of that month. After that, the soil moisture decreased in the container and transpiration also declined.

In July, the temperature was high, above the average. There were 16 days with maximum temperature above 30 °C. At the same time, precipitation was 15 mm less than the average. As a consequence of this extreme drought, the plant parts of most species above the ground completely dried up, and only a few of them e.g. *Achillea*, *Euphorbia* remained active. Transpiration declined more and more below the potential. The transplanted vegetation remained in this stage until the last ten days of August, when precipitation occurred again causing the vegetation to recover.

In September, there was 20-25 mm of precipitation above the average. The vegetation began to grow again and transpiration also restarted. At the end of the growing season, the water budget of the stand was calculated using the well-known water budget equation for the evapotranspirometer:

$$E = P + f - I - (w_2 - w_1) \quad (5)$$

where f means the water supply in the equipment. On the basis of this equation the actual water budget for the period May—Sept 1988 can be calculated as follows:

$$309 = 222 + 20 - 39 + 106 \text{ mm} \quad (6)$$

where 309 represents the estimated total amount of water loss, by transpiration, during the time period.

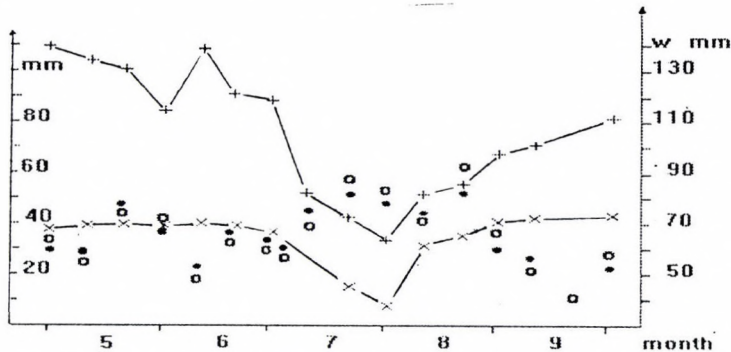


Fig. 2. The transplanted model grassland with unlimited water supply.
 E_p (o), E (•), W_{0-50} (+), W_{50-100} (x) Szarvas, 1989

Second experiment in 1989

Unlike the previous year, in 1989, an abundant water supply was fed externally into the evapotranspirometer. At the bottom of this container, there was a 20 cm constant layer of water which kept the whole soil profile full of moisture right up to the surface. As a consequence, the transplanted vegetation could take up as much water as it needed. It is true such conditions were different from the original ones, but in this year the aim was to measure the physiological water demand of vegetation and estimate the k values. The whole vegetation period was cooler than the average and precipitation was above average.

During the whole period (Apr--Oct 1989), the water consumption of the vegetation, which practically equalled the transpiration rate, had fluctuated around the potential evapotranspiration level. Sometimes it was higher than the evaporation of "A" pan. It may seem strange, but it can be regarded as a normal phenomenon in situations where the wind can carry advective extra energy to the vegetation. This phenomenon would occur in nature, too. Most probably, this is the case in the original site which was located on a slope where the local hill--valley wind is a common factor. In this case, the transplanted vegetation stand was higher than the surrounding vegetation because of the abundant water supply. This difference in height gave the transplanted vegetation an opportunity to receive extra energy by the wind and turbulent diffusion.

In July, the deep rooted species began to grow and used up a significant portion of the soil moisture. The changes in soil moisture content due

Table 1

The evapotranspiration (E) and the coefficient k of the transplanted grassland community. k_r is a similar coefficient for a regular lawn (*Poa pratensis*, *Lolium multiflorum*, *Trifolium repens* var. *lodicense*) kept short all the time. Szarvas, 1989

Month	4	5	6	7	8	9	10
E		108	105	192	120	87	50 mm
k		0.9	1.0	1.1	1.0	1.1	0.9
k_r	0.8	0.9	0.9	0.9	0.9	0.9	0.8

to transpiration and precipitation can be seen clearly in Fig. 2. The moisture content of the upper 50 cm layer shows a typical large mid-summer depression, while in the deeper layer of 50—70 cm, the depression is less intensive and restricted to July and August. The minimal values are at the end of July in both layers. After this, the curve began to rise till the end of the period.

It is interesting to note that in September, the transpiration had fallen back in spite of the high level of soil moisture content.

The total water budget of the whole period according to formula 5 can be seen as follows:

$$577.4 = 33.1 + 263.7 + 26.3 - 63.9 - (18.2) \text{ mm} \quad (7)$$

where the last part (18.2) is the cumulated error. The k coefficient of the transplanted community has been calculated as the ratio of the observed (measured) values of "A" pan and E_p as the ratio of the two.

If we compare k and k_r it can be seen that k_r has been almost constant because the species composition and the activity of the species are also constant, while values of k increase above k_r and even exceed 1.0 twice. The reason is — most probably — the advective extra energy the stand receives from its environment, as has been mentioned above.

Having k and the equation (4) the E values of the original community at Albertirsa were calculated (Table 2). Of course in this case we have to use the local meteorological data from Albertirsa area. Comparing the E values of the two sites (Albertirsa and Szarvas), a basic similarity can be seen between them, therefore it can be concluded that k values are good estimations, and the whole method is appropriate.

Table 2

E_p and E values calculated for Albertirsa (original site), and measured E (transplanted community) at Szarvas 1989

Month	5	6	7	8	9	10
E_p (Alb.)	109	98	173	118	97	68 mm
E_p (Alb.)	98	98	190	118	108	61
E (Sza.)	108	105	192	120	87	50

Discussion

Transpiration is controlled by meteorological factors (radiation, temperature, humidity, wind, etc.) and also by biological factors (ecophysiological character of the community, close-up and spatial structure of the stand, etc.) which characterise altogether the value of k . Once the value k is known for a given community, the optimal water consumption can be calculated, i.e. the physiological need for water from the observed meteorological data. For a better estimation of k , we would need several years of observations. But if a community is transplanted into an evapotranspirometer and provided with water abundancy — which is an unusual or even an artificial condition — changes may be expected in the composition of the community. After three years, signs were seen of such changes.

The results from the two year experiment seem to show that the loess grassland (evapo)transpiration is closely correlated to the soil moisture supply. Transpiration may increase after summer precipitation (Fig. 1), and also in the fall, where a regular (second) maximum can be observed which corresponds to the usual increase of activity and growth in every continental grassland in our climate. During this period (Sept—Oct), certain species of the community use the soil moisture preserved in the deeper layers and/or the precipitation, which has a second maximum in autumn. This increase in transpiration after summer precipitations was also recorded at other xerotherm grassland sites with an ADC LCA-2 infrared analyser (NÉMETH 1994, KALAPÓS 1994).

But to see the whole picture more clearly, observations should be recorded for several years.

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SOIL-VEGETATION INTERRELATIONSHIPS IN ISOBERLINIA WOODLANDS OF NORTHWESTERN NIGERIA

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Isoberlinia woodlands in northwestern Nigeria were sampled in 280 quadrats (100 m²) regularly spaced along established transects from upper to lower slopes. Vegetation measurements included density, basal, area, crown cover and height of woody species ≥ 3 m high. Also, total number of species and canopy cover per plot, and species diversity were determined. Soil pits were systematically excavated along the transects, and soil samples taken from each horizon in each pedon, air-dried and analyzed for physical and chemical properties. Canonical correlation analysis (utilizing principal component scores of soil and vegetation variables) was used to show the interrelationships between soil and vegetation components. Results showed a reciprocal relationship between plant size and silt, manganese and aluminium. There existed a positive relationship between plant height and species diversity, and soil reactions and nutrient status. Aluminium also related positively with plant density and canopy cover. Hence canonical correlation analysis identified soil variables which affect the vegetation components, thus suggesting that both soil and vegetation are interdependent.

Keywords: Canonical correlation, Guinea savanna, Isoberlinia woodlands, ordination, quartzite ridges

Introduction

A large number of factors are in operation in determining the distribution of floristic components of vegetation, and the study to elucidate these factors is an important ecological objective. Several explanations advanced for the existence of savanna have been linked to soil either as the primary factor or that it has an indirect effect (MONTGOMERY and ASKEW 1983). These edaphic explanations include soil moisture and nutrient status. Various soil types found in savanna exhibit variable amounts of nutrients and these reflect the occurrence of different vegetation associations. Many

of these soil phases with discrete vegetational units abound in the Guinea Savanna. These repeated occurrences of certain vegetation associations on different soil within the Guinea Savanna is a subject of study. It is thus of interest to investigate and identify such soil factors or groups of factors which determine the occurrence and physiognomy of vegetation, and the influence of vegetation on soil properties.

Studies involving elucidation of edaphic factors have been carried out in the Guinea Savanna (WILD 1971, JONES 1973, KADEBA 1978, 1982, ISICHEI and SANDFORD 1980, SOBULO 1982, AYODELE 1986, MUOGHALU and ISICHEI 1991); but these have not been correlated with the distribution of vegetation associations or species. AHN (1970), and JONES and WILD (1975) have reviewed this subject and point to the fact that the distribution of these associations or species may be controlled by simultaneous interactions of several edaphic factors. This factor-complex varies along gradients within the Guinea Savanna. Therefore the study of soil and vegetation relationships presents a synthetic picture of the mosaic events occurring within the Guinea Savanna. Any analytical solution must therefore take into account these species variabilities in the vegetation. This is usually carried out by means of the multivariate analysis technique (KENKEL 1986). The work reported in this paper was carried out to investigate the relationship between soil and vegetation in Isoberlinia Craib et Staff woodlands in Northwestern Nigeria. The interrelationships between soil and vegetation present an important dynamics in the Guinea Savanna which previous studies (SIDERIUS 1974, KADEBA 1982, SOBULO 1982, MUOGHALU and ISICHEI 1991) have been unsuccessful to bring out. Their attempts have been based on site to site comparisons and did not take into account within stand variations. Observations are that within stand variations could be as large or even larger than variations between stands. These have to be quantitatively analysed. AWETO (1981) stated that interrelationships between soil and vegetation are multivariate since components of vegetation have different effects on soil and its fertility. This is an expression of major trends of events existing between soil and vegetation which form an integrated system of correlating functions.

Isoberlinia woodlands represent such integrated systems of correlated functions. They are vegetation associations in the Guinea Savanna found at discrete positions on quartzite and plinthite ridges. The study was conducted in the woodlands found in Kainji Lake National Park located in Northwestern Nigeria lying between latitudes $9^{\circ} 45'$ and $10^{\circ} 23'$ N and longitudes $3^{\circ} 40'$ E and $5^{\circ} 47'$ E, and with two non-contiguous sectors: Borgu and

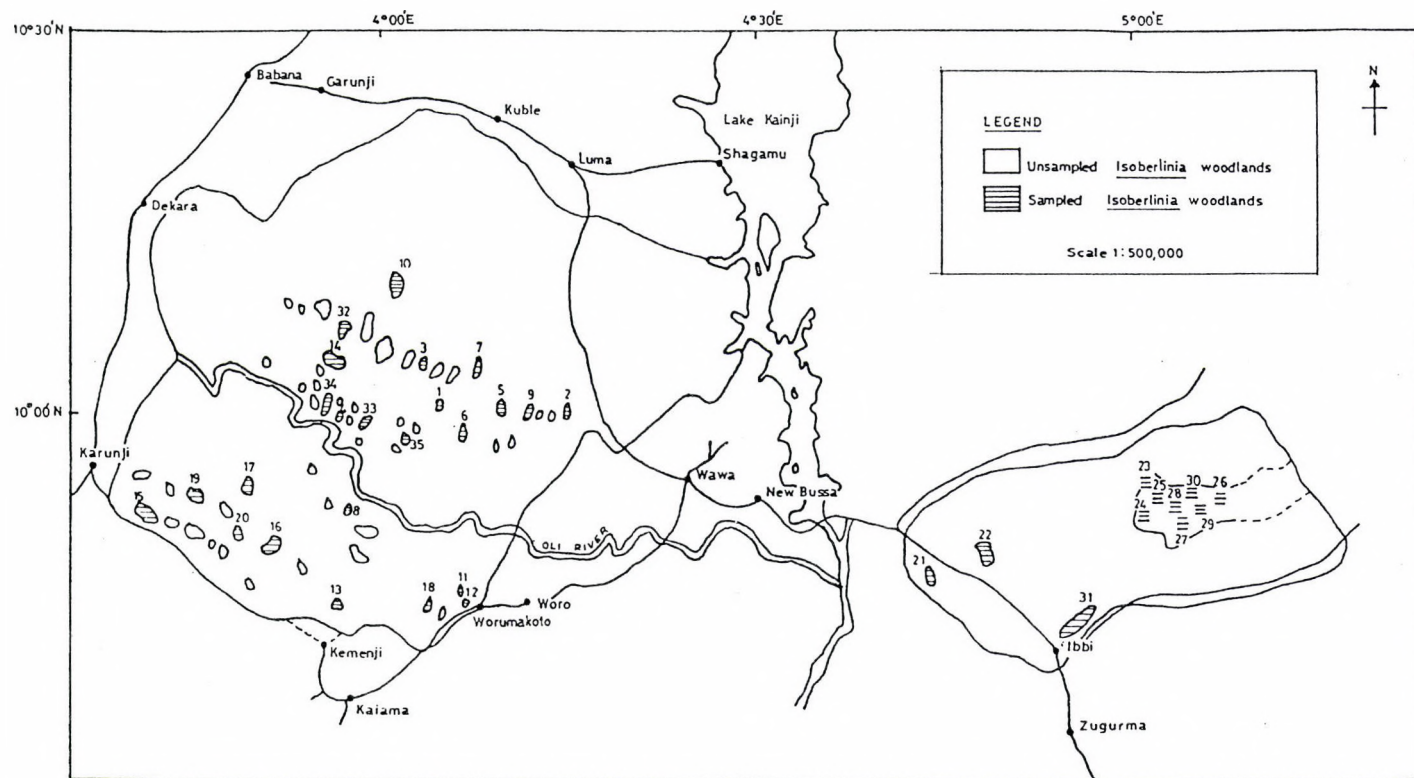


Fig. 1. Kainji Lake National Park: Identified and sampled *Isoberlinia* woodlands

Zugurma (Fig. 1). Both sectors cover an area of 5340.82 km² and are underlain by basement complex metamorphic rocks, mainly gneiss and granite. Isoberlinia woodlands are formed on the outcrops of these rocks.

The climate of the area has been reported by AFOLLOYAN (1982). Soils are shallow and of ferruginous tropical type with low exchangeable acidity bases, nitrogen and organic carbon. The soils are slightly acidic to neutral.

Methods

Vegetation and soils were systematically sampled (COCHRAN 1963) from fourteen distinct woodlands. In each woodland, a sampling plot of 250 m x 200 m was marked out and five belt transects established. Vegetation samples were taken in twenty 10 m x 10 m quadrats regularly spaced at 50 m interval from upper to lower slopes of the ridges along the established transects in each woodland. In each quadrat, density, basal area, crown cover and height of woody species ≥ 3 m high were determined. Three soil pits were excavated in plots with slope angle $> 1^\circ$ and two in those with slope angle $< 1^\circ$ along the transects. Each pit measured 1.5 m x 1.5 m x 1.2 m. Soil samples were collected from each horizon in each pedon and air-dried, ground and analysed for particle size (Hydrometer method), pH in 0.01 M CaCl₂ (1:2 soil: solution ratio), exchangeable acidity and cations (BLACK et al. 1965), organic carbon (Walkley-Black-method), available phosphorus (Bray No. 1 Method) and total nitrogen (Kjeldahl-method).

This study applies multivariate techniques to the analysis of relationships between soil and vegetation in Isoberlinia woodlands. Ordination, using principal component analysis (PCA), of soil and vegetation variables was aimed at discerning underlying gradients of the environment so as to use the factor variables for canonical analysis. Before analysis, the soil data were first normalized to logarithmic base 10 of the original values (GREIG-SMITH 1983, BERTNESS and ELLISON 1987). The ordination was then derived from the correlation matrix with the KAISER (1958) varimax rotation model. The aim was to find out if a variant of PCA could be ecologically meaningful. The patterns and structure of the interrelationships between soil and vegetation variables were investigated by canonical correlation analysis (CCA). This used the matrix of PCA scores of soil variables to avoid the problem of collinearity (AWETO 1981).

Results

Table 1 shows the summary of the vegetation variables in the sampled woodlands. Analysis reveals that plot 9 has the greatest number of woody stems with a density of 310 plants per hectare and the least numbers are in plot 26 with a density of 175 plants ha⁻¹. Other plots have variable density between these two extremes. Mean height of woody species also shows variation (plot 2 : 109.07 m; plot 26 : 51.23 m). Large-sized species are observed in plot 7 (basal area 19.29 m² ha⁻¹; crown cover 15976.22 m² ha⁻¹). Plots 24 and 26 present the lowest values of these variables. Table 1 also reveals that although plot 9 has the highest density of woody species, it nevertheless has a low basal area compared to plots 2 and 7. Canopy cover of the

Table 1

Summary of vegetation variables of *Isoberlinia* woodlands in northwestern Nigeria

Plot	Density of woody species (ha ⁻¹) $\pm$ 95% C.I.	Height of woody species (m) $\pm$ 95% C.I.	Crown cover of woody species (m ² ha ⁻¹) $\pm$ 95% C.I.	Basal area of woody species (m ² ha ⁻¹) $\pm$ 95% C.I.	Canopy cover (%)	Total number of species per plot	Shannon—Wiener species diversity index	Slope angle (°)
R/2	305 $\pm$ 23	109.07 $\pm$ 2.63	7345.27 $\pm$ 845.45	17.68 $\pm$ 1.97	60.10	14.00	1.81	7.00
7	240 $\pm$ 48	64.54 $\pm$ 3.24	15976.22 $\pm$ 4102.88	19.29 $\pm$ 4.71	60.70	8.00	1.09	5.00
8	195 $\pm$ 26	72.52 $\pm$ 3.68	5160.57 $\pm$ 893.53	10.90 $\pm$ 2.05	52.30	9.00	1.52	20.00
9	310 $\pm$ 42	64.32 $\pm$ 2.15	3782.04 $\pm$ 683.38	14.84 $\pm$ 2.76	66.90	10.00	1.37	2.00
13	240 $\pm$ 13	78.12 $\pm$ 1.74	5316.60 $\pm$ 603.70	11.71 $\pm$ 1.11	50.40	13.00	2.13	0.00
14	250 $\pm$ 14	81.04 $\pm$ 1.90	4422.98 $\pm$ 539.52	8.61 $\pm$ 0.91	49.20	13.00	2.08	3.50
15	255 $\pm$ 12	82.36 $\pm$ 1.38	4307.88 $\pm$ 487.06	10.02 $\pm$ 0.96	63.80	13.00	2.02	5.00
18	190 $\pm$ 14	98.38 $\pm$ 2.64	5872.28 $\pm$ 750.54	11.29 $\pm$ 1.49	51.90	12.00	1.82	4.50
21	250 $\pm$ 29	56.97 $\pm$ 2.70	2609.42 $\pm$ 473.73	7.09 $\pm$ 1.18	50.80	8.00	1.02	3.50
24	180 $\pm$ 28	56.79 $\pm$ 2.02	2205.26 $\pm$ 431.10	6.16 $\pm$ 1.03	49.20	8.00	1.46	2.09
26	175 $\pm$ 16	51.23 $\pm$ 2.24	2547.29 $\pm$ 494.63	5.96 $\pm$ 1.16	46.50	9.00	1.74	2.19
32	220 $\pm$ 27	73.01 $\pm$ 2.60	4849.73 $\pm$ 691.31	10.51 $\pm$ 1.37	54.80	8.00	1.58	1.00
33	240 $\pm$ 16	75.32 $\pm$ 3.75	6677.44 $\pm$ 713.90	16.12 $\pm$ 2.20	44.00	8.00	1.94	1.08
34	190 $\pm$ 20	53.92 $\pm$ 3.03	3846.00 $\pm$ 920.46	8.09 $\pm$ 2.23	39.60	7.00	1.35	0.00

C.I. = Confidence interval.

Table 2

Mean physical properties of soils of *Isoberlinia* woodlands
in northwestern Nigeria (+ 95% C.I.)

Plot	% Sand	% Silt	% Clay
R/12	60.43 $\pm$ 8.76	22.66 $\pm$ 8.06	16.91 $\pm$ 2.42
7	54.40 $\pm$ 10.51	33.28 $\pm$ 8.89	12.32 $\pm$ 2.32
8	52.66 $\pm$ 11.32	20.71 $\pm$ 7.54	26.63 $\pm$ 11.20
9	66.09 $\pm$ 8.42	23.13 $\pm$ 6.97	10.78 $\pm$ 2.22
13	68.42 $\pm$ 10.65	16.76 $\pm$ 4.66	14.82 $\pm$ 12.22
14	70.88 $\pm$ 8.00	13.17 $\pm$ 2.12	15.94 $\pm$ 7.07
15	57.47 $\pm$ 5.38	19.93 $\pm$ 3.40	22.60 $\pm$ 2.99
18	45.80 $\pm$ 7.38	21.40 $\pm$ 3.89	32.80 $\pm$ 6.24
21	60.26 $\pm$ 4.54	19.02 $\pm$ 3.10	20.71 $\pm$ 5.49
24	41.24 $\pm$ 3.08	27.53 $\pm$ 2.96	31.24 $\pm$ 3.99
26	53.58 $\pm$ 5.40	20.71 $\pm$ 5.52	25.71 $\pm$ 4.84
32	69.60 $\pm$ 12.65	13.06 $\pm$ 6.28	17.33 $\pm$ 14.82
33	48.06 $\pm$ 7.56	19.73 $\pm$ 3.62	32.20 $\pm$ 7.62
34	50.76 $\pm$ 12.33	29.56 $\pm$ 4.50	19.68 $\pm$ 12.03

woodland plots shows variation and does not present any pattern either with crown cover or basal area.

The summaries of the soil properties are presented in Tables 2 and 3. Sand is the most varied property with the highest proportions. Silt and clay have comparable proportions but with clay being more variable. Of the cations, calcium is the most variable and most abundant (Table 3). Magnesium ranks second and sodium is the least abundant. Exchangeable acidity is low reflecting low levels of Al and H. There are low levels of ECEC, Fe and Mn. Organic carbon and total nitrogen contents are low with the former being more variable. Available P is higher than any of the anions. The soils range from medium acid to neutral in reaction.

Ordination of soil variables by rotation the PCA axes is given in Table 4. Components included here, account for at least 90% of the total variance. Each component is identified by the variables' loadings of 0.60 and above. Soil reaction (pH), sodium and calcium concentration and ECEC loaded on component I. The soil component is thus identified as soil reaction and nutrient status. Other components are similarly identified; their respective names and the percentages they account for in the original variance are presented in Table 5. Similar results are presented in Tables 6 and

Table 3

Mean chemical properties of soils of *Isoberlinia* woodlands in northwestern Nigeria ($\pm$ 95% C.I.)

Plot	pH	Al ³⁺	H ⁺	Na ⁺	K ⁺	Ca ⁺²	Mg ⁺²	Fe ⁺³	Mn ⁺	% Total	Avail.	% D.C.
meq/100 g soil												
R/2	5.80	0.04 $\pm$ 0.02	0.34 $\pm$ 0.09	0.14 $\pm$ 0.03	0.28 $\pm$ 0.06	2.11 $\pm$ 0.59	0.58 $\pm$ 0.12	0.12 $\pm$ 0.02	0.05 $\pm$ 0.03	0.08 $\pm$ 0.02	1.94 $\pm$ 0.99	1.14 $\pm$ 0.59
7	5.74	0.12 $\pm$ 0.19	0.35 $\pm$ 0.10	0.12 $\pm$ 0.04	0.38 $\pm$ 0.06	2.06 $\pm$ 0.89	0.56 $\pm$ 0.02	0.16 $\pm$ 0.04	0.06 $\pm$ 0.04	0.09 $\pm$ 0.05	2.82 $\pm$ 2.06	1.24 $\pm$ 0.61
8	6.56	0.08 $\pm$ 0.04	0.18 $\pm$ 0.04	0.20 $\pm$ 0.09	0.26 $\pm$ 0.05	3.20 $\pm$ 1.49	1.69 $\pm$ 0.34	0.15 $\pm$ 0.02	0.04 $\pm$ 0.02	0.08 $\pm$ 0.05	8.92 $\pm$ 2.68	1.07 $\pm$ 0.73
9	5.78	0.04 $\pm$ 0.02	0.25 $\pm$ 0.06	0.06 $\pm$ 0.02	0.21 $\pm$ 0.07	1.32 $\pm$ 0.38	0.48 $\pm$ 0.05	0.16 $\pm$ 0.04	0.06 $\pm$ 0.02	0.06 $\pm$ 0.02	1.98 $\pm$ 0.72	0.54 $\pm$ 0.19
13	6.25	0.08 $\pm$ 0.05	0.19 $\pm$ 0.06	0.16 $\pm$ 0.03	0.12 $\pm$ 0.04	2.45 $\pm$ 0.98	0.76 $\pm$ 0.43	0.14 $\pm$ 0.02	0.01 $\pm$ 0.01	0.05 $\pm$ 0.02	6.50 $\pm$ 3.85	0.60 $\pm$ 0.48
14	6.30	0.06 $\pm$ 0.04	0.16 $\pm$ 0.09	0.17 $\pm$ 0.02	0.34 $\pm$ 0.09	2.94 $\pm$ 1.06	1.46 $\pm$ 0.36	0.14 $\pm$ 0.03	0.07 $\pm$ 0.04	0.13 $\pm$ 0.06	10.42 $\pm$ 2.00	0.95 $\pm$ 0.63
15	6.60	0.05 $\pm$ 0.04	0.18 $\pm$ 0.06	0.13 $\pm$ 0.02	0.26 $\pm$ 0.12	3.92 $\pm$ 1.64	1.70 $\pm$ 0.63	0.14 $\pm$ 0.05	1.06 $\pm$ 0.03	0.10 $\pm$ 0.03	7.86 $\pm$ 2.08	0.86 $\pm$ 0.69
18	6.54	0.05 $\pm$ 0.06	0.17 $\pm$ 0.05	0.17 $\pm$ 0.06	0.34 $\pm$ 0.16	2.95 $\pm$ 1.44	1.52 $\pm$ 0.49	0.14 $\pm$ 0.04	0.06 $\pm$ 0.03	0.09 $\pm$ 0.04	7.78 $\pm$ 2.80	1.06 $\pm$ 0.69
21	6.34	0.02 $\pm$ 0.06	0.16 $\pm$ 0.04	0.13 $\pm$ 0.02	0.16 $\pm$ 0.05	1.68 $\pm$ 0.57	0.66 $\pm$ 0.38	0.10 $\pm$ 0.10	0.06 $\pm$ 0.02	0.05 $\pm$ 0.02	8.10 $\pm$ 2.54	0.62 $\pm$ 0.38
24	5.98	0.06 $\pm$ 0.04	0.21 $\pm$ 0.06	0.12 $\pm$ 0.02	0.12 $\pm$ 0.03	1.72 $\pm$ 0.45	0.86 $\pm$ 0.24	0.08 $\pm$ 0.02	0.08 $\pm$ 0.03	0.04 $\pm$ 0.01	6.36 $\pm$ 1.43	0.69 $\pm$ 0.38
26	5.78	0.13 $\pm$ 0.10	0.20 $\pm$ 0.04	0.14 $\pm$ 0.01	0.16 $\pm$ 0.06	1.84 $\pm$ 0.77	0.74 $\pm$ 0.30	0.11 $\pm$ 0.02	0.10 $\pm$ 0.04	0.10 $\pm$ 0.04	6.02 $\pm$ 2.20	0.69 $\pm$ 0.52
32	6.70	0.06 $\pm$ 0.02	0.24 $\pm$ 0.13	0.12 $\pm$ 0.01	0.23 $\pm$ 0.09	1.99 $\pm$ 1.53	1.67 $\pm$ 0.54	0.06 $\pm$ 0.02	0.04 $\pm$ 0.03	0.12 $\pm$ 0.07	2.13 $\pm$ 1.16	8.62 $\pm$ 0.52
33	5.63	0.34 $\pm$ 0.38	0.23 $\pm$ 0.09	0.13 $\pm$ 0.02	0.15 $\pm$ 0.12	1.29 $\pm$ 1.25	0.90 $\pm$ 0.79	0.12 $\pm$ 0.02	0.06 $\pm$ 0.05	0.09 $\pm$ 0.05	9.88 $\pm$ 2.88	0.88 $\pm$ 0.61
34	6.12	0.09 $\pm$ 0.03	0.18 $\pm$ 0.05	0.14 $\pm$ 0.01	0.36 $\pm$ 0.11	3.38 $\pm$ 0.79	2.09 $\pm$ 0.44	0.07 $\pm$ 0.01	0.04 $\pm$ 0.02	0.13 $\pm$ 0.08	1.29 $\pm$ 0.88	0.45 $\pm$ 0.33

Table 4
Rotated principal components matrix of soil variables of
Isoberlinia woodlands

Variable	Principal components					
	I	II	III	IV	V	VI
Soil reaction (pH)	<u>0.70</u>	0.11	0.19	-0.23	0.48	0.04
Aluminium concentrations	0.05	-0.21	-0.04	-0.16	<u>0.92</u>	-0.07
Hydrogen concentrations	0.47	0.52	0.29	-0.13	0.21	-0.09
Sodium concentrations	<u>-0.77</u>	-0.42	0.06	-0.03	0.07	-0.16
Potassium concentration	-0.52	<u>0.69</u>	0.26	-0.13	0.07	0.31
Calcium concentration	<u>0.93</u>	-0.11	-0.12	0.01	0.15	0.06
Magnesium concentration	0.17	<u>-0.87</u>	-0.07	-0.09	0.28	-0.04
Effective cation exchange capacity	<u>0.98</u>	-0.09	0.02	-0.02	-0.07	-0.03
Total nitrogen concentration	-0.49	0.39	-0.02	0.29	0.53	0.46
Organic carbon concentration	-0.43	0.02	0.52	0.02	0.58	0.18
Phosphorus concentration	0.21	<u>0.87</u>	-0.31	-0.11	-0.01	-0.20
Iron concentration	-0.01	-0.08	<u>0.92</u>	0.01	0.16	-0.01
Manganese concentration	0.17	-0.12	-0.09	-0.19	-0.10	<u>0.94</u>
Sand proportion	-0.06	-0.28	-0.13	<u>-0.90</u>	0.14	0.22
Silt proportion	-0.20	-0.39	-0.14	<u>0.87</u>	-0.04	0.03
Clay proportion	0.30	<u>0.67</u>	0.31	0.47	-0.09	-0.29

7 for vegetation variables. These components are used in canonical correlation analysis.

The relationships between soil and vegetation are sought by canonical correlation analysis performed on PCA matrix of soil and vegetation variables. The analysis produced three canonical correlations ($r_1 = 0.98$, $r_2 = 0.92$, $r_3 = 0.88$) significant at $P < 0.001$. The canonical correlations with their respective weights are shown in Table 8. The significance of the correlations represents the pattern of interrelationships between these two sets of data. Each component is identified by soil and vegetation components

Table 5

Soil components, their descriptions and proportion of total variance accounted for

Component	Description	Variance accounted for (%)
I	Soil reaction and nutrient status	26.45
II	Clay, magnesium and phosphorus concentrations	22.19
III	Iron concentration	15.35
IV	Sand and silt proportions	13.27
V	Aluminium concentration	13.23
VI	Manganese concentration	9.50

Table 6

Rotated principal components matrix of vegetation variables of *Isoberlinia* woodlands

Variable	Principal components			
	I	II	III	IV
Woody plant density	-0.08	-0.48	<u>0.69</u>	-0.15
Woody plant height	-0.16	<u>-0.66</u>	0.01	-0.51
Woody plant crown cover	<u>0.85</u>	0.27	0.04	0.17
Woody plant basal area	<u>0.77</u>	0.02	0.33	0.11
Total number of species per plot	0.22	0.56	-0.08	0.15
Species diversity	0.34	0.26	-0.15	<u>0.73</u>
Percentage canopy cover	0.21	-0.03	<u>0.83</u>	0.15

Table 7

Vegetation components, their descriptions and proportion of total variance accounted for

Component	Description	Variance accounted for (%)
I	Woody plant size	23.93
II	Woody plant height	20.15
III	Woody plant density and canopy cover	20.08
IV	Species diversity	12.32

Table 8

Canonical factor structure of vegetation — soil
interrelationships of *Isoberlinia* woodlands

	Canonical correlations		
	r_1	r_2	r_3
(Vegetation weights)	0.98	0.92	0.88
Woody plant size	<u>-0.66</u>	0.18	-0.24
Woody plant height	-0.12	<u>0.87</u>	-0.10
Woody plant density and canopy cover	<u>-0.50</u>	0.22	<u>0.59</u>
Species diversity	<u>-0.53</u>	<u>0.60</u>	0.22
(Soil weights)			
Soil reaction and nutrient status	-0.40	<u>0.53</u>	<u>-0.51</u>
Clay, magnesium and phosphorus concentrations	0.09	-0.32	-0.41
Iron concentration	<u>0.51</u>	-0.06	0.24
Sand and silt proportions	<u>0.63</u>	0.16	0.24
Aluminium concentration	<u>-0.56</u>	-0.09	<u>0.72</u>
Manganese concentration	<u>0.54</u>	-0.41	0.25
Degrees of freedom	42	30	20
Probability level	0.001	0.001	0.001

with weights of 0.50 or more. The first canonical correlation has a strong reciprocal relationship between woody plant size, density, canopy cover and species diversity, and iron and manganese concentrations, and sand and silt proportions. The second correlation shows a strong positive relationship between woody plant height and species diversity, and soil reaction (pH) and nutrient status. On the third correlation is a positive relationship between woody plant density and canopy cover, and aluminium; but negative with soil reaction and nutrient status. The most highly weighted soil and vegetation components are those describing woody plant size/height and aluminium concentration cum sand and silt proportion.

