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CONTENTS

BARCZI, A, PENKSZA, K., CZINKOTA, I. and NÉRÁTH, M.: A study of connections between certain phytocological indicators and soil characteristics in the case of the Tihany peninsula	1
BORHIDI, A.: Studies in Rondeletieae (Rubiaceae), XIII. new combinations of Mexican and Central American plants	15
BORHIDI, A., DARÓK, J. and KAPOSVÁRI, F.: Two new species of the genus <i>Javorkaea</i> Borhidi et J. Komlódi (Rubiaceae)	17
BUCZKÓ, K. and ÁCS, É.: Zonation of periphytic algae in two Hungarian shallow lakes (Lake Velence and Fertő)	21
CSONTOS, P., TAMÁS, J. and KALAPOS, T.: Soil seed banks and vegetation recovery on dolomite hills in Hungary	35
DIEGO-PÉREZ, N., OVIEDO PRIETO, R., LOZADA, L. and FONSECA, R. M.: Vegetación costera de lagunas y zonas inundables Cuba-Guerrero, México	45
FARKAS, Á., OROSZ-KOVÁCS, ZS., BUBÁN, T. and FEJES, J.: Pollen viability of pear cultivars . . .	113
KISS, A. and NÉMETH, J.: Temporal changes of algal communities in the "Mély-mocsár" (Hungary)	119
MATUS, G.: Distribution of species attributes in secondary succession of an overgrazed pasture in East Hungary	137
PAPP, B. and RAJCZY, M.: Bryophyte flora of the branch-systems of the Danube in Szigetköz in 1991-92	149
PAPP, M., HAMVAS-MIKÓ, M. and NAGY, M.: Floristical and phytocenological studies on the pasture of village Penészlek (Northeast Hungary)	167
PRÉCSÉNYI, I. and MÉSZÁROS, I.: The responses of a <i>Potentilla arenaria</i> Borkh. subpopulation to some soil factors in sandy grassland	193
RAUS, TH.: Zwergbinsen-Gesellschaften des Fimbristylidenion bisumbellatae in Griechenland – Kenntnisstand und Forschungsbedarf	203
SZABÓ, T., FARKAS, Á., OROSZ-KOVÁCS, ZS., BUBÁN, T., NAGY-TÓTH, E., ZORN, R., GÖRÖG, E., FEJES, E. and SZÉKELY, M.: Pollen viability and fruit set in apple cultivars	215
TÓTH, A. and TÖRÖK, K.: Survival chances of loess grassland fragments in the Hortobágy, Hungary: a case study on the community transformation effect of a collapsed wayside inn	225
VOJTKÓ, A.: The vegetation of the Bükk plateau (NE Hungary) II. the grassland communities of the limestone and dolomite rocks	239
ZAHEDI POUR, H. and EJTEHADI, H.: Grazing effects on diversity of rangeland vegetation: a case study in Mouteh Plain, Iran	271
ZAHEDI POUR, H. and TURCSÁNYI, G.: Comparison of diversities of three differently grazed sites in Iran	281
ZIMA, G., BACIC, T., BEDE, M. and ZAHIROVIC, Z.: Comparative study of stomata and some other properties in three new Croatian wheat (<i>Triticum aestivum</i> L.) genotypes	289

Book reviews (Ed. K. T. KISS)

Butterworth, F. M., Corkum, L. D. and Guzmán-Rincón, J. (eds) (1995): Biomonitoring and biomarkers as indicators of environmental change. (E. I. SIMAY)	299
Cox, E. J. (1996): Identification of freshwater diatoms from live material. (K. T. KISS)	301
Davidian H. H. (1995): The Rhododendron species. Volume IV. Azaleas. (T. A. SZABÓ)	302
Lange-Bertalot, H. and Metzeltin, D. (1996): Indicators of oligotrophy. (K. T. KISS)	302
Lappin-Scott, H. M. and Costerton, J. W. (1995): Microbial biofilms. (J. MAKK)	303
Lenzenweger, R. (1996): Desmidiaceenflora von Österreich, Teil 1. (K. T. KISS)	304
Ludes, B. and Coste, M. (1996): Diatomées et médecine légale. Application de la recherche des diatomées au diagnostic de la submersion vitale. (K. T. KISS)	304
Nikolov, H. (1996): Dictionary of Plant Names in Latin, German, English and French. (Z. KERESZTY)	305
Noad, T. C. and Birnie, A. (1992): Trees of Kenya. (Z. KERESZTY)	306
Olrik, K. (1994): Phytoplankton – ecology, determining factors for the distribution of phytoplankton in freshwater and sea. (A. SCHMIDT)	306
Pizzaro, H. (1995): The genus Characiopsis Borzi (Mischococcales, Tribophyceae). Taxonomy, biogeography and ecology. (K. T. KISS)	307
Reichardt, E. (1995): Die Diatomeen (Bacillariophyceae) in Ehrenbergs Material von Cayenne, Guayana Gallica (1843). (K. T. KISS)	308
Rogers, A. (1995): Peonies. Illustrated and with an essay on landscaping by Linda Engstrom. (T. A. SZABÓ)	310
Sims, P. E. (ed.) (1996): An atlas of British diatoms (K. T. KISS)	311
Van den Hoek, C., Mann, D. G. and Jahns, H. M. (1995): Algae, an introduction to phycology. (H. M. SHAFIK)	311
Verma, D. P. S. and Shoemaker, R. C. (eds) (1996): Soybean: genetics, molecular biology and biotechnology. (E. I. SIMAY)	313
Vyverman, W., Vyverman, R., Hodgson, D. and Tyler, P. (1995): Diatoms from Tasmanian mountain lakes: a reference data-set (TASDIAT) for environmental reconstruction and a systematic and autecological study. (K. T. KISS)	313

A STUDY OF CONNECTIONS BETWEEN CERTAIN PHYTOECOLOGICAL INDICATORS AND SOIL CHARACTERISTICS IN THE CASE OF THE TIHANY PENINSULA

A. BARCZI¹, K. PENKSZA², I. CZINKOTA¹ and M. NÉRÁTH¹

¹*Dept. Soil Science and Agricultural Chemistry, University of Agricultural Sciences
H-2103 Gödöllő, Péter Károly u. 1, Hungary*

²*Dept. Botany and Plant Physiology, University of Agricultural Sciences
H-2103 Gödöllő, Péter Károly u. 1, Hungary*

Coenological sampling (37 samples) according to the Braun-Blanquet method (1951) was carried out between July and September of 1994 (Penksza *et al.* 1994). Sample quadrats for studying the effects of treading measured 0.5 by 0.5 metres. The "saline" area was sampled in July 1995. Characteristics of different soil types were also determined (on-site and laboratory examinations). In our study of connections, we obtained two lists of data: a list that comprises of measured results (soil characteristics), while the other one contains values of the empirical scale (of relative phytoecological indicators). We found a definite connection between some phytoecological indicators and soil characteristics

Key words: plant, soil, relationship, characteristics

INTRODUCTION

A detailed survey of soil and botanical characteristics of the Tihany peninsula was carried out in order to determine the influence of soil types and various soil characteristics on plant associations of the peninsula. Our research strove to determine whether one (knowing soil characteristics) is able to draw conclusion as regards values of relative ecological indicators of the species of the association.

The following topics were examined:

- Whether there is a connection between soil characteristics and average values of relative indicators of plant species growing on the soil.
- What is the influence of the characteristics of a certain soil type on the composition of plant associations growing on the soil.
- Which relative ecological indicators have a connection with soil characteristics.
- What is the reason of such connections.

Among the results of the coenological survey, coverage values of species of the associations and also the Borhidi-type relative ecological indicators of species

were taken into consideration. Our study is a test as well, primarily to test the connections between average values of certain relative ecological indicators and soil characteristics.