Discussion

The vegetation of the woodlands shows variations in the structural characteristics. Some woodlands have high woody species density while others have low density. This reflects the stage of development of the woodlands.

High woody species density is mostly observed in plots with samplings indicating juvenile stage of development. Low density reflects maturity of the woodlands with large girth-sized species. Hence species are abundant in woodlands with smaller basal area and lower height. Woodland tree height averaged between 14 m and 18 m and increases down the slopes of ridges probably due to deeper and richer soils at lower slopes.

Soil physical properties show that the surface soils are sandy; clay and silt contents are low. Thus the structural stability, water-holding and exchange capacity of the woodland soils are poor. The low nutrient values may also be attributed to low mineralization rate due to reduction in temperature and greater stability of organic residue under tree canopy as in the woodlands.

The canonical correlation analysis identifies three patterns of inter-relationships between soil and vegetation. The first canonical correlation indicates a reciprocal interrelationship between vegetation and soil variables. Plant size, for instance, would have been expected to be positively related to silt since silt is known to influence plant growth by improving water-holding capacity and porosity of soils (ETHERINGTON 1975). The use of standardized components rather than actual data scores might have brought about this (AWETO 1981). The relationship between the vegetation and manganese might be that this element is limiting to plants growth. The association with aluminium is direct as this contributes to the pH of the soils. The soils are mildly acid to neutral, conditions that favour the availability of nutrients at exchange sites. The relationship in the second canonical correlation between woody plant height and species diversity with soil reaction and nutrient status is positive. An increase in soil nutrient leads to increased vegetation height and species diversity and the latter would lead to much vegetation cover that will ameliorate the soil environment (through protection and litter production). Hence adequate vegetation cover replenishes soil with nutrients. The third canonical correlation shows a positive association between woody plant density and canopy cover with aluminium. This confirms the relationship between these two soil and vegetation components as observed in the first canonical correlation and for the reason advanced therein. The relationship of the two vegetation and nutrient status is negative; the negative sign on the soil components might be spurious as simple correlations between these two sets of data is positive. Again this suggests that the component scores used for this analysis might place arbitrary signs on the results due to standardization.

Conclusion

It is clear from the canonical correlation analysis that nutrient status and particle size proportions exert marked effects on the vegetation components of Isoberlinia woodlands. Though of low concentrations the micro-nutrients affect species diversity, density, size and canopy cover. Thus the vegetation parameters influence the amount of nutrients the soil holds and subsequently its fertility. Isoberlinia woodlands are therefore dynamic ecosystems and the relationship between the soil and vegetation cannot be sought by stand comparisons alone. A multivariate technique used in analyzing these ecosystems identified soil variables that affect the vegetation and vice versa. This suggests that the soil and vegetation components of the woodlands are interdependent and exert reciprocal influence on each other.

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EFFECTS OF ENVIRONMENTAL FACTORS ON THE CO₂ FIXATION IN THREE GRASS SPECIES OF A SANDY GRASSLAND UNDER FIELD CONDITIONS

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Diurnal and seasonal changes of CO₂ fixation were measured by radiocarbon method under field conditions at actual temperature, PAR and soil moisture content in three grass species *Bromus tectorum*, *Poa bulbosa* and *Iragus racemosus*, representing different life forms and strategies of drought adaptation as well as different types of CO₂ fixation in the dry sandy grassland *Festucetum vaginatae*.

The highest CO₂ fixation rate (64 mg·g⁻¹·h⁻¹) was measured in the winter-spring annual C₃ *Bromus tectorum*. This species showed light saturation at lower PAR values in the vegetative stage and at higher PAR values in the period of flowering. The intensity of CO₂ fixation correlated with rising temperature showing maximum rate at 21.5 °C.

The photosynthetic activity of the winter-spring perennial C₃ *Poa bulbosa* is low, reaching 21.6 mg CO₂·g⁻¹·h⁻¹ as maximum in early April before flowering while the summer annual C₄ *Iragus racemosus* can produce a rate as high as 43 mg fixed CO₂·g⁻¹·h⁻¹ in early phase of its development in July. *Iragus racemosus* did not show light saturation under field conditions, maximum rate of photosynthesis was reached at 37 °C while below 30 °C temperature limitation was detected.

Introduction

By now a considerable amount of handbooks, review articles, experimental and theoretical works have been published in the field of ecophysiology (MOONEY 1991) but still a relatively small number of plant species have been studied thoroughly under natural conditions (SCHULZE and CALDWELL 1994). In this respect the perennial open sandy grassland, *Festucetum vaginatae*, can be taken as an exception, because it is one of the most thoroughly studied communities in Hungary.

Ecophysiological studies started with the measurement of carboxylating enzyme activities and the identification of different carbon assimilation types in this way (HORÁNSZKY and NAGY 1977, NAGY and HORÁNSZKY 1980).

Since the eighties, field studies revealed the daily and seasonal changes of photosynthesis, transpiration, water status and water use effi-

ciency of the dominant, mostly perennial xerophyton graminoids and forbs (TUBA 1984, KOVÁCS-LÁNG and MÉSZÁROS-DRASKOVITS 1985, ALMÁDI et al. 1986, KOVÁCS-LÁNG et al. 1989, KALÁPOS 1989, 1994_{a,b}).

The basic question to be examined in the long run is how the species of different photosynthetic characteristics and drought adaptation strategies can fit into the community, and coexist with other species in complex environmental (e.g. weather, soil moisture) patterns.

As the continuation of the former research the aim of the recent work was to study the diurnal and seasonal changes of photosynthetic activity of three grass species of the perennial open sandy grassland to reveal how the CO₂ fixation of the species is affected by the ever changing environmental variables under field conditions, and to collect information on the controlling and limiting role of different environmental factors.

The plant species selected — Bromus tectorum, Poa bulbosa, Tragus racemosus — represent different life forms and strategies of drought adaptation and also represent different types of CO₂ fixation.

The study area

The study site is located on the sandy area of Bugac (Kiskunság National Park) in Central Hungary at 110 m above sea level.

The climate of the region has continental and slight submediterranean character (BORHIDI 1961, 1993) with a semiarid period in summer. The annual mean temperature is 10.3 °C and the yearly amount of precipitation is about 500 mm.

One of the main features of the climate is the low relative air humidity in summer which is below 40% at least 14–16 days in a month and hardly exceeds 10% at noon (VERSEGHY et al. 1987).

The maximum light intensity on clear days reaches 70–80 (Klux (2000 μmol photon·m⁻²·sec⁻¹) (ALMÁDI et al. 1986).

The soil moisture content in the upper 0–10 cm, where significant amount of roots is located, varies from 4–6% in the wet spring period to 0.8–2% in the dry summer (KOVÁCS-LÁNG et al. 1985, 1989). Water shortage is the most important limiting factor for plants.

The dominant and characteristic species of the open perennial sandy grassland Festucetum vaginatae danubiale are Festuca vaginata, Koeleria glauca, Stipa borysthenica, Carex liparicarpos, Poa bulbosa, Euphorbia seguieriana, Alkanna tinctoria, Potentilla arenaria, Fumana procumbens.

The floristic composition and seasonal phenological changes are described in KÁRPÁTI and KÁRPÁTI (1955), and VERSEGHY and KOVÁCS-LÁNG (1971).

There is a significant life form diversity in the community (PRÉCSÉNYI and HORVÁTH 1993) what can be even raised by slight disturbance.

The considerably high proportion of C₄ species in the summer-autumn period also indicates the local aridity (KALÁPOS 1991).

The species investigated

Poa bulbosa L.

It is a perennial hemicryptophyte short grass with a latent period in summer. The floristic area of the species covers the central and southern parts of Europe, northern part of Africa, Asia Minor, Central Asia, Iran (HULTÉN 1962, MEUSEL et al. 1965, TOWNSEND et al. 1968, FEINBRUN-DOTHAN 1986, SIMON 1992).

It has been introduced to North America (California, Nevada), Australia and South Africa as well.

Flowering time is April--June. In Hungary Poa bulbosa is a rather common species on light, dry, calcareous sand, loess, loam and salt-affected soils with low humus and nutrient content.

It is typical component of the semidesert like sand vegetation, of sandy meadows (Astragalo-Festucetum), sand pastures (Potentillo-Festucetum pseudovinae), loess meadows (Salvio-Festucion) and loess pastures (Cynodonti-Poëtum) SOÓ (1964--80).

Bromus tectorum L.

A variable winter annual plant with a rather similar floristic area than Poa bulbosa, extending originally in the southern part of western Eurasia (HULTÉN 1962, MEUSEL et al. 1965, TOWNSEND et al. 1968, FEINBRUN-DOTHAN 1986, SIMON 1992).

It is introduced weed in northern Europe, in North America, South Africa, Japan and New Zealand. It is spreading rapidly.

Flowering time is May--June. In Hungary Bromus tectorum is rather common on dry, warm, light sand, loam or loess soils with low humus and nutrient content.

It is characteristic element of pioneer communities (Brometum tectorum) both on calcareous and acidic sands, but it can be found also in several other types of sand vegetation, in meadows, pastures and on agricultural areas (SOÓ 1964--80).

Tragus racemosus (L.) All.

The floristic area of the species covers the tropical and subtropical regions of both the Palaeotropis and Neotropis. In Europe the northern

border of the area reaches Slovakia, Lower Austria, South Germany. In the temperate region it is a summer annual plant (HULTÉN 1962, SIMON 1992).

It is the plant of dry regions in Asia Minor and Arabic Africa (TOWNSEND et al. 1968, TACKHOLM 1974).

Flowering time is August. Photosynthesis type is C_4 . In Hungary Iragus racemosus abundant mainly on dry, light calcareous sand soils with low humus and nutrient content mainly in the Duna—Tisza Mid-Region. Frequently occurs in semidesert like annual sand vegetation (Brometum tectorum), in perennial open sand grassland (Festucetum vaginatae), in sand meadows (Astragalo-Festucetum) and on agricultural areas (SOÓ 1964--1980).

Methods

Daily course of CO_2 fixation was measured on selected days according to the phenology of the species by the radiocarbon method (SESTÁK et al. 1971, FIELD et al. 1989, KOVÁCS-LÁNG et al. 1989).

The days of measurements: for Bromus tectorum 4, 5, 19 April, 3, 26 May 1990; for Poa bulbosa 4, 5, 19 April, 3 May 1990; for Iragus racemosus 17 August, 9 Sept 1989, 13 July, 17 August, 13 Sept 1991. Short-term effect of watering was studied on 13 July, 1991.

The apparatus used for CO_2 fixation measurements is a portable variant of that developed by LÁNG et al. (1985) what is suitable for low cost ecophysiological fieldwork (FEKETE and TUBA 1982, KOVÁCS-LÁNG and MÉSZÁROS-DRASKOVITS 1985). CO_2 fixation was measured in the field under actual temperature and light conditions.

The closed exposition chamber was filled with air containing 1% CO_2 with 0.5 mCi/min radioactivity. Leaves or leaf segments cut from the upper third of leaves were introduced into the exposition chamber by a folded and perforated transparent celluloid strip through a mercury blockade. The fixation time was 2 minutes. The temperature in the chamber was kept similar to the surface temperature of the leaves in their original position in the stand. After the exposure the leaves (3--4 parallel in each sample from different individuals) were heat-denatured and dried between filter paper on 95--100 °C by ironing. The radioactivity of the samples was determined in laboratory by liquid scintillation technique (BECKMAN liquid scintillometer). The results are given in terms of fixed CO_2 per dry weight ($mg\ CO_2 \cdot g^{-1} \cdot h^{-1}$). Photon flux density (PAR) was measured by a LICOR quantum sensor. Both the chamber atmospheric and leaf surface temperatures were measured by micro thermometers containing 4 MTH-type thermistors.

Soil moisture content was determined by gravimetry. In each case 4--8 parallel samples were taken from the rhizosphere of the plants (5--10 cm depth). Soil temperature was measured by soil thermometers put in the soil at 0, 5, 10, 15 cm.

Regression, correlation covariance analyses and "t"-test for significance analysis (SOKAL-ROHLF 1981, SVÁB, 1981) were used for the evaluation of the connections between ecophysiological and environmental variables.

Results and Discussion

Bromus tectorum

The winter-spring annual grass germinates — after the summer dormant period of seeds — in October. The seedlings after winter stagnation start with their vegetative growth at the end of March or beginning of April. A rapid phenological development is characteristic of the species which produces inflorescence by the first decade of May and grains by the end of May first days of June, depending on the weather conditions of the different years. Bromus tectorum populations can exhibit marked variation in phenology and biomass allocation depending on environmental conditions (RICE et al. 1992). The rapid growth allows the plant to reach reproductive size more rapidly and set seed before soil moisture becomes limiting in late spring.

In accordance with its rapid growth Bromus tectorum showed the highest photosynthetic activity among the species investigated till now in the dry sand grasslands (FEKETE and TUBA 1982, TUBA 1984, KOVÁCS-LÁNG and MÉSZÁROS-DRASKOVITS 1985, KOVÁCS-LÁNG et al. 1989, KALAPOS 1994a, JABBOUR and KOVÁCS-LÁNG 1994). The detected rates of CO₂ fixation varied between 3.39–64 mg CO₂·g⁻¹·h⁻¹ in its vegetation period. The maximum rate, 64 mg CO₂·g⁻¹·h⁻¹ was measured in early May in the phase of full flowering (Fig. 1).

The daily course of photosynthetic activity on the different days of measurement in most cases followed the course of irradiation. The photosynthetic activity on subsequent days (4 and 5 April) in the same phenological

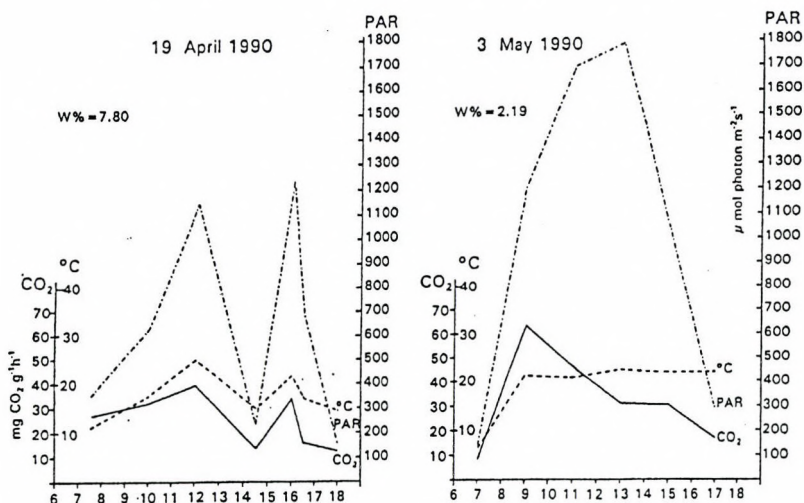


Fig. 1. Daily course of CO₂ fixation in Bromus tectorum under field conditions

phase can be 2.5 times higher due to the different weather conditions, with more favourable light and temperature on the second day.

According to experimental work of RICE et al. (1992) Bromus tectorum leaves reach light saturation of photosynthesis at about $1000 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ photon flux density, so below this value we can expect the close correlation of photosynthesis with light conditions, if there is no other limiting factors.

The results of measurements on 3 May, a clear day with bright sky, with photon flux densities well over $1000 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ document that in this case there was no light regulation. The peak in the daily course of photosynthetic activity shifted to the morning hours as it is characteristic of xerophyte perennial grasses in the dry summer period, as a sign of water limitation (KOVÁCS-LÁNG and MÉSZÁROS-DRASKOVITS 1985, ALMÁDI et al. 1986). Probably water conditions of the day — a bright, sunny, windy day — can give explanation for this photosynthetic behaviour. Although soil moisture content was not too low, the slow water movement in soil could limit transpiration and cause stomatal closure by noon.

By the end of its phenological development leaves became yellow, photosynthetic pigments seemingly get destroyed, the still living plant showed rather low rate of CO_2 fixation ($18 \text{ mg CO}_2\cdot\text{g}^{-1}\cdot\text{h}^{-1}$ at 1.6% soil water content).

Poa bulbosa

The green above ground parts of the perennial hemicryptophyte grass Poa bulbosa are present in the sand grassland in the winter and early spring period, from November until the middle of May. Its growth in the nutrient poor sand soil can be limited mainly by temperature and lack of nutrients. Although its shallow root system can face lack of water in the upper layers of the sand soil in dry springs as it occurred several times in the eighties. But usually Poa bulbosa develops in early spring and can produce seeds before soil moisture becomes limiting. Young spikelets on shoots appear by the beginning of April, and stock leaves get totally dry by the end of May.

The results of CO_2 fixation measurements show that Poa bulbosa is a plant of rather low photosynthetic activity. The detected rates of CO_2 fixation varied between $1.5\text{--}21.6 \text{ mg}\cdot\text{g}^{-1}\cdot\text{h}^{-1}$. In this respect it is more similar to the perennial xerotherm "water saver" Festuca vaginata or Koeleria glauca (KOVÁCS-LÁNG et al. 1989) than to spring annuals. Measuring the net photo-

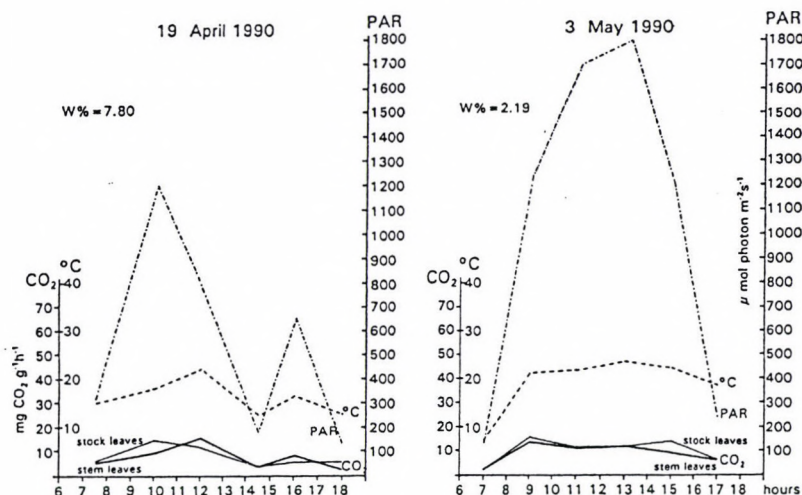


Fig. 2. Daily course of CO₂ fixation in *Poa bulbosa* under field conditions

synthetic capacity in early spring TUBA (1984) found the same low activity what he also could not explain by the phenological dynamics of the species. The low photosynthetic activity probably is an inherent feature of the species.

Although it is rather surprising if we take into consideration the fact, that among the species present and active in the community in spring *Poa bulbosa* has the highest pigment concentration in its leaves (FEKETE et al. 1980).

Its maximal photosynthetic activity could be detected in the first days of April with $21.7 \text{ mg CO}_2 \cdot \text{g}^{-1} \cdot \text{h}^{-1}$ fixed (Fig. 2), and with further phenological development decreased, producing maximal values of $14\text{--}15 \text{ mg CO}_2 \cdot \text{g}^{-1} \cdot \text{h}^{-1}$. Our comparative measurements showed stock leaves more active than the leaves of stems.

The daily course of CO₂ fixation in the leaves of *Poa bulbosa* on the April days of measurements followed the course of PAR, the relationship between light conditions and photosynthetic activity is not so close as in *Bromus tectorum*. On the 3rd of May similarly to *Bromus*, *Poa bulbosa* had its maximal activity in the morning hours and after it the daily course of photosynthesis showed the effect of water limitation with a drop in activity by noon.

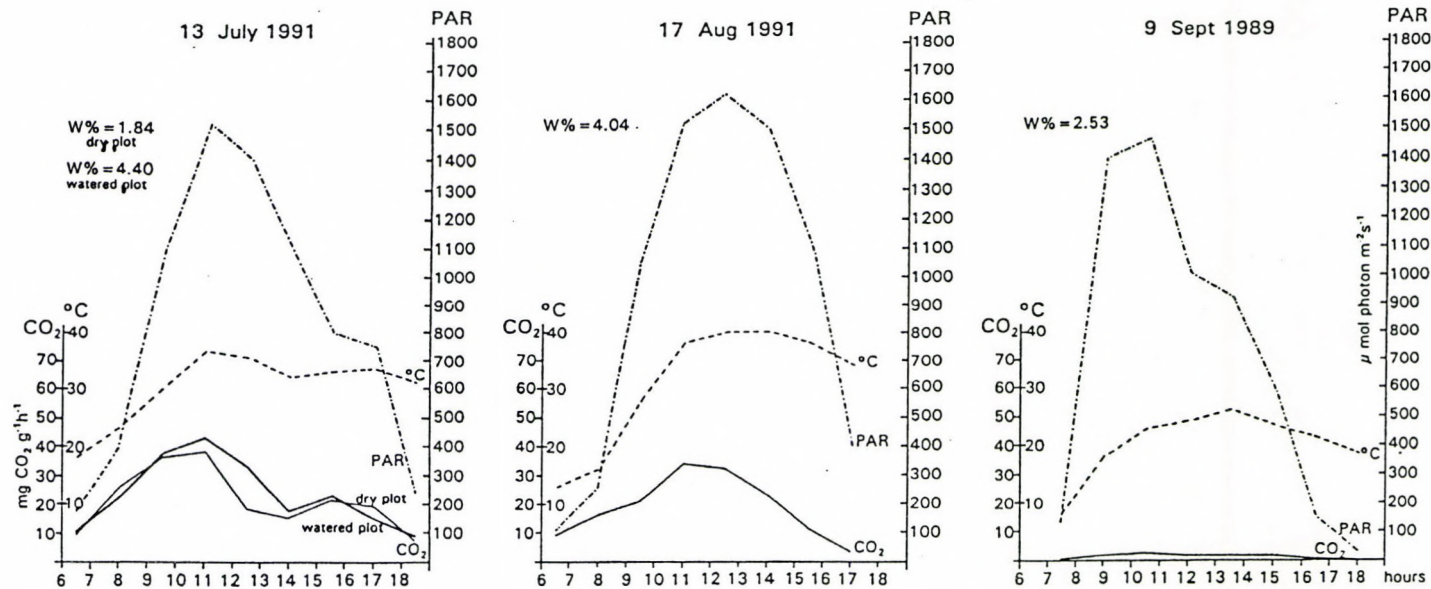


Fig. 3. Daily course of CO_2 fixation in *Tragus racemosus* under field conditions

Tragus racemosus

The summer annual C₄ plant appears in open patches of the slightly disturbed sand grassland usually at the end of June, early July, when xerophytic perennials with decreased photosynthetic activities are present. During its development the plant produces leaf and stem rosettes which sit tight onto the soil surface in the early morning hours but after about 9 a.m. their position changes, they definitely rise up from the soil. This behaviour of the stems has some advantages: can ensure plants the better utilization of dew what condensates in much bigger quantity on the very surface of the soil and helps in avoiding the extreme warming up of leaves during the hot summer days when the surface temperature of soil can reach even 50--60 °C.

The rate of CO₂ fixation of Tragus racemosus in its vegetative period, on 13 July, and when flowering, on 17 August is high, much exceeding the highest rates showed by perennial grasses even in their optimal period in spring (KOVÁCS-LÁNG et al. 1989). The detected rates of CO₂ fixation varied from 1.8 to 43 mg·g⁻¹·h⁻¹ this latter was measured in July. Mature plants with ripe grains and with few green parts in September have very low photosynthetic activity.

The daily course of photosynthesis (Fig. 3) seemingly depends on meteorological conditions and on soil moisture content. C₄ plants in most cases have their maximal daily rates of photosynthesis at noon parallel with highest irradiation values, so their daily courses show usually one peak (SCHULZE and HALL 1982). Analysing the relationship between net photosynthesis of some species of the sand grassland Festucetum vaginatae and light conditions of the days of measurements KALAPOS (1994a) found, that in the case of C₄ plants the daily variance of net photosynthesis is determined in 78% by regression with the daily course of radiation.

In our measurements it is true for the CO₂ fixation of Tragus racemosus on 17 August and 9 September, but there are also days when due to low soil water content or high atmospheric evaporative demand the water uptake by the plant cannot cope with the demand of transpiration and the consequent partial stomatal closure at noon results in a drop of both the photosynthetic and transpiration activity (SCHULZE and HALL 1982, TENHUNEN et al. 1987). The daily course measured on 13 July clearly demonstrates this situation. What is more, Tragus plants in previously watered plots followed the same course that day with a higher morning and a moderate afternoon peak.

Table 1
Daily sums of fixed CO₂ (mg·g⁻¹·day⁻¹) in the grasses of the sandy grassland of Bugac

	4th April	5th April	19th April	1990 3rd May	26th May	13th July dry	wet	1991 17th Aug.	13th Sept.	1989 9th Sept.
<u>Bromus tectorum</u>	124	258	330	405	167					
<u>Poa bulbosa</u>										
stockleaves	108	158	100	123						
stemleaves			97	107						
<u>Tragus racemosus</u>										
leaves of										
vegetative shoots						288	315	165		
flowering shoots								219	2.25	1.53
Soil moisture W%	5.93	5.74	7.80	2.19	1.61	1.84	4.40	4.04	1.80	2.53

It is worth mentioning that on 17 August while the C₄ type Tragus racemosus showed a light regulated course of photosynthesis the perennial xerophytic C₃ grass Koeleria glauca exhibited a drop in activity at noon as a result of water limitation. SCHULZE and HALL (1982) found similar behaviour between C₄ and C₃ species. The daily sums of fixed CO₂ by Tragus decreased by the end of its life cycle (Table 1).

Comparing the photosynthetic behaviour of the two grasses which are present and active in the same period in spring we have to emphasize the big differences in the level of activities, and in the dynamics of development. Parallel with its rapid growth Bromus tectorum produces new stem leaves, has an increasing activity until the flowering period as it can be detected by the daily sums of fixed CO₂ (Table 1). Poa bulbosa on the other hand has a well-developed rosette of stock leaves by early spring and their activity decreases step-by-step supposedly with their senescence.

We have to emphasize the very high performance of Bromus tectorum showing the absolutely highest rate of photosynthesis among the species measured till now in the dry sandy grassland. This behaviour of Bromus tectorum corresponds with the findings among others of MOONEY et al. (1976) and TUBA (1984) reporting about high photosynthetic activities of winter and spring annuals.

In the other species present in the spring time the photosynthetic activity was much lower, and the maximal rates were shown earlier, mostly in April.

Earlier investigations on CO₂ fixation rates of other species in the dry sand grassland showed Koeleria glauca as the most active among xerophytic perennials, reaching 24--28 mg CO₂·g⁻¹·h⁻¹ fixation in April (KOVÁCS-LÁNG and MÉSZÁROS-DRASKOVITS 1985, ALMÁDI et al. 1986, JABBOUR and KOVÁCS-LÁNG 1994).

The activity of Carex liparicarpos in spring can reach also 24 mg CO₂·g⁻¹·h⁻¹ while Festuca vaginata showed only 13 mg CO₂·g⁻¹·h⁻¹ as maximum rate of CO₂ fixation, what decreases significantly by summer.

During the dry and rather hot summer period in July and August the C₄ type Tragus racemosus can show considerably high rates of photosynthesis 38 mg CO₂·g⁻¹·h⁻¹ as a maximum what could increase up to 43 mg under the influence of watering as it was documented in our parallel measurements performed on individuals from the watered plot. Figure 4 demonstrates the relationships between PAR (μmol photon·m⁻²·sec⁻¹) and CO₂ fixation of the species.

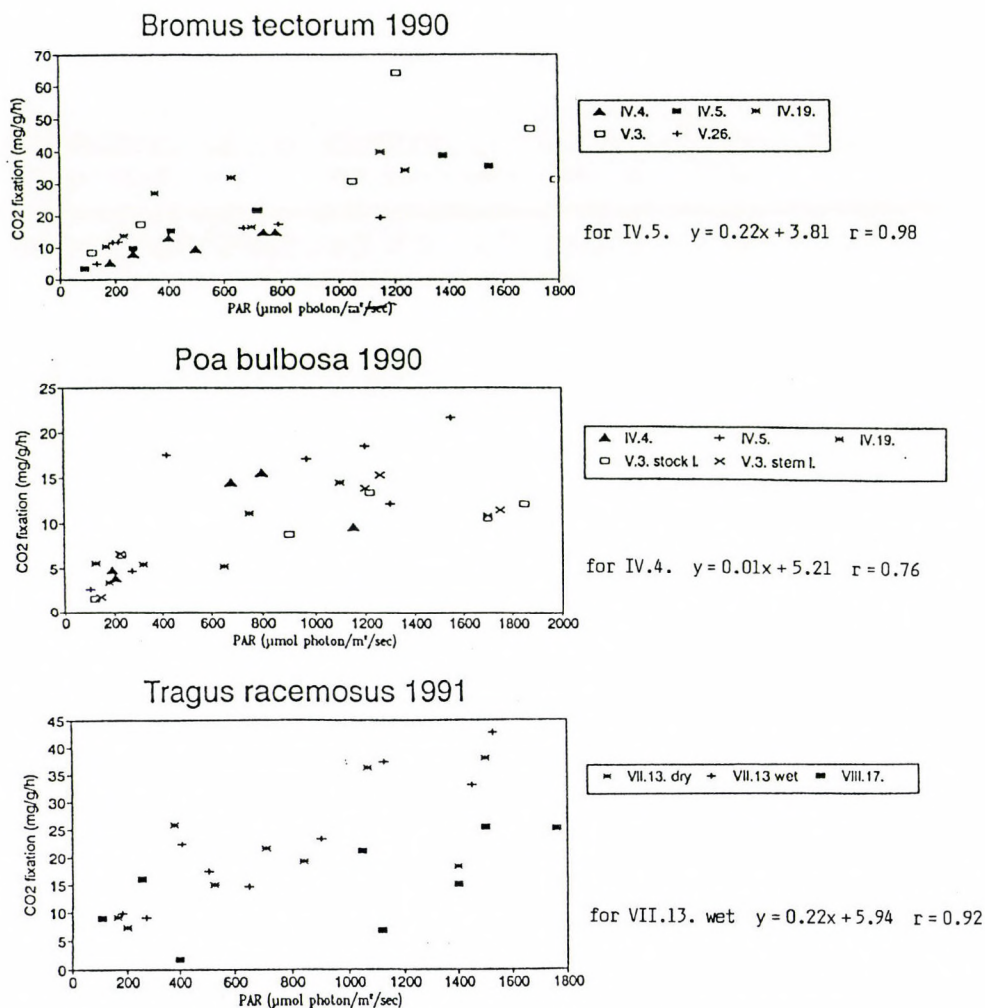


Fig. 4. Relationship between irradiance (PAR) and leaf CO_2 fixation for several species of the Festucetum vaginatae community. Data from field measurements

C_3 grass species show tendency to light saturation. With Bromus tectorum the saturation PAR value on the days 4 April and 26 May is lower, $600\text{--}700 \mu\text{mol photon}\cdot\text{m}^{-2}\cdot\text{sec}^{-1}$, but in its most active period increases up to $900\text{--}1000 \mu\text{mol photon}\cdot\text{m}^{-2}\cdot\text{sec}^{-1}$. The same value was measured for Bromus tectorum in experiments of RICE et al. (1992) and BOOKMAN and MACK (1983).

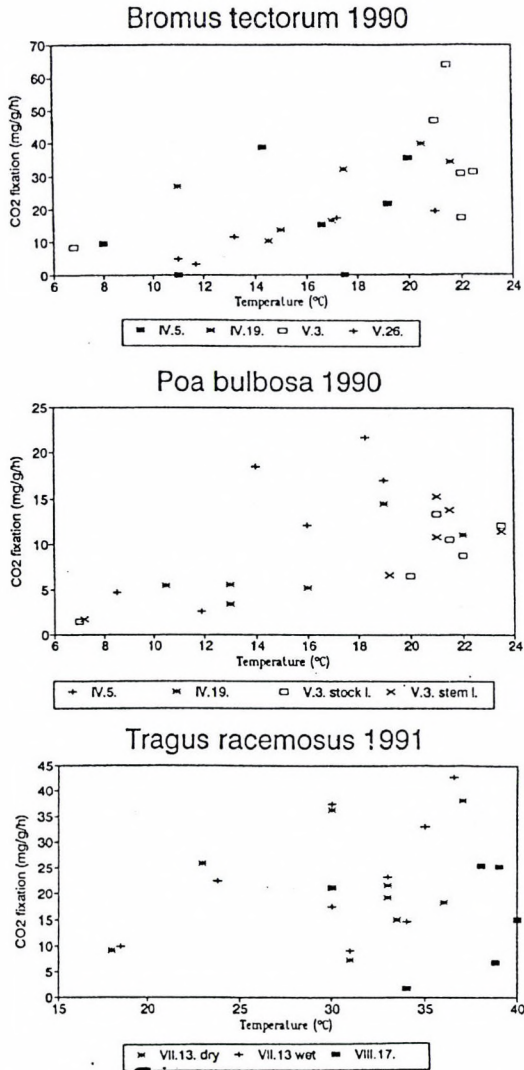


Fig. 5. Relationship between temperature and CO₂ fixation

In the case of *Poa bulbosa* (Fig. 4) we can see that low PAR values are usually linked with lower CO₂ fixation. On 5 April and 3 May when meteorological conditions for measurements were rather untroubled with clear sky, correlation between PAR and CO₂ fixation resulted in light saturation at about 1200–1400 $\mu\text{mol photon}\cdot\text{m}^{-2}\cdot\text{sec}^{-1}$. The increasing PAR value of light

saturation with the phenological development under field conditions is characteristic for this species as well.

The C_4 summer annual Iragus racemosus does not show light saturation according to Fig. 4 what documents rather linear relationship between PAR and CO_2 fixation values on the different days of measurements. There is no significant difference between plants from the dry and watered plots. Figure 5 shows the relationships between temperature ($^{\circ}C$) and CO_2 fixation rates. The points are more scattered than in the case of PAR-photosynthesis.

With Poa bulbosa there is a rather good tendency of parallel changes, i.e. lower temperatures are associated with lower CO_2 fixation rates.

For Bromus tectorum we can see temperature dependence as well, but in Fig. 5 with Bromus the points for 3 May clearly document the determining effect of light on the photosynthetic activity. That day apart from the early morning hours temperature changed in a narrow range while CO_2 fixation rates show rather big changes presumably due to changes in PAR. RICE et al. (1992) found that temperature response of net photosynthesis in Bromus tectorum could be characterised with an optimum at 25–30 $^{\circ}C$ followed by a sharp decline.

In Hungary such high temperatures in the vegetation time of Bromus tectorum are not characteristic. In the range of our measurements from 6.8 to 22.3 $^{\circ}C$ we could detect the increasing activity of CO_2 fixation with the raising temperature.

As to the effect of temperature on CO_2 fixation in Iragus racemosus (Fig. 5) earlier, in July there is a tendency for parallel changes between the two variables, but later in August other factors may influence the connections. The temperature range on 17 August was between 30 and 40 $^{\circ}C$, what is optimal for C_4 plants so one cannot expect temperature limitation under such conditions.

KALAPOS (1994a) found that net photosynthesis of Iragus and other C_4 plants of the Festucetum vaginatae community was determined by light conditions. For Iragus, as it does not show light saturation, light is always limiting factor, while temperature under the field conditions in the temperate climate of Hungary acts as limiting factor only below 30 $^{\circ}C$. This statement is clearly demonstrated by Fig. 5.

The behaviour of species with respect to environmental factors can be demonstrated with the values of environmental variables associated with the maximum rates of photosynthesis of the different species (Table 2). The

Table 2

The maximum rates of photosynthesis measured in the species and the related values of environmental variables

	Fixed CO ₂ mg·g ⁻¹ ·h ⁻¹	PAR μmol·m ⁻² ·sec ⁻¹	Temperature, °C	W soil, %	WUE mg CO ₂ ·g ⁻¹ ·H ₂ O
<u>Bromus tectorum</u> (3rd May)	64.1	1210	21.5	2.19	8.2
<u>Poa bulbosa</u> (5th April)	21.7	1550	18.3	5.74	6.9
<u>Iragus racemosus</u> (13th July)	38	1500	37.0	1.84	8.8

maximum rates of photosynthesis of the C₃ plants are reached near 20 °C or below it, while the C₄ Iragus racemosus reached maximum rate at 37 °C.

There are clear differences between the photosynthetic behaviour of the C₃ Bromus versus the C₄ Iragus concerning light conditions as well. Maximum rate of CO₂ fixation in Iragus is reached at high PAR according to its reaction to light given in Fig. 4. Poa bulbosa also shows maximum activity in early spring at high PAR values but at that time its temperature dependence is strong as well.

The given values of soil moisture in the slightly humic sand soil means that soil moisture is available for plants, even for Iragus at W% = 1.84. Watering under this conditions did not result in significant increase of CO₂ fixation rates.

The rather high values of water use efficiencies also make probable the absence of water limitation in the time of maximum activities of the species.

According to earlier measurements on other species of the Festucetum vaginatae community KOVÁCS-LÁNG and KALAPOS (1992) perennial xerophyte species also show maximum photosynthetic rates in April at rather high PAR (1500--1800) and temperature (20--26 °C) values with sufficient water content (2.0--5.8%) of the soil.

The maximum rates of photosynthesis measured in the field can be considered as a relative measure of the photosynthetic capacity of the species. Under natural conditions in the Festucetum vaginatae grassland the highest capacity can be measured in the C₃ winter-spring annual Bromus tectorum, while in summer the C₄ Iragus racemosus shows the highest performance.

The changes in the pattern of the daily course of CO_2 fixation are similar to that detected earlier for other species of the community (KOVÁCS-LÁNG et al. 1989) and show the same tendency what was reported by SCHULZE et al. (1980) for some wild species of the Negev.

The changes in the daily sums of assimilated CO_2 correspond well with the level of activities of the species (Table 1). In the case of winter-spring species the daily sum values can be influenced by the increasing day-lengths in May as it probably is the case with Poa bulbosa. With Bromus tectorum the effect of daylength is concealed by the definite tendency of changes.

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THE MUTUAL EFFECTS OF SOME SULPHURIC COMPOUNDS AND VITAMIN E
ON THE GROWTH AND CELL STRUCTURE OF SCHIZOCHLAMYS AND SCENEDESMUS SPECIES,
AND THE POST-EFFECTS OF THEIR CULTURAL LIQUIDS

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Introduction

Sulphur is known as an essential structural element of the organisms. It is present in most of proteins, i.e. enzymes (urease, papainase, co-carboxylase, co-enzyme-A) and in certain redox systems (cysteine-glutathion, thioredoxin). It has a paramount role in the structural conversion of the chromomeres and in the cell division and multiplication as well (TAMIYA 1963, SUMNER 1989). Hence, it is obvious that any sulphuric compound in unpropitious doses or in inadequate elemental proportion in the chemical compounds may sensitively affect the metabolism of the cells.

Plants, inclusively algae, take up sulphur from sulphates (amounting in fresh waters up to 0.32 mg/l), but they can also use sulphur containing organic compounds (SCHIFF, 1964). Sulphites, derivatives of sulphurous acid (H_2SO_3) and very reduced sulphuric compounds (H_2S) are generally harmful for plants. Absorption depends on several factors, though it can be regulated (e.g. Anacystis nidulans, Synechococcus sp. PCC 7942) by the transmembranal systems according to the given environment (LAUDENBACH and GROSSMAN 1991). For Diatoms optimum supply of sulphur depends on favourable take-up of silicon (SCHIFF 1964).

Many sulphuric compounds are widely spread in the environment (air, soil, water) generally unfavourable as quality and quantity as well. The little town Zalatna (Transylvania), due to its Nonferrous Processing Plant, excels in emanating such compounds together with heavy metals wasting incessantly the once wonderful surrounding. In order to reveal biological and ecological consequences of this disastrous impact and related to this, to determine actual physiological effects of some presumptive pollutant sulphuric compounds, competent researches were granted in 1990 (BÁTHORY et al.

1995, BARNA and NAGY-TÓTH 1993, BERCEA et al. 1993). The experimental data gathered in this study, as a continuation of the previous investigations, deal with the mutual effects of some oxidized and reduced sulphuric compounds and vitamin E.

Material and Methods

According to the purpose of the investigations, the most common and possible pollutant sulphuric compounds were experimented, namely: sodium sulphate (Na_2SO_4), sodium sulphite (Na_2SO_3) and dithionite ($\text{Na}_2\text{S}_2\text{O}_6 \cdot 2 \text{H}_2\text{O}$) as well as cysteine ($\text{C}_3\text{H}_7\text{NO}_2\text{S}$). Simultaneously, a series with sodium carbonate (Na_2CO_3) was parallelly set up in order to control separately the effect of sodium. Other series with vitamin E (D,L-Tocopherol), the potent antioxidant and its solvent ethanol, as well as sodium sulphite combined with cysteine or vitamin E were also set up. The basic concentration of the compounds were established according to the sulphur content in the control Kuhl-Lorenzen's nutrient solution (i.e. $32.854 \text{ mg S/l} = 0.41 \text{ mM S /KUHL and LORENZEN 1964/}$). Furthermore, the sulphuric compounds were also used in 10x and in 50x higher concentrations. They were added to the Kuhl-Lorenzen's solution substituting its original sulphur source ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$). For each series 3 pH variants (5–5.5, 6.5–7, 8.5–9) were adjusted (with H_2SO_4 n/10, and/or KOH 20% + NaOH 20%, K:Na = 3.5:1). Vitamin E was used in more extended concentrations since the data about its effects on plants are rather scarce; so there were prepared the following concentrations: 0.025, 0.25, 2.5, 25 and 250 mg vitamin E/l, solved in equivalent volume of 5 ml ethanol.

The solutions were distributed (200 ml) in Erlenmeyer flasks (of 300 ml), sterilized (in autoclave at 105°C and 1.5 at for 1 h) and after cooling the samples were inoculated with aliquot amounts of algal suspensions.

The algae by which the physiological effects of the compounds have been revealed were wilfully so chosen as to differ both taxonomically and ecologically (NAGY-TÓTH 1992, 1994). They were: Schizochlamys genatinosa A. BRAUN, picked out from a sample (took on May 5th, 1963) of a transient bog (pH 5–5.5, temp. $20\text{--}22^\circ\text{C}$) near Szélicse (Kolozs district); Scenedesmus acutus MEYEN found in a sample (June 1st, 1965) taken from "Fortuna" Lake, Danube Delta (pH 8–8.5, temp. 21°C); Sc. intermedius CHODAT, sampled (June 10th, 1967) from a puddle (pH 7.5, temp. 20°C) by Szvinice (Danube basin, Iron Gate region). They were, at that time, selected in pure cultures and maintained in laboratory collection (NAGY-TÓTH and BARNA 1987). Before inoculation, subcultures were set going in the same conditions as the experimental ones.

The initial densities of the starting experimental cultures were: Schizochlamys genatinosa, 600 cells/ μl (extinction, $E = 0.025$); Scenedesmus acutus, 600 cells/ μl ($E = 0.055$); Sc. intermedius, 100 cells/ μl ($E = 0.017$). The cultures were grown in neon lamps light (Day-light tubes of 40 W) of $12 \pm 2 \text{ klux}$ intensity daily 12 h.

The cultivation lasted 14 days. The experiments were repeated twice.

The results were evaluated by optical extinction, E , FEK-M6 photocolorimeter) and cell densities (cells/ μl , No., Bürker's haemocytometer), biomass production (dry weight at 105°C) and by microscopical recordings (NAGY-TÓTH and BARNA 1994). From the fresh biomass (centrifuged and washed) the photosynthetic pigments (HAGER and MEYER-BERTENRATH 1966) and the soluble protein (LOWRY et al. 1951) were determined. Otherwise, the methods applied are generally comparable with the German Testverfahren mit Wasserorganismen (1991). Alterations occurred in the physiological properties of the media due to the algal cultivation were assayed by Lepidium- and Sinapis-test (germination and seedlings elongation) (BRUGOVITZKY and BOSICA 1967).

Results and Discussion

Changes in growth and multiplication

All oxidized sulphuric compounds used in these experiments in basic concentrations (1x) were slightly retardant, while in higher doses (10x, 50x) strongly inhibiting or toxic for the growth and multiplication. Among the compounds sodium sulphite was the most potent. The reduced sulphuric compound, cysteine, and the sulphurless sodium carbonate favoured the growth of the algae. The effects were stronger in acidic media than in neutral or alkaline ones. Among the algae, Scenedesmus intermedius was the most sensitive, while Scenedesmus acutus seemed to be rather tolerant (Table 1). Thus, the data recorded revealed, first of all, the genetically determined physiological specificity which prevailed depending on the chemical structure of the compounds and on the cultural conditions.

The less harmful compound proved to be sodium dithionite. In its basic and 10x higher concentrations in neutral media none of algal growth were modified, but in the 50x doses a slight inhibition was observed. In acidic media a strong inhibition (60-70%) was recorded. The effects of the sodium sulphate were stronger and more differentiated. In basic concentration both in acidic and in neutral media it diminished (20-50%), while in alkaline media, surprisingly, stimulated (50%) the multiplication of Scenedesmus acutus. In higher doses (10x, 50x) at lower pH the inhibition increased, but in alkaline media the stimulation though weakened still persisted. Sodium sulphite exhibited in any instances a stronger inhibition in Scenedesmus acutus, and it was toxic for Sc. intermedius and Schizochlamys gelatinosa. Acidity augmented (nearly in a rate of 20-30%) its effectiveness, too (Table 1).

Unfavourable sulphuric compounds or amounts can act harmfully upon cell metabolism in many ways. Among them, more dangerous seem to be those which induce changes in the membrane systems (EDMUNDS et al. 1976) and generate free radicals (HUR and WELLBURN 1993) which arise singlet oxygen.

Cysteine alone displayed beneficial effects in both concentrations (1x, 10x) applied, though mostly in higher doses and dissolved in neutral and alkaline media. Acidity diminished also its favourable effects (Table 1). One could conclude from these data that the acidification in the environment, which can bring about by oxidized sulphuric compounds, might have a wider and more harmful effect than the polluting substances themselves. Cysteine, supplemented to the media together with sodium sulphite, overruled

Table 1

The effects of some sulphuric compounds and vitamin E on the growth and multiplication of *Scenedesmus acutus*, *Sc. intermedius* and *Schizochlamys gelatinosa* (relative values: E = extinction, Nr. = number of cells, Bi = biomass)

Algae	Compounds	Conc.	1x			10x			50x		
		pH Para- meters	5	7	9	5	7	9	5	7	9
<i>Scenedesmus acutus</i>	$\text{Na}_2\text{S}_2\text{O}_6$	E.	69	112	285	50	100	862	54	85	85
		Nr.	45	107	118	29	99	214	18	42	82
		Bi.	60	113	127	43	95	240	40	86	73
	Na_2SO_4	E.	77	85	230	63	262	392	69	85	230
		Nr.	61	85	134	44	73	152	22	47	140
		Bi.	47	73	173	42	57	166	25	46	180
	Na_2SO_3	E.	77	104	280	35*	46	192	19*	18*	32
		Nr.	53	80	141	15	18	137	12	21	22
		Bi.	66	83	130	15	20	126	12	20	24
<i>Scenedesmus intermedius</i>	Na_2SO_3	E.	*	70		*	*		*	*	
		Nr.		73							
		Bi.		75							
<i>Schizochlamys gelatinosa</i>	Na_2SO_3	E.	76	85		*	*		*	*	
		Nr.	66	80							
		Bi.	63	85							
<i>Scenedesmus acutus</i>	Cysteine	E.	131	154	231	119	277	500			
		Nr.	95	105	171	115	190	301			
		Bi.	93	106	160	120	200	280			
<i>Scenedesmus intermedius</i>	Na_2SO_3 + cysteine	E.	*	153		*	84		*	*	
		Nr.		135			75				
		Bi.		129			70				
<i>Schizochlamys gelatinosa</i>	Na_2SO_3 + cysteine	E.	109	137		*	90		*		
		Nr.	120	151			93				
		Bi.	110	139			85				
<i>Scenedesmus intermedius</i>	Na_2SO_3 + vitamin E	E.	*	(17)*		*	*		*	*	
		Nr.		9							
		Bi.		(27)*							
<i>Schizochlamys gelatinosa</i>	Na_2SO_3 + vitamin E	E.	60	93	*	*			*	*	
		Nr.	62	89							
		Bi.	55	97							
<i>Scenedesmus acutus</i>	Na_2CO_3	E.	77	200	246	146	300	335	50*	60*	38*
		Nr.	58	134	92	138	177	187	48	68	26
		Bi.	57	130	157	127	293	207	53	55	36
<i>Scenedesmus intermedius</i>	KL-solution (control)	E.	0.130								
		Nr.	3,350								
		Bi.	150								
<i>Schizochlamys gelatinosa</i>	KL-solution (control)	E.	0.095								
		Nr.	520								
		Bi.	205								
<i>Schizochlamys gelatinosa</i>	KL-solution (control)	E.	0.145								
		Nr.	1,130								
		Bi.	245								

Table 2

The influence of vitamin E on the growth and development of Scenedesmus intermedius and Schizochlamys gelatinosa (values in % compared to the control)

Concentrations		0.025	0.25	2.50	25.00	250	Ethanol 5 ml/200 ml	Ethanol + Na ₂ SO ₃	KL-solution (control)
Algae	Param.								
<u>Scenedesmus</u> <u>intermedius</u>	E.	726	863	1337	69	37	45		0.095
	Nr.	708	802	1260	56	35	15	18	521
	Bi.	695	776	1190	60	46	16	32	205
<u>Schizochlamys</u> <u>gelatinosa</u>	E.	648	531	1034	108	83	90	85	0.145
	Nr.	1177	1128	1604	97	79	85	77	1130
	Bi.	595	860	960	119	85	76	104	245
									= 100%

the noxious effects. Moreover, in the neutral solution and basic dosis (1x) of sodium sulphite it produced a significant stimulation (30–50%) in both algal species. Even in the higher concentration (10x) of sodium sulphite cysteine improved evidently the growth conditions of Schizochlamys gelatinosa and Scenedesmus intermedius (Table 1).

Cysteine can be beneficial in many processes. As a precursor of methionine and/or glutathione and phytochelatins it can favourize their biosyntheses. If in overoptimal amounts it can induce liberation of free sulphide (LEHNINGER 1976, SCHMIDT and JÄGER 1992). Most of ten cysteine promotes any process linked to the sulphur metabolism (NAGY-TÓTH and BARNA 1994). Pronounced specific sensitivity of different algal species (Coelastrium microporum, Oocystis borgei, O. solitaria, Scenedesmus bijuga, Chlorella vulgaris) toward cysteine was revealed long time ago and it was even used for isolation of unialgal cultures (BARKLEY 1956), and to improve synchronized division of some of them (EDMUNDS et al. 1976). Nevertheless, cysteine in excess becomes toxic, bleaching the cells (SCHMIDT and JÄGER 1992). However, this phenomenon did not occur in the present experiments.

Vitamin E alone in lower concentrations (0.025–0.25–2.50 mg/l) increasingly stimulated and then, in higher doses (25–250 mg/l), slowed the growth and multiplication (Table 2). Its best concentration seemed to be 2.50 mg/l. The effects were specific both in respect of stimulation and inhibition; Schizochlamys gelatinosa being more sensitive in stimulation, but not in inhibition. In spite of its favourable influence it diminished only moderately the harmful or toxic effects of the sodium sulphite. Its protective or repairing role was less than that of the cysteine. The species

specific reaction could be observed in this case, too; Schizochlamys gelatinosa responded more sensitively than Scenedesmus intermedius. This behaviour appears all the more interesting since toward oxidized sulphuric compounds Scenedesmus intermedius has had higher sensibility (Table 1).

It is evident, vitamin E occurs in algae; e.g. Anabaena cylindrica, Chlamydomonas reinhardtii, Chlorella vulgaris, Scenedesmus obliquus (AARONSON et al. 1977). But relatively few data are available about its role in the metabolism of plants, algae inclusively. Nevertheless, its antioxidant effects is rather well-known. It is able to remove singlet oxygen ($^1O_2^*$) from the cells by acting as a chemical scavenger (1 mol of vitamin E can remove 120 mols of $^1O_2^*$). In the antioxidant defence processes superoxide dismutases play key role. Their activities are strongly supported, among other substances, by vitamin E too (LEHNINGER 1976, OKADA et al. 1979, STAJNER et al. 1993). Pollutant gases (SO_2 , O_3) from anthropogenic atmospheric emissions can induce formation of damaging radicals which can be neutralized by vitamin E. Sulphuric compounds may also disbalance the absorption of those nutrient elements (e.g. N, K, P, Ca) on which the biosynthesis of vitamin E depends (SUNDQUIST et al. 1980).

Ethanol alone in the concentration of 25 ml/l (i.e. 5 ml/200 ml of nutrient solution, equivalent with the volume used to dissolve vitamin E), hindered the multiplication, especially that of Scenedesmus intermedius (Table 2). Together with sodium sulphite the harmful effects strengthened. This finding seems to contradict earlier results asserting the growth promoting effects of ethanol (CONRAD and SALTMAN 1964, DANFORTH 1964, PÉTERFI et al. 1968).

The variation of the biomass production

The amounts of biomass obtained cannot be correlated in every experimental condition with optical and cell densities since the different compounds, during the inhibition or promotion, produced specific consequences on the structure and dimension of the cells accomplished by division and development. Naturally, the biomass quantity varied considerably and significantly depending on algae, compounds and pH of media. Thus, the rate of inhibition caused by the oxidized sulphuric compounds in their basic doses varied, generally, between 10–30% by Scenedesmus acutus, 20–30% by Sc. intermedius and 15–40% by Schizochlamys gelatinosa. Similarly to the multiplication, in acidic media the effects were stronger than in alkaline ones.

Table 3

Pigment and soluble protein contents (given in % compared to the control) in *Scenedesmus intermedius* and *Schizochlamys gelatinosa* grown under the influence of sodium sulphite, cysteine and vitamin E

Compounds	Algae	<i>Scenedesmus intermedius</i>		<i>Schizochlamys gelatinosa</i>		
		Concs.		1x		
	Para-meters	1x	10x	1x	7	10x
	pH	7	7	5	7	7
Na ₂ SO ₃	chl. a	95		100	140	
	chl. b	100		110	140	
	carot.	100		100	136	
	Tot. pigm.	97		102	140	
	Protein	127		144	118	
Na ₂ SO ₃ + cysteine	chl. a	121	39	83	121	68
	chl. b	132	52	90	125	65
	carot.	119	38	86	114	6
	Tot. pigm.	123	42	121	98	88
	Protein	146	99	121	98	88
Na ₂ SO ₃ + vitamin E	chl. a	7		45	60	
	chl. b	16		65	100	
	carot.	19		6	6	
	Tot. pigm.	11		52	63	
	Protein	108		87	85	
KL-solution (control)	chl. a	0.57	} = 100%	0.47	} = 100%	
	chl. b	0.25		0.20		
	carot.	0.16		0.14		
	Tot. pigm.	0.98		0.81		
	Protein	10.49		8.46		

Thanks to the beneficial influence of cysteine the photosynthetic bioproduction was improved; viz. in a proportion of 20–100% by *Scenedesmus acutus* and about 30–40% by *Sc. intermedius* and *Schizochlamys gelatinosa* as well.

Modification in the chloroplast aspects and photosynthetic pigment contents

Under the unfavourable conditions of oxidized sulphuric compounds and acidic media the chloroplasts diminished, their margins became fringed, the surfaces looked granulated, the green colour paled till yellow (Table 3). Such modifications can hint on the changes in the structure of thylakoids and their pigment contents.

The total amount of the pigments in the cells of the control cultures did not show any remarkable specificity, as it was, otherwise, found in.

former researches (NAGY-TÓTH et al. 1980). Nevertheless, in Scenedesmus intermedius it was a little higher (with about 15--20%) than in Schizochlamys gelatinosa, due mainly to its chlorophyll-a content. Under the influence of the chemical compounds studied, both the total amounts and their proportion varied significantly.

Surprisingly, sodium sulphite, in its basic concentration, did not alter profoundly neither the quantity nor the quality of pigments in the cells of Scenedesmus intermedius, all the more (in a rate of 40%) in Schizochlamys gelatinosa, especially the chlorophylls. Somewhat a similar enhancement of chlorophyll-a and b content was produced by sulphur dioxide in Euglena gracilis, too (DE KONING and JEGIER 1970). In higher dosis (10x) the oxidized sulphuric compounds damaged drastically all the pigments and reduced (with more than 30%) their total amounts.

Cysteine added together with sodium sulphite brought about a somewhat increasing in Scenedesmus intermedius and contrary decreasing in Schizochlamys gelatinosa the pigment contents, however in this latter species they were a little higher than in the control culture.

Vitamin E did not improve neither the total amount nor the composition of the photosynthetic pigments damaged by sodium sulphite. Their contents became significantly lower than in the cells of the control culture. However, vitamin E alone in moderate concentrations (0.025--2.50 mg/l) stimulated (in a rate of 50--180%) biosyntheses, especially by Scenedesmus intermedius (Tables 2 and 3) revealing the specific sensitivity in respect of pigment contents, too (Table 4).

It is noteworthy to remind that the bioaccumulation processes were better by Schizochlamys gelatinosa whereas the pigment contents by Scenedesmus intermedius. Variation of pigment content might be influenced very closely by vitamin E. According to earlier researches, sulphur insufficiency can induce the growth of chloroplasts (SCHIFF 1964). Vitamin E favouring, directly or indirectly, the reduction (its chromanol groups being donors of H^+) of oxidized sulphuric compounds, can supply plenty of sulphur to the metabolism of the cells which would be able to reverse the consequences found in the present experiments, i.e. diminished amount of chloroplast constituents. But, vitamin E has to be closer linked to the processes disentangled by unpropitious sulphuric compounds. It is in the chloroplasts (MOTHES 1958), even in their envelope (1/3 part) and the thylakoid membranes (2/3 parts) as well (FRYER 1992). Exogenously added vitamin E is also incorporated into thylakoids (FRYER 1992). It prevents autooxidation of polyunsaturat-

Table 4

Variation of pigment and soluble protein contents (given in % related to the control) in Scenedesmus intermedius and Schizochlamys gelatinosa grown under the influence of vitamin E

Concentrations		0.025	0.25	2.50	25	250	Ethanol 5 ml/200 ml	Ethanol + Na ₂ SO ₄	KL-solution (control)
Algae	Parameters								
<u>Scenedesmus intermedius</u>	chl. <u>a</u>	293	288	265	5	11	14	6	0.57
	chl. <u>b</u>	288	284	168	8	20	24	14	0.25
	carot.	244	213	194	12	25	31	16	0.16
	Tot. pigm.	284	274	254	7	15	19	10	0.98
	Protein	131	158	179	59	61	100	83	10.49
<u>Schizochlamys gelatinosa</u>	chl. <u>a</u>	166	70	96	47	30	70	55	0.47
	chl. <u>b</u>	170	70	100	50	30	75	55	0.20
	carot.	150	57	71	50	29	79	6	0.14
	Tot. pigm.	164	68	93	48	30	73	55	0.81
	Protein	63	49	58	88	51	177	103	8.46
									= 100%

ed fatty acids (PUFAs), components of the thylakoid membranes, and protects catalase and superoxide dismutases which play key roles in antioxidant defence (LEHNINGER 1976, FRYER 1992, STAJNER et al. 1993).

Ethanol without vitamin E (but in the same volume) reduced the pigment content; nearly in the same proportion as the growth and multiplication.

Protein content

Protein content varied almost similarly as the pigments. Under the effect of sodium sulphite it was higher in all the algal species (Table 5). Toxic gases containing sulphuric compounds and heavy metal ions brought, among other changes, about increased protein content in forest tree leaves (BERCEA et al. 1993). Addition of cysteine to the sodium sulphite containing media stimulated somewhat the protein synthesis; but in Schizochlamys gelatinosa in acidic media only. Vitamin E in the presence of sodium sulphite did not repair the protein synthesis, though in proper concentration increased its content. Ethanol alone was more favourable than together with vitamin E (Table 4).

The considerable physiological difference in many regards between these two algal species might be traced back to their genuine specificity in protein content and composition as well; Schizochlamys gelatinosa in any condition excelled in its lowest protein content among the Transylvanian algal species (NAGY-TÓTH and BARNA 1987, 1989).

Table 5

The effect of the cultural liquids of different algal species grown a fortnight in nutrient media containing various sulphuric compounds on the germination (in % compared to the tapwater control) of Lactuca sativa cv. Luna seeds (germination potential, 24 h; germination faculty, 48 h)

Compounds	Concentrations		1x		10x	
	Algae	pH	5	7	5	7
		h				
Na ₂ SO ₃	<u>Scenedesmus acutus</u>	24	78	56	38	28
		48	100	91	60	77
	<u>Scenedesmus intermedius</u>	24	*	59	*	
		48	*	100	*	
	<u>Schizochlamys gelatinosa</u>	24	53	75		
		48	81	102		
Na ₂ SO ₃ + cysteine	<u>Scenedesmus intermedius</u>	24	*	25		12
		48		81		58
	<u>Schizochlamys gelatinosa</u>	24	6	3		9
		48	77	37		42
Na ₂ SO ₄ + vitamin E	<u>Scenedesmus intermedius</u>	24	*	*	*	*
		48	*	5	*	*
	<u>Schizochlamys gelatinosa</u>	24	*	*	*	*
		48	*	*	*	*
KL-solution (control)	<u>Scenedesmus acutus</u>	24		94		
		48		102		
	<u>Scenedesmus intermedius</u>	24		9		
		48		53		
	<u>Schizochlamys gelatinosa</u>	24		72		
		48		98		
Tapwater (control for germination): 100% = seeds						

*Inhibition

Morphological variations

They (morphoses, pleiomorphism) occur rather frequently by different algal species under the effects of life conditions. They could appear in peculiarly characteristic shape of cells or coenobia and sculptural elements. Among such algae Scenedesmus intermedius Chod. strain Kazán especially susceptible to pleiomorphic variations (NAGY-TÓTH 1987, NAGY-TÓTH and BARNA 1987). Certainly, pleiomorphic configurations were produced by sulphuric compounds, too.

In media containing sodium sulphite and cysteine, most of the coenobia of Scenedesmus intermedius were distortionated, twisted, atypically assembled because of changed cell shape (i.e. ellipsoidic or ovoid, irregularly swelled). Spines became either longer and frequently recurved or shorter, processus-like. Generally, these morphoses resemble to those appearing in cultures grown in media prepared with waste water from leather factory (NAGY-TÓTH 1987). Vitamin E did not abolish the appearance of unusual morphoses. In cultures grown in the presence of sodium sulphite and vitamin E there were frequent di- and monodesmoidic coenobia of puffed cells. Media containing vitamin E alone but in overoptimal doses brought about one-celled Chodatella-like thalli having supranumeraria spines, or four-celled scenedesmoidic Scenedesmus longispina resembling thalli provided with longer and stronger spines.

In cultures of Schizochlamys gelatinosa it was more difficult to ascertain any characteristic morphoses because of the spherical cells, lack of peculiar colonies and external cell wall ornamentations. Notwithstanding, in the cultures grown under unfavourable conditions there were striking differences in cell sizes and chloroplast structures; e.g. bladder-like cells with small chloroplast, or unusual small cells seemingly with fragmented chloroplasts.

Remanent effects of the cultural liquids

The liquids of the algal cultures, i.e. the cell-less used-up nutrient media can exert unfavourable effects on other organisms and their surroundings, respectively. Such liquids could become pernicious, firstly due to the excretion, especially under unfavourable life conditions, by algal cells of several organic micromolecular substances (DENFFER 1948, FOGG and WESTLAKE 1955, FOGG 1963, HESS et al. 1967, GIMMLER et al. 1969, BADOIR and WAYGOOD 1971, MIHNEA 1976), besides inorganic ions, and secondly, because of their ionic disbalance which is a consequence of the selective and unproportionated uptake (LAUDENBACH and GROSSMAN 1991).