MATERIALS AND METHODS

SOILS OF THE TIHANY PENINSULA

Lóczy (1913) described marshlands in the surroundings of Tihany. In the same publication, Ballenegger and László gave a general description of the soils of Lake Balaton area on a 1 : 400,000-scale map. The first detailed (1 : 25,000) survey of soils of the Tihany area was done by Ballenegger (1942). A 1 : 50,000 scale soil map of the peninsula was created by Teőreök and Sarkadi within the framework of Kreybig's soil mapping in 1949. On the basis of his own survey, Góczán (1968) published data on soil situation in a study, and later prepared the area's 1 : 10,000 soil map (Góczán 1970). Soil descriptions conform the genetic categorization of soils, as determined by Stefanovits and Szűcs (1961). Recent soil map of the Tihany peninsula was published by Barczy (1995), a study in which 16 soil types of the Tihany peninsula are mentioned

FLORA OF THE TIHANY PENINSULA

Several previous papers dealt with the vegetation of the Tihany peninsula (Borbás 1900, Rédl 1942). The first detailed field-works in the area were done by Soó (1928, 1930, 1931, 1932, 1933). He was also the first who published the vegetation map of the peninsula, differentiating ten association-groups (Soó 1932). This vegetation map shows outlined range of the main types of plant associations. According to this publication, the peninsula is mainly a cultivated area, former forests and steppes are now replaced by pastures or, on steep hillsides, by cultivated forests. Only water and marshland associations, swampy and steppe meadows, rocky grasslands and to some extent, *Cotino-Quercetum pubescentis* associations are considered as being endemic associations.

The phytogeography of the Bakony Mts and its surroundings were described by Fekete (1988). The lichen flora of the peninsula was published by Gallé (1967). According to the survey, most lichens between Csúcs-hegy and Nyereg-hegy are xeromorphic and basophilous. Floristic data on mosses were carried out by Boros *et al.* (1958). They enumerated 130 species. Most of these species are characteristic of shrub-forests and rocky grasslands: *Grimmia plagiopodia* (Csúcs-hegy), *Astomum crispum*, *Hymenostomum tortile*, *Mannia fragrans*, *Riccia ciliifera*, *Tortella flavovirens* subsp. *viridiflava*. Rose flora of the plateau of Lake Balaton was surveyed by Facsar (1980). Later on, he separately published data on the range of *Rosa livescens* (Facsar 1987). The peninsula's shore vegetation was studied by Felföldy (1943), its grasslands by Kárpáti and Kárpáti (1965), and Rychnovská and Kvet (1965), and its shrub-forest by Jakucs (1961). Kárpáti *et al.* (1986, 1987, 1989) presented the vegetation map of the peninsula. Szeplet and Tóth (1991) presented the vegetation map of the Belső-tó and the Külső-tó. Penksza *et al.* (1994) briefly summarized the effect of treading and grazing on the vegetation.

COMBINED STUDIES OF SOIL AND PLANT CHARACTERISTICS

Botanists always endeavoured to express the value of plants as indicators – that means the indication of certain characteristics of a habitat in which a certain plant is most likely to occur – in numerical figures. The first published data in this concept were halophytic values concerning salt-

tolerance on seashores (Iversen 1936). This was followed by Ellenberg's researches (1950, 1952) who, after establishing scales on the basis of certain requirements of arable crops, extended scales and their values to the total range of the German flora. Besides flowering plants, indicator values of mosses and lichens are also presented. Ever widening and various types of scales were published (Ellenberg 1974, Ellenberg *et al.* 1991). On the basis of empirical values, relative ecological indicators of the Hungarian flora were established on Zólyomi's initiative (Zólyomi 1964). The list contained 1400 species (Zólyomi *et al.* 1967). Zólyomi and Précsényi (1964) studied the possible adoption of the method and the application of relative ecological indicators. Relative ecological indicators were tested also by Bagi (1987). One of the most complete lists was compiled by Simon (1988, 1992). On the basis of Ellenberg's works, and taking the concept of strategies of plants by Grime (1979, 1988) into consideration, Borhidi (1991, 1993, 1995) determined the indicator values of the species of the Hungarian flora. Indicator values on a five-grade scale for all endemic Hungarian vascular plants were published by Soó (1964, 1980). A good survey of different scales of ecological indicators is offered by Bartha (1995).

On the basis of Borhidi (1995), our present study deals with the following categories and their values (TB, WB, RB, NB, LB, CB, SB).

Botanical studies usually refer to scientific background and tests of soils (H. Marrs and Proctor 1979, Dyrness and Youngberg 1966). Besides examining flora and elements of the microclimate, Kovács (1966, 1970) and Jakucs (1972) studied the relationship between flora and different soil types. Moreover, there are many studies investigating connections among ecological indicators and among soil characteristics and relative ecological indicator values of plants. Kunzmann (1990), on the basis of different moisture content, established categories and pending on these categories, examined the amount of available nitrogen.

For each type of soil, Kunzmann (1989) determined the max. and min. values of water capacity (in the primary root area), max. and min. values of available water in the soil, subsoil water table, amount of air in the soil and pH values. He found that the relationship between plants and ground water are determined by the soil's water management, infiltration abilities, permeability, available capillary water and physical qualities.

Kunzmann (1990) revised Ellenberg's empirical scale as regards the type of available water. At the same time water dynamics in the soil profile was examined and amount of infiltrating water was measured. Besides water capacity, special attention was given on the characteristics of soil water. For each plant species, an optimum range of moisture content was determined. Based on this range, a medium value was calculated. The mentioned study proposes further examination of the studied parameter, in connection with water and nutrient supply of plants.

Stein (1987) studied the presence of indicator plants in extensive and intensive agricultural systems. To compare the two systems, the soil was analysed by electro-ultra-filtration method. In case of extensive agriculture, a connection between the soil's moisture content and the amount of mineralised nitrogen was proved.

Bartha *et al.* (1994) traced the amount of accumulating nitrogen in the soil. Their study, sampling four areas, strove to determine provable connection between the N content of the topsoil and the presence of degradation-indicator herbaceous plants. Data were evaluated with variance analysis. Duncan-test at a probability level of 95% was used to compare average values. Research results concluded that there is a significant difference between the easily available N content of the soil and the N uptake of the plants. Similarly to other scientists (Kovács 1964, 1969), the mentioned study concluded that there is no detectable connection between N content of the soil and N values of plants.

Bagi (1989) studied soil characteristics of salt-affected soils as a reason for the occurrence of *Gypsophila muralis*.

Barucha and Satyanarayan (1954) proved Ca^{2+} accumulation of plants living on soils with high lime content. Jefferies and Willis (1964) drew parallel between chemical composition of certain acido- and calciphilous plants and the soil these plants live in.

SAMPLING SITES

The following areas of the Tihany peninsula were sampled: Nyereg-hegy (a hill), Levendulás, Vad-parlag and southern shore of Belső-tó (an inner lake) (Fig. 1). Choosing the site we acted on the principle that the site should closely represent the area's flora and soil. We chose sites we thought were important and characteristic of the area. As a consequence, degraded areas were also included.

Coenological sampling, according to the Braun-Blanquet method (1951), was carried out between July and September of 1994. Our 37 on-site quadrats measured 2 by 2 metres in slope steppe grasslands, 4 by 4 metres in dry grasslands, 10 by 10 metres in shrub-forests and 20 by 20 metres in forests. To examine the effect of treading we sampled 0.5 by 0.5 quadrats on the northern slope of Nyereg-hegy on tourists' routes and 2–3 m away from these beaten routes.

Levendulás and Vad-parlag are grazed areas at present. The area of Nyereg-hegy is nongrazed for 10 years by now, this is where shrub-forests and slope steppe grasslands were sampled. Our fourth sampling area is a meadow at present: a strip of land about 20–50 metres from the southern shore of Belső-tó (formerly this area was grazed, it has been a meadow for 3–4 years), and the immediate shore of the inner lake, where flora refers to the soil's sodification.

Apart from samples of the "saline" area, associations were sampled by Penksza *et al.* (1994). Present study uses data of the above-mentioned studies. Species are named according to Simon (1992), while associations conform Soó (1980) nomenclature. The area of lavenders is called *La-*

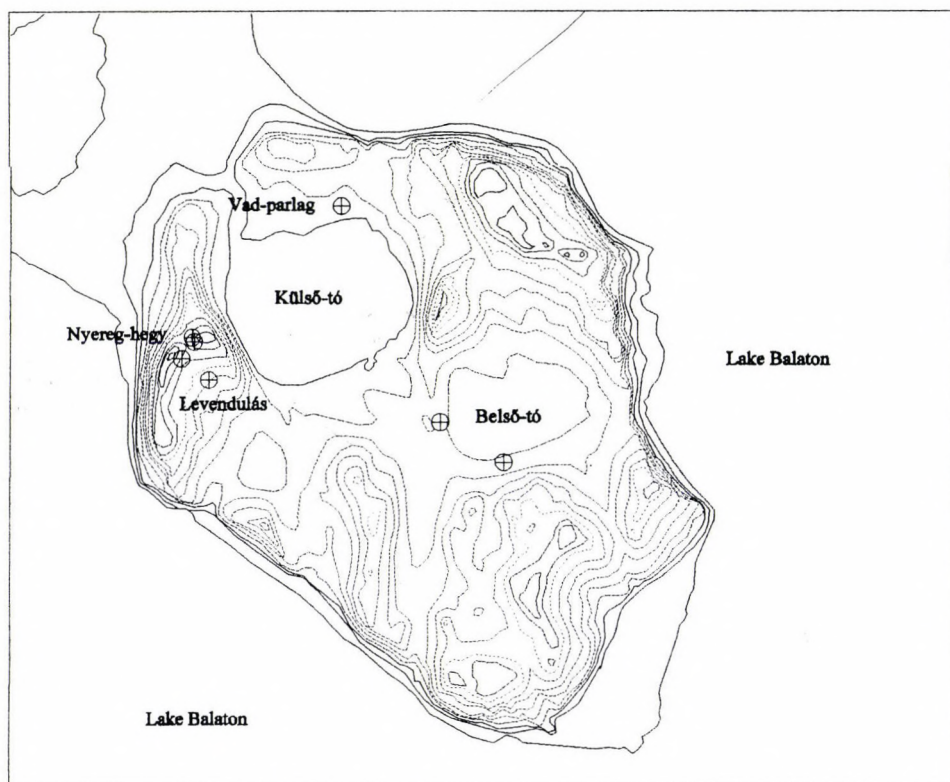


Fig. 1. Sample areas of the Tihany peninsula

vandulo-Festucetum pseudovinae (Penksza *et al.* 1994). The meadow, being potentially a *festucetum rupicolae* subassociation of *Cleistogeno-Festucetum rupicolae*, is called *Festucetum rupicolae*.

Soil was sampled with the Pürckhauer-type soil sampling technique (Benzler 1982). Description of soil types conform Stefanovits (1956, 1992), Szabolcs (1966) and Szodfridt (1993). Sampling and designation of sample sites were carried out taking the basic principles of soil mapping (Várrallyay 1987, Baranyai 1989), and botanical aspects into consideration. Laboratory test of soil samples was carried out according to valid standards (Buzás 1988, 1993).

Among the soil's chemical parameters, pH value, total carbonate expressed in CaCO_3 , and also the amount of humus, NH_4^{4+} and NO_3^{3-} ions, P_2O_5 , K_2O , Na, Ca, Mg, Zn, Cu, Mn, Fe, Mo, B, SO_4^{2-} was determined. Sticky point according to Arany, mechanical composition, hygroscopicity and pF curves were also determined.

Data were processed according to Sváb's (1967) principles.

The study area was sampled in seven places with four repetitions. For all examined places and parameters, an average of the results of soil sampling was calculated. In a randomized block system, data of plant enumeration, sampled at an average of 5 repetitions, were variance analysed. Each sample was considered a repetition. At 5% we calculated the significant difference (SD%) with T-probe.

For each plant species an average cover value was calculated. Average cover values of species form a vector. Its dimension equals the number of plant species at the sample site (generally there are about 30–50 species per associations). Since each sampling site means different number and various types of plant species, such vectors mathematically are not comparable. We therefore made the following steps of transformations: Supplementing – with a cover value of zero – sampling sites with all species of the total sampled area, we obtained a 2400 dimension vector for each site. This was multiplied with the matrix of the Borhidi-type relative ecological indicators. The number or rows of this matrix equals the number of dimensions of the coverage vector and rows contain all plant species of Hungary; whereas the matrix's columns of the matrix represent the 8 Borhidi-type relative ecological indicators. As a result of this vector transformation, each sampling site was characterized by an 8-dimension vector. These vectors are mathematically comparable. Further on, sampling sites (7 sites) were considered as a 7 by 8 matrix. For further study these matrixes (one by one) were merged with the 7 by 38 matrix of soil characteristics, obtaining a matrix of 7 by 46. In our study we examined this final matrix, which contains 46 columns (parameters) and 7 rows (sampling sites).

Each column was analysed with linear regression. A symmetrical 46 by 46 matrix of the coefficients of correlation contains correlation values we examined. Correlations with high coefficient values (Table 1) were examined and plotted in a system of rectangular coordinates. We studied and tried to determine how close are the connections between the chosen characteristics and indicators, and also the reasons of such connection.

RESULTS AND DISCUSSION

This study examines the connection between the soil's humus content, thickness, actual moisture content, the amount of silt in the soil and certain relative ecological indicators of plants, such as water and nitrogen demand. We obtained the following results. The higher the soil's humus content is, the higher the presence of acidophilic plants in the association on that soil will be.

Generally, humus substances of the soil are acidic – for example fulvic and humic acid – and as the amount of such components increases, soil pH slightly decreases. RB values (soil reaction) however, are not in close connection with the soil's pH value (in this case, coefficient of correlation is only 0.07). In case of

Table 1
Correlation matrix with high coefficient values

VAL	TB	WB	RB	NB	LB	KB	SB	
0.5712	0.948	0.4056	0.9744	0.4344	1.1088	0.7224	0.3288	
3.604	5.8512	2.1624	5.883	2.1412	6.6409	4.3831	2.0458	
5.4002	8.0104	3.1992	8.587	2.604	7.4214	4.9662	0.062	
1.305	1.675	1.995	2.0125	1.76	2.2875	1.635	1.26	
1.0471	2.1164	1.7908	2.3828	1.7464	2.9711	1.9166	0.222	
1.5984	3.7728	4.0608	4.7472	3.744	5.6112	5.136	2.0688	
1.3623	2.907	1.3452	2.9412	1.6131	3.3972	2.2287	0.7125	
VAL	TB	WB	RB	NB	LB	KB	SB	
0.06	0.07	0.44	0.14	0.37	0.19	0.27	0.10	pF 2.3
0.23	0.23	0.57	0.30	0.48	0.34	0.42	0.16	pF 2.7
0.22	0.25	0.70	0.34	0.63	0.41	0.54	0.37	pF 4.2
0.30	0.35	0.48	0.36	0.52	0.44	0.37	0.15	pF 6.2
0.39	0.53	0.83	0.60	0.82	0.72	0.80	0.26	depth of soil
-0.03	-0.02	0.22	0.02	0.17	0.06	0.09	-0.15	available water
0.23	0.35	0.67	0.41	0.66	0.53	0.60	0.14	calculated moisture
0.38	0.52	0.82	0.59	0.81	0.70	0.78	0.24	actual moisture in soil
0.55	0.42	-0.10	0.39	-0.25	0.21	0.07	-0.65	0.25– mm fraction
-0.22	-0.10	-0.34	-0.14	-0.24	-0.12	-0.10	-0.06	0.05– mm fraction
-0.09	0.09	0.77	0.20	0.83	0.39	0.63	0.86	0.01– mm fraction
0.30	0.25	0.12	0.22	0.12	0.20	0.05	-0.15	0.005– mm fraction
-0.44	-0.43	0.27	-0.35	0.31	-0.23	-0.07	0.64	<0.001 mm fraction
0.18	0.12	-0.52	0.04	-0.57	-0.10	-0.23	-0.67	sand
-0.18	-0.12	0.52	-0.04	0.57	0.10	0.23	0.67	clay
0.05	-0.11	-0.26	-0.12	-0.40	-0.25	-0.29	-0.41	silt
0.45	0.26	0.05	0.24	-0.11	0.10	-0.05	-0.41	hygroscopy
-0.15	0.03	0.29	0.05	0.45	0.22	0.30	0.49	bulk density
0.26	0.12	-0.17	0.07	-0.21	-0.02	-0.23	-0.41	pH
0.26	0.21	-0.30	0.17	-0.37	0.03	-0.03	-0.47	K _A
-0.31	-0.41	-0.14	-0.40	-0.16	-0.39	-0.42	-0.04	SAR
0.00	-0.11	-0.10	-0.13	-0.12	-0.18	-0.25	0.15	CaCO ₃
-0.76	-0.84	-0.54	-0.82	-0.54	-0.83	-0.69	0.26	organic matter

Table 1 cont.