The initial acidic (pH = 5) and neutral (pH = 7) nutrient solutions, under the influence of a fortnight growth of Scenedesmus intermedius and Schizochlamys gelatinosa, became alkaline (pH = 8–9). Their physiological quality has been ascertained by Lactuca sativa germination- and Sinapsis alba rootlets and hypocotyl elongation-tests (PILET 1961, BRUGOVITZKY and BOSICA 1967, BRUGOVITZKY et al. 1967). The data obtained varied depending on

Table 6

Rootlets elongation (in % compared to the control) of *Sinapsis alba* seedlings developed under the influence of cultural liquids of algae grown in media containing sulphuric compounds and vitamin E

Compounds	Concentrations Algae pH	1x		10x	
		5	7	5	7
Na ₂ SO ₃	<i>Scenedesmus acutus</i>	92	92	95	71
	<i>Sc. intermedius</i>	*	83	*	*
	<i>Schizochlamys gelatinosa</i>	83	89	*	*
Na ₂ SO ₃ + cysteine	<i>Scenedesmus intermedius</i>	*	94	*	97
	<i>Schizochlamys gelatinosa</i>	107	82	*	103
Na ₂ SO ₃ + vitamin E	<i>Scenedesmus intermedius</i>	*	*	*	*
	<i>Schizochlamys gelatinosa</i>	(44)	*	*	*
KL-solution (control)	<i>Scenedesmus acutus</i>		77		
	<i>Sc. intermedius</i>		87		
	<i>Schizochlamys gelatinosa</i>		91		
Tapwater (control for rootlets length): 180 mm = 100%					

*Inhibition

cultural liquids, the initial pH of the solutions, the algal species grown in them, and the biotests as well (Tables 5--8).

The seeds of *Lactuca sativa* germinated better in distilled water than in tapwater, and generally, better in both than in whichever cultural liquids or in Kuhl--Lorenzen's standard nutrient solution (Tables 5 and 8). The germination potential was more affected than the germination faculty; i.e. the differences were higher after 24 h, than after 48 h. The influence of acidity was better sensed by the liquids of *Schizochlamys gelatinosa*; which inhibited the germination if initially contained sodium sulphite, but not if it had cysteine (Table 5). The inhibition increased with the concentration of sulphuric compounds initially added. The effect attributed to the higher amounts was stronger than those owing to the composition of the compounds. Among the neutral cultural liquids (resulted from the Kuhl--Lorenzen's nutrient solution) that of *Scenedesmus intermedius* was doubtless inhibiting. The remanent effect of the vitamin E on the germination varied according to its initial concentration and in each case brought about inhibition (Table 8).

The rootlets elongation of *Sinapsis alba* displayed less differentiated results (Table 6). Excepting the liquid initially containing cysteine, all the others were below the tapwater control; those of Kuhl--Lorenzen's solu-

Table 7

Hypocotyl elongation (in % compared to the control of Sinapis alba seedlings modified by the cultural liquids of algae grown in different media

Compounds	Concentrations		1x		10x	
	Algae	pH	5	7	5	7
Na ₂ SO ₃	<u>Scenedesmus acutus</u>		176	181	123	140
	<u>Scenedesmus intermedius</u>		*	169	*	*
	<u>Schizochlamys gelatinosa</u>		178	182	*	*
Na ₂ SO ₃ + cysteine	<u>Scenedesmus intermedius</u>		*	143	*	129
	<u>Schizochlamys gelatinosa</u>		161	116	*	135
Na ₂ SO ₃ + vitamin E	<u>Scenedesmus intermedius</u>		*	*	*	*
	<u>Schizochlamys gelatinosa</u>		(24)	*	*	*
KL-solution (control)	<u>Scenedesmus acutus</u>			174		
	<u>Sc. intermedius</u>			165		
	<u>Schizochlamys gelatinosa</u>			195		
Tapwater (control for hypocotyl elongation)			248 mm = 100%			

*Inhibition

Table 8

Sensibility of different biotests (Lactuca sativa — germination, Sinapis alba — rootlets and hypocotyls elongation) to the cultural liquids of Scenedesmus intermedius and Schizochlamys gelatinosa grown a fortnight in nutrient solution containing vitamin E

Algae	Concs.		0.025	0.25	2.50	25	250	Ethanol 5 ml/200 ml	Ethanol + Na ₂ SO ₃	KL-solution (control)
	Biotests	h								
<u>Scenedesmus intermedius</u>	germin.	24	81	64	53	—	—	—	—	6 = 9%
		48	98	96	95	—	1	—	—	46 = 53%
	rootlets		92	103	115	(50)	(30)	—	—	157 = 87%
	hypocot.		185	139	162	(50)	(23)	—	—	409 = 165%
<u>Schizochlamys gelatinosa</u>	germin.	24	38	91	9	—	—	—	—	46 = 72%
		48	58	98	19	—	—	—	—	84 = 98%
	rootlets		78	62	62	(20)	(17)			164 = 91%
	hypocot.		137	126	108	(20)	(16)			483 = 195%
Tapwater (control)	germin.	24	64							
		48	86							
	rootlets		180 mm	= 100%						
	hypocot.		248 mm							

(...) germinated and developed after the time considered

tion implicitly. Vitamin E containing liquids revealed also an evident specificity; that of Schizochlamys gelatinosa inhibited, while the cultural liquid of the Scenedesmus intermedius seemingly did not influence the elongation of rootlets (Table 8).

The hypocotyl elongation of Sinapis alba did not similarly reveal unambiguous results about the remanent effects of sulphuric compounds and/or their residuals left in the cultural liquids (Table 7). Curiously, all of them were more favourable than the tapwater control, even that of vitamin E (Table 8). However, there were no clear differences depending on compounds or on algal species.

Conclusions

The effects of sodium sulphite (Na_2SO_3), sodium sulphate (Na_2SO_4) and sodium dithionate ($\text{Na}_2\text{S}_2\text{O}_6$) simultaneously and mutually with cysteine and vitamin E on Scenedesmus acutus, Sc. intermedius and Schizochlamys gelatinosa were investigated. Sulphuric compounds were used in 0.41 mM S (equivalent to that in the Kuhl—Lorenzen's nutrient solution) and in 10x and 50x higher concentrations, while vitamin E in 0.025--250 mg/l. All compounds were prepared in acidic (pH = 5), neutral (pH = 7) and alkaline (pH = 8.5--9) media variants.

Sodium sulphite was toxic for Scenedesmus intermedius and Schizochlamys gelatinosa in any condition, while for Scenedesmus acutus it was inhibitive. Its noxious effects could be ceased by cysteine, but weakened only by vitamin E. Cells grown in inhibitive conditions contained higher amount of protein, which in Schizochlamys gelatinosa decreased under the simultaneous influence of cysteine or vitamin E, while in Scenedesmus intermedius it was only reduced by vitamin E. Pigment content in Scenedesmus intermedius was comparable with that of control, but in Schizochlamys gelatinosa it was higher under the influence of sodium sulphite. Addition of cysteine increased, while vitamin E did not modify (Scenedesmus intermedius) or decreased (Schizochlamys gelatinosa) the amount of pigments.

Sodium sulphate in basic concentration in acidic and neutral media diminished, while in alkaline medium stimulated the growth and multiplication of Scenedesmus acutus.

Sodium dithionate proved to be harmful only in acidic media in 50x higher concentration.

Cysteine and vitamin E in appropriate concentrations stimulated the growth and multiplication of these algal species. Cysteine proved to be adequate in 0.41 mM S amount, while vitamin E in 2.50 mg/l. Both compounds improved significantly the unfavourable growth conditions of algae.

The cell-less cultural liquids of algae might be harmful for other organisms, as it was revealed by Lactuca sativa and Sinapis alba biotests.

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INFLUENCE OF VITAMINS AND NICOTINAMIDE NUCLEOTIDES ON THE INDUCTION OF RED COLOUR SHIFT IN DYER'S SAFFRON FLOWERS

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Eleven vitamins and four nicotinamide nucleotides were administered externally at various concentration (1-10,000 and 0.001-1,000 μM , respectively) to the slurries of a cultivar of *Carthamus tinctorius* L. (Benibana) flowers. After incubation for given intervals, their effects on red colour appearance were evaluated spectrophotometrically. Almost test vitamins restrict the reddening of flowers. Among them, ascorbic acid exhibits the strongest restriction (9.3% on average). Isoascorbic acid is a strong inhibitor (8.5%). Inhibitory action of orotic acid ranks next (5.3%). Biotin follows this (3.7%). Thiamin, pyridoxine and nicotinic acid reduce carthamin accumulation at far lesser levels (1.3, 0.4 and 0.2%, respectively). Only folic acid promotes the reddening, but its activity is negligible (promotion 1.0%). Nicotinamide nucleotides act on carthamin formation reducingly. The reducing action is pronounced in nicotinamide adenine dinucleotide (NAD^+) more strongly than nicotinamide adenine dinucleotide phosphate (NADP^+) (average inhibition 4.7 and 0.9%, respectively). The reduced forms seem to be unfavourable to appear red coloration rather than the oxidized ones (former: inhibition 5.7%, latter: promotion 0.2% on average). Negative contribution of test vitamins and nicotinamide nucleotides towards the colour modification in Benibana flowers are outlined on the basis of the experimental findings.

Introduction

Carthamin-instigated reddening of orange-yellow florets is one of the most important discriminative markers of *C. tinctorius* cultivars. Benibana is a typical cultivar, whose floral colour shifts by slow degrees from yellow to red in its life-cycle. The colour shift is manifested through various catalytic reactions (SAITO et al. 1983, SAITO 1992, SAITO and TAKAHASHI 1985). Some aspects of the transpigmentation reaction have been revealed by our recent studies, however, the finer mechanism still remains

Abbreviations: UV = ultraviolet light, VIS = visible light.

largely unknown. In particular, the functional characteristics of the bio-initiators including active metabolites have ever been suggested, but only partially. In addition to catalytic proteins (SAITO et al. 1985, SAITO 1993, SAITO and UTSUMI 1985_{a,b}), sugars (SAITO 1992), amino acids (SAITO and MATSUMURA 1993), amines and amides (SAITO and ENOMOTO 1995), ethers and alcohols (SAITO and KAWABATA 1995), esters and ketones (SAITO and MIYAKAWA 1994) are found to be contributory metabolites to affect flower colour modification. Our knowledge from recent chemosystematic works indicate that a vast variety of metabolites arise in plant tissues. Hence, other potent metabolites affecting the colour shift must be left unused. It seemed to be worthwhile to screen the bio-metabolites or others to specify the effective substances more systematically.

In this work, vitamins and nicotinamide nucleotides will be tested at various concentrations and their efficacies towards the floret colour modification evaluated spectrophotometrically.

Material and Methods

Chemicals

Nicotinic acid, thiamin hydrochloride, riboflavin, sodium pantothenate, pyridoxine, cyanocobalamin, orotic acid monohydrate, ascorbic acid, isoascorbic acid, biotin, nicotinamide adenine dinucleotide (oxidized or reduced form), nicotinamide adenine dinucleotide phosphate (oxidized or reduced form), potassium carbonate and acetone were purchased from Wako Pure Chemical (Osaka, Japan). Cellulose powders were obtained from Funakoshi Yakuhin (Tokyo, Japan). Other chemicals and reagents used were of all analytical grade of purity obtainable commercially. Water used was predistilled just before conducting experiments.

Plant material

Commercially obtained seeds of Benibana (Yamagata, Japan) were sown in our experimental field on April 27, 1993. After about three months' cultivation, bright-yellow tube flowers (223 g fresh mass) were harvested from freshly opened flowering heads and used immediately to the feeding experiments. Heat-denatured florets were prepared as follows: prior to the experiments, 0.5 g fresh florets were plunged into boiling methanol in a 30 ml flask, which was kept for 5 min at 92 ± 1 °C. After cooling, methanol was removed by pipetting off and dried in the air overnight at room temperature. The dried florets were used to the feeding tests.

Feeding tests

Distilled water (1 ml each) containing given concentrations of test vitamins (1–10,000 μ M) or nicotinamide nucleotides (0.001–1,000 μ M) was pipetted in a porcelain mortar. To the solutions, florets (0.5 g each) were dipped and crushed into small pieces with a pestle. After grinding for 5 min, the resulting slurries were left in the air for 25 min at 25 ± 1 °C to ensure floret reddening.

Estimation of induced carthamin contents

Red pastes were extracted three times with each fresh 20 ml 0.5% (w/v) K_2CO_3 . The extracts were acidified with 0.2 g citric acid. Cellulose powders (0.1 g each) were suspended in the acid solutions, stirred and centrifuged at 4,000x g for 5 min. The red pellets were washed with sufficient amounts of water (100 ml x3) through centrifugation (4,000x g, 5 min) and then treated with 50% (v/v) acetone. The pooled acetone layers (100 ml each) were used to the spectrophotometric estimation process. A Hitachi, model U-1100 was used to the spectrophotometric assay. The reference was 60% (v/v) acetone. The spectrometric readings at 521 nm were consulted with a calibration curve to calculate the induced carthamin contents. Final data were averaged from three to five repetitions of separate experiments.

Results and Discussion

Catalytically induced reddening of Benibana florets is known to be affected sensitively by various inorganic and organic chemicals, some of which are promotive and others are inhibitory. Manganese (II or III) acetate and potassium permanganate (SAITO 1991), hydrogen peroxide and hydrogen peroxide (SAITO and TAKAHASHI 1985), sugars (SAITO 1992), amino acids (SAITO and MATSUMURA 1993), ethers and some alcohols (SAITO and KAWABATA 1995) and esters and ketones belong to the former group. Various metal cations (SAITO et al. 1985), antioxidants (SAITO and TAKAHASHI 1985, SAITO 1993), phosphorous compounds (SAITO et al. 1985) and amines and amides (SAITO and ENOMOTO 1995) can be grouped as the latter member.

In this work, we noticed the efficacies of vitamins and nicotinamide nucleotides on the floret reddening of Benibana. The experimental data from feeding of eleven vitamins are summarized in Table 1. It is clear that, on the whole, vitamins tested at 1--10,000 μM levels restrict red colour appearance. Ascorbic and isoascorbic acids show the strongest inhibitory effects (inhibition 9.3 and 8.4%, respectively on average of five test concentrations). Orotic acid and biotin are also positive inhibitors (inhibition 5.3 and 3.7%, respectively). Inhibitory actions of riboflavin, pantothenic acid and thiamin reduce still more (inhibition 1.9, 1.9 and 1.3%, respectively). Far weaker inhibitions are seen in pyridoxine and nicotinic acid (inhibition 0.4 and 0.2%, respectively). Folic acid promotes floret reddening, but the activity is negligible (promotion 1.0% on average). Nicotinamide nucleotides affect floret red-shift in Benibana. The data of nucleotide addition to fresh florets at 0.001--1,000 μM levels are listed in Table 2. Here, inhibitory effects are also indicative in both nicotinamide adenine dinucleotide and nicotinamide adenine dinucleotide phosphate. Stronger inhibition is pronounced in the former (inhibition 4.7 and 0.9%, respectively

Table 1

Effect of vitamins on the reddening of dyer's saffron flowers

Vitamin	Fed (μ M)	Carthamin formed (μ g/ml)	Rate (% of control)
Nicotinic acid	1	17.1	3.0
	10	17.8	7.2
	100	16.1	- 3.0*
	1,000	16.6	0
	10,000	15.2	- 8.4
Thiamin	1	16.6	0
	10	16.5	- 0.6
	100	14.7	-11.4
	1,000	17.6	6.0
	10,000	16.5	- 0.6
Riboflavin	1	15.9	- 4.2
	10	16.3	- 1.8
	100	16.3	- 1.8
	1,000	16.5	- 0.6
	10,000	16.4	- 1.2
Pantothenic acid	0	16.3	- 1.8
	10	16.0	- 3.6
	100	15.6	- 6.0
	1,000	16.7	0.6
	10,000	16.8	1.2
Pyridoxine	1	16.5	- 0.6
	10	16.2	- 2.4
	100	16.7	0.6
	1,000	15.9	- 4.2
	10,000	17.4	4.8
Cyanocobalamin	1	17.6	6.0
	10	16.9	1.8
	100	16.8	1.2
	1,000	15.5	- 6.6
	10,000	16.2	- 2.4
Orotic acid	1	15.9	- 4.2
	10	17.2	3.6
	100	15.9	- 4.2
	1,000	16.1	- 3.0
	10,000	13.5	-18.7
Ascorbic acid	1	15.4	- 7.2
	10	15.8	- 4.8
	100	15.2	- 8.4
	1,000	16.3	- 1.8
	10,000	12.6	-24.1
Isoascorbic acid	1	16.8	1.2
	10	15.6	- 6.0
	100	15.7	- 5.4
	1,000	14.6	-12.6
	10,000	13.4	-19.3

Table 1 (cont.)

Vitamin	Fed (μ M)	Carthamin formed (μ g/ml)	Rate (% of control)
Folic acid	1	17.0	2.4
	10	16.0	- 3.6
	100	16.8	1.2
	1,000	16.8	1.2
	10,000	17.2	3.6
Biotin	1	15.9	- 4.2
	10	16.0	- 3.6
	100	17.0	2.4
	1,000	16.0	- 3.6
	10,000	15.0	- 9.6

*Inhibition.

Blank run observed in distilled water was 16.6 (μ g carthamin/ml).

on average). Their reduced forms seem to be unfavourable to induce red colour shift rather than the oxidized ones (former: inhibition 5.7%, latter: promotion 0.2% on average). Similar patterns are seen in the data obtained using dry florets (see Table 3).

Vitamins and nicotinamide nucleotides are well-recognized to be versatile functioning substances which participate in the biochemical catalyses of various important reactions known as oxidation-reduction, decarboxylation, transamination and racemization. The current results from the feeding experiments indicate that externally supplied vitamins and nicotinamide nucleotides act on the red colour appearance in Benibana flowers restrictingly. In general, the magnitude of the restriction activities is higher in redox functioning substances such as ascorbic acid (isoascorbic acid), riboflavin, thiamin, NAD^+ (NADH), NADP^+ (NADPH), folic acid and nicotinic acid (inhibition 3.7% on average). Perhaps, they exert their restrictive effects on the red colour appearance through alteration of redox potentials in the reaction system of floral tissues and/or cells — flower reddening and carthamin accumulation are known to be controlled by oxidation reactions (SAITO et al. 1983, SAITO 1993, SAITO and TAKAHASHI 1985). Of course, no participation of other control mechanisms can be omitted, because orotic acid, biotin, pantothenic acid and pyridoxine which work as cofactors of enzyme catalyzing decarboxylation, racemization, carboxylation, transamination or others also inhibit floret reddening (inhibition 2.8% on average).

Specifying the individual role of vitamins and nicotinamide nucleotides in the flower colour modification process seems to be possible by examining their effects at cell-free systems and/or enzyme levels.

Table 2

Effect of nicotinamide nucleotides on the reddening of fresh florets from dyer's saffron

Fed (μ M)	Carthamin formed (μ g/ml)				Rate (% of control)			
	NADP ⁺	NADPH	NAD ⁺	NADH	NADP ⁺	NADPH	NAD ⁺	NADH
0.001	14.8	16.2	15.5	17.3	-12.4	- 4.1	-8.3*	2.4
0.01	17.1	15.6	15.4	15.9	1.2	- 7.7	- 8.9	- 5.9
0.1	19.4	18.5	16.8	15.5	14.8	9.5	- 0.6	- 8.3
1	18.5	15.9	17.3	15.7	9.5	- 5.9	2.4	- 7.1
10	19.0	15.8	17.2	14.7	12.4	- 6.5	1.8	-13.0
100	16.4	14.9	15.6	15.6	- 3.0	-11.8	- 7.7	- 7.7
1,000	17.3	15.1	16.6	16.4	2.4	-10.7	- 1.8	- 0.3

*Inhibition

Blank run observed in distilled water was 16.9 (μ g carthamin/ml).

Table 3

Effect of nicotinamide nucleotides on the reddening of dry florets from dyer's saffron

Fed (μ M)	Carthamin formed (μ g/ml)				Rate (% of control)			
	NADP ⁺	NADPH	NAD ⁺	NADH	NADP ⁺	NADPH	NAD ⁺	NADH
0.001	1.6	1.6	1.2	1.5	0	0	- 2.5	- 6.3*
0.01	1.5	1.4	1.5	1.6	- 6.3	-12.5	- 6.3	0
0.1	1.5	1.5	1.6	1.7	- 6.3	- 6.3	0	6.3
1	1.6	1.8	1.5	1.5	0	12.5	- 6.3	- 6.3
10	1.3	1.5	1.4	1.7	-18.8	- 6.3	-12.5	6.3
100	1.8	1.5	1.4	1.5	12.5	- 6.3	-12.5	- 6.3
1,000	1.8	1.6	1.2	1.4	12.5	0	-25.0	-12.5

*Inhibition

Blank run observed in distilled water was 1.6 (μ g carthamin/ml).

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COMPARISON OF CARTHAMIN PRODUCTIVITIES IN DYER'S SAFFRON FLOWERS PROCESSED BY VARIOUS TECHNIQUES

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The florets of dyer's saffron were processed by various techniques and carthamin productivities were compared in the extracts from the reddened materials through an established method. KMnO_4 (200 nmol) was the most effective to induce carthamin in the fresh florets (increment 68%). H_2O_2 (200 nmol) followed this (increment 62%). Glucose oxidase (33 munit) came next (increment 34%). Acetone (5.2 mmol) showed inhibitory effect (inhibition 4%). Sono-oscillatory vibration of the floret pastes expedited the reddening. In citric acid/sodium citrate buffer (50 mM, pH = 3.0) at 25 ± 1 °C for 15 minutes' vibration, carthamin yield in the sonicated materials was promoted by 17% (1.2-fold) higher than that of the non-sonicated control. The instrumental vibration of H_2O_2 - or KMnO_4 -treated florets resulted in elevating carthamin productivities by further 63 and 31%, respectively. The utility of the applied techniques is assessed by referring to the practical use of carthamin as a red colorant for textile fabrics and processed foods.

Introduction

The results from the technical processing of raw materials have long been recognised to reflect directly or indirectly on the product yield. Many workers, therefore, select carefully efficient techniques before starting their works. To acquire a high product yield, vast varieties of methods have been reported in the publications, almost all of which are of great use to both experimental and practical fields.

The reddened florets of dyer's saffron (*Carthamus tinctorius*) are requisite raw materials for preparing carthamin dye (SAITO 1991). They have

Abbreviations: ODS = octadecyl silane, HPLC = high performance liquid chromatography, TLC = thin-layer chromatography, UV = ultraviolet light, VIS = visible light, i.d. = inner diameter.

usually been obtained by processing fresh florets of dyer's saffron through the traditional methods, where laborious works are inevitably practiced (SAITO 1990). Four improved procedures are now available: KMnO_4 - (SAITO 1991, SAITO and KATSUKURA 1992), H_2O_2 - (SAITO 1992, SAITO and TAKAHASHI 1993), glucose oxidase- (WADA and OTA 1986) and sonic oscillatory-method (SAITO and MIYAKAWA 1994). All above techniques indicate that carthamin can be obtained more easily at higher sizable levels. Hence, on selecting a protocol, comparative data, if available, would be convenient to obtain carthamin dye. However, no such direction has ever been appeared in the literature.

The present works are planned to compare carthamin productivities in the flower florets of dyer's saffron processed through currently available techniques.

Material and Methods

Materials

Fresh florets from dyer's saffron (240 g) were harvested in our experimental field on August 2-6, 1993. Carthamin was prepared from processed florets following the method of SAITO et al. (1992). Glucose oxidase from *Aspergillus niger* (practical grade for biochemical use, specific activity 201 units/mg), KMnO_4 , H_2O_2 , citric acid, K_2CO_3 and acetone were purchased from Wako Pure Chemical (Osaka, Japan). Avicel cellulose was purchased from Asahi Kasei Kogyo (Tokyo, Japan). Cellulose and silica gel TLC plates were obtained from Merck (Darmstadt, Germany). Other chemicals and reagents used were of all analytical grade of purity obtained separately from several commercial suppliers.

Instruments

A supersonic oscillator, Bransonic, model B-1200 (Yamato, Tokyo) was used to vibrate flower pastes. Two Hitachi spectrophotometers, model U-1100 (used for monitoring VIS absorbance change at 521 nm) and model U-3210 (used for registering UV/VIS absorbance from 300 to 600 nm) were used in this work. HPLC was conducted using a Jasco system component, 880 series furnished an ODS column (Wakosil 5C₁₈, 5 μm , 4x 250 mm i.d.).

Preparation of processed florets

Prior to conduct the experiments, aqueous solutions of 20 mM KMnO_4 , 10 mM H_2O_2 , 30% (v/v) acetone and 33 units/ml glucose oxidase were prepared. An aliquot of each solution (4-20 ml) was added separately to a weighed weight of fresh florets (1-5 g) in a porcelain mortar. The florets were crushed into small pieces with a pestle (maceration 5 min) and allowed to stand for 25 min at room temperature ($25 \pm 1^\circ\text{C}$) to induce red coloration in the floret pastes.

Supersonic oscillation of floret pastes

Fresh florets (0.5 g each) were crushed at 25 ± 1 °C to become fine pieces in 50 mM citric acid/sodium citrate buffer, pH = 3.0 (5 ml) with a porcelain pestle in a mortar, in which 20 mM KMnO_4 or 10 mM H_2O_2 had previously added. The porcelain mortar, which contains floret slurries was sealed tightly with a silicon film and placed in an oscillatory chamber, then it was sono-irradiated at 45 kHz for given intervals at 25 ± 1 °C.

Determination of carthamin contents

At the end of the incubation, the reddened pastes were transferred to 50 ml glass tubes and centrifuged for 5 min at 4000x g. After pipetting off the supernatant, the pellets were suspended in 50 ml distilled water and centrifuged again as previously done. The washing was repeated further twice, at each repetition, fresh 50 ml distilled water was replaced. The washed precipitates were suspended in 120–360 ml 60% (v/v) acetone, centrifuged for 5 min at 4000x g and the resulting acetone layers pooled. The acetone extraction was carried out 4–5 times and the combined extracts were taken up to a net 100–300 ml with 60% acetone, which were used to the spectrophotometric estimation of carthamin contents as described in one of our previous papers (SAITO et al. 1992). The rate of flower reddening was expressed as the amount of carthamin (% of control) and the specific value was defined as picomol carthamin per minute per millilitre.

Screening of reddish products

The processed florets from each treatment were subjected to the product isolation and partial purification, which were conducted following the method of SAITO et al. (1992). The products thus recovered were co-chromatographed with an authentic specimen on cellulose and silica gel TLC plates in (A) 1-butanol/acetic acid/water (4:1:2, v/v), (B) acetic acid/water (15:85, v/v) or in (C) phenol saturated with water. For HPLC analysis, recovered products and authentic carthamin (10–20 μl) were injected and developed in 2-propanol/acetone/water (3:1:1, v/v) with a flow rate of 0.3 ml/min at 40 °C in the column oven. The column elution was monitored at 520 nm. UV/VIS spectra were registered in 65% (v/v) methanol. The spectrophotometric data were used to the conventional identification process of the recovered products.

Results and Discussion

A protocol for preparation of useful metabolite(s) is usually presented in the literature, accentuating its specific utility at the practical application. On planning the extraction of plant products, if plural methods are available at the same time, workers eventually hesitate to decide what method is useful. In such a case, reports of comparative data on the procedure to be used are always helpful to carry out works quickly with success. For preparing carthamin, as already described above, four different procedures have already been reported, except for the routinely applied traditional methods. They are all useful, though as a matter of course, several good and weak points are seen in them.

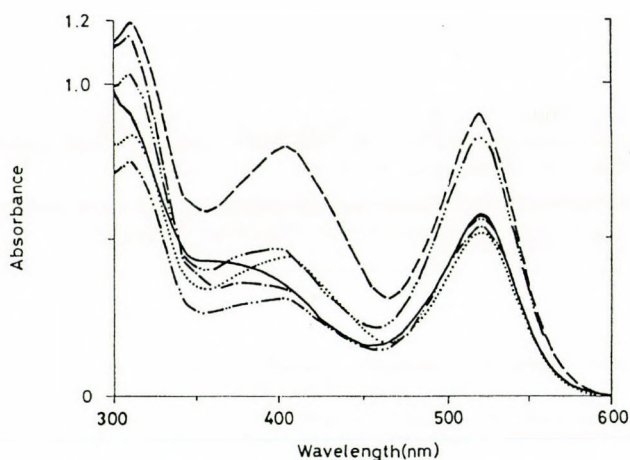


Fig. 1. UV/VIS spectra of induced products and an authentic carthamin. Induced products from the five different procedures were dissolved in 65% (v/v) methanol and the spectra recorded automatically in the absorbance range from 300 to 600 nm as shown in the figure. -----: H_2O_2 -induced product, -.-.-: KMnO_4 -induced product,: glucose oxidase-induced product, -....-: acetone induced product,: maceration product, —: authentic carthamin

In this experimental model, we reconducted the available protocols to compare directly their efficacies towards carthamin production. Preliminarily, a red dye obtained through processing florets with the selected protocols was identified by conventional three different methods, UV/VIS measurement, TLC and HPLC. Figure 1 shows UV/VIS spectra of induced products and an authentic specimen in 65% (v/v) methanol. The patterns are roughly coincident, showing a specific VIS absorption maximum of carthamin (521 nm). The data are endorsed by the results of chromatographies on cellulose and silica gel plates or on an ODS column (Table 1).

When reddened orange-yellow florets with the test protocols, the processed pastes show their characteristic carthamin productivities. Table 2 summarizes the results of carthamin yield through the different treatments. KMnO_4 is the strongest carthamin inducer (increment 68%) as reported in our previous communications (SAITO 1991, SAITO and KATSUKURA 1992, 1993a). A high production of carthamin is also brought by H_2O_2 — H_2O_2 efficacy is pronounced in a buffer solution (increment in H_2O : 48%, in 50 mM citric acid/sodium citrate buffer, pH = 3.4, 62%). Glucose oxidase can induce carthamin in dyer's saffron florets, but the efficacy is reduced further (increment 34%). Aqueous acetone has been reported to be effective to release precarthamin, a precursor of carthamin, from the triturated flower tissues

Table 1

Chromatographic behaviours of induced products and authentic specimen

Chromatography	Induced product Avicel cellulose					Carthamin	Induced product Silica gel					Carthamin
	1	2	3	4	5		1	2	3	4	5	
R_f -Value												
A	0.11	0.13	0.15	0.13	0.17	0.11	0.72	0.70	0.75	0.72	0.71	0.72
B	0	0	0	0	0	0	0.65	0.67	0.71	0.65	0.64	0.65
C	0.03	0.02	0.02	0.03	0.02	0.03	0.23	0.15	0.31	0.35	0.25	0.22
Elution time (min)	3.49	3.43	3.49	3.44	3.50	4.05	—	—	—	—	—	—
Pressure (kgf/cm ²)	59	62	58	57	59	57	—	—	—	—	—	—

A: 1-butanol/acetic acid/water (4:1:2, v/v), B: acetic acid/water (15:85, v/v), C: phenol saturated with water. 1 — H₂O₂-induced product, 2 — KMnO₄-induced product, 3 — glucose oxidase-induced product, 4 — acetone-induced product, 5 — maceration product.

Table 2

Comparison of carthamin productivity in reddened dyer's saffron florets processed by different techniques

Method	Carthamin formed (pmol/mL/min)	Net increment (% of control)
H ₂ O ₂ (water)	119.2 ± 8.9	48.1
H ₂ O ₂ (citric acid/citrate)	130.0 ± 13.8	61.5
KMnO ₄	135.3 ± 10.9	68.1
Glucose oxidase	107.7 ± 4.8	33.8
Acetone (30%, v/v)	40.8 ± 3.2	-49.3*
Citric acid/citrate buffer	81.6 ± 2.1	1.4

*Decrease

Control: 80.5 ± 5.7 (pmol/mL/min).

(SAITO 1993, SAITO and KATSUKURA 1993b). The attempt to induce carthamin formation by acetone, however, is not successful. The organic solvent acts on floret reddening rather inhibitorily (inhibition 49%).

The application of electromagnetic radiation of floral pastes has been shown to be a promising technique to induce carthamin decomposition (SAITO et al. 1990), precarthamin mobilization (SAITO and MIYAKAWA 1995) and carthamin formation (SAITO and MIYAKAWA 1994). To re-assess the sono-oscillatory effect, floral pastes were exposed to supersonic vibration in a short time. Under the condition of the present study (irradiation at 45 kHz for 15

Table 3

Effect of supersonic oscillation on the reddening of flower florets. Incubated in citric acid/sodium citrate buffer at various pH values

pH Value	Carthamin formed (pmol/ml/min)	Net increment (% of control)
3.0	155.0 $\pm$ 8.4	92.5
4.0	143.4 $\pm$ 15.2	78.1
5.0	138.2 $\pm$ 8.2	71.7
6.0	143.0 $\pm$ 10.8	77.6

Non-sonicate control: 80.5 $\pm$ 5.7 (pmol/ml/min). Incubation was done at 25 $\pm$ 1 °C for 15 min. The data are shown from three to four separate experiments.