VAL	TB	WB	RB	NB	LB	KB	SB	
0.23	0.25	0.04	0.25	-0.04	0.20	0.20	-0.33	NH ₄
0.26	0.34	0.28	0.37	0.24	0.37	0.44	-0.05	NO ₃
0.15	0.19	-0.40	0.10	-0.33	0.04	-0.12	-0.52	P ₂ O ₅
-0.04	0.09	-0.17	0.04	-0.05	0.10	0.01	-0.29	K ₂ O
0.18	0.00	0.06	0.00	-0.03	-0.07	-0.13	0.09	Ca
-0.24	-0.21	0.25	-0.17	0.33	-0.06	0.04	0.70	Mg
-0.19	-0.32	-0.13	-0.32	-0.15	-0.35	-0.35	0.28	Na
-0.24	-0.31	-0.60	-0.34	-0.65	-0.45	-0.45	-0.42	Zn
-0.72	-0.63	-0.43	-0.62	-0.34	-0.53	-0.43	-0.06	Cu
-0.51	-0.36	-0.26	-0.37	-0.10	-0.25	-0.22	-0.05	Mn
-0.51	-0.36	-0.03	-0.31	0.06	-0.20	0.02	0.47	Fe
0.32	0.34	0.75	0.42	0.66	0.47	0.61	0.57	Mo
0.48	0.28	0.03	0.26	-0.13	0.09	-0.03	-0.23	SO ₄ ²⁻
1.00	0.97	0.54	0.95	0.43	0.86	0.70	-0.31	VAL
	1.00	0.66	0.99	0.58	0.95	0.83	-0.19	TB
		1.00	0.74	0.98	0.84	0.94	0.53	WB
			1.00	0.66	0.97	0.88	-0.09	RB
				1.00	0.80	0.92	0.61	NB
					1.00	0.96	0.08	LB
						1.00	0.34	KB
							1.00	SB

shallow-profiled soils with high humus content, potential (hidden) acidity has to be considered besides actual acidity; but still there is not an exact explanation for the connection between humus content and acidity tolerance. We examined the close relationship between profile thickness and certain ecological indicators. The deeper a profile is, the higher the ground water (soil moisture) demand of associations will be (Fig. 2). In sites where the soil is only 10 cm thick (treaded and nontreaded areas of Nyereg-hegy, the immediate shore of Belső-tó, and Vad-parlag), values for relative water demand of plants of the associations are lower. The area called Levendulás, where the soil is thicker (40 cm), species with high relative ground water (soil moisture) values are present, for example *Galium aparine* and *Dactylis glomerata*. The shrub-forest's soil is 30 cm thick, average value of ecological indicators is the second highest among our sampled areas, that is 3.19. Species of this area that have high relative soil moisture content values include *Galium aparine* and *Ulmus minor*. The meadow is also 30 cm thick, but its association is characterised by species with lower average ground water and soil moisture values. Ecological indicator value is 2.16 in case of the

treaded area of Nyereg-hegy. This shows that anthropogenic influence turns closed grassland associations into open ones and results in the appearance of ruderal species that can easily accommodate to changes.

Relative ground water or soil moisture demand of plants is correlated to the soil's water management. This connection, however, is not as close as to the total thickness of A and B horizons of the soil. The amount of available water, calculated from the soil's pF curve is an important characteristic of the soil. Though the amount of available water is influenced by the type of association and the plant's ability to uptake water; in case of shallow soils (for example on Nyereg-hegy), however, water storage is rather influenced by the thickness of the soil. Besides pF values of the soil, profile thickness also has to be considered for the calculation and examination of available moisture. The correlation between the soil's thickness and relative nitrogen demand of plants (Fig. 3) is similar to that that exist between the profile's depth and the association's average relative ground water (soil moisture) values. Coefficient of correlation is 0.82. It can be proved that the thicker the profile is, the higher the association's relative nitrogen demand will be.

Nitrogen demand of soils are expressed in mg/100 g of soil. As thickness increases, in absolute values, more nitrogen becomes available for plant nutrition, compared to shallow soils.

We observed that in the area called Levendulás the average of relative nitrogen demand of associations is 3.74. Soil is 40 cm deep here. Species with high relative nitrogen demand of this area include *Convolvulus arvensis*, *Echium italicum*, *Artemisia austriaca* and *Carduus nutans*. In the shrub-forest, the soil's depth is 30 cm. There are species with high relative nitrogen demand present in this area, such as *Falcaria vulgaris*, *Achillea nobilis*, *Chondrilla juncea* and *Artemisia austriaca*. Soil is also 30 cm deep on the meadow, but the presence of nitrogen demanding species is lower than we expected. Their average value is 1.79.

Figures 4 and 5 show the correlation between the soil's silt content and – among ecological indicators of association living on the soil – relative water (moisture) and nitrogen demand. This chart shows that the higher the soil's silt content is, the higher the association's relative ground water demand will be.

Water management of soils are influenced by soil moisture, soil depth and also by soil texture. On examination of pF curves of soils with different physical characteristics, loamy soils are considered to have a good water management. Such soils have adequate supply of available water and on-site examinations prove that their structure is also good. As regards particle size analysis, soils with higher silt content probably have a better water management, which fact is in parallel with water demand of plants.

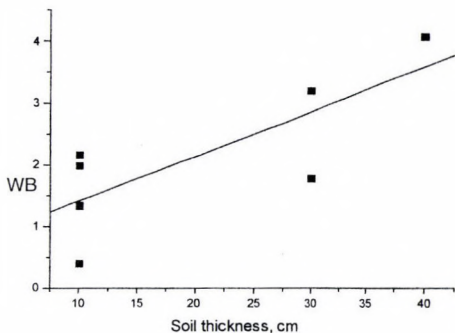


Fig. 2. Relationship between the thickness of the soil profile and water indicator values of plants

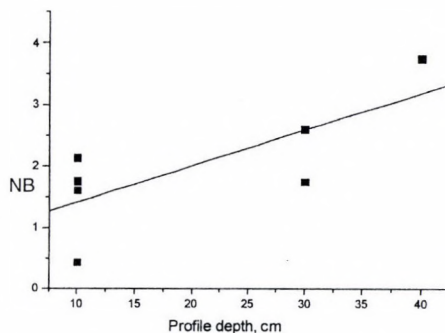


Fig. 3. Relationship between the thickness of the soil and nitrogen indicator values of plants

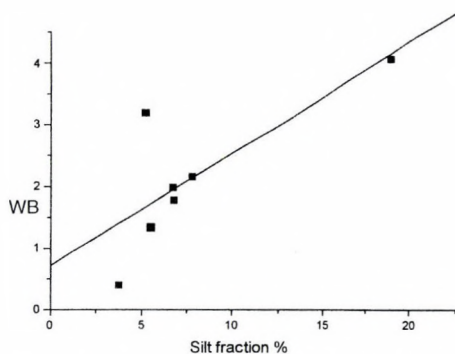


Fig. 4. Relationship between the soil's silt content and water indicator values of plants

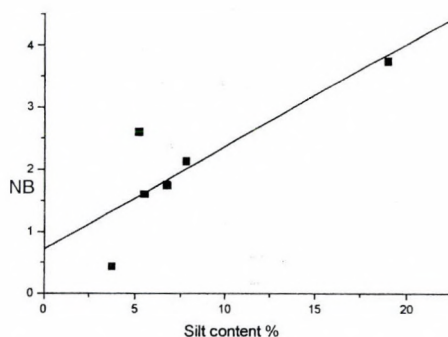


Fig. 5. Relationship between the soil's silt content and nitrogen indicator values of plants

Moist soils of Levendulás has the highest silt content (18.956%). Species with high soil moisture values of the association of this area include *Galium aparine* and *Dactylis glomerata*. We observed the lowest silt content (3.7093%) on gravelly skeletal soils of the treaded area of Nyereg-hegy. *Potentillo arenariae-Festucetum pseudovinae* association of this area is characterised by drought resistant species, such as *Festuca pseudovina*, *Thymus glabrescens* and *Potentilla arena-ria*. It is clearly observable in Fig. 5 that similarly to Fig. 4, to the case of water indicator values, higher silt content of the soil (expressed in the percentage of total amount of particles) means that the association living on that soil is characterised by species with higher nitrogen indicator values. Since Levendulás has the highest silt content, relative nitrogen demand is also the highest in this area (3.744) here. Species with high nitrogen demand of *Lavandulo-Festucetum pseu-*

dovinae association include *Convolvulus arvensis*, *Echium italicum*, *Artemisia austriaca* and *Carduus nutans*. Previous charts has revealed that among relative ecological indicators of plants, relative demand for ground water (soil moisture) and for nitrogen has a similar relationship to certain soil characteristics we examined. Therefore we studied the correlation between these two relative ecological indicators as well (Fig. 6). Since our data processing included not only the absence or presence of species, but coverage value of each species was also taken into consideration, among relative ecological indicators we really studied the associations' actual relationships. Our experience proves that there is a close relationship between nitrogen and water indicator values of plants. One of our conclusions is that these indicator values of empirical scales suit well to be applied in botanical surveys.

Examining the relationship (weighted by coverage values of each species) between NB (relative nitrogen indicator values) and WB (relative ground water (soil moisture) indicator values) of species of the Tihany peninsula, we found that the value of coefficient of correlation is 0.98. This means that these two relative indicators are in a very close connection. Expressed in other way, the higher the water indicator values of the species of a certain area is, the higher the nutrient – primarily nitrogen – indicator values of species will be.

Our last point was to examine whether connections shown in Fig. 7 are provable in the case of the flora of Hungary. Figure 7 proves that considering total range of the Hungarian flora, the two studied Borhidi-type ecological indicators – these are the nutrient supply (NB) and relative water indicator values (WB) – are in not detectable connection. This present coenological study, however, has

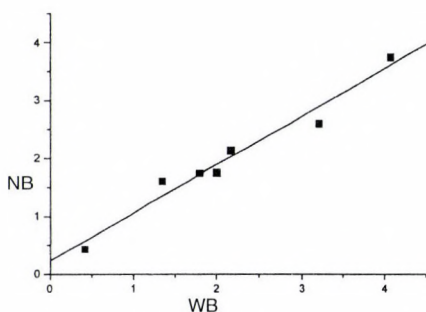


Fig. 6. Relationship between water and nitrogen indicator values of plants

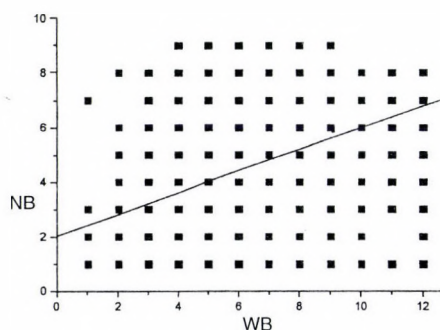


Fig. 7. Relationship between water and nitrogen indicator values of plants, respecting the total flora of Hungary

shown that in an actual situation, taking coverage values of species of association into consideration, there is a strong relationship between ecological indicator values of species of that given association (see Fig. 6).

REFERENCES

- Bagi, I. (1987): Statistical relationships between the ordination of coenological relevés and characteristic indicator values. – *Acta Bot. Hung.* **33**: 199–210.
- Bagi, I. (1989): A *Gypsophila muralis* L. kiskunsági szikéséken való előfordulásának talajtani okai és természetvédelmi vonatkozásai. – *Bot. Közlem.* **76**: 51–63.
- Ballenegger, R. (1942): A tihanyi-félsziget talajviszonyainak áttekintése. – *Magyar Biol. Kut. Munk.* **14**: 1–9.
- Ballenegger, R. and László, G. (1913): A Balatonvidék talajviszonyainak vázlatja. – In: Lóczy, L. (ed.): A Balaton környékének geológiai képződményei és ezeknek vidékek szerinti telepedése. A Balaton Tudományos Tanulmányozásának Eredményei I(1/1). Kilián Frigyes M. K. Egyetemi Könyv., Budapest, pp. 577–579.
- Baranyai, F. (ed.) (1989): *Útmutató a nagyméretarányú országos talajterképezés végrehajtásához*. – Agroiinform, Budapest, 152 pp.
- Barczy, A. (1995): A Tihanyi-félsziget talajterképezése és a talajokban bekövetkezett változások leírása a talajterképek alapján. – GATE, Gödöllő, Szakdolgozat. (kézirat)
- Bartha, D. (1995): Ökológiai és természetvédelmi jelzőszámok a vegetációs értékelésben. – *Tilia* **1**: 170–184.
- Bartha, D., Bidló, A. and Kovács, G. (1994): *Degradáltságvizsgálatok a Kőszegi-hegységben*. – In: Bartha, D. (ed.): A Kőszegi-hegység vegetációja. Sopron, pp. 183–197.
- Benzler, J. H. (1982): *Bodenkundliche Kartieranleitung*. – Hannover, 331 pp.
- Barucha, F. R. and Satyanarayan, Y. (1954): *The problem of calcicolous plants*. – Aichinger Festschr., Wien, pp. 395–405.
- Borbás, V. (1900): A Balaton tavának és partmellékének növényföldrajza és edényes növényzete. – A Balaton Tudományos Tanulmányozásának Eredményei II (2/2). Kilián Frigyes M. K. Egyetemi Könyv., Budapest, 431 pp.
- Borhidi, A. (1991): A magyar flóra magatartás típusai II. – Magyar Ökológus Kongresszus, Abstract, Keszthely, p. 22.
- Borhidi, A. (1993): A magyar flóra szociális magatartástípusai, természetességi és relatív ökológiai értékszámai. – A KTM TH és a JPTE közös kiadványa, Pécs, 96 pp.
- Borhidi, A. (1995): Social behaviour types, naturalness and relative ecological indicator values of the Hungarian Flora. – *Acta Bot. Hung.* **39**: 97–181.
- Boros, Á., Felföldy, L. and Vajda, L. (1958): A Tihanyi-félsziget mohafldrája. – *Annal. Biol. Tihany* **25**: 292–302.
- Braun-Blanquet, J. (1951): *Pflanzensoziologie*. – Springer Verlag, Wien, 631 pp.
- Buzás, I. (1988): *Talaj- és agrokémiai vizsgálati módszerkönyv II.* – Mezőgazdasági Kiadó, Budapest, 243 pp.
- Buzás, I. (1993): *Talaj- és agrokémiai vizsgálati módszerkönyv I.* – INDA 4231 Kiadó, Budapest, 357 pp.
- Dyness, C. T. and Youngberg, C. T. (1966): Soil-vegetation relationships within the ponderosa pine type in the Central Oregon Pumice region. – *Ecology* **47**: 122–138.
- Ellenberg, H. (1950): *Landwirtschaftliche Pflanzensoziologie I. Unkrautgemeinschaften als Zeiger für Klima und Boden*. – Ulmer Verlag, Stuttgart, 141 pp.