Table 4

Effect of supersonic oscillation on the reddening of flower florets in the presence of H₂O₂ or KMnO₄

Chemicals	Incubation (min)	Carthamin formed (pmol/ml/min)	Net increment (% of control)
H ₂ O ₂	15	180.8 $\pm$ 17.0	124.6
H ₂ O ₂	30	141.2 $\pm$ 11.9	75.4
KMnO ₄	15	160.6 $\pm$ 8.6	99.5
KMnO ₄	30	160.0 $\pm$ 9.9	98.8

Non-sonicate control: 80.5 $\pm$ 5.7 (pmol/ml/min). Incubation was done at 25 $\pm$ 1 °C for given intervals as indicated in the table. For further details of the experimental conditions or others, see Material and Methods.

min at 25 $\pm$ 1 °C), carthamin yield is leveled up by 16.9%. Further prolonged irradiation is rather unfavourable to carthamin production. Decrease in carthamin yield perhaps comes from the expeditious degradation of carthamin, because alternative activities are involved in carthamin metabolism — one controls carthamin formation (SAITO et al. 1985, SAITO 1993) and another catalyzes carthamin decomposition (KANEHIRA and SAITO 1990). The sono-sound effect is sensitive to pH values in the maceration media (Table 3). At present works, flower pastes vibrated in 50 mM citric acid/sodium citrate, a pH = 3.0 is most promising (increment 12.0% compared with non-sono-treated control). A marked increase in carthamin production is clear by the addition

of H_2O_2 (increment 63.1%) or KMnO_4 (increment 31.4%) (see Table 4). Here, longer radiation of sono-sound on floret pastes results in reducing carthamin yield -- decreases in carthamin yield observed by further 15 min sono-sound radiation (% obtained by subtraction from the initial 15 min irradiation) were: H_2O_2 -containing batch (49.2), KMnO_4 -containing batch (0.70%).

Considering above results, sono-oscillatory treatment of floret pastes is most promising to induce a high yield of carthamin dye. In the presence of KMnO_4 or H_2O_2 , carthamin productivity is increased further. Time intervals for completing over-all process can be shortened considerably. No microbial spoilage of the starting materials is brought. The instrumental treatment is simple and easy. In case of with no-sono-oscillator, the KMnO_4 -method (SAITO 1991) seems to be the most useful technique. KMnO_4 is an useful chromogenic reagent for reddening florets. It reddens orange-yellow florets swiftly at relatively lower concentrations. The method is easy and simple. The costs are beneath notice. The H_2O_2 -method (SAITO 1992) is promising. It is simple and costless. No noxious by-products are generated during the operation process. A patented glucose oxidase-method (WADA and OTA 1986) is contributive to induce carthamin dye in fresh floret pastes, though carthamin yield is relatively low (see Table 2). The enzymatic method seems to be somewhat disadvantageous: the reaction is affected by external factors, the cost is too expensive to apply for practical use.

The present experiments assess the improved protocols for preparing carthamin dye in fresh florets of dyer's saffron. Carthamin thus obtained can be used to dye textiles, cosmetic goods and processed foods. On following the specified technique, ample dye is produced easily and freely. Carthamin, one of the highest priced red dyes, will be supplied no doubt at a very low cost in no distant future.

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EFFECT OF SALT STRESS ON SOME ANTINUTRITIONAL FACTORS IN AMARANTHUS SPECIES

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Oxalate and nitrate are regarded as antinutritional factors in many vegetable crops including Amaranthus. Since salinity is known to cause several metabolic disorders in plants, it was thought worthwhile to study influence of salinity on the level of these two metabolites in leaves of three Amaranthus species (A. caudatus (L.), A. hypochondriacus (L.) and A. paniculatus (L.)). The plants were raised in field plots and subjected to increasing salinity treatments ($\text{NaCl} + \text{CaCl}_2$) ranging from 4 to 16 ECe (mS cm^{-1}). The analysis of oxalate and nitrate in salt treated plant was made at vegetative and flowering stage. The level of total oxalic acid and soluble oxalic acid fraction was found to be lowered by salt treatment at both stages and this decrease was more pronounced in A. hypochondriacus. Salinity also brought about marked decline in the amount of nitrates in the leaf tissue in all the three Amaranthus species. These observations indicate that the salt stressed Amaranthus plants are not inferior in nutrition quality so far as oxalate and nitrate levels are concerned.

Introduction

Nitrate and oxalic acid have been regarded as antinutritional factors in leafy vegetables especially when they are consumed in large quantities. The high intake of nitrate has been considered as a possible cause of methamoglobinemia after reduction of the nitrate to nitrite (SCHMIDT et al. 1971). The reduction of nitrate to nitrite is possible by bacterial action or by other enzymatic activity in vegetable leaves during the post harvest period or at high pH values in association with diarrhea in the intestinal tract of infants (SHUPHAN et al. 1967). The negative importance of soluble oxalic acid in vegetable is due to its ability to withdraw calcium from other foods (BENGTSOON 1969). High oxalate content is suspected to increase the incidence of urinary calculi, oxalemia and axaluria (DEMPSEY et al. 1960, SENGBUSH et al. 1965). RODRIQUEZ et al. (1985) noticed that oxalates present in wild forage causes hypocalcemia when they are ingested in significant quantities. Amaranth is also considered as an oxalate and nitrate ac-

cumulating crop (SCHMIDT et al. 1971). SUVACHITTANONI et al. (1973) reported an incidence of urinary bladder stone disease in North East Thailand when Amaranthus rich in oxalate (33 gKg^{-1} on F.W. basis) was ingested. In the present study an attempt has been made to study the influence of salinity on these two antinutritional factors of vegetable and grain type amaranths.

Material and Methods

The seeds of Amaranthus hypochondriacus (L.) (AG-114) NBRI evolved, A. paniculatus (L.) and A. caudatus (L.) were obtained through the courtesy of NBRI Lucknow and from local stock, respectively. Seeds were sown in field plots and subjected to $\text{NaCl} + \text{CaCl}_2$ stress after establishment of seedlings for two weeks. Then plots were irrigated alternating with tapwater and salt water of 4, 8, 12 and 16 ECe. (mS cm^{-1}). These four concentrations of $\text{NaCl} + \text{CaCl}_2$ were prepared according to standard procedure described in USDA, Handbook-60. Control plants received only tapwater. The plants were treated with increasing levels of $\text{NaCl} + \text{CaCl}_2$ twice a week, alternating with watering the plants with equal amount of water to avoid salt accumulation and to check the loss of water due to evapotranspiration. The leaves were harvested at two stages namely vegetative (after 28 days) and flowering stage and oven dried. The nitrate content was estimated following the method of CATALDO et al. (1975). The oxalic acid was fractionated into soluble and insoluble fraction as described by BENGTSSON et al. (1966) and estimated following the method of ABAZA et al. (1968). The values depicted in Figures represent means of three determinations.

Results and Discussion

Effect of salinity on nitrate content in leaves of the three Amaranthus species is depicted in Fig. 1. It can be seen from the figure that leaf nitrate content in control plants of the three Amaranthus species are in the order, A. caudatus > A. paniculatus > A. hypochondriacus at vegetative stage and A. paniculatus > A. hypochondriacus > A. caudatus at flowering stage. It is clear from the figure that nitrate content in leaves of the three Amaranthus species is reduced due to increasing doses of salinity at both vegetative and flowering stages. This decrease is more prominent in A. paniculatus. Although accumulation of nitrate under saline conditions has been reported in some plants like bean (FROTA and TUCKER 1974), in several other plant species decrease in the nitrate content due to salinity has been noticed. The NO_3^- concentrations are always found to decrease with increasing accumulation of Cl^- under salinity in Phaseolus aureus roots (IMAMUL HUQ and LARHER 1983). PEREZ-ALFOCEA et al. (1993) also reported decrease in NO_3^- level due to salt stress in cultivars of Lycopersicon esculentum and L. pennellii. BANULS et al. (1990) reported that in Citrus inhibition of NO_3^- up-

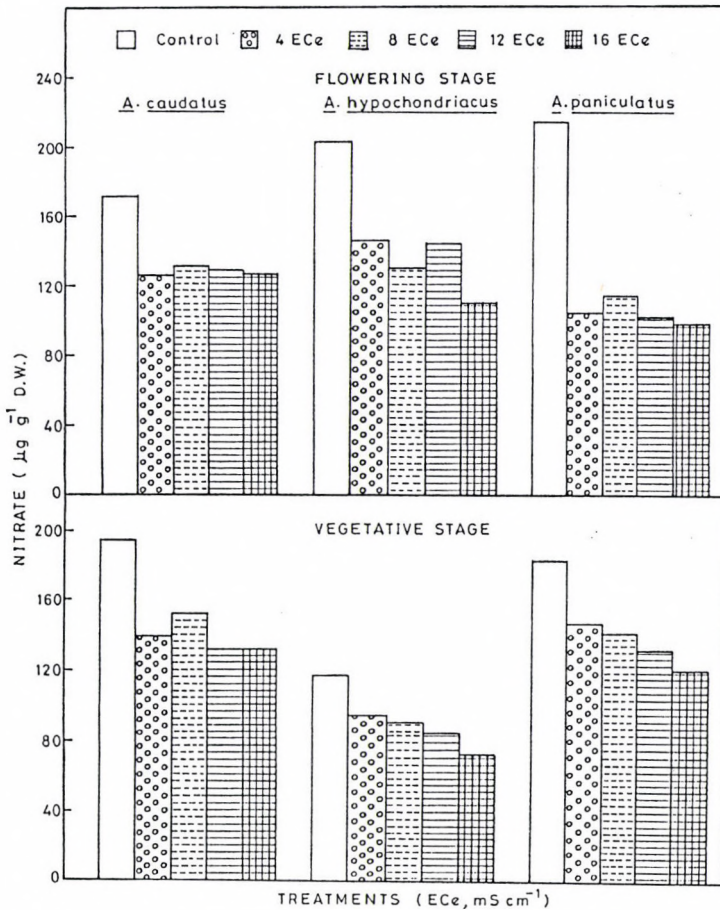


Fig. 1. Effect of salinity on nitrate content in leaves of three *Amaranthus* species

take was due to Cl^- under NaCl salinity. HALAL et al. (1975) admitted that whether reduction in nitrate content in salt stressed barley is due to higher NO_3^- reduction or to reduced uptake of labelled NO_3^- from the nutrient solution could not be deduced from their experimental results. Whatsoever may be the reason for decline in nitrate level under saline conditions, it is certainly advantageous in vegetable crops from the point of human consumption. *Amaranthus* foliage is reported to contain 0.67% to 0.98% nitrate (SCHMIDT et al. 1971). Our observations indicate that nitrate contents in leaves of salt stressed plants are far below these levels.

Effect of salinity on different oxalic acid forms in leaves of the three *Amaranthus* species is depicted in Figs 2 and 3. From the figures it is

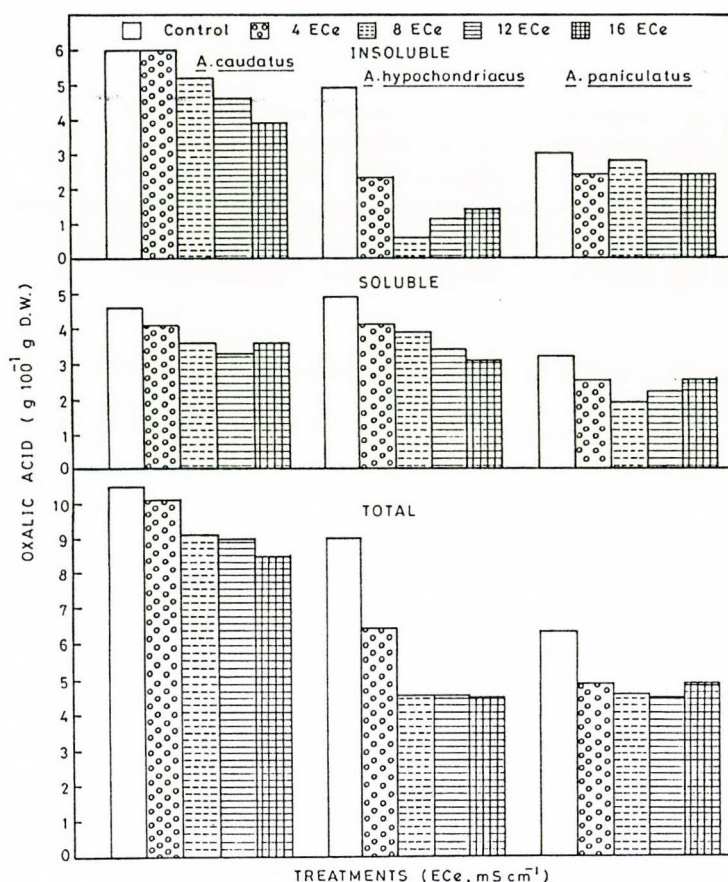


Fig. 2. Effect of salinity on oxalic acid content in leaves of three *Amaranthus* species at vegetative stage

obvious that total oxalic acid content in leaf tissue of *A. caudatus*, *A. hypochondriacus* and *A. paniculatus* is decreased with increasing salinity treatments at both vegetative and flowering stages. But at flowering stage we find quite inconsistent pattern of oxalic acid accumulation in leaves of salt stressed *A. caudatus* plants. Soluble oxalic acid fractions were decreased both at vegetative and flowering stages in all the three *Amaranthus* species with increasing salt doses. Insoluble oxalate fraction in *A. caudatus*, *A. hypochondriacus* and *A. paniculatus* leaf tissue were decreased with increasing salinity treatments at vegetative stage whereas, insoluble oxalate fraction shows increase in leaves of all the three *Amaranthus* species under saline conditions at flowering stage. *Amaranthus* is found to be one of

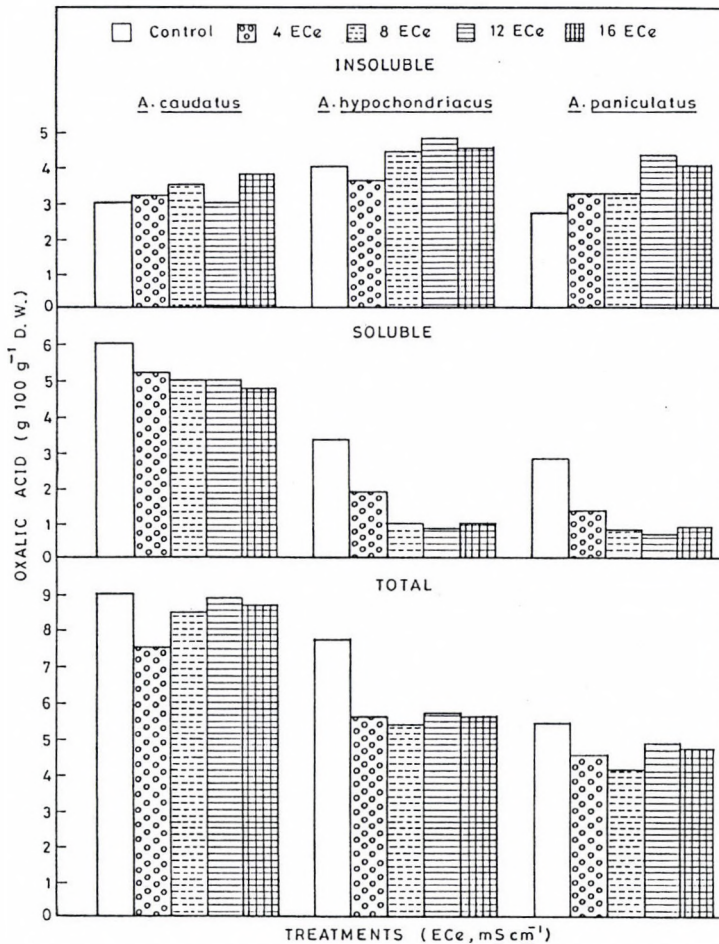


Fig. 3. Effect of salinity on oxalic acid content in leaves of three *Amaranthus* species at flowering stage

the oxalate rich plant species. The values of oxalic acid in leaves of the different *Amaranthus* species recorded by different workers were in the range of 7.1 to 9.1% total oxalic acid on dry weight basis (MATHAMS and SUTHERLAND 1952, MARSHALL et al. 1967, VITYAKON and STANDAL 1989). The leaf oxalate level recorded in the present investigation is higher than this range particularly at vegetative stage in *A. caudatus* and *A. paniculatus*.

AUSTENFELD (1974) noticed that oxalate content reduced up to 50 mm NaCl salinity treatments in *Salicornia europea* while it was not affected due to higher doses of NaCl treatments. SING (1974) observed decrease in oxalic

acid content with increasing NaCl salinity in Chenopodium album and suggested that Cl^- or other anions if available compete for cations and depress the oxalate synthesis. KARADGE (1981) also made similar observations with Portulaca oleracea and noticed that a continuous drop in the K^+ as well as Ca^{2+} content in the salt-treated leaves might affect the total oxalate content and specifically bound oxalic acid. Our observations also indicate that salt stress has caused appreciable lowering of total oxalic acid in all the three Amaranthus species as have been observed in other oxalate accumulating species such as Chenopodium, Salicornia and Portulaca. At the same time we can find that fate of the two oxalate fractions (soluble and insoluble) differ under saline conditions particularly at flowering stage. Thus there is a decline in soluble fraction in salt-stressed plants, while insoluble oxalate content has increased. We have seen that at this stage there is considerable increase in Ca^{2+} level in the leaf tissue of salt stressed Amaranthus plants (data not shown). Hence the increase in insoluble oxalate can be at least partially explained as a possible way to trap excess Ca^{2+} . Thus only at the flowering stage, oxalate partitioning in soluble and insoluble fractions has been altered by salinity in all the three Amaranthus species, while there is decrease in overall oxalate content. ZINDLER-FRANK (1976) assumed that aspartate former C_4 monocots and malate former C_4 dicots accumulate oxalate. Amaranthus is a C_4 dicot and it is an aspartate former but still an oxalate accumulating species. According to GILFORD (1974) high productivity of C_4 species Pennisetum purpureum might not only depend on efficient photosynthesis but also on the fact that it does not channel part of its carbon into oxalate. In C_4 species generally there are low rates of photorespiration. Hence, the synthesis of oxalic acid may be taking place from precursors such as oxaloacetate or ascorbate (NUSS and LOEWUS 1978) rather than glycolate. The decline in total oxalic acid under saline conditions in the three Amaranthus species clearly suggest that less carbon is diverted towards the synthesis of this organic acid under such situation. Similarly decline in soluble oxalic acid in salt stressed leaves also rule out the possibility of involvement of this organic acid in osmoregulatory process as observed in case of Atriplex (OSMOND 1966).

Recently VITYAKON and STANDAL (1989) studied forms of oxalate in Amaranthus gangeticus and implication of oxalic acid for human health. They suggested that attempts should be made to reduce soluble oxalate to minimise toxic effects. According to these authors this can be achieved by manipulating the soil nutrient environment, increasing soil Ca^{2+} , decrease or un-

changed K^+ should be useful for this purpose. We noticed that in case of Amaranthus increasing salinity treatments decreased soluble oxalate fraction. Thus, Amaranthus plants raised in saline fields appear to be less harmful as vegetable as far as this antinutritional factor is concerned.

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PHYSIOLOGICAL STUDIES IN NITROGEN METABOLISM OF GROUNDNUT
(ARACHIS HYPOGAEA L.) I — ENZYME NITRATE REDUCTASE

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The behaviour of enzyme nitrate reductase in two groundnut cultivars JL-24 and TMV-10 was studied employing an *in vivo* technique. The analysis of enzyme activity in leaves during different growth stages revealed a peak of enzyme activity in one month old plants. The enzyme activity in leaves displayed diurnal variations with a peak at 1.00 p.m. and very low activity during dark period. Substantial enzyme activity was detected in roots, nodules, stem, petiole, gynophore and pods in mature plants of both the cultivars. Possible role of this enzyme in nitrogen metabolism of groundnut is discussed.

Introduction

Enzyme nitrate reductase (Ec 1.6.6.1) which brings about reduction of nitrate to nitrite is regarded as a rate limiting step in the assimilation of nitrogen (HAGEMAN 1979). Like other legume species groundnut is also bestowed with the capacity of biological nitrogen fixation. However, nitrogen fixation in grain legumes seems to be limited by the amount of photosynthate available, which appears insufficient to support simultaneously the reduction process and grain production especially under environmental constraints. It is argued that the possibility of using both biological nitrogen fixation and nitrogen fertilizer may be one of the strategies to attain high yields at relatively low cost (FRANCO and MUNNS 1982). The seasonal patterns of nitrate uptake and reduction and the patterns of nitrogen fixation in soybean and phaseolus bean indicate that the process of nitrate assimilation and nitrogen fixation are successive events, each contributing nitrogen at defined stages of plant development (FRANCO et al. 1978, HARPER and HAGEMAN 1972, THIBODEAU and JAWORSKI 1975). However, such studies in case of groundnut are limited. The present investigation represents one such attempt in this direction.

Material and Methods

Healthy seeds of groundnut cultivars JL-24 (Spanish bunch) and TMV-10 (Virginia bunch) were sorted out and sown in the field of botanical garden in Kharif (June) and Rabi (January) season. The plants were properly irrigated and every care was taken to raise disease free plants. After every fifteen days nitrate reductase activity in the leaves at identical position on the field grown plants was studied. Three such assays gave the mean value of the NR activity in leaves at respective growth stage. The experiment was continued for 3 months up to the maturity of crop in both seasons. For study of diurnal variation in enzyme activity, leaves of three months old plant were removed from identical positions at different time intervals of the day. This experiment was conducted for 3 consecutive days. To study distribution of enzyme activity in different plant parts in kharif season; the three months old plant of both cultivars were carefully uprooted in the morning hours and they were separated into different plants parts, i.e. roots, nodules, stems, leaves, gynophores and pods for assay of enzyme activity. For study of nitrate reductase *in vivo* method of JAWORSKI (1971) as described by KNYPL (1974) was followed with slight modifications. Leaf discs of one cm diameter were cut with the help of leaf punch, while other plant parts (root, stem, gynophore and pods) were cut into small pieces. 500 mg of the plant material was suspended in 10 ml of incubation medium containing 0.2 M phosphate buffer (pH = 6.2), 20 mM KNO_3 , 5% (v/v) n-propanol and 1.25% triton-x-100 in sealed jars and incubated at 25 °C in the dark for 60 minutes. NR activity was measured by determining the NO_2 production which was detected by treating 0.4 ml of the incubation mixture with 0.3 ml each of 1% sulfanilamide in 2 N HCl and 0.02% N(1-naphthyl) ethylene diamide hydrochloride. After 20 minutes the solution was diluted to 4 ml with distilled water and the absorbance was read at 540 nm on Shimadzu double beam spectrophotometer. The amount of nitrite was estimated from a standard curve of sodium nitrite prepared in a similar manner.

Results and Discussion

Figure 1 records the changes in NR activity in leaves of groundnut cultivars JL-24 and TMV-10 during different growth phases in kharif and rabi seasons, respectively. It is clear from the figure that leaves of one month plants display maximum NR activity in case of both varieties and this peak period of enzyme activity is seen in both kharif as well as in rabi season. The enzyme activity shows a sharp decline in a later phases of growth which are marked by pod development. A behaviour of nitrate reductase during growth of few legume species has been investigated by some workers. HATMAN (1981) observed a peak enzyme activity at 24 days stage in soybean cultivar "Altona". SINHA et al. (1978) found that NR activity in the leaves of *Vigna radiata* increased from seedling stage onwards and was maximum during early fruit development stage. It further showed a decline at pod filling stage. In another legume *Phaseolus vulgaris* also FRANCO et al. (1979) found a maximum NR activity at flowering stage. The behaviour of NR in above groundnut cultivars similar to that of soybean indicates the possibility that like soybean here also nitrate reduction is more important at the pre-flowering stage.

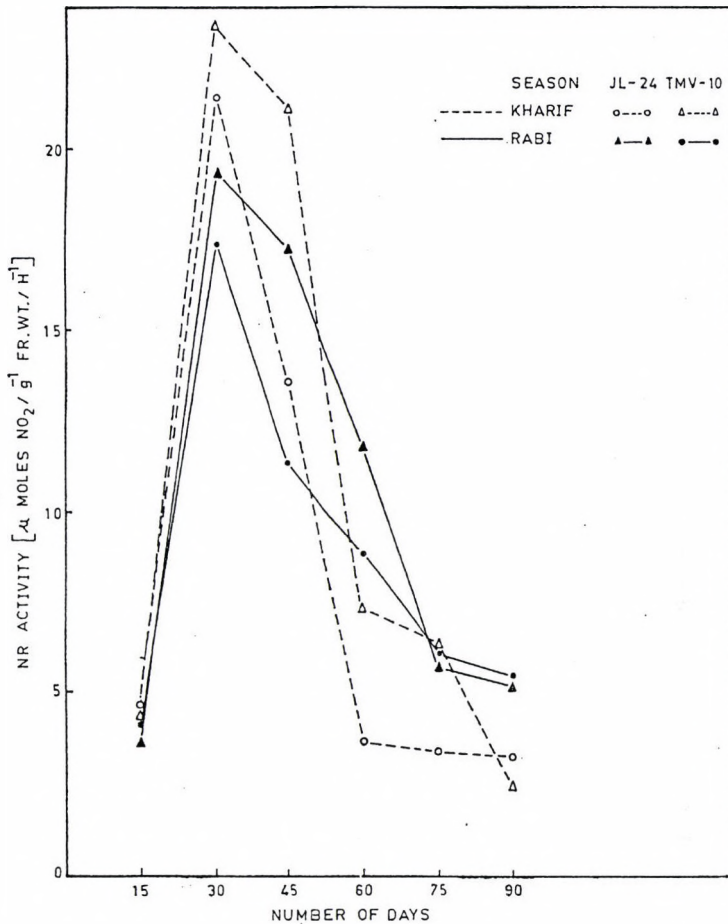


Fig. 1. Changes in NR activity in leaves of groundnut cultivars JL-24 and TMV-10 during different growth phases in kharif and rabi seasons

The changes in NR activity in leaves of groundnut cultivars JL-24 and TMV-10 during different hours of the day are recorded in Fig. 2. We can find from the figure that there are definite diurnal variations in the enzyme activity and the activity is low during dark period as compared to light period. The enzyme activity attains a peak at 1.00 p.m. in case of both the cultivars and the lowest enzyme activity is recorded at 1.00 a.m. during night. There are several reports of diurnal variations in NR activity (SHIBATA et al. 1969, KRASTINA et al. 1983, LILLO 1984).

Among legumes such variations have been reported for soybean and winged bean by HARPER and HAGEMAN (1972), MUNJAL et al. (1983). According to

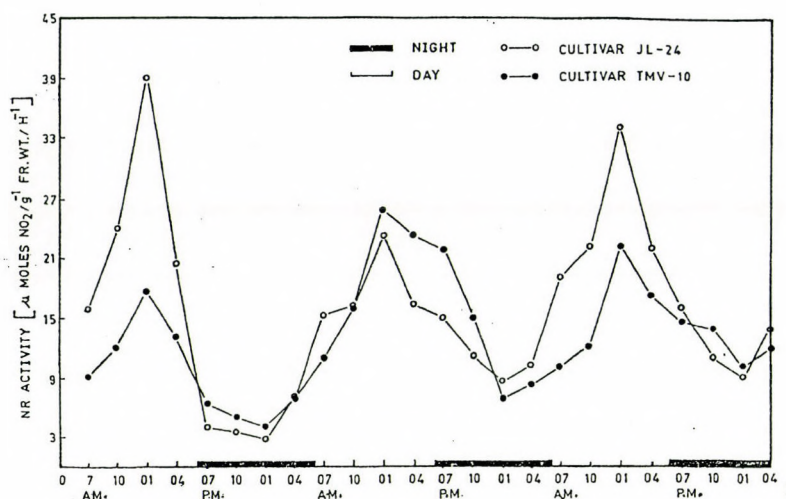


Fig. 2. Diurnal variations in *in vivo* nitrate reductase activity in leaves of groundnut (*Arachis hypogaea* L.) cultivars

LILLO (1984) diurnal variation in the enzyme activity seems essential as a metabolic regulation mechanism mainly for nitrate reductase activity. KAISER et al. (1993) found that when spinach leaves were harvested during a normal day night cycle, extractable NRA was low during the night and high during the day time. According to them these diurnal changes can be attributed to protein phosphorylation/dephosphorylation mechanism rather than a rapid protein turnover. DE CIRES et al. (1993) indicated that the level of carbon assimilation products like hexose and triose phosphate possibly regulate the NR activation system and mediate light-dark modulation of the enzyme.

Activity of NR in different parts of groundnut cultivars JL-24 and TMV-10 in different seasons is recorded in Fig. 3. It is evident from our findings that all parts of groundnut are capable of nitrate reduction. Among these parts leaf shows maximum NR activity and this is quite obvious in the view of close association of this enzyme with photosynthetic process. In stem and root parts also considerable enzyme activity is detected. ANDREWS et al. (1984) based on work with six legume species namely lupine, pigeon-pea, pea, broad bean, soybean and kidney bean suggested that stem tissue can contribute significantly to overall nitrate metabolism. Our findings with groundnut also indicate similar trend. It is interesting to note here that the reproductive parts especially, gynophore and the fruiting structures display significant NR activity. Occurrence of NR activity in the pericarp

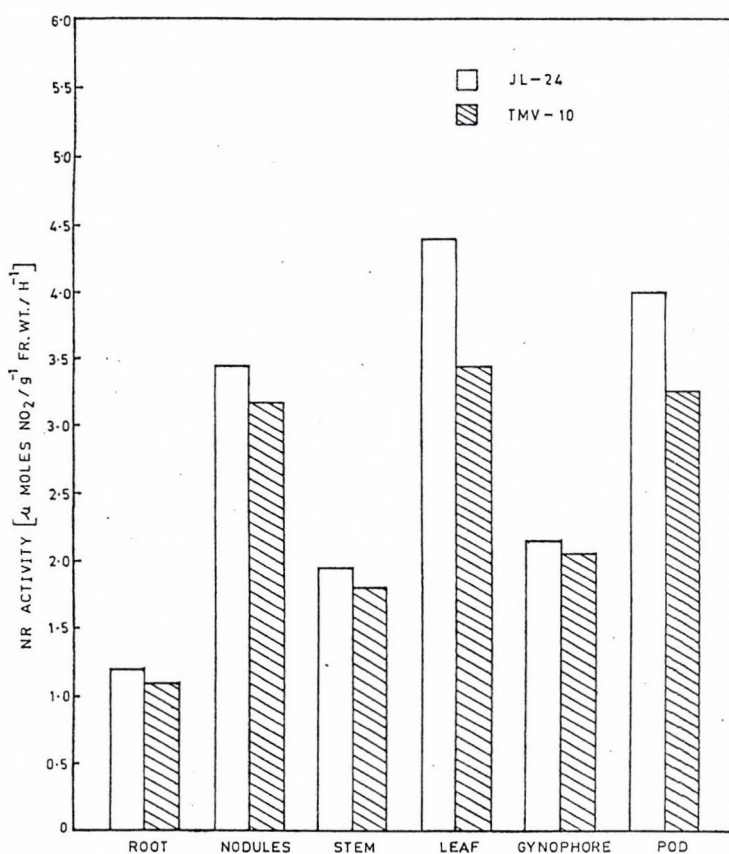


Fig. 3. Nitrate reductase activity in different plant parts of groundnut cultivars JL-24 and TMV-10

of legume fruits has been noticed by several workers with the help of in vivo technique as well as by in vitro assays of enzyme activity (SCHLESIER 1977, SAINIS and SANE 1978, STREIT and FELLER 1982). Pericarp ascribed a key role in nitrogen economy of these legume fruits SCHLESIER (1977). In groundnut occurrence of NR in gynophore and fruiting structure is particularly significant in the context of underground pod development. Thus these findings for the first time indicate that the developing pod along with gynophore in groundnut possesses a fairly good capacity of nitrate assimilation. Further these observations may prove helpful in standardizing nitrogen fertilization in this crop.

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Al EXCESS MEDIATED EFFECTS ON BIOMASS PRODUCTION AND ETHYLENE SYNTHESIS IN MAIZE LEAVES

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Maize (*Zea mays* L. cv XL-72.3) plants submitted to increasing Al concentrations (0–81 mg/l) showed a sharp decrease of leaves elongation and fresh and dry weight after the 9 mg/l Al treatment. Total activities of 1-aminocyclopropane-1-carboxylate synthase increased until 27 mg/l Al treatment, whereas that of ethylene forming enzyme showed maximum values with the 81 mg/l Al treatment. Endogenous ACC concentration showed minimum values in the 0 mg/l Al treatment, whereas ethylene production increased until the 81 mg/l Al treatment. It is suggested that the *in vivo* Al mediated effects on 1-aminocyclopropane-1-carboxylate synthase and ethylene forming enzyme activities are not inhibitory, whereas ethylene synthesis is stimulated, being the biomass production inhibited.