- Ellenberg, H. (1952): *Landwirtschaftliche Pflanzensoziologie II. Wiesen und Weiden und ihre standortliche Bewertung*. – Ulmer Verlag, Stuttgart, 143 pp.
- Ellenberg, H. (1974): *Zeigerwerte der Gefäßpflanzen Mitteleuropas*. – Scripta Geobotanica 9, Goltze Verlag, Göttingen, 97 pp.
- Ellenberg, H., Weber, H. E., Düll, R., Wirth, V., Werner, W. and Paulissen, D. (1991): *Zeigerwerte von Pflanzen in Mitteleuropa*. – Scripta Geobotanica 18, Goltze Verlag, Göttingen, 248 pp.
- Facsar, G. (1980): *A Bakony és a Balaton-felvidék rózsafiórájának fontosabb jellemzői*. – A nyolcadik Bakonykutató Ankét, Zirc, pp. 37–45.
- Facsar, G. (1987): Néhány kritikus Rosa taxon kutatása a Balaton-felvidéken és a Bakony kapcsolódó területein. – *Fol. Mus. Hist.-nat. Bakonyiensis* 6: 73–76.
- Fekete, G. (1988): *Természetes növénytakaró*. – In: Ádám, L., Marosi, S. and Szilárd, J. (eds): *A Dunántúli-középhegység*, B). Regionális tájféldrajz. Akadémiai Kiadó, Budapest, pp. 149–174.
- Felföldy, L. (1943): Vegetáció tanulmányok a Tihanyi félsziget északi partvonalán. – *Magyar Biol. Kut. Munk.* 15: 42–74.
- Gallé, L. (1967): Zuzmótársulások a Tihanyi-félsziget gejzirkúpjairól. – *Bot. Közlem.* 54: 143–146.
- Góczán, L. (1968): "Erubáz" mészlepedékes csernozjom a Tihanyi-félszigeten. – *Földr. Ért.* 17: 375–377.
- Góczán, L. (1970): *A Tihanyi-félsziget talajviszonyai*. – In: Magyarázó a Balaton környéke 1:10000 építésföldtani térképsorozathoz. Tihany. MÁFI, Budapest, pp. 63–78.
- Grime, J. P. (1979): *Plant strategies and vegetation processes*. – John Wiley and Sons, Chichester, New York, Brisbane, Toronto, 222 pp.
- Grime, J. P. (1988): *Comparative plant ecology*. – Unwin Hyman, London, Boston, Sydney, Welington, 742 pp.
- H. Marrs, R. and Proctor, J. (1979): Vegetation and soil studies of the enclosed heathlands of the Lizard peninsula, Cornwall. – *Vegetatio* 41: 121–128.
- Iversen, J. (1936): *Biologische Pflanzentypen als Hilfsmittel in der Vegetationsforschung*. – Levin und Munksgaard, Kopenhagen, 224 pp.
- Jakucs, P. (1961): *Die phytologischen Verhältnisse der Flaumeichen-Buschwälder Südost-Mitteleuropas*. – Akadémiai Kiadó, Budapest, 314 pp.
- Jakucs, P. (1972): *Dynamische Verbindung der Wälder und Rasen*. – Akadémiai Kiadó, Budapest, 228 pp.
- Jefferies, R. L. and Willis, A. J. (1964): Studies on the calcicole-calcifuge habit. I. Methods of analysis of soil and plant tissues and some results of investigations on four species. – *J. Ecol.* 52: 121–138.
- Kárpáti, I. (1978): Magyarországi vizek és ártéri szintek növényfajainak ökológiai besorolása. – *A keszthelyi Agrártudományi Egyetem Kiadványai* 20: 1–62.
- Kárpáti, I. and Kárpáti, V. (1965): Adatok a Tihanyi-félsziget sztyeppvegetációja ökológiai viszonyaihoz. I. A mintavételi helyek és az analizált növényi cönózisok leírása. – *Annal. Biol. Tihany* 32: 247–265.
- Kárpáti, I., Szeglet, P. and Tóth, I. (1987): Die Vegetationskarte der Bozsauer-Bucht. – *BFB-Bericht* 63: 63–68.
- Kárpáti, I., Kárpáti, V., Gacsó, L. and Szeglet, P. (1986): Die Vegetationskarte des Inneren und Ausseren Sees in Tihany. – *BFB-Bericht* 58: 55–60.
- Kárpáti, I., Kárpáti, V., Szeglet, P. and Tóth, I. (1989): Ökologische Untersuchungen in den Schilfbeständen des Neusiedler Sees I. – *BFB-Bericht* 71: 101–110.
- Kovács, M. (1964): Der ökologische Feuchtegrad als Kriterium zur Beurteilung von Grünlandstandorten, ein Vergleich bodenkundlicher und vegetationskundlicher Standortmerkmale. – *Dissertationes Botanicae*, Berlin, Stuttgart, pp. 32–33, 104–242.

- Kovács, M. (1966): Die Wirkung der geomorphologischen (expositionsbedingten) mikroklimatischen und bodenfaktoren auf die Entwicklung des Standortes der azidophilen Wälder im Mátra-Gebirge. – *Acta Bot. Acad. Sci. Hung.* **12**: 293–324.
- Kovács, M. (1969): Pflanzenarten und Pflanzengesellschaften als Anzeiger des Bodenstickstoffs. – *Acta Bot. Acad. Sci. Hung.* **15**: 101–118.
- Kovács, M. (1970): Transektuntersuchung der Gradienten der ökologischen Heterogenität in kontakten Gesellschaften Bodenfaktoren und horizontale Zonation. – *Acta Bot. Acad. Sci. Hung.* **16**: 117–142.
- Kunzmann, G. (1989): Der ökologische Feuchtegrad als Kriterium zur Beurteilung von Grünlandstandorten, ein Vergleich bodenkundlicher und vegetationskundlicher Standortmerkmale. – *Dissertationes Botanicae*, Berlin, Stuttgart, pp. 16–31, 127–166, 197–243.
- Kunzmann, G. (1990): Die Bestimmung des ökologischen Feuchtegrades von Grünlandstandorten mit einem modifizierten Zeigerartenverfahren. – *Z. f. Kulturtechnik und Landentwicklung* **31**: 368–380.
- Kunzmann, G. (1990): Überprüfung der Ellenberg'schen Feuchtezahlen anhand bodenkundlicher Parameter auf Grünlandstandorten in Mittelhessen. – *Verhandlungen der Gesellschaft für Ökologie* **19**: 386–397.
- Lóczy, L. (1913): *A Balaton környékének geológiai képződményei és ezeknek vidékek szerinti telepődése*. – A Balaton Tudományos Tanulmányozásának Eredményei, I. Kilián Frigyes M. K. Egyetemi Könyv., Budapest, 611 pp.
- Penkcsa, K., Barcsi, A., Néráth, M., Gyimóthy, G. and Centeri, Cs. (1994): *Changes in the vegetation of Tihanyi-félsziget (Tihany peninsula, near lake Balaton, Hungary) as a result of treading and grazing*. – Proceedings of International Conference, Anthropization and Environment of rural settlements, Flora and Vegetation. Sátorajújhely, 22–26 August 1994.
- Rédl, R. (1942): *Bakony-hegység és környékének flórája*. Magyar flóraművek V. – Editio Ordinis Scholarum Piarum, Veszprém, 157 pp.
- Rychnovská, M. and Kvet, J. (1965): Contribution to the ecology of the steppe vegetation of the Tihany Peninsula. III: Estimation of drought resistance based on the saturation of water deficit. – *Annal. Biol. Tihany* **32**: 289–296.
- Simon, T. (1988): A hazai edényes flóra természetvédelmi értékének becslése. – *Abstracta Botanica* **12**: 1–23.
- Simon, T. (1992): *A magyarországi edényes flóra határozója*. – Tankönyvkiadó, Budapest, 892 pp.
- Soó, R. (1928): Adatok a Balatonvidék flórájának és vegetációjának ismeretéhez. (Beiträge zur Kenntnis der Flora und Vegetation des Balaton-Gebiets). – *Magyar Biol. Kut. Munk.* **2**: 132–136.
- Soó, R. (1930): Adatok a Balatonvidék flórájának és vegetációjának ismeretéhez. II. (Beiträge zur Kenntnis der Flora und Vegetation des Balaton-Gebiets). – *Magyar Biol. Kut. Munk.* **3**: 169–185.
- Soó, R. (1931): Adatok a Balatonvidék flórájának és vegetációjának ismeretéhez. III. (Beiträge zur Kenntnis der Flora und Vegetation des Balaton-Gebiets). – *Magy. Biol. Kut. Munk.* **4**: 293–317.
- Soó, R. (1932): Adatok a Balatonvidék flórájának és vegetációjának ismeretéhez. IV. (Beiträge zur Kenntnis der Flora und Vegetation des Balaton-Gebiets). – *Magy. Biol. Kut. Munk.* **5**: 112–120.
- Soó, R. (1933): A Balatonvidék növényközvetkezeteinek ökológiai és szociológiai jellemzése. – *Math. Term. Tud. Ért.* **50**: 669–712.
- Soó, R. (1964): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve. I.* – Akadémiai Kiadó, Budapest, 519 pp.
- Soó, R. (1980): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve. VI.* – Akadémiai Kiadó, Budapest, 557 pp.
- Stefanovits, P. (1956): *Magyarország talajai*. – Akadémiai Kiadó, Budapest, pp. 299–307.
- Stefanovits, P. (1992): *Talajtan*. – Mezőgazda Kiadó, Budapest, 380 pp.