Keywords: 1-aminocyclopropane-1-carboxylic acid, 1-aminocyclopropane-1-carboxylic acid synthase, ethylene, ethylene forming enzyme, excess aluminium, maize

Introduction

There have been some conflicting reports about the extent of involvement of ethylene in leaf senescence. Foliar senescence triggered by ethylene has been suggested by AHARONI et al. (1979_{a,b}), AHARONI and LIEBERMAN (1979), GRODZINSKI et al. (1982), LESHAM et al. (1986), and KAO and YANG (1983), however according to THOMAS and STODDART (1980) and ROBERTS et al. (1984) these results must be viewed with caution. Furthermore, it has been suggested that leaf senescence, involving ethylene production might be retarded by several ions, or by anaerobic conditions (KAO 1978, YU and KAO 1980, KAO and YU 1981). In this context Al toxicity appears to be the result

Abbreviations: ACC = 1-aminocyclopropane-1-carboxylic acid, ACC synthase = 1-aminocyclopropane-1-carboxylate synthase, BSA = Bovine serum albumin, Chl = chlorophyll, EFE = ethylene-forming enzyme, Hepes = 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid, Mes = 1-(N-morpholino)ethanesulfonic acid, SAM = S-adenosylmethionine

of several interactions, and there is no consensus on its mechanisms in higher plants (HAMPP and SCHNABL 1975, JACKSON et al. 1990). Nevertheless, aluminium toxicity has a deleterious effect on numerous aspects of the affected species physiology, affecting biomass production and leaf senescence (DEMOPOULOS 1973, VLADIMIROV et al. 1980, GUTTERIDGE et al. 1985, GUTTERIDGE 1987, JACKSON et al. 1990). In this study data is presented relating the effect of Al excess on ethylene production (through the methionine dependent pathway of maize leaves), along with the interacting effects on leaf senescence.

Material and Methods

Maize (*Zea mays* L. cv XL-72.3) seeds were washed in distilled water and sterilized by immersion in a 0.1% mercury bichloride solution for 2 min; seeds were then washed 5 times in deionized water and placed in an oven at 28 °C for 24 h. The seeds were germinated on moist filter paper at 28 °C for 3 days. The seedlings were grown in a glasshouse (30/37–15/19 °C day-night temperature) in pots filled with a mixture of vermiculite and Trio-hum tray substrate (2:3) for two weeks and then irrigated for 20 days with Al solutions having concentrations ranging between 0 and 81 mg/l (pH = 4). The experiments were carried out with plant material collected after a 20 days period, using the second youngest leaf of each plant.

Ethylene was determined with a Pye Unicam 204 gas chromatograph, equipped with a flame ionization detector, using a 1500 mm x 4 mm column of Porapak Q (80/100 mesh). Maize leaves were aseptically transferred to 33 ml flasks; these were sealed with serum caps and after 6 h in the dark ethylene evolution was quantified.

The ACC extraction was performed with some minor modifications, according to RIOV and YANG (1982). Maize leaves (0.2 g) were homogenized in 4 ml of cold 80% ethanol, the ACC extract was suspended in 1 ml of H₂O and assayed, using 3 ml reaction tubes, and measured according to the method of LIZADA and YANG (1979). At the end of incubation 0.1 ml of 10 mM HgCl₂ and 0.2 ml H₂O were added to the reaction tube which was then sealed with a serum cap and kept in an ice bath. ACC was converted to ethylene by injecting 0.1 ml of a cold mixture of 5% NaOCl and saturated NaOH (2:1, v/v), through the serum cap with a 1 ml syringe. After mixing, the ethylene released to the gas phase was determined by gas chromatography. To determine the efficiency of ACC conversion to ethylene, a known amount of ACC (from 0.5 to 2 nmol) was added as an internal standard to another similarly incubated reaction mixture and was degraded as described above. Yields of ethylene were consistently between 65 and 70%.

ACC synthase (EC 4.4.1.14) was extracted as follows: maize leaves were homogenized with an equal weight of a solution containing 25 mM Hepes (pH=8.5), 4 mM mercaptoethanol, and 0.5 μM pyridoxal phosphate. The homogenate was pressed through four layers of cheesecloth and then centrifuged at 3800 g for 60 min. The supernatant and the pellet were divided and dialyzed overnight against 2 mM Hepes (pH=8.5) containing 0.1 mM mercaptoethanol and 0.2 μM pyridoxal phosphate. The protein of the obtained samples were measured according to the method of LOWRY et al. (1951), using a BSA standard curve, and corrected to 3 mg protein/ml. In the enzyme assay, a standard reaction mixture, consisting of 50 mM Hepes (pH=8.5), 160 μM SAM and 0.4 ml of enzyme solution in a total volume of 0.6 ml, was used. Incubation was carried out at 30 °C for 5 h, using 2 ml reaction tubes. The amount of ACC formed was assayed according to LIZADA and YANG (1979), as already described. Each determination of protein concentration was the mean based on three replicates of three independent series (S.E. was equal or lower than 10%).

EFE activity was measured in maize leaves (0.1 g) sliced into fragments of 1 mm ca. and then infiltrated with a resuspension medium containing 0.2 mM KH₂PO₄, 1 mM KNO₃, 1 mM MgSO₄,

10 mM CaCl_2 , 20 mM Hepes, 20 mM Mes, 0.5 M mannitol, and 1 mM ACC, adjusted to pH = 5.5 with NaOH as reported by GUY and KENDE (1984). The samples were added to 3 ml reaction tubes, sealed with a rubber serum cap and incubated at 22 °C with gentle shaking, in the dark, for 4 h. Ethylene evolution was then quantified by gas chromatography.

Results and Discussion

It has been proved (FOY 1978) that several ion concentrations overpass Al toxicity through competition mechanisms. Al toxicity is also related with the ionic strength of the nutrient solution along with its Al activity (PAVAN and BINGHAM 1982). With decreasing ionic strength (thus, increasing dilution) of the nutrient solution, the activity of Al (for the same concentration) increases, therefore changing the critical levels of Al toxicity (KHASHAWNEH 1971, PAVAN and BINGHAM 1982). Thus, as increasing ionic concentration of a nutrient solution increases the ionic strength, decreasing the concurrent relative activity of Al (FOY 1978), this experiment was design to maximize the toxic effects of Al, by using as irrigating medium only increasing concentrations of Al solution. Accordingly, maize leaves elongation decreased to 79.5% between the 9 and the 81 mg/l Al treatment (Table 1), and, furthermore, the fresh and dry weight showed a similar pattern, decreasing to 41% and 45%, respectively (Table 1). On a fresh weight basis ethylene production also showed a 1.5-fold increase between the 0 and the 81 mg/l Al treatment (Fig. 1), therefore indicating, as previously suggested (AHARONI et al. 1979_{a,b}, AHARONI and LIEBERMAN 1979, GRODZINSKI et al. 1982, LESHAM et al. 1986, KAO and YANG 1983), a positive correlation between the decreased leaf elongation and biomass production and ethylene biosynthesis. On a protein basis, ACC synthase activity further showed a 1.24-fold

Table 1

Effects of increasing Al concentrations on the elongation and fresh and dry weight of maize leaves

	Al treatments (mg l ⁻¹)			
	0	9	27	81
Elongation (cm)	91.6 ± 2.3	98.4 ± 1.1	91.4 ± 2.3	78.2 ± 3.8
Fresh weight (g)	31.6 ± 1.13	47.6 ± 1.7	32.0 ± 1.27	19.55 ± 0.46
Dry weight (g)	3.25 ± 0.11	4.55 ± 0.12	3.25 ± 0.12	2.05 ± 0.02

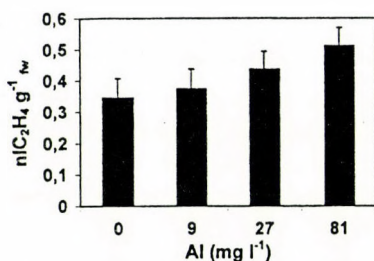


Fig. 1. Effects of increasing Al concentrations on ethylene evolution of maize leaves

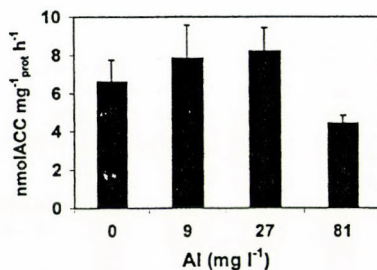


Fig. 2. Effects of increasing Al concentrations on the ACC synthase activity of maize leaves

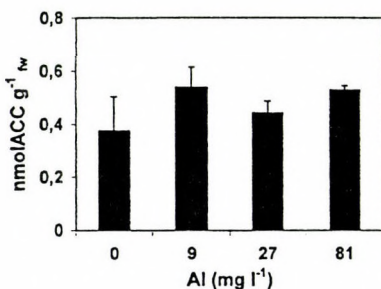


Fig. 3. Effects of increasing Al concentrations on the endogenous ACC production of maize leaves

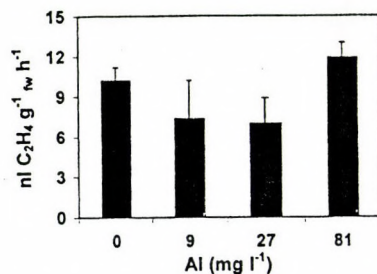


Fig. 4. Effects of increasing Al concentrations on the EFE activity of maize leaves

increase between the 0 and the 27 mg/l Al treatment (Fig. 2), whereas on a fresh weight basis, the concentration of endogenous ACC showed minimum values in the 0 mg/l Al treatment (Fig. 3). Thus, the obtained data showed that *in vitro* activity of ACC synthase is only inhibited in samples submitted to Al concentrations higher than 27 mg/l and, furthermore, the endogenous ACC concentrations do not correlate with Al concentrations. Accordingly, although it was previously suggested (ADAMS and YANG 1979, YU et al. 1979, KONZE and KENDE 1979, YU and YANG 1980, KENDE and BOLLER 1981) that the conversion of SAM to ACC is the step at which ethylene biosynthesis is regulated, *in vivo* Al concentrations do not seem to affect this enzyme activity. On a fresh weight basis EFE activity showed maximum values with the 81 mg/l Al treatment (Fig. 4). The participation of chemical elements in the opening of the cyclopropane ring has been suggested for the chemical oxidation of ACC (BOLLER et al. 1979, BALDWIN et al. 1985), for the degradation of ACC by free-radical-producing enzymes (VIOQUE et al. 1981, BOUSQUET and

THIMANN 1984) and for the production of ethylene by plant extracts in vitro (KONZE and KWIATOWSKI 1981), yet apparently the in vivo activity of this enzyme complex is not affected in samples submitted to the Al concentrations tested.

Conclusion

Under the experimental conditions used, the results on maize submitted to increasing Al concentrations showed that foliar senescence is positively correlated with ethylene production. Additionally, increasing ACC synthase and EFE activities seem to be responsible for increasing ethylene production. Yet, as the rate of SAM to ACC conversion is higher than that of ACC to ethylene conversion, ACC accumulates.

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ASSESSING THE IMMEDIATE DESICCATION INJURY IN VIGNA RADIATA (WILCZEK) SEEDS

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Seeds of two mungbean cultivars (Vigna radiata) were desiccated to different levels of moisture. In SML 32, seed desiccation had no effect on germination and its speed. Vigour in terms of root and shoot lengths, seedling dry weight were significantly improved while electrical conductance (EC) was reduced and dehydrogenase activity did not change with desiccation. However, in ML 267 seed germination and its speed, root and shoot length, seedling dry weight and dehydrogenase activity declined significantly and EC was increased with desiccation. In ML 267, seeds recorded desiccation injury. SML 32 seeds were adjudged to be tolerant while ML 267 to be sensitive to desiccation. Desiccation tolerant seeds were marked with low level of starch depletion, high soluble sugars and sucrose content during desiccation.

Introduction

The orthodox seeds survive longer at low moisture levels (HARRINGTON 1960). However, these moisture levels have to be standardized so that the seeds are not damaged with extreme desiccation. Such studies are important for carryover seed lots or the elite material. It is contended that the lower limits of seed moisture for sealed storage as provided by FEDERAL SEED ACT (1968) are quite high and can be safely further reduced. Further physiological studies can help to monitor desiccation injuries in seeds. Such studies are limited (SAVITA et al. 1991, 1993). Here the effect of extreme desiccation has been studied on the physiology of seeds of two cultivars of Vigna radiata to locate desiccation injuries (if any).

Materials and Methods

Fresh harvested seeds of Vigna radiata cultivars viz., SML 32 and ML 267, procured from the Department of Seed Science and Technology, PAU, Ludhiana, were at 10.29 and 10.24 per cent moisture, respectively. The different seed lots were desiccated to different moisture levels in a single layer over 400 g fused calcium chloride in desiccators for 2, 7, 15 and 45 days at

32 $\pm$ 2 $^{\circ}$ C. Thereafter, moisture contents of the seed lots were determined in triplicate by drying the ground seed at 130 $^{\circ}$ C for 60 minutes (ANONYMOUS 1985). Following desiccation the seeds were sealed in brown glass bottles. Seed germination was effected in between paper at 25 $\pm$ 1 $^{\circ}$ C in a BOD incubator. Per cent germination was counted daily up to 7th day of germination. Speed of germination was calculated after AGRAWAL and DADLANI (1984). Root and shoot lengths of 7-day-old seedlings were recorded and seedling dry weight was recorded after drying ten seedlings in triplicate from each treatment at 80 $\pm$ 2 $^{\circ}$ C in a hot air oven for two days. Electrical conductance (EC) of seed leachates (after dipping 100 seeds in 50 ml distilled water for 18 h at 25 $^{\circ}$ C) was measured on a digital conductivity meter. Total dehydrogenase activity was measured with TTC test (ALONI 1982). Starch, soluble sugars and sucrose contents were measured according to MACRAE (1971), LOEWUS (1952) and ROE (1934), respectively.

Results and Discussion

The main objective of the present set of experiments was to assess the injury at physiological level to the seeds due to extreme desiccation. In cv SML 32 the desiccation from 10.3 to 2.1 per cent had no effect on seed germination. While in cv ML 267 germination declined significantly on desiccation to below 7.1 per cent seed moisture. Such a cultivarial response was also observed in *Brassica juncea* seeds on desiccation to very low levels (SAVITA et al. 1993). ELLIS et al. (1981, 1982) noticed no injuries in extremely desiccated cassava and cowpea seeds. However, the desiccation from 14.8 to 3.7 per cent moisture reduced the germination in pea seeds drastically. This desiccation damage could be avoided if moisture content of these seeds was raised with humidification before germination (ELLIS et al. 1990).

Table 1

Per cent germination, speed of germination, root and shoot length, seedling dry weight, electrolyte leakage and dehydrogenase activity at different moisture levels in *Vigna radiata* seeds

Cultivar	Moisture content (%)	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling dry weight (mg)	Electrolyte leakage ohm 24 h ⁻¹ 50 seeds ⁻¹	Dehydrogenase activity OD 200 mg ⁻¹ h ⁻¹
SML 32	10.29	94.5	93	3.56	2.66	64	38.8	0.090
	6.53	96.7	94	6.43	2.98	100	36.3	0.092
	3.96	97.9	92	6.21	2.74	71	36.6	0.094
	2.11	96.2	96	6.04	3.40	93	34.3	0.093
	CD (0.05)	NS	NS	1.22	0.49	2.00	1.76	NS
NL 267	10.24	70	62	3.41	3.21	92	26.4	0.090
	7.10	77	56	3.72	2.79	91	26.5	0.085
	4.27	65	50	3.29	1.70	62	32.0	0.073
	2.34	65	44	1.52	1.01	43	31.0	0.071
	CD (0.05)	4.38	3.57	1.15	0.32	3.00	0.58	0.003

Table 2

Soluble sugars, sucrose and starch contents (mg g^{-1} dry weight) in *Vigna radiata* seeds at different moisture levels

Cultivar	Moisture content (%)	Soluble sugars	Sucrose	Starch
SML 32	10.29	11.5	6.0	249
	6.53	12.3	5.0	240
	3.96	14.6	5.5	199
	2.11	16.6	4.0	120
	CD (0.05)	1.12	0.67	11.00
ML 267	10.24	11.5	7.0	330
	7.10	13.4	5.0	240
	4.27	10.6	3.0	199
	2.34	10.1	3.0	139
	CD (0.05)	0.40	1.30	18.00

In SML 32 seed vigour remained unaffected in terms of speed of germination, while root and shoot lengths and seedling dry weight were increased significantly with desiccation. However, in ML 267, a significant reduction in speed of germination, root/shoot lengths and seedling dry weight was noticed with desiccation. In pigeonpea and soybean root/shoot dry weight was reduced with desiccation while in wheat no such reduction was shown (SAVITA et al. 1991). NUTILE (1964) reported delayed germination and rise of abnormal seedlings in desiccated soybean seeds. In SML 32 seeds, EC was reduced while in ML 267 seed it was increased with desiccation thus pointing out desiccation injury in the later. SAVITA et al. (1991) showed increased EC with desiccation in cvs RLM 198 and 619 of raya seeds. Similar was shown in pigeonpea and soybean seeds (SAVITA et al. 1992), pea (SIMON and RAJAHARUN 1972) and cotton seeds (SIMON and WIEBE 1975). However, no increase of EC was shown in desiccation-tolerant wheat seeds. Desiccation-tolerant seeds showed no change in dehydrogenase activity in raya and wheat, while desiccation sensitive seeds or soybean and pigeonpea recorded its reduction (SAVITA et al. 1991). In SML 32 seeds, no change in dehydrogenase activity was recorded, while ML 267 seeds showed a reduction of dehydrogenase. Based on the data SML 32 seeds are adjudged as desiccation-tolerant while those of ML 267 as desiccation sensitive.

Desiccation tolerant seeds of SML 32 were marked with low rate of starch degradation, a higher level of soluble sugars and sucrose in desiccated seeds (Table 2). Soluble sugars have been implicated in desiccation

tolerance through membrane protection against desiccation in several anhydrous systems (KOSTER and LEOPOLD 1988). In corn seed hybrids, CHEN and BURRIS (1990) suggested that raffinose/sucrose ratio rather than their absolute content were important in membrane stabilization during drying. In an earlier work, SAVITA et al. (1991) showed an accumulation of sucrose in desiccation tolerant wheat seeds while its reduction was shown in desiccation sensitive soybean and pigeonpea seeds.

In sum, cv SML 32 seeds were behaving as tolerant to desiccation while those of ML 267 as sensitive to desiccation below 7.1 per cent seed moisture. Thus, lower seed moisture limits in SML 32 and ML 267 are 2.1 and 7.1 per cent. Desiccation tolerance in seeds of SML 32 was marked with higher levels of soluble sugars, sucrose and low level of starch degradation at similar levels of seed moisture.

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METABOLIC CHANGES DURING IN VITRO MULTIPLICATION OF
CURCUMA LONGA CVS. SUROMA AND PTS-28

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In vitro propagation of Curcuma longa cvs. Suroma and PTS-28 was achieved on MS (MURASHIGE and SKOOG 1962) basal salts supplemented with 4.0 mg/l BA+1.0 mg/l IAA and 100-150 mg/l Ads and 3% sucrose. The effects of media variables and light conditions on micropropagation were investigated. The frequency of shoot multiplication increased 4-fold at every 4-week intervals. The isolated shoots were rooted on half-strength basal MS mineral salts supplemented with 0.25-0.5 mg/l IBA or IAA and 2% sucrose. The biochemical changes during shoot elongation, multiplication and rooting were determined in two cultivars of Curcuma longa. The total chlorophyll, total protein and total carbohydrate content were determined at various stages during in vitro culture. Catalase, peroxidase and acid phosphatase activity varied during shoot elongation, multiplication and rooting. This study may help in the mass cloning of Curcuma cultivars with high curcumin content.

Keywords: In vitro, multiplication, enzyme assay

Introduction

Curcuma longa (turmeric) belongs to the family Zingiberaceae, an important tropical horticultural plant valued all over the world as a spice and also for its medicinal properties. Curcuma is vegetatively propagated through rhizome, obtained from the current crop with the risk of spreading systemic infections thus, limiting the supply of high quality rhizomes. The quality of the rhizome depends on its age at harvesting time. A method to mass multiply high quality clones to higher yield than the original plant would be of benefit to food and pharmaceutical industry (BALACHANDRAN et al. 1990). Breeding of Curcuma longa is seriously handicapped by poor flowering and seed set. Most of the crop improvement programmes of these species have been confined to evaluation and selection of naturally occurring clonal variations. In vitro culture techniques provide an alternative way of plant propagation and as a tool for crop improvement programme

(VASIL 1988). Clonal multiplication of turmeric through multiple shoot induction has been reported (BALACHANDRAN et al. 1990). Several factors have been implicated in the induction of shoot multiplication from shoot primordia. These factors includes growth regulators, carbohydrates, photoperiod and nutrient composition of the medium. The metabolic events underlying the phenomenon of plant regeneration via shoot multiplication in the Zingiberaceae are not yet reported. The present paper deals with the influence of growth regulators and culture conditions, and the metabolic changes in *C. longa* cvs. Suroma and PTS-28 during shoot proliferation and rooting in vitro.

Material and Methods

Explant source

Rhizomes of turmeric (*Curcuma longa* cvs. Suroma and PTS 28) were collected from High Altitude Research Station of Orissa University of Agriculture and Technology, Pattangi, Orissa, India and incubated in a bed of sterile moist sandy soil to induce sprouting of shoot buds, the pale-white sprouting buds were collected and washed with 2% (v/v) detergent solution. 'Teepol' (Qualigen, India) for 15 min and subsequently surface sterilised using 0.2% (w/v) aqueous solution of mercury chloride for 25 min followed by several rinses in sterile distilled water. The sprouting buds were aseptically dissected under a dissecting microscope and meristems with apical dome or with one or two leaf primordia ranging in size from 0.1–0.5 mm were removed and used as explants.

Culture medium

Isolated shoot meristems were placed on MS (MURASHIGE and SKOOG 1962) medium supplemented with various concentrations of cytokinins i.e. 6-benzylaminopurine (BA: 0.0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 8.0 mg/l), kinetin (Kn: 0.0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 8.0 mg/l), adenine sulfate (Ads: 50, 100, 150 and 200 mg/l) and auxins i.e. indole-3-acetic acid (IAA: 0.0, 0.5, 1.0, 1.5 and 2.0 mg/l), indole-3-butyric acid (IBA: 0.0, 0.5, 1.0, 1.5 and 2.0 mg/l) and 1-naphthaleneacetic acid (NAA: 0.0, 0.5, 1.0, 1.5 and 2.0 mg/l). Routinely, 25 ml of molten medium gelled with 0.8% (w/v) agar (Qualigen, India) was dispensed for shoot elongation and 80 ml of the molten medium was poured in 250 ml conical flasks (Borosil, India) to induce shoot multiplication and rooting. The culture vessels (both tubes and conical flasks) were plugged with non-absorbent cotton wrapped in one layer of cheese-cloth and autoclaved at 1.06 kg/cm^2 pressure and 121°C temperature for 15 min. The pH of the medium was adjusted to 5.8 prior to autoclaving. The cultures were incubated under a 14 h photoperiod having light intensity of $55 \mu\text{Em}^{-2}\text{s}^{-1}$ from cool, white fluorescent lamps at $25 \pm 2^\circ \text{C}$ during shoot proliferation and induction of rooting. For shoot multiplication, the culture flasks were incubated under 14 h photoperiod or continuous illumination (24 h) with a constant light intensity of $55 \mu\text{Em}^{-2}\text{s}^{-1}$ from cool, white fluorescent lamps at $25 \pm 2^\circ \text{C}$.

Induction of rooting and transplantation

The in vitro grown shoots (1–2 cm) were separated and inoculated into semi-solid basal half-strength MS medium supplemented with IAA or IBA (0.0, 0.5, 1.0 and 1.5 mg/l) and 2% (w/v)

sucrose for induction of root. The incubation conditions were the same as mentioned earlier. The rooted plantlets were removed from the culture vessels, washed gently under running tap water and planted in earthen pots containing a mixture of sand, soil and cowdung (1:2:1) (v/v). The plantlets were acclimatized in the greenhouse.

Scoring of data and statistical analysis

All the cultures were examined periodically and the morphological changes recorded on the basis of visual observations. There were twenty cultures per treatment and each experiment was repeated at least three times, subculturing was carried out at an interval of four weeks. The effects of different treatments were quantified on the basis of percent of cultures showing response and the number of shoots/explant, percentage of rooting and percentage of survival. The data pertaining to percent of culture response to multiple shoots were analysed statistically by Duncan's Multiple Range test (HARTER 1960).

Biochemical analysis

Samples were collected at shoot elongation (12 days of culture), multiplication (after 4-week of culture) and rooting (7 days of culture in rooting medium) for estimation of total chlorophyll, total protein and carbohydrates. Chlorophyll a and b were analysed by acetone crude extract and spectrometrically determined at 663 and 645 nm using a UV-spectrophotometer (UVIDEK-650, Japan). Quantitative analysis of chlorophyll a and b (mg/g on fresh tissue basis) were calculated following the formulae of JENSEN (1978). The Conventional microkjeldahl method was employed for the estimation of total nitrogen; soluble nitrogen was determined by the above method after precipitating the protein in the extract of the fresh material with trichloroacetic acid (TCA) (ANON 1970). Total carbohydrate was estimated by the methods of DUBOIS et al. (1965).

Enzyme extraction and assay

Catalase

In vivo raised samples (100 mg) at three developmental stages were homogenized in a chilled mortar and pestle in a Tris-HCl buffer (pH = 8.5) (1 ml of buffer per 100 mg of tissue) containing 5 mM EDTA-Na, 5 mM DTT, 10% (w/v) insoluble polyvinyl pyrrolidone (PVP), and 0.5 mM phenylmethylsulfonyl fluoride (PMSF) (PMSF added just before extraction). The homogenate was strained through four layers of miracloth and centrifuged at 20,000 g and 4 °C for 30 min. The supernatant was used for assays of catalase activity. The catalase activity was determined by floating disc method (NIR et al. 1986); 6 mm diameter discs of Whatman-42 paper, each treated with 10 µl of crude enzyme was placed in a vial containing 5 ml of 30 mM H₂O₂ at 20 °C. Ten discs were used separately for each crude extract. The activity of catalase in each growth phase was calculated according to the activity of bovine-liver catalase (o = 11,000 U/mg protein). One unit of catalase activity was expressed as micromoles of H₂O₂ degraded per min at 20 °C.

Peroxidase

In vitro raised samples (100 mg) at different stages of culture were homogenised in chilled mortar and pestle in 4 ml cold 0.1 M phosphate buffer (pH = 6.1) containing 30 mg of insoluble PVP and 15 mg sodium ascorbate. The homogenate was filtered through four layers of miracloth and centrifuged at 12,00 g and 4 °C for 10 min; the supernatant was used for the peroxidase assay. The assay mixture contained 0.1 M phosphate buffer (pH = 6.1), 4 mM guaiacol as donor, 3 mM H₂O₂ as substrate, and 0.4 ml crude enzyme extract. The total reaction volume was 1.2 ml. The rate of change in absorbancy (OD) at 421 nm was measured using a UV-spectrophoto-

meter (Jasco, UVIDEK-650, Japan). The level of enzyme activity was expressed as the OD difference per minute per milligram protein (BARNETT 1974).

Acid phosphatase

Samples of fresh tissue (100 mg) were crushed in 10 ml 50 mM citrate buffer (pH = 5.3) in a chilled mortar and pestle. The homogenate was filtered through four layers of miracloth and centrifuged at 10,000 g for 10 min. The supernatant was used for acid phosphatase assay. The substrate solution (3 ml) was kept at 37 °C for 5 min, 0.5 ml of enzyme extract was added and subsequently mixed with 9.5 ml of sodium hydroxide (0.085 N). This mixture corresponded to a zero time assay blank. The remaining solution (substrate + enzyme) was kept for 15 min at 37 °C. The activity was measured as absorbance at 405 nm using a UV-Spectrophotometer (Jasco UVIDEK-650, Japan). The activity was expressed as nanomoles p-nitrophenol released per min per mg protein. Protein content was determined according to BRADFORD (1976) using bovine serum albumin (BSA) as a standard.

Results and Discussion

In vitro shoot multiplication

Within 10-12 day of culture proliferation of the meristem took place depending upon the type and concentration of the growth regulators (data not shown). Most of the treatments induced shoot bud proliferation in 90-95% and 80-85% of the cultures in cv. Suroma and PST-28, respectively (Fig. 1). Browning of the cultures and a decline in the rate of shoot proliferation were noted in the media devoid of growth regulators. The multiple shoots was produced in the media containing 4.0 mg/l BA, 1.0 mg/l IAA and 100-150 mg/l Ads. The percentage of cultures showing shoot multiplication were 76.8 and 67.4 in cvs. Suroma and PTS-28 with the number of shoots/culture varied 6.78-27.4 and 3.12-20.2 in cvs. Suroma and PTS 28, respectively (Table 1). Decrease in the concentration of BA in the medium reduced the frequency of shoot multiplication. Addition of higher concentration of IAA (< 2.0 mg/l) induced a low rate of shoot proliferation. Similar observations were made earlier in ginger (SATO et al. 1987, IKEDA and TANABE 1989, POOSAPAYA and KRAISINTU 1993, FARIA and ILLG 1995). The frequency of shoot multiplication increased 4-fold on subculturing at 4-week intervals (Fig. 2). The number of multiple shoots per explant increased until the 7--8th subculture and thereafter the rate of multiplication became almost static.

The rate of shoot multiplication was higher under continuous light (24 h) than 14 h photoperiod (data not shown). The rate of shoot multiplication was, however, inhibited under both the photoperiods when the medium was supplemented with high dose of IAA (2.0 mg/l). The ability of the cultures to produce multiple shoots declined significantly when cultured on MS medium

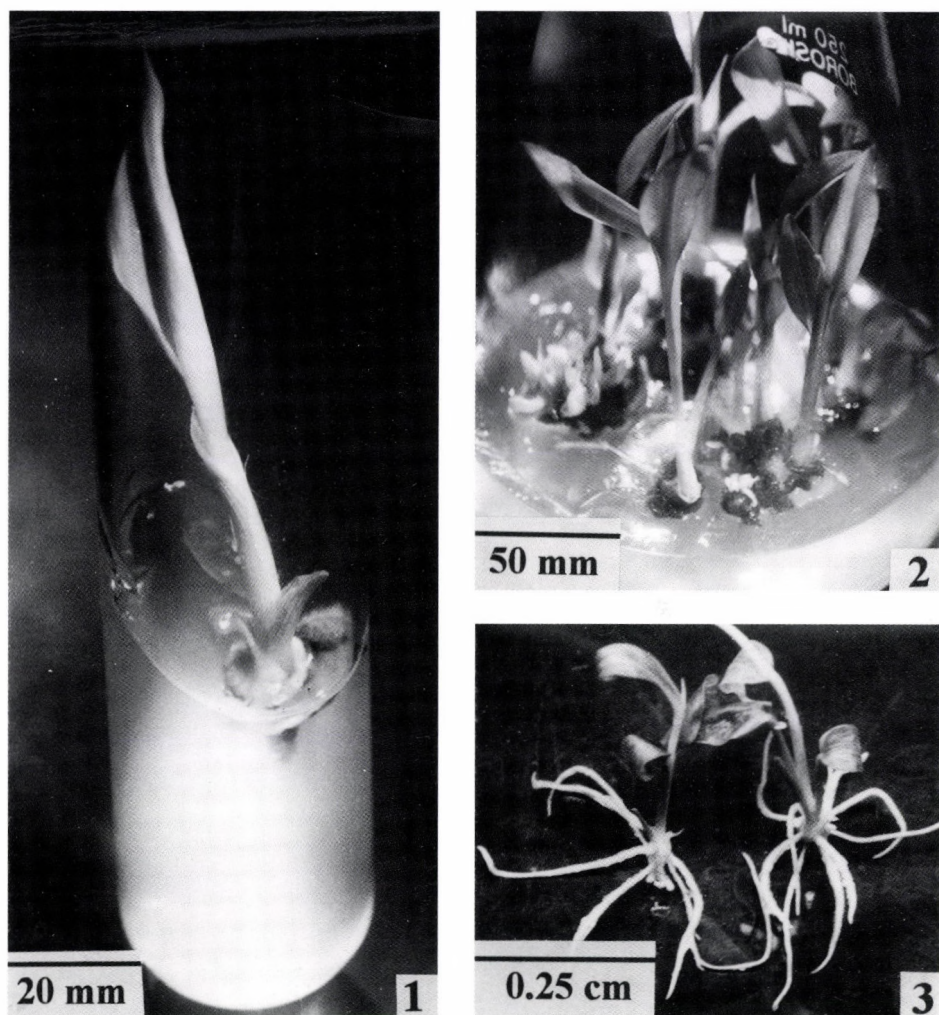


Fig. 1—3. 1. Growth of meristem of *C. longa* cv. Suroma after 2 weeks of culture (bar = 20 mm) — 2. Multiple shoot formation from meristematic bud of *C. longa* cv. Suroma after 4 weeks of culture (bar = 50 mm) — 3. Root formation in micropropagated shoots of *C. longa* cv. Suroma in half strength MS medium supplemented with 0.25 mg/l IBA after 2 weeks of culture (bar = 0.25 cm)

in combination with either BA + NAA or IBA under 14 h or continuous illumination (data not shown). The effects of light on *in vitro* morphogenesis have been reported earlier (MURASHIGE 1974, SEIBERT and KADKADE 1980).

Table 1

Effect of various media on induction of multiple shoots (A) and number of shoots/culture (B) of *Curcuma longa* cvs. Suroma and PTS-28 after 4-weeks of culture under 24 h photo-period

MS basal salts + Growth regulator (mg/l)			Cultivars			
BA	IAA	ADS	Suroma		PTS28	
			A*	B*	A*	B*
0	0	0	0	0	0	0
1.0	0	0	24.2 $\pm$ 0.4	6.8 $\pm$ 0.2	18.4 $\pm$ 0.3	3.12 $\pm$ 0.2
2.0	0.5	0	35.4 $\pm$ 0.8	10.1 $\pm$ 0.3	36.2 $\pm$ 0.2	9.43 $\pm$ 0.4
2.0	1.0	50	42.6 $\pm$ 0.4	16.1 $\pm$ 0.4	43.1 $\pm$ 0.4	13.2 $\pm$ 0.3
4.0	1.0	100	76.8 $\pm$ 0.3	27.4 $\pm$ 0.3	67.4 $\pm$ 0.3	19.4 $\pm$ 0.2
4.0	1.5	100	63.7 $\pm$ 0.4	18.8 $\pm$ 0.2	58.2 $\pm$ 0.4	16.2 $\pm$ 0.4
6.0	1.0	100	32.2 $\pm$ 0.2	9.7 $\pm$ 0.3	36.2 $\pm$ 0.3	8.3 $\pm$ 0.6
4.0	1.0	150	70.6 $\pm$ 0.4	24.3 $\pm$ 0.7	64.4 $\pm$ 0.2	20.2 $\pm$ 0.4
4.0	1.5	150	60.4 $\pm$ 0.3	18.36 $\pm$ 0.2	53.8 $\pm$ 0.3	15.4 $\pm$ 0.3
6.0	1.5	150	34.8 $\pm$ 0.4	9.76 $\pm$ 0.3	27.4 $\pm$ 0.2	6.4 $\pm$ 0.2

*Data represent mean of the three independent values; 20 replicates per treatment.

In vitro rooting

The microshoots developed more number of roots on half-strength MS basal salts supplemented with 0.25--0.5 mg/l IBA or IAA in 92.45% and 86.41% of cultures of 'Suroma' and 'PTS-28', respectively (Table 2). Root initials formed within 8--10 days which developed into a good root system in 14--15 days (Fig. 3). Root initiation was delayed in the growth regulator free medium and also at high concentrations of IAA or IBA with loss of chlorophyll in the growing shoots. Subsequently, the micro-shoots became yellowish in colour. This may be due to the physiological disorders in the conductive tissues. The rooted plantlets were transferred to pots containing sand : soil : cowdung (1:2:1) and kept in the greenhouse for acclimatization, after one month of transfer, 95% of the plants survived the field conditions.

Biochemical changes during growth and development

The total chlorophyll content varied at different developmental stages as shown in Fig. 4. The total chlorophyll content was more during multiplication in both the cultivars than at shoot elongation and rooting. Total carbohydrate and total protein content were the maximum at the root initiation stage which varied between the two cultivars (Figs 5 and 6). During

Table 2

Effect of various media (half-strength basal MS + 2% sucrose + different concentrations of auxins) on rooting of micro-shoots of *C. longa* cvs. Suroma (A) and PTS-28 (B) after two weeks of culture

Auxins (mg/l)		Percentage of shoots rooted $\pm$ S.E.*	
IAA	IBA	A	B
0	0	0	0
0.25	0	83.23 $\pm$ 0.4 b	86.41 $\pm$ 0.3 a
0.5	0	74.18 $\pm$ 0.2 c	70.2 $\pm$ 0.4 c
1.0	0	36.23 $\pm$ 0.4 e	34.6 $\pm$ 0.7 e
1.5	0	20.22 $\pm$ 0.8 g	18.6 $\pm$ 0.7 g
0	0.25	92.45 $\pm$ 0.3 a	88.5 $\pm$ 0.4 a
0	0.50	81.43 $\pm$ 0.7 b	76.4 $\pm$ 0.3 b
0	1.0	41.28 $\pm$ 0.6 d	40.3 $\pm$ 0.4 d
0	1.5	28.21 $\pm$ 0.6 f	22.7 $\pm$ 0.6 f

*20 replicates/treatment; repeated three times.

a, b, c, d, e, f, g — Values represent means with standard error. For each treatment, means followed by different letters are significantly different at $P = 0.05$.

shoot proliferation, a low catalase activity was observed. The catalase activity reached its peak at the multiplication stage and declined thereafter. However, peroxidase activity was higher during rooting in both cultivars (Fig. 7). This is in agreement with earlier observations on other materials (GASPAR 1981, 1982). The peroxidase activity (Fig. 8) declined even when the rooted shoots were kept in the medium for longer period after root initiation as the marker for the induction and sequential rooting in the culture medium in vitro as reported earlier in other plants (BERTHON et al. 1987).

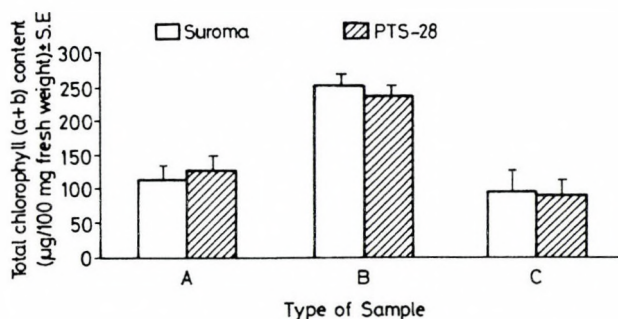


Fig. 4. Changes in the total chlorophyll content associated with shoot elongation (A), multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample; repeated thrice

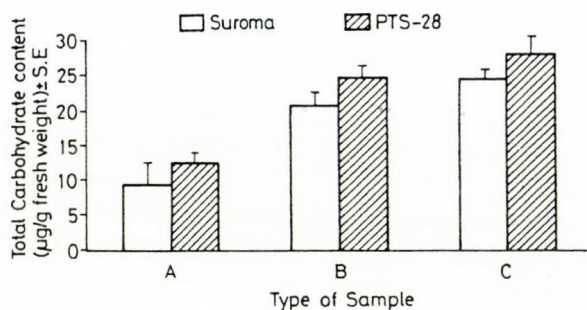


Fig. 5. Changes in the total carbohydrate content associated with shoot elongation (A), multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample; repeated thrice

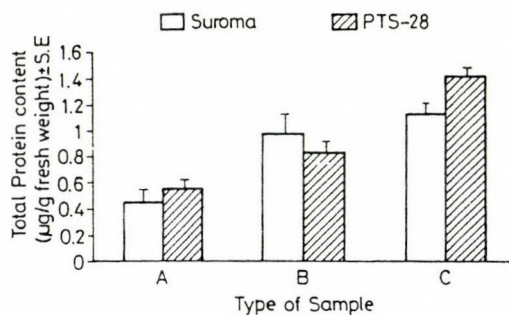


Fig. 6. Changes in the total protein content associated with shoot elongation (A), shoot multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample; repeated thrice

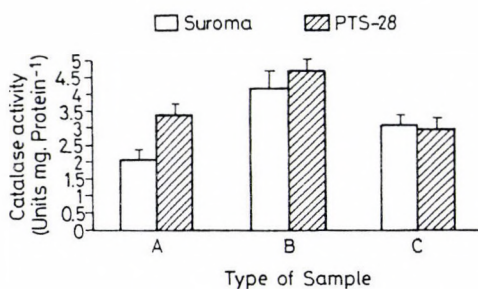


Fig. 7. Changes in the catalase activity at the shoot elongation (A), shoot multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample; repeated thrice

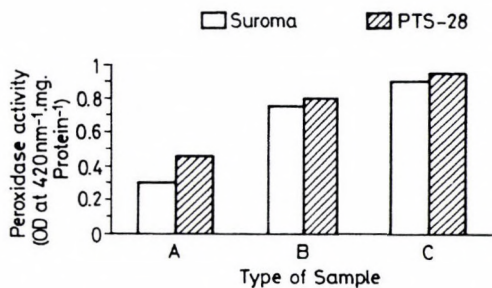


Fig. 8. Changes in the peroxidase activity at the shoot elongation (A), shoot multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample; repeated thrice

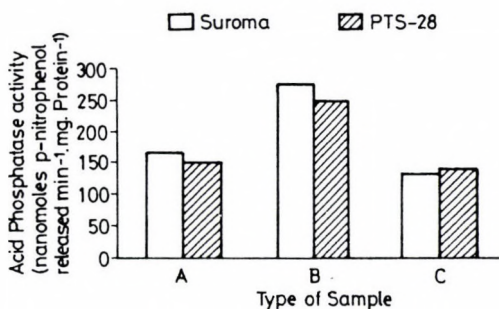


Fig. 9. Changes in the Acid Phosphatase activity at the shoot elongation (A), shoot multiplication (B) and rooting (C) of *C. longa* cv. Suroma and PST-28; 10 replicates/sample

The results also indicated that the acid phosphatase activity was the maximum during shoot multiplication in comparison with the shoot elongation and rooting (Fig. 9); the activity was also varied between the cultivars.

The present study showed the possibility of obtaining more than 4-fold increase in plant production every 4-week by manipulation of growth regulators and culture conditions. The variations of metabolic activity in the different cultivars might be helpful in turmeric improvement programme.

Acknowledgements

The authors wish to acknowledge to the Department of Forest and Environment, Government of Orissa for providing necessary facilities.

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APPLICATION OF ISODEGRADATION CURVES IN NATURE CONSERVATION

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An important question of Conservation Biology, how vegetation tolerates human impact. The Nature Reserve Area "Remete-gorge" near Budapest expanding into the capital like a green peninsula served as a suitable study area. A highly diverse limestone rock and forest vegetation was studied by analysing 113 phytosociological sampling plots and mapped on a surface of 57 ha. In the study several impact factors were identified and mapped. For evaluating their degradational effects on the flora and vegetation the categories of social behaviour types and their "naturalness values" (BORHIDI 1995) were used, which are closely correlated to the C-S-R strategic model of GRIME (1979). The SBTs different naturalness values are given and they express the grade of intactness and/or degradation by using statistical formulas like degradation quotient (DQ). DQ-values projected to vegetation map enables processing degradation map. The grade of degradation expressed in percents calculated of the presence/absence and cover of species. Locating this on the map places of similar grade of degradation may be connected with curves drawn by computer. Analysing isodegradation curves (ISODEGs) human impact is easily recognisable (e.g. in the surroundings of water-clarifying plant, burnt areas, etc.). ISODEGs thicken in areas where plant communities resist degradation, e.g. in Quercus-Carpinetum, however, the isodegradation curves enter into areas occupied by less resistant communities as Mercuriali-Tiliatum and Ceraso-Quercetum pubescentis. Isodegradation curves are useful for detecting and comparing stages of degradation and studying its processes; moreover, they help in need of active protection.

Keywords: Vegetation map, degradation map, social behaviour types, degree of degradation, spatial informatics

Abbreviations: ISODEG = isodegradation curve, SBT = social behaviour types, C = natural competitors, S = specialists, G = generalists, NP = natural pioneers, DT = disturbance tolerants, W = weeds, I = naturalised alien species, A = adventives, RC = ruderal competitors, AC = aggressive alien species or invaders.

Nomenclature: HORVÁTH et al. (1995).

Introduction

The central problem in nature conservation is the degradation process induced by human influence. Areas selected for protection has often been destroyed by producing authorities or by tourists before or even during the official procedure of declaration, partly because of lack of information. For this reason it is an important point the qualification of the areas protected and in way of protection for answering the questions, which and where are the degraded areas, what are the tendencies of degradation, how far this process evolved, and which are the more or less stable plant communities.

Study area

Budapest, the capital of Hungary has two and half million inhabitants. They may enjoy the remnants of the original vegetation in the close surroundings protected in the frame of different categories of conservation areas. A serious human impact is effectuating by the half million of hikers visiting the mentioned areas each weekend. The study area Remete-gorge is a representation of these protected areas expanding into the capital like green peninsulas (Fig. 1). It is an area of 57 hectares strictly protected since 1974. Its florula contains about half thousand vascular plants — including 31 protected species — representing the 20% of the Hungarian flora.

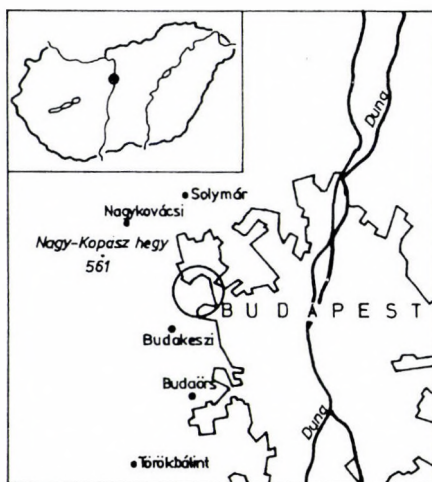


Fig. 1

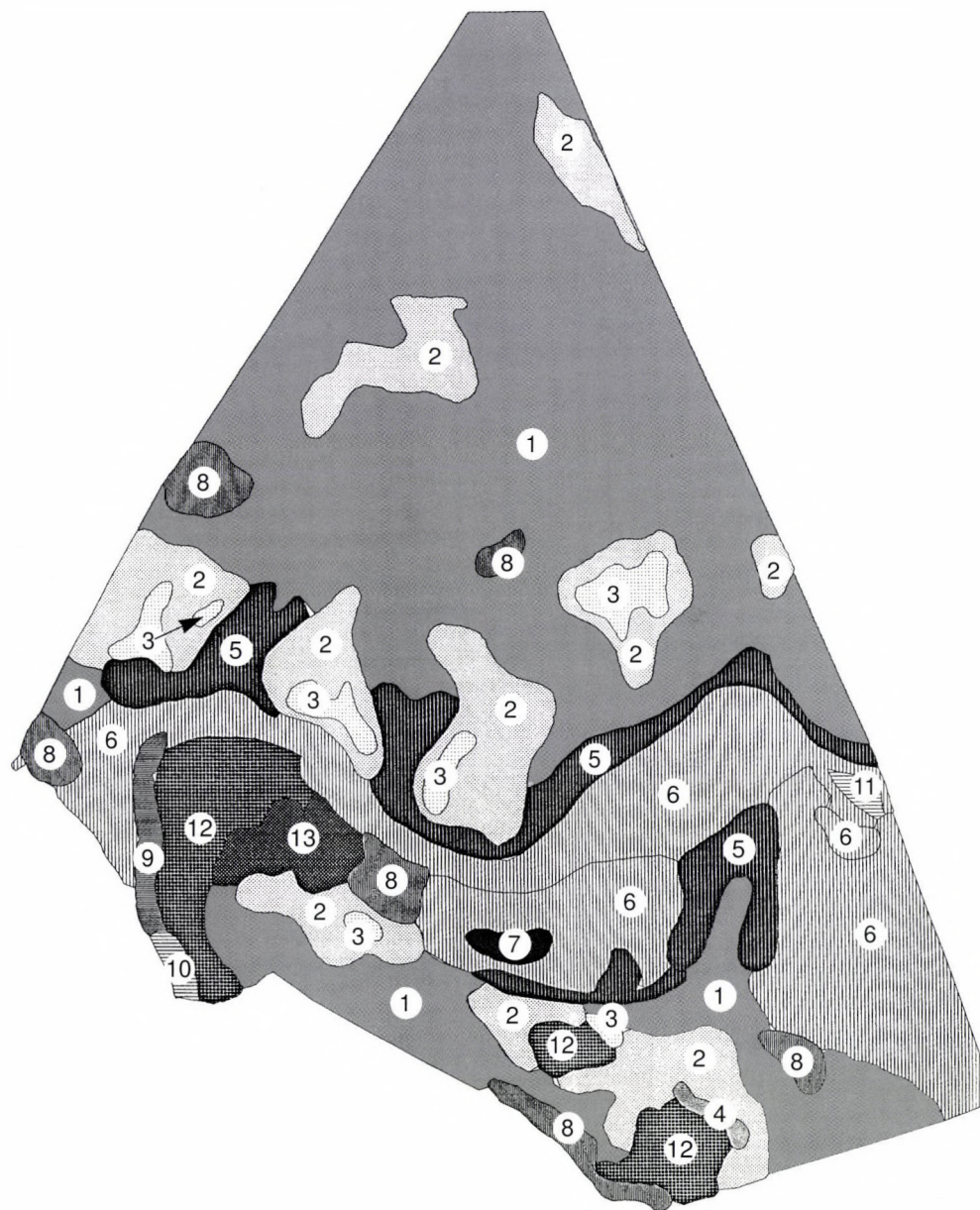


Fig. 2. Vegetation map of the Remete-gorge. Vegetation types. 1. Hairy oak—Flowering ash limestone woodland (*Orno-Quercetum pubescentis*), 2. Mahaleb cherry—Hairy oak shrub-woodland—dry grassland mosaic (*Ceraso-Quercetum pubescentis et Cleistogeno-Festucetum rupicolae*), 3. Limestone rock sward (*Asplenio-Melicetum ciliatae et Festuco pallenti-Brometum*), 4. Ground cherry beath (*Prunetum fruticosae*), 5. Lime Ash-gorge forest (*Mercuriali-Tilietum*), 6. Oak-Hornbeam wood (*Quercus Carpinetum betulis*), 7. Beech wood (*Melico-Fagetum sylvaticae*), 8. Sessile oak—Turkey oak wood (*Quercetum petraeae-cerris*), 9. Oak-elm forest fragment (*Quercus-Ulmetum*), 10. River side forest (*Salicetum albae-fragilis*), 11. Pionering willow shrubland. Weed vegetation of limestone quarries, 12. upper layer, 13. lower layer

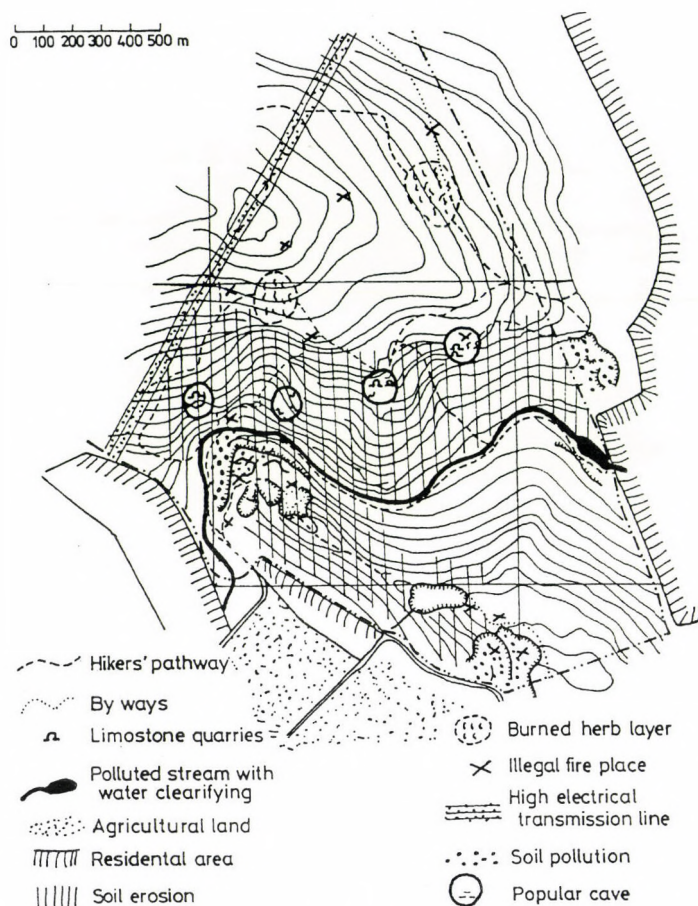


Fig. 3. Human impact factors in Remete-Gorge

Vegetation map of the Remete-gorge

On the vegetation map (Fig. 2) of the area it is seen that the high-plains of the hills are covered mostly by a dry hairy oak-flowering ash limestone woodland (*Orno-Quercetum pannonicum*) of submediterranean character. On the rocky ridges of the southern slopes rock-swards (*Asplenio-Melicetum ciliatae*) and a mosaic of limestone grassland (*Cleistogeno-Festucetum rupicolae*) with a mahaleb cherry-hairy oak shrubland (*Ceraso mahalebeto-Quercetum pubescentis clematidetosum rectae*) are shown with rare green dots. The limestone blocks are crossed by a narrow deep valley of a temporary creek which is the proper Remete-gorge. On its clastic alluvium a lime-ash

gorge forest (Mercuriali-Tilietum) is developed. The northern slopes of the gorge is covered by of different types of an oak-hornbeam wood (Querco-Carpinetum).

Impact factors

On this map (Fig. 3) it is seen the impact factors causing the main disturbances of the area. These are: limestone quarries set up before the protection. A water clarifying plant is built at the eastern end of the gorge. The gorge is bordered by settlements on both sides. The southern side of the hilly area is confined with agricultural land. The gorge is an area highly frequented by hikers attracted by its aesthetic values (panoramic views, caves, attractive flora and vegetation). The great density trampling on the steep slopes causes serious erosion of soil and vegetation. Tourists make illegal patches, fire-places, waste-deposits causing local polluting centres and dangerous fires.

Methods

Sampling

Vegetation answers sensibly to all these impacts and my aim was to analyse these vegetation responses with a comprehensive evaluating method. The unequal degradation of the different habitats, due to the different human impacts made necessary to use a space-informatical approach both in the sampling and interpretation for the determination of their degree and territorial extension. 113 samples were made according to the classic Zürich-Montpellier method in representative density and amount for each degradation level and evaluated on the base of the social behaviour types. Synchronously with the phytosociological sampling a vegetation map of the study area has also been developed. Degradation levels determined using social behaviour types were projected to a degradation map. For both MAPINFO program was used.

Social behaviour types

The concept of the social behaviour types and their use for qualifying naturalness of vegetation versus disturbance of the plant communities has been proposed by BORHIDI in 1991 and elaborated in 1993 and 1995. For similar purpose had been developed the floristically focused nature conservation category system of SIMON (1984, 1988). The social behaviour types are integral parts of the C-S-R strategic model of GRIME (1979).

The four first categories (Competitors, Specialists, Generalists, Natural Pioneers) express the stage of the naturalness while the others inform us about the degree of the degradation by using different statistical formulas, like the degradation quotients below.

Degradation quotient

For a numerical evaluation of the degree of degradation the following formulas are proposed:

$$DQ_{\text{sample}} = \frac{\sum_{a=1}^f C_a}{\sum_{a=1}^n C_a} \times 100$$

where DQ = degradation quotient, C = cover %, f = number of degradation indicator species, n = number of species.

$$DQ_{\text{patch}} = \frac{\sum_{k=1}^z DQ_{\text{sample}}^k}{z}$$

where z = number of samples in the patch.

By applying degradation quotients on the plots of vegetation map it may be converted into a degradation map.

In this case the individual categories were not distinguished within the naturalness and degradation indicator groups, respectively. Although a DI species is not equivalent with an AC species (as it had been expressed by given rank numbers of each categories). Our comparative study using both approaches showed us that in this case the binary grouping of the data gave sufficient information to the determination of degradation degrees in the chosen scale.

Isodegradation lines (ISODEGs)

A more precise and gradual grading of degradation can be obtained by using of "isodegs". An "isodeg" is a line connecting places of identical degree of degradation. In our study the unpublished computer program (DIGITERRA) of CZIMBER has been used. With their application on the degradation map we can obtain isodeg maps. They may be based on the simple frequency data of the samples and by using variants weighted with cover values and calculated with the presented formula.

Results

Social behaviour types of the Hungarian and Remete-gorge flora

Analysing the percentual distribution of the social behaviour types of the Hungarian flora and that of the florula in the Remete-gorge the following conclusions to be drawn (Fig. 4). The Hungarian flora contains 2300 species and the florula of Remete-gorge 471 species. The degree of degradation of the Hungarian flora is 46%, while that of the Remete-gorge is 40%. It is seen that the degradation of the Remete-gorge is expressed by the elevated rate of the DI and W species. At the same time the representation of the na-

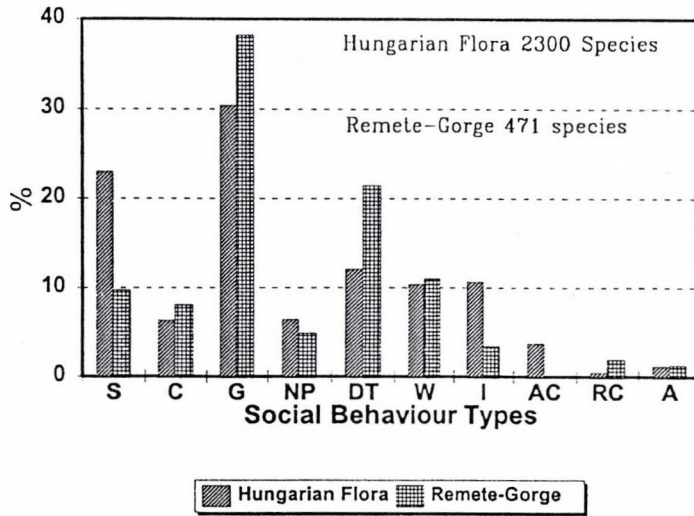


Fig. 4

turalness indicators is also notable. The specialists are most sensible to degradation and their proportion reaches almost 10%. Changes in the composition of the florula in Remete-gorge during the last 70 years shows us the synanthropic tendency of the habitats expressed by the 5 to 20% diminution of the naturalness categories while the increase within the degradation categories varies between 25 and 85% (Fig. 5).

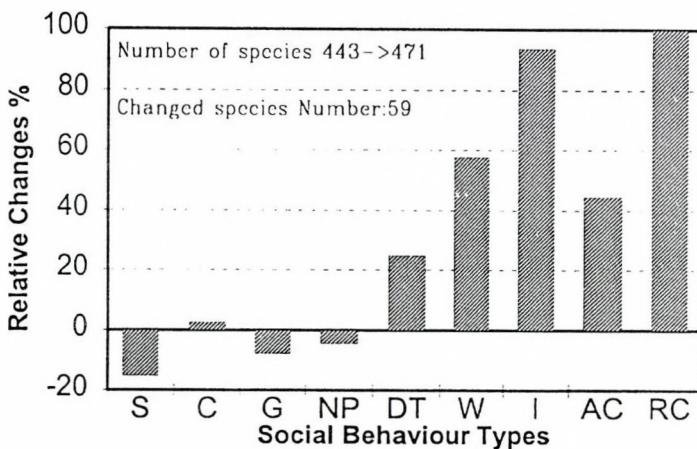


Fig. 5

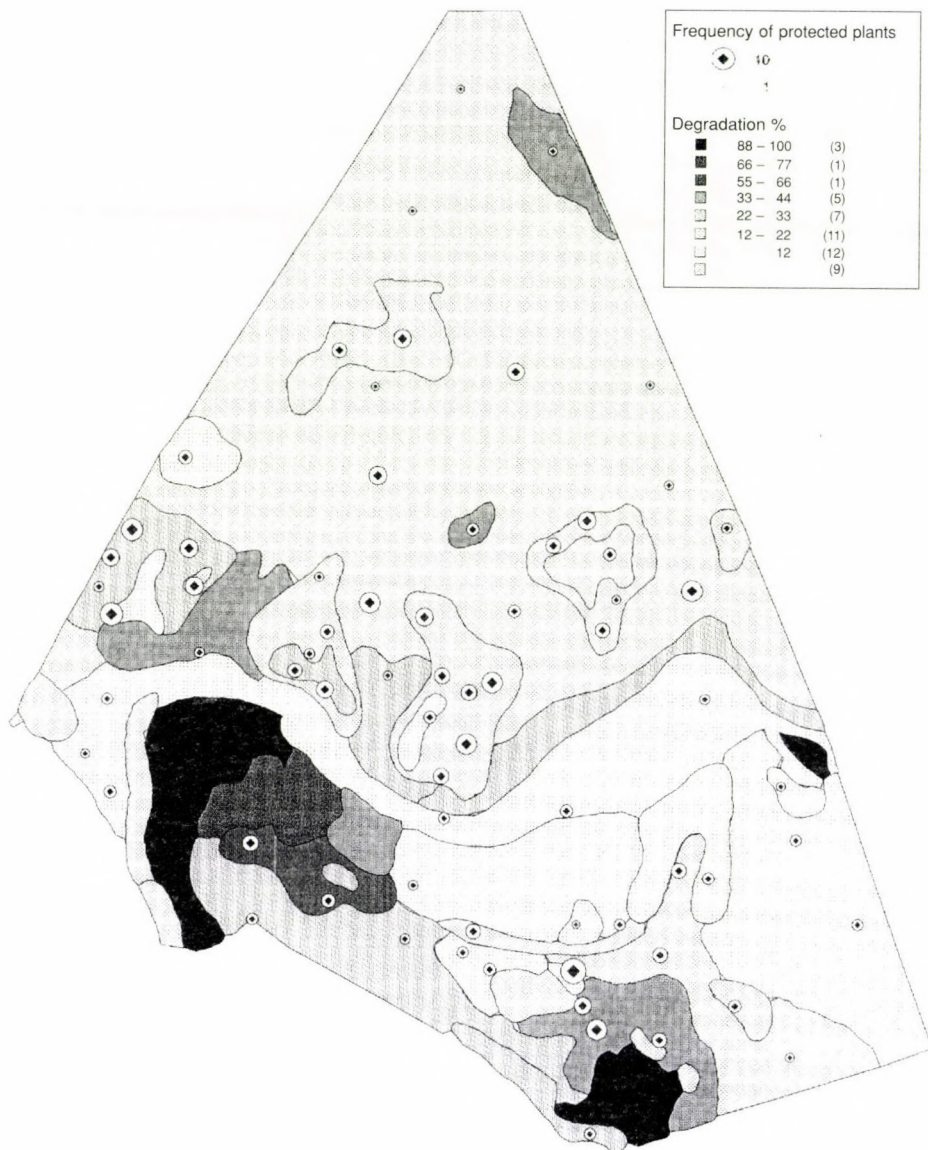


Fig. 6. Degradation of the Remete-gorge. Map of cover based in herb layer. Intensity of degradation is expressed with the mean of degradation rate values expressed by areas from light to dark pattern. The number of species occurring in the samples are indicated by black dots of different size

Degradation map of the Remete-gorge (Fig. 6)

Because the degradation effects are focused on the upper soil layers, which are indicated mostly by herbaceous plants, the evaluation of the samples were made using the herb layer data. The number of the protected plant species occurring in the samples are indicated by black dots of different size. The most important statements are the following: intensity of degradation is expressed with degradation rate values expressed by areas from light to dark pattern.

The least degraded stage is represented by the oak-hornbeam wood of the northern slopes and some rock-sward patches of difficult access, where the degradation rate varies between 0 to 10%. The opposite extremity is represented by the sites of intensive human impacts like the quarries and the water treatment plant, with a degradation rate over 80%. A medium-rated degradation (between 20 to 40%) can be observed in the lime-ash gorge forest and in the more frequented (loaded with tourist patches) parts of the mahaleb cherry-hairy oak shrubland mosaics. Less degraded sites are occupied by the hairy oak-flowering ash limestone woodland and the limestone shrubland-grassland mosaic. Most of the protected plants are living in this mosaic, even in the rather heavily degraded stands. There is an example also for the regeneration process of the vegetation, in the eastern quarry of smaller extension, where on the bare surfaces after cessation of the mining activity a primary succession has started.

ISODEG maps

Presence-based isodeg

Obviously, the degree of degradation may vary within one community to a great extent. Examples are the patches of the hairy oak flowering ash woodland stand damaged by local fires, where the degree of the degradation rate may reach 70 to 90%. On the other side, similar degree of degradation can be observed in several contact areas of two different communities.