- Stefanovits, P. and Szűcs, L. (1961): *Magyarország genetikus talaj térképe*. – OMMI, Budapest, 1. sor, 1. sz.
- Stein, K. (1987): Die Vegetation als Indikator der Nährstoffversorgung. Ein Vergleich intensiv und extensiv gedüngter Grünlandstandorte. – *Mitteilgn. Dtsch. Bodenkundl. Gesellsch.* **53**: 299–304.
- Sváb, J. (1967): *Biometriai módszerek a mezőgazdasági kutatásban*. – Mezőgazdasági Kiadó, Budapest, 410 pp.
- Szabolcs, I. (1966): *A genetikus üzemi talaj térképezés módszerkönyve*. – OMMI, Budapest, 428 pp.
- Szeglet, P. and Tóth, I. (1991): Offene Wasserflächen im Röhricht des "Außeren Sees" bei Tihany. – *BFB-Bericht* **77**: 165–181.
- Szodfridt, I. (1993): *Erdészeti termőhelyismeret-tan*. – Mezőgazda Kiadó, Budapest, 320 pp.
- Teőreők, J. and Sarkadi, J. (1949): *Siófok. 5260 Ny./I. térképlap*. – Talajtani és Agrokémiai Kutatóintézet Térképtára, Budapest.
- Várallyay, Gy. (1987): *A nagyméretarányú talaj térképezés módszerkönyve*. – Agroinform, Budapest.
- Zólyomi, B. (1964): New method for ecological comparison of vegetational units and of habitats. – *Acta Biol.* **14**: 333–338.
- Zólyomi, B. and Précsényi, I. (1964): Methode zur ökologischen Charakterisierung und Vegetationseinheiten und zum Vergleich der Standorte. – *Acta Bot. Acad. Sci. Hung.* **10**: 377–419.
- Zólyomi, B., Baráth, Z., Fekete, G., Jakucs, P., Kárpáti, I., Kárpáti, V., Kovács, M. and Máthé, I. (1967): Einreihung von 1400 Arten der ungarischen Flora in ökologischen Gruppen nach TWR-Zahlen. – *Fragmenta Botanica* **3**: 101–142.

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STUDIES IN RONDELETIEAE (RUBIACEAE), XIII. NEW COMBINATIONS OF MEXICAN AND CENTRAL AMERICAN PLANTS

A. BORHIDI

*Phytotaxonomic Research Group, Hungarian Academy of Sciences
H-7624 Pécs, Ifjúság útja 6, Hungary*

New combinations of five Central American and Mexican species of *Rondeletia* s.l. are proposed classifying them to the genera *Arachnothryx* Planch., *Javorkaea* Borhidi et J. Komlódi, and *Rogiera* Planch. respectively.

Key words: Mexican and Mesoamerican *Rondeletia*, new combinations

Some new species have been discovered and described by D. Lorence from Mexico and Central America belonging to the section *Rondeletieae*. They are described in the framework of the genus *Rondeletia* L. in a broader sense, which does not fit to the type species of the genus (Borhidi 1982, 1989, 1995, Borhidi and Járαι-Komlódi 1983). Therefore a modern concept of *Rondeletia* and allied genera has been developed. According to this concept the right place of the recently described taxa are as follows:

Arachnothryx chiriquiana* (Lorence) Borhidi, *comb. nova

Basionym: *Rondeletia chiriquiana* Lorence 1994, *Novon* 4: 129–132. (Fig. 7, p. 131).

Holotype: PANAMA. Chiriquí: Fortuna Dam area, along shores of Río Chiriquí where it enters reservoir. Col.: H. W. Churchill 5924, MO 3595277.

Note: The species belongs to the section *Calycosae* (Standl.) Borhidi.

Arachnothryx evansii* (Lorence) Borhidi, *comb. nova

Basionym: *Rondeletia evansii* Lorence 1997, *Novon* 7: 52–54. (Fig. 4, p. 53).

Holotype: HONDURAS. Lempira: Parque Nacional de Celaque, sendero entre la planta eléctrica y la primera casa abandonada de Don Tomás. Col.: P. House 1163, PTBG 16112.

Note: The species belongs to the section *Laniflorae* (Standl.) Borhidi.

Arachnothryx pringlei (Lorence) Borhidi, *comb. nova*

Basionym: *Rondeletia pringlei* Lorence 1997, *Novon* 7: 54–55. (Fig. 5, p. 54).
Holotype: MEXICO. Veracruz: hills near Orizaba. Col.: C. G. Pringle 6135, GH.

Note: The species belongs to the section *Arachnothryx*.

Javorkaea megalantha (Lorence) Borhidi, *comb. nova*

Basionym: *Rondeletia megalantha* Lorence 1994, *Novon* 4: 132–134. (Fig. 8, p. 133).

Holotype: HONDURAS. Cuyamel (Dept. Cortés). Col.: M. A. Carleton 653, US 1208409.

Rogiera breedlovei (Lorence) Borhidi, *comb. nova*

Basionym: *Rondeletia breedlovei* Lorence 1994, *Novon* 4: 129. (Fig. 6, p. 130).

Holotype: MEXICO. Chiapas: Municipio de Tenejapa, paraje of Mahben Chauk. Col.: D. E. Breedlove 7682, F 1617735.

REFERENCES

- Borhidi, A. (1982): Studies in *Rondeletieae* (Rubiaceae) III. The genera *Rogiera* and *Arachnothryx*. – *Acta Bot. Hung.* 28: 65–71.
- Borhidi, A. (1989): Studies on *Rondeletieae* (Rubiaceae) XI. Critical notes on some Central American species of *Rondeletia* s.l. – *Acta Bot. Hung.* 35: 309–312.
- Borhidi, A. (1995): Studies in *Rondeletieae*, XII. New combinations of Mexican and Central American taxa. – *Acta Bot. Hung.* 38: 139–142. (1993–94).
- Borhidi, A. and Járαι-Komlódi, M. (1983): Studies in *Rondeletieae* (Rubiaceae) IV. A new genus: *Javorkaea*. – *Acta Bot. Hung.* 29: 13–27.
- Lorence, D. H. (1994): New species in Mexican and Mesoamerican Rubiaceae. – *Novon* 4(2): 119–136.
- Lorence, D. H. (1997): New taxa, a new name, and a new combination in Rubiaceae from Southern Mexico and Mesoamerica. – *Novon* 7(1): 46–58.

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TWO NEW SPECIES OF THE GENUS *JAVORKAEA* BORHIDI ET J. KOMLÓDI (RUBIACEAE)*

A. BORHIDI¹, J. DARÓK² and F. KAPOSVÁRI³

¹Phytotaxonomic Research Group, Hungarian Academy of Sciences

H-7624 Pécs, Ifjúság útja 6, Hungary

²Dept. Botany, Janus Pannonius University

H-7624 Pécs, Ifjúság útja 6, Hungary

³Central Laboratory, Medical University

H-7624 Pécs, Szigeti út 12, Hungary

Two Mexican species of *Rondeletia* (Rubiaceae) are transferred to the recently described genus *Javorkaea*.

Key words: *Rondeletia*, *Javorkaea*, new combinations

INTRODUCTION

Revising the specimens of the genus *Rondeletia* in the National Herbarium of Mexico two species claimed the attention by their habits being very similar to the type species of the genus *Javorkaea* described by Borhidi and J. Komlódi in 1983. The two species were classified as *Sommeria acuminata* described by Ørsted ex Standley in 1927, and transferred to the genus *Rondeletia* by Lorence and Castillo-Campos in 1988, the other one was described by the later authors in the same article as *Rondeletia uxpanapensis* Lorence et Castillo-Campos a species of Central and South Mexico.

DISCUSSION

The scanning microscopic studies made on the flower and pollen of the three species convinced the present authors, that all the three belong to the genus *Javorkaea*. Consequently, the genus originally considered as a monotypic one turned to consist of three species. Having information about a broader variability range of the genus, this fact made necessary to extend its diagnostic description as follows:

The genus *Javorkaea* includes tropical trees and shrubs. Their twigs and leaves are covered by strigillose hairs. Stipules end in a long acuminate tip. Inflores-

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cence terminal cymose-corymbose, many-flowered. Calyx zygomorphic 4–7-lobed, 1–2 lobes twice as broad as the others, deeply nerved. Corolla radial or slightly zygomorphic, 4–7-lobed, sometimes one lobe with undulate margin, tube villous outside, pilose inside at its lower third. Throat of the corolla open, naked, lobes are hairy inside at the base and in the sinuses between the lobes. Pollen 4-colporate, pori and colpi not at the same place. Fruit a dry septicidal elliptic or oblong capsule, usually compressed laterally, sometimes opening upwards from the base. Species belonging here:

Javorkaea hondurensis (Donn. Smith) Borhidi et J. Komlódi, *typus generis*

Javorkaea acuminata (Øerst. ex Standl.) Borhidi, *comb. nova*

Basionym: *Sommeria acuminata* Øerst. ex Standl. 1927, *Wash. Acad.* **17**: 340.