On the presence-based map (based on absence-presence of the species) (Fig. 7) the qualitative differences of the samples and the quantity of the degradation indicator species are emphasized. Two main polluted fronts are invading the protected area. In the southern edge several different impacts are combining focused on the two quarries filled with waste deposits. The other strip of degradation extends through the middle of the eastern part

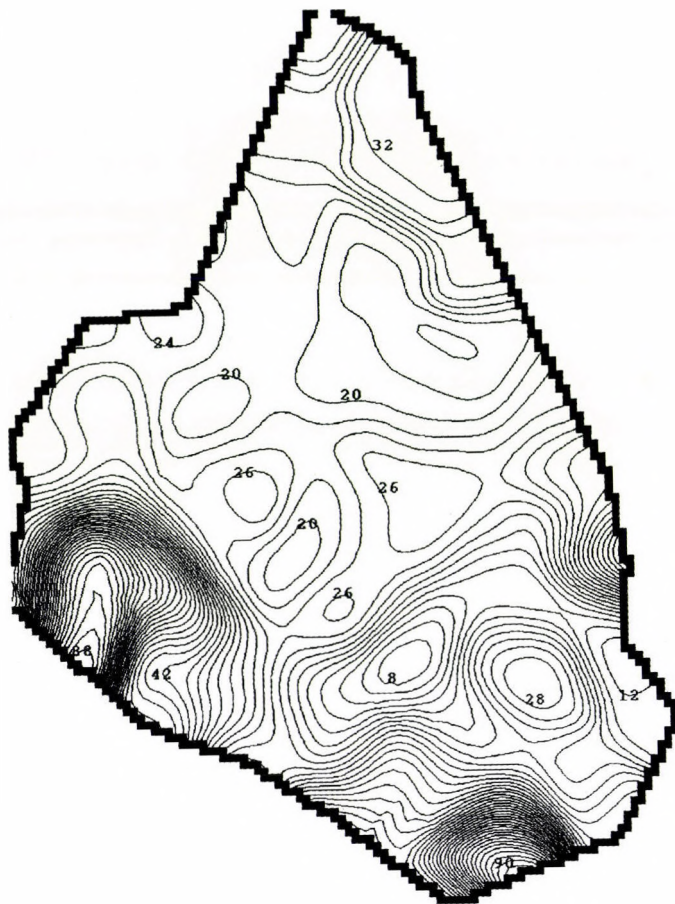


Fig. 7

starting from the water treatment plant. These fronts are dividing the original vegetation into two isolated blocks and serve as routes of penetration to further degrading elements.

Cover-based isodeg

On the cover-based map (Fig. 8) the quantitative characteristics of the samples and the population density of the degradation indicators are emphasized. New degraded centres appear, where the high cover of few disturbance indicators, not the high number of the degradation indicators, is the relevant feature. These new centres may be of ephemeral character caused

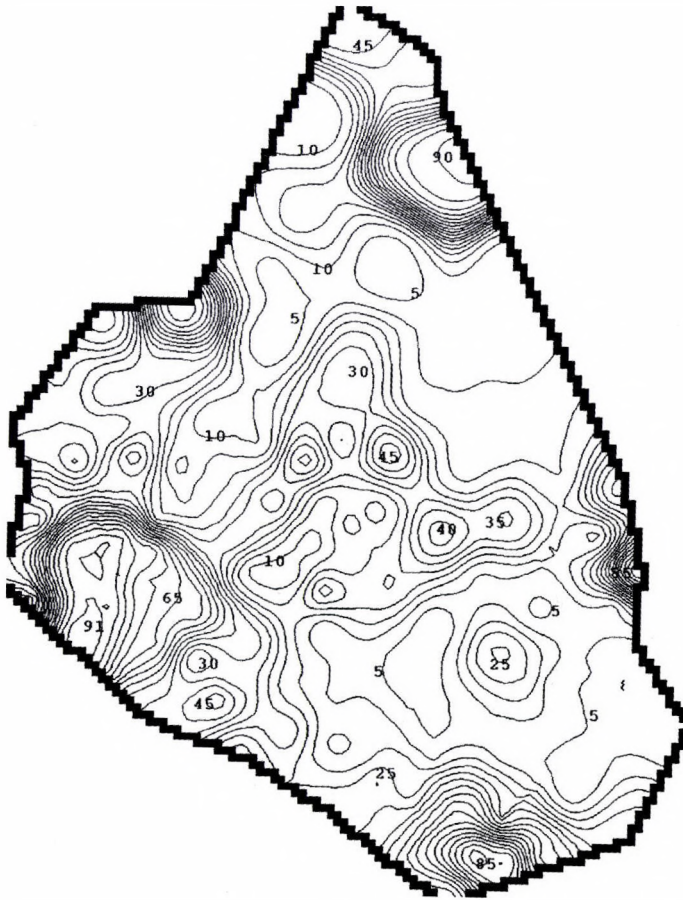


Fig. 8

by fire and eliminated soon by the normal regeneration of the natural woodland. Others may forecast the invasion of aggressive alien competitors (AC) like *Impatiens parviflora*.

Thickening of the isodegs may indicate the border of stable and unstable habitats/communities. For example, the oak-hornbeam wood is a highly resistant community against invaders, where the stability of the community is strictly regulated by the shadow tolerant hornbeam excluding the mostly heliophilous weeds. Among the natural communities, the lime-ash gorge forest is one of the most vulnerable. Its patchwise open canopy and temporarily available nutrient surplus permit the penetration of weedy and alien competitors.

Discussion

It is to be mentioned that similar studies have been developed by BEMMERLEIN-LUX et al. (1991) using an other method based on the ecological groups of ELLENBERG (1974, 1991) and the hemerobity index of JALAS (1955) and KOWARIK (1988). The mentioned studies deal mainly with extremely transformed areas, while in our study the aim is to find appropriate method for distinguishing small differences and fine tendencies of degradation for an early forecasting and prevention of the deterioration of the natural vegetation.

Consequently the main field of applicability of the present method belongs to the frame of the presynantropization phase of FALINSKI (1966, 1975).

Conclusions

Summarizing, a new evaluation method is presented for the quantitative and spatial determination of the degrees of naturalness and degradation of the floras and vegetation. This method is based on the social behaviour types of BORHIDI (1991, 1993, 1995) and contains its spatial application and the introduction of the concept of isodegs. The purpose is to give an objective method for a comparative ranking of natural, semi-natural and artificial habitats and communities to the nature conservation and environment protection practice. Use and advantages of the method is presented in the actual example of the Remete-gorge of Budapest.

Acknowledgements

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BOOK REVIEWS

Editor: K. T. KISS

CALDWELL, MARTYN M.—PEARCY, ROBERT W. (eds): *Exploitation of Environmental Heterogeneity by Plants — Ecophysiological Processes Above- and Belowground.* — Academic Press, Inc., San Diego, California, 1994, 429 pp.

There is an emerging interest in the role played by temporal and spatial heterogeneity in ecological organisation and biodiversity in the past decade. This volume edited in the series *Physiological Ecology* presents an innovative synthesis of studies of plant responses to temporal and spatial heterogeneity, the exploitation of resources from pulses and patches by plants, and their competition with their neighbours.

Approximately half of 14 chapters of this volume is directed to the aboveground environment. These chapters are designed to the nature of canopy patchiness and light transitions. These are the mechanisms by which plants perceive, acclimate, and exploit this patchiness. Through chapters dealing with the light problem of aboveground we could get information about the physical nature of solar radiation or light gaps as sensing the light opportunities in highly dynamic canopy environments and about the connection of competitive light interception and economic space filling. After these some other chapter is discussing the photosynthetic aspects of acclimation to changing light environment and photosynthetic utilisation of sunflecks. In another hand the light might be affect the seeds, too, and this aspect is treated in Chapter 7.

The other chapters are dealing the analogous questions of the belowground environment, heterogeneity in the soil environment and how root systems adjust and acquire water and nutrients in connection with soil variability. Connecting with soil we could read about causes of soil nutrient heterogeneity at different scales, the root-soil responses to water pulses in dry environments and other viewpoints of root-soil relations, or about exploiting nutrients in fertile soil microsites. The Chapter 13 is presenting data about physiological ecology of tree seedling regeneration, while Chapter 14 inform the readers about spatial heterogeneity at small scales and how plants respond to it. Later is dealing with wide aspects of plasticity including artificial selection for phenotypic one.

The problematic point may be the scale to measure the heterogeneity and its computations. This viewpoint is discussed more chapters, which contain mathematical descriptions of different effects or statistical computations.

Summarising the recent results on exploitation of environmental heterogeneity, this volume will be valuable for both researches and students in plant physiology, ecology, agronomy or forestry.

E. SIMAY

CARLILE, M. J.—WATKINSON, S. C.: *The Fungi.* — Academic Press, Ltd., London, 1994, 482 pp.

The study of fungi, mycology, is of importance for wide range of readers interested in many branches of the life sciences. Fungi are of major significance as mutualistic symbionts and parasites of plants, so their knowledge is important for plant scientist even for plant pathologist. But the fungi are representing a major component of microbial world of the biosphere and it has role in life of plants, animals and of mankind, too.

This volume is edited in 8 major parts reviewing the present status of science of mycology. Among of these parts the first is an introducing one dealing with the fungi as a major group of organism, the basics of the mycology, the classification of organisms into main groups and the study of fungi.

The following part is addressed to fungal diversity. The second part is given the classification of fungi and slime moulds into major groups at first and a comprehension of these groups like cellular and plasmodial slime moulds, *Oomycetes*, *Chytridiomycetes*, *Zygomycetes*, *Ascomycetes*, *Basidiomycetes*, *Deuteromycetes*, yeasts and lichens. These groups are introduced by some demonstrative members illustrating with drawing and electronmicrographs.

Valuable and interest illustrations are to find in the later parts, too, like the Chapter 3. This part is discussing the fungal cells and the vegetative growth of fungi. We could read about structure and composition of fungal cells, including form and dimensions of fungal hyphae, the nucleus and its connection with the different type of hyphal septa, mitochondria and mitochondrial DNA, plasmids and viruses, and others. The growth and form of fungal cells are introduced through both yeasts and hyphal fungi, and the connections with growth of populations and colonies are also demonstrated.

The Chapter 4 is dedicated to spores, its dormancy and dispersal, including the role of spores in mycology and in the life of organisms. This is connecting with taxonomy and developmental biology, too. In keywords, we could get informations about initiation of sporulation, spore liberation, spore dispersal and deposition, dormancy and survival and spore germination. Connecting with spores the Chapter 5 discusses the genetic aspects. It contains data about life cycles, mating systems, genetic exchange, variation, microevolution and speciation, phylogeny and evolutionary trends.

Chapters 6 and 7 are addressed to "life styles" of fungi, with their role of ecosystems. This comprises the place of principal groups of fungi in ecosystems, communities and successions, the role of fungi in biodeterioration. But these parts are also including parasitism, mutualism and symbiosis, connecting with plants and animals and with fungi, too.

Another viewpoint is presented in Chapter 8, with is dealing with associations of fungi and biotechnology. There are introducing through different aspects of fermentation and enzyme technology, the production of alcoholic beverages, the cultivation of fungi for food and food processing by fungi. The different role of primary and secondary metabolites like ethanol, citric acid, antibiotics and alkaloids are also presented. The methods of improvement are also mentioned, like selection of fungal strains or gene cloning.

Because of general discussions presented in this volume, it will be an interest book for students and readers working in different branches of biology.

E. SIMAY

BREWSTER, J. L.: Onions and Other Vegetable Alliums. — C.A.B. International, Wallingford, UK. 1994, 236 pp.

The edible alliums like chives, garlic, leeks, onions, shallots are some of the most ancient cultivated vegetables. This book covering numerous viewpoints of *Allium*-growing has appeared as No. 3. of *Crop Production Science in Horticulture* series (Series Editors: Jeff ATHERTON and Alun REES). It begins by discussing the classification aspects of more important *Allium* spp. including subgenera and sections. This is followed by treating origins, distribution and the economic importance of the most important food alliums. Then the book is dealing with their structure (Chapter 2). There are several interesting illustrations connecting with structure, including draws and scanning electron micrographs. The next part (Chapter 3) treats with both genetics and breeding covering from chromosomes of alliums to breeding against pest and diseases through pollination control.

The further chapters discuss the physiology, flowering and seed production of these economic important species. We could read about factors affecting bulb growing and aspects of growth and development (Chapter 4), production of different *Allium* species in culture (Chapter 5), physiology and environmental control of flowering or possibility of the synchronisation of flowering and seed production (Chapter 6).

Chapter 7 is intended for crop storage and dormancy. The physiological-structural aspects are also pointed out here. At first when the bulb development and structure are discussed in relation to dormancy. The effects of environmental and biological factors like effects of tem-

perature, cultivar, roots are treated, too. We could get knowledge about pre- and postharvest technology of storage, too.

The interactions of alliums and other organisms are reviewed in Chapter 8. These interactions might be interactions with weeds, pest, diseases or even symbionts. According to data the weeds could have serious competition effects with alliums, especially when they are grown from seed. That is why the seed emergence is relative slow, the seedlings are relative small and their growth rate is also low. Among of pests one of the most important parasites the nematodes infesting the plants from the soil and causing damages on roots or another species on leaves, stems or flowering parts. The parasitic arthropods might be trips, flies, moths or even aphids which could spread viruses, too.

The disease causing pathogens might be bacteria, viruses or fungi. Later organisms represents several groups of fungi and could cause damage on every parts of the plants and the book has a valuable table contents the most important pathogens with their symptoms on vegetable alliums. However some fungi may be symbionts as the VA-mycorrhizas like Glomus mosseae.

The last part of the book (Chapter 9) contains data about biochemistry and food science of alliums. These data are covering the flavour compounds with their precursors and enzyme reactions or their biological functions. This chapter is treating the medicinal effects of alliums, too.

Because of the wide thematic of this volume, the book is probably interest for growers, students and anybody interested in the scientific principles that form the basis of their practice. It also presents an example of how different disciplines interrelate when applied.

E. SIMAY

DUFF, K. E.—ZEEB, B. A.—SMOL, J. P.: Atlas of Chrysophycean cysts. — Development in Hydrobiology 99. Kluwer Academic Publishers. Dordrecht, Boston, London, 1995, 189 pp.

This book is a unique taxonomical summary in many respects. Chrysophytes are a divers group of algae, primarily of freshwater algae, with over 1000 known species. They are often a dominant group of phytoplankton, sometimes forming waterblooms, too. Chrysophytes possess diverse nutritional strategies, are often characterised by marked seasonality. During blooms they can cause taste and odour problems in drinking water supplies. Many species have well-defined ecological optima and narrow tolerances for different limnological variables, such as pH, temperature, salinity, conductivity and trophic status. This has resulted a huge interest in the use of chrysophytes in long-term monitoring programs and in paleolimnological studies. Chrysophytes are represented in the sedimentary record by two remains, by their silica-scales, bristles, spines (Synurophyceae and some Chrysophyceae) and by resting cysts (stomatocyst) believed to be produced by all chrysophytes.

Authors have compiled description almost 250 cyst morphotypes. This is certainly not a complete survey of cyst morphotypes, but it does represent many of the dominant morphotypes and many rare forms from different lakes, ponds with different ecological conditions.

After the introductory part in Chapter 2 reader finds a short description of methods, in Chapter 3 detailed description of cyst body-, pore/collar morphology, ornamentation of cyst surface showing these structural elements on precise drawings.

Detailed cyst descriptions are shown in Chapter 4. Differentiation of stomatocyst groups is by the shape (spherical, oval) and existing or lacking of different forms of collar or ornamentation (granules, spinulae, simple spines, branched spines, ridges, reticulums). Description of cyst differs from the traditional way, like a description of an algal species. It starts with its "biological affinity" (like at "Stomatocyst 1, This cyst is probably the mature or immature form produced by a number of chrysophytes. At least two Paraphysomonas species have cysts of this type"). Then it is singed the locality of cyst, continued by its description on the basis of scanning electron-microscopy, then light microscopy with references concerning on this type of cyst and finished by the characteristics of its ecology. Each de-

scription is completed by 1-3 LM and SEM micrographs and 1-3 drawings of the cyst. The chapter finishes by a series of figures showing size continuum of 112 chrysophycean stomatocyst morphotypes and 12 collective categories that are distinguishable using LM. In chapter 5 are enumerated as "additional morphotypes" stomatocyst which have no sufficient SEM specimens for full description, with a short description and with a single SEM micrograph.

This is a very useful book for paleoecologists who want to complete their study with stomatocysts. We recommend this Atlas to researchers working with living chrysophytes and to algologists working with phytoplankton. The book can be useful in university education, too.

K. T. KISS

MAXTED, N.: An Ecogeographical Study of *Vicia* subgenus *Vicia*. Systematic and Ecogeographic Studies on Crop Genepools. 8. — International Plant Genetic Resources Institute, Rome, Italy, 1995, 184 pp.

The genus *Vicia* and its subgenus *Vicia* has numerous species with economic importance and their wild relatives. In this book an ecogeographical study is presented. According to present systematic viewpoint this subgenus contains nine sections, nine series, 38 species and 36 sub-specific taxa. This study presents ecogeographic data for each taxon throughout the geographical range of the subgenus. Data of representative herbarium specimens are also presented.

The book contains a very valuable key for identification for sections, series and species and a summarizing table for all taxons of subgenus *Vicia* at first including infra-specific taxons. After this section we could find the ecogeographic conspectus by sections, series and species. The descriptive section contains the correct name of species and infra-specific taxa, with phenology, chromosome number, geographical distribution, ecology and taxonomic notes. Maps and draws are also published for description and ecogeography of species.

The ecogeographic conspectus is followed by a large discussion of data including the ecology and phytogeographics. The phytogeographic studies of *Vicia faba* L. is pointed out, because this species is one of the more important *Vicia* which serve important protein source as both feed and human food. The status of present conservation of *Vicia* subgenus *Vicia* is also giving listing the *ex situ* germplasm holdings.

The appendices contains list of herbaria visited or which loaned herbarium specimens, institutes holding *ex situ* collections, synonymized checklists, specimen citations. There is an index of taxa, too. So, this book may be very useful for study of this important Leguminous plants.

E. SIMAY

CANTER-LUND, H.—LUND, J. W. G.: Freshwater algae, Their microscopic world explored. — Biopress Limited, Bristol, 1995, 360 pp.

It is very difficult to speak about this book without superlatives. This picture-book about the freshwater algae, living in different inland water bodies is a special mixture of a textbook and a popular book. It is written in simple language, understandable by everyone, but with every effort to avoid "simple" becoming scientifically incorrect. Technical terms are reduced to a minimum and they are explained when first encountered. They are explained in the glossary too, sometimes the explanations are broader here than in the text.

In no sense is the structure of the book in accord with the normal textbook tradition. Textbook pictures illustrate the text, here the text is a commentary based on the pictures. It follows, therefore, that certain features such as the structural methods of growth and the reproductive processes which occur in the algae shown are not mentioned as they would be in a textbook.

Reader find in the first chapter the short description of term of algae, also important information about the size-, the colour-, the reproduction-, the occurrence-, the ecology of

algae with special reference to eutrofication and seasonal cycle of phytoplankton. The next nine chapter is the "taxonomical part" of the book, showing the mean groups of algae (Chlorophytes, Euglenophytes, Xanthophytes, Bacillariophytes, Chrysophytes, Haptophytes, Rhaphidophytes, Cryptophytes, Dinophytes, Rhodophytes and Cyanophytes). The last three chapters is a special part of the book showing the symbiosis of algae with plants, invertebrates, lichens; the animal feedings on algae; and fungi living on and in algae. The book is finished by a good and complete glossary, by enumeration of a few dozen of references on different subject in algology ("suggestions for further reading"), by index of algal-, animal-, fungal genera and index of algal genera associated with animals or fungi, and by a general index.

The book contains 387 colour and 253 monochrome photographs in really high quality. It can be questionable that authors gave only the genus name of algae illustrated. I agree with them. It is no question to determine the most part of species on micrographs. I think the book is not a determination book, therefore, it would be "dangerous" if someone wants use it in this sense. In this case it is better to indicate only the genus name of algae.

I recommend the book first of all for biologists and for people interested "into a world of great beauty and fascination which they normally never see but which is around them whenever they go outdoors", as is written in preface. I am sure the book is very interesting and important for specialist, too and also in university education.

K. T. KISS

UHERKOVICH, G.—SCHMIDT, A.—ÁCS, É.: *A Scenedesmus zöldalga nemzetség* (Chlorococcales, Chlorophyceae), különös tekintettel magyarországi előfordulású taxonjaira. /The green algal genus *Scenedesmus* (Chlorococcales, Chlorophyceae) with special attention to taxa occurring in Hungary/. — Magyar Algológiai Társaság, Budapest, 1955, 234 pp.+XXXIII plates

About 30 years after the appearance of the book "Die Scenedesmus-Arten Ungarns" by UHERKOVICH, a new and completed volume was published about this important chlorococcalean algal genus. UHERKOVICH, the famous specialist of this group summarise his knowledge from the taxonomy of *Scenedesmus* species occurring in Hungary.

The book includes the morphology, reproduction, occurrence of *Scenedesmus* species. In the first chapter the general characteristics of the genus is discussed (cell morphology, structure of coenobium, reproduction, teratological forms). The spreading of *Scenedesmus* species and the published sampling sites are shown in the second chapter. In the taxonomical part of the book can find the detailed taxonomy of the *Scenedesmus* genus with the keys of determination. The language of the book is Hungarian and English, too, except the description of species (this part only in Hungarian including a short /Hungarian—English/ dictionary of the most important terms). More than 600 drawings help the determination of species.

We warmly recommend this book to botanists and first of all to algologists.

Order Address: Dr Keve T. KISS, Hungarian Algological Society, Göd, Jávorka S. u. 14, H-2131 Hungary

I. GRIGORSZKY

MORTENSEN, E.,—JEPPESEN, E.—SONDERGAARD, M.—NIELSEN, L. K. (eds): Nutrient dynamics and biological structure in shallow freshwater and brackish lakes. — Kluwer Academic Publisher, 1994, 507 pp.

This book is a volume of Hydrobiologia concerning the subject "Nutrient dynamics and biological structure in shallow freshwater and brackish lakes". It is a proceeding of an international conference held on 16—20 August, 1992 in Silkeborg, Denmark. This conference has 5 main themes, each introduced by an invited speaker:

— Nutrient dynamics with special emphasis on sediment water interactions and changes in loading,

- Biological structure and trophic interaction,
- Submerged macrophytes dynamics and role in the lake ecosystem,
- Comparison of freshwater and brackish lake ecosystems,
- Modelling the impact of nutrients, the biological structure and the recovery process.

The topic of this meeting was chosen basing on that fact, that "although shallow lakes are often the most common lake type in lowland countries, less attention has been paid to them than to deep stratified lakes and few comparisons have been made between shallow freshwater and brackish lakes", as we can read it in preface of book. The volume is divided into seven main themes:

- Ecosystem level, top-down control (with 10 articles),
- Phytoplankton, zooplankton (with 7 articles),
- Macrophytes (with 8 articles),
- Benthos, benthic-pelagic coupling (with 4 articles),
- Nutrient dynamics, internal loadings (with 7 articles),
- Lake restoration (with 6 articles),
- Others (with 2 articles).

It is surprising that there is only one article dealing with periphytic algae in this volume. It is well known that in littoral zone of many shallow lakes the primary production of periphytic algae in many cases higher than that of phytoplankton. To determine the quality of shallow water bodies, besides the studies on water chemistry and phytoplankton, it is necessary and essential to investigate the benthonic complex — i.e. the aquatic plants and their periphyton — and reveal its role in them.

I can recommend this book to hydrobiologist, who deal with nutrient dynamics and biological structures in shallow lakes.

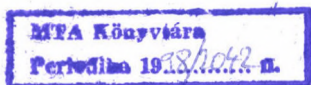
É. ÁCS

SANDGREN, C. D.—SMOL, J. P.—KRISTIANSEN, J. (eds): Chrysophyte algae. Ecology, phylogeny and development. — Cambridge University Press, Cambridge, 1995, 399 pp.

Research activity concerning on chrysophytes (Chrysophyceae and Synurophyceae) has increased quickly over the last decade. Chrysophytes are primarily freshwater flagellate organisms that typically constitute a dominant or subdominant group of the phytoplankton in lakes with moderate to low productivity. They have long been under-studied by algologists because of difficulties in culturing and preserving chrysophytes, and because of the tendency to study eutrophic lake systems in which chrysophytes are relatively rare or less frequent. However, the critical importance of chrysophytes in carbon flux through oligotrophic, freshwater food webs has been the subject of considerable research. The mixotrophic nutritional capacity of most chrysophytes provides them with a distinct advantage in nutrient poor lakes. In other hand some chrysophyte species are abundant in eutrophic waters, too. The silica-scaled chrysophytes are the subject of paleoecology.

Seventeen papers presented at the Third International Chrysophyte Symposium (Aug. 12–16, 1991 at Queen's University, Kingston, Ontario) are published in this book. This volume contains chapters contributed by the plenary speakers plus several original papers submitted by other symposium participants. The book is arranged into subsections according to the symposium themes. The first paper presents the history of chrysophyte research. There are three papers about phylogeny, systematics and evolution; four papers about development, physiology and nutrition; five papers about ecology, paleoecology and reproduction; and four papers called as contributed original papers about the chrysophytes.

Papers about the evolution of plastid genomes (TERRENCE et al.) and the modern concept of chrysophyte classification (PREISIG) are fundamental in the subject. The contribution about the mixotrophy in chrysophytes is important (HOLEN and BORAAS). Much of what is known about algal mixotrophy has come from the study of chrysophytes. The phagotrophy of these algae is an interesting and new subject in algology in the last decade. It is also an important question the chrysophyte blooms in the plankton and neuston of marine and freshwater systems (NICHOLLS), because some species form blooms in winter in the ice-covered lakes, caused critical situation



of water quality. In practical aspect the paper of SIVER is important, too (The distribution of chrysophytes along environmental gradients: their use as biological indicators).

All of papers are interesting because of our "poor" knowledge about chrysophytes. We recommend the book to phycologists, palaeoecologists, limnologists and plankton ecologists. It can be very useful in university education, too.

K. T. KISS

STEPHENSON, S. L.—STEMPEN, H.: *Myxomycetes — A Handbook of Slime Molds*. Timber Press, Portland, Oregon, 1994, 183 pp.

The book has been intended for amateur mycologists and for everyone interested in the beauty and diversity of the natural world. It is easy to understand even for persons, not too experienced in biology, since the authors give the explanation of all important terms.

The first 5 chapters provide a summary of the most important information worth knowing about myxomycetes. The description of their life cycle, their structural features, the types of plasmodia and fruiting bodies is given. The methods, how to collect myxomycete fruiting bodies in nature and how to establish moist chamber cultures from samples of tree bark or other types of organic debris at home or in the laboratory, are presented. Some instructions for microscopical examination are also given.

The authors provide information on the worldwide distribution of myxomycetes both in terms of the major types of habitats in which they characteristically occur as well as some of the microhabitats in which at least some members of the group can be found. Some ecological aspects are also treated, such as trophic stages, substrate relationships, fruiting season, insect associates, myxomyceticolous fungi and bryophyte-myxomycete associations.

The sixth chapter deals with the classification and identification of myxomycetes. Dichotomous keys of the orders and 54 selected species are given. The keys serve first of all not for the exact identification but for the introduction of the characteristic groups of species. The keys are followed by the description of species. All the 54 selected species are illustrated in pen-and-ink drawings and any myxomycete that does not key out in the keys often can be identified from the information on similar or look-alike species provided in the "comments" sections of the descriptions. The most comprehensive taxonomic works for the identification of the species not included in this book are also cited.

Besides the pen-and-ink drawings, the book is illustrated with very good microscopical photographs. Sixteen plates of nice water-colour portraits can arouse interest of persons not yet got acquainted with this wonderful group of organisms.

A glossary of technical terms, a list of references cited and an index complete the work.

This book is a useful introductory work that makes the reader acquainted with this truly fascinating but little known group of organisms.

N. BODONYI

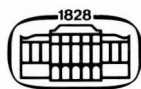
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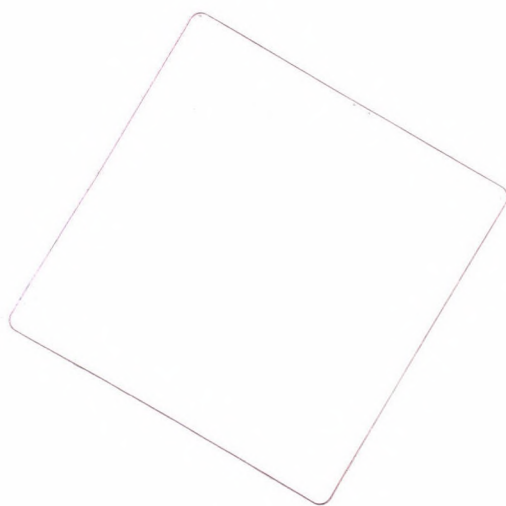
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Floral Biology of Temperate Zone Fruit Trees and Small Fruits

Edited by

JÓZSEF NYÉKI and MIKLÓS SOLTÉSZ

This book is a comprehensive synthesis of information on floral biology and pollination of fruit trees. A complete overview is presented on temperate zone fruit trees and small fruits. Major chapters are devoted to the biological and ecological backgrounds of floral biology and pollination. All related items are discussed ranging from flower development and pollination requirements to orchard planning and bee pollination.

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Phytogeography and Vegetation Ecology of Cuba

by
ATTILA BORHIDI

The interrelationships between climate and zonal vegetation, the correlations between soils and edaphic plant communities are discussed in the book. Special attention is given to the ecological effects of the ultramafic (serpentine) rocks on the tropical flora and vegetation, and to the problems of the genesis and ecology of savannas in Cuba.

A detailed analysis of the Cuban flora according to life-forms and distribution patterns is presented. The study discusses the evolution and phytogeographic characteristics of the flora of Cuba in relation to other floras of the west Indies and to the flora genesis of the Neotropics. The geobotanic regions of Cuba, their geography, climate, soils, flora and vegetation are described indicating important areas for nature conservation. The main vegetation types of the islands are treated in the text, and their distribution is presented in a vegetation map of 1:1,250,000 scale. Forty forest and shrubland communities are classified with a numerical method. More than 200 phytosociological units are sampled and characterized. The new edition contains a much more detailed description and documentation of the plant communities than the previous one, and discusses new views about the flora genesis of the Neotropical flora.

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... (Fekete and Précsényi 1981) ...
... (Borhidi et al. 1979a) ...

The list of references should contain the names and initials of all authors (the abbreviation et al. is not accepted here); for *journal articles* year of publication, the title of the paper, title of the journal abbreviated, volume number, first and last pages.

For *books* or *chapters in books*, the title is followed by the publisher and place of publication. Book title words should be written with majuscules. Titles of papers published only in Hungarian should be translated in parentheses. All items are recommended to be cited both in the text and references.

Examples:

Jakucs, p. 1961: Die Phytozoönologischen Verhältnisse der Flaumeichen-Buschwälder Südostmitteleuropas. Akadémiai Kiadó, Budapest

Fekete, G., Précsényi, I. 1981: Niche structure of a perennial sandy grassland. In: Stefanovits, P., Berczik, Á., Fekete, G., Seidl, M. (eds): Man and the Biosphere Programme. Survey of 10 Years Activity in Hungary. Budapest, 68–102.

Borhidi, A., Muñoz, O., Del Risco, E. 1979a: Clasificación fitocenologica de la vegetación de Cuba. Acta Bot. Hung. 25: 263–301.

Jakucs, P. 1973: „Síkfőkút Projekt”. Egy tölgyes ökoszisztéma környezetbiológiai kutatása a bioszféra program keretein belül (Síkfőkút-Project. Environmental-biological research of an oakwood eco-system within the framework of the Biosphere program). MTA Biol. Oszt. Köz. 16: 11–25.

4. *Footnotes* should be typed on a separate sheet.

5. *Tables* should be typed on separate pages. They should be numbered serially with Arabic numerals and have a concise heading each. Vertical lines are not used. Clear wording of column heads is advisable.

6. *Figure captions* should be provided on a separate sheet.

7. *Illustrations* must not be inserted in the text. Figures will be redrawn. Therefore the most important point is the clearness of the figures, even pencil drawings are accepted (with a duplicate). Photographs should be sharp and well contrasted. All the illustrations should bear the figure number and author's name in pencil on the reverse.

The editors will send information to the first author about the arrival and *acceptance* of the paper. Two *proofs* will be provided, which are requested to be returned within 48 hours of receipt to the editor. Alterations in the text and especially in the illustrations are expensive and should be avoided. Twenty five *offprints* are supplied free of charge.