Syn.: *Rondeletia acuminata* (Øerst. ex Standl.) Lorence et Castillo-Campos 1988, *Biotica* **13**: 148.

Arachnothryx acuminata (Øerst. ex Standl.) Borhidi 1989, *Acta Bot. Hung.* **35**: 310.

Specimina examinata:

- Oaxaca, Arroyo Lumbre 3 km al Este de Santa Cruz Tepetotutla, 780 m s.m., Col.: Meave del Castillo *et al.*, no. 1588, 05.02.1993.
- Oaxaca, Sierra de Juárez, Rancho La Primavera rumbo al Rio Faisán, 1600 m s.m., Col.: Guillermo Perez Cruz, no. C 103, 01.04.1980.
- Oaxaca, 6.5 km al Sur de Santa Cruz Tepetotutla 2040 m s.m., Col.: A. Rincón Gutierrez *et al.*, no. 218, 22.12.1993.
- Oaxaca, 5 km al NE de Puerto Eligio 900 m s.m., Col.: Refugio Cedillo y R. Torres, no. 2398, 02.06.1983.
- Oaxaca, Puerto Antonio, 5.3 km al N de Vista Hermosa, carr. Oaxaca-Tuxtepec 1230 m s.m., Col.: P. Tenorio, no. 11024 R. Torres, 09.03.1986.
- Oaxaca, 31 km al Sur de Valle Nacional, camino a Oaxaca, Col.: E. Martinez *et al.*, no. 8797, 22.11.1984. 2 spec.
- Oaxaca, 13 km al N de La Esperanza, dist. Ixtlán, 1900 m s.m., Col.: Abiasai García *et al.*, no. 3045, 09.04.1987.
- Oaxaca, Carretera Oaxaca-Tuxtepec, 111 km, Col.: Th. McDougall, 25.11.1963, 2 spec.
- Oaxaca, 3.6 km al SO de La Esperanza, carr. Tuxtepec-Oaxaca, 1700 m s.m., Col.: R. Torres, nos 11690, 11675, 11293, 24.02.1988.
- Oaxaca, 3.1 km al Sur de Santa Cruz Tepetotutla, 2200 m s.m., Col.: Claudia Gaillardio Hernandez *et al.*, no. 847, 25.02.1994.

- *Idem*, 2040 m s.m., Col.: Claudia Gaillardo Hernandez *et al.*, no. 058, 04.04.1994.
- *Idem*, 2010 m s.m., Col.: Claudia Gaillardo Hernandez *et al.*, no.: 1219, 31.10.1994.
- Oaxaca, 39 km al S de Valle Nacional sobre la carr. Oaxaca, 1750 m s.m., Col.: Rzedowski, no. 33902, 22.02.1976.
- *Idem*, 1800 m s.m., Col.: Rzedowski, no. 33835, 27.12.1975.
- Oaxaca, Puerto San Antonio entre Metates y La Esperanza, carr. Tuxtepec-Oaxaca, 1250 m s.m., Col.: Abisai Garcia M. *et al.*, no. 1830, 04.08.1985.
- Oaxaca, Sierra de Juarez, Ruta 175, Tuxtepec a Oaxaca, 4 km al SO de La Esperanza, 1700 m s.m., Col.: D. Lorence, no. 4264, 04.06.1983.
- *Idem*, Col.: D. Lorence, no. 4176, 28.05.1983.
- *Idem*, Col.: D. Lorence & R. Torres, no. 4016, 14.04.1982.
- *Idem*, Col.: Cedillo *et al.*, no. 924, 03.08.1981.
- Oaxaca, 13 km al SO de La Esperanza, carr. Oaxaca-Tuxtepec, Col.: R. Torres, no. 10937, 17.10.1987.

Javorkaea uxpanapensis* (Lorence et Castillo-Campos) Borhidi, *comb. nova

Basionym: *Rondeletia uxpanapensis* Lorence et Castillo-Campos 1988, *Biotica* **13**: 150.

Syn.: *Arachnothryx uxpanapensis* (Lorence et Castillo-Campos) Borhidi 1989, *Acta Bot. Hung.* **35**: 311.

Specimina examinata:

- Oaxaca, Mpio María Chimalapa. Lomas al Sur del Rio Verde cca 9 km al N de Santa María, Col.: H. Hernandez G., no. 1143, 23.04.1985.
- Veracruz, 25 km al SE del Campamento Hnos Cedillo, Rio Marquez, Hidalgotitlán, Col.: B. Ortiz et Martiniano, no. 144, 07.05.1975. Num. Rec. Inf. 21629, 3 spec.
- *Idem*, Num. Rec. Inf. 21624, 2 spec.
- *Idem*, Num. Rec. Inf. 21623, 1 spec.

REFERENCES

- Borhidi, A. (1989): Studies on *Rondeletieae* (Rubiaceae) XI. Critical notes on some Central American species of *Rondeletia* s.l. – *Acta Bot. Hung.* **35**: 309–312.
- Borhidi, A. (1995): Studies in *Rondeletieae*, XII. New combinations of Mexican and Central American taxa. – *Acta Bot. Hung.* **38**: 139–142. (1993–94).

- Borhidi, A. and Járαι-Komlódi, M. (1983): Studies in Rondeletieae (Rubiaceae) IV. A new genus: *Javorkaea*. – *Acta Bot. Hung.* **29**: 13–27.
- Borhidi, A., Darók, J. and Kaposvári, F. (1997): *The variability range of the genus Javorkaea Borhidi and J.-Komlódi (Rubiaceae)*. – Abstracts, IXth Hung. Plant. Anat. Symp., Szeged, p. 20.
- Lorence, D. H. and Castillo-Campos, G. (1988): Tres nuevas especies y una nueva combinación en el género *Rondeletia* (Rubiaceae, Rondeletieae) de Veracruz y Oaxaca, México. – *Biotica* **13**: 147–157.

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ZONATION OF PERIPHYTIC ALGAE IN TWO HUNGARIAN SHALLOW LAKES (LAKE VELENCE AND FERTŐ)

K. BUCZKÓ¹ and É. ÁCS²

¹*Dept. Botany, Hungarian Natural History Museum
H-1476 Budapest, Pf. 222, Hungary*

²*Dept. Microbiology, Eötvös L. University
H-1088 Budapest, Múzeum krt. 6-8, Hungary*

The vertical zonation of the algal coating in the two largest Hungarian sodic lakes was studied. 57 taxa were determined from the Lake Fertő and 59 from the Lake Velence. The top few centimetres seem distinct in both lakes, while below this stratum, two groups can be distinguished.

The top level can be characterised by low abundance and low chlorophyll-*a* content and a high ratio of dead cells. The second group is characterised by great abundance, high chlorophyll-*a* content. In the third group, the abundance as well as the chlorophyll-*a* content are again smaller (approximately, half of the preceding group).

In respect of the vertical zonation, the effect of wave movement and light supply were found to be of decisive importance.

Key words: algae, periphyton, shallow lake

INTRODUCTION

In course of the spatial analysis of the distribution of living organisms in waters typically the horizontal spreading is investigated, whereas the vertical zonation of the biomass is also important. In oceans, seas and deep continental lakes the changes of vertical zonation have been recorded on a large scale, embracing several metres (Jónsson 1987, Hoagland and Peterson 1990, Chung *et al.* 1991). In the case of shallow lakes, however, these type of studies have been neglected.

This approach is partly due to the fact that the phytoplankton of shallow lakes, which can be mixed till the bottom were often considered as a unified mass due to the regular disturbing effect of the wind homogenising the water.

In spite of the general mixing and disturbed state of the phytoplankton, the periphyton is developed on the artificial objects immersed to the water, as well as the underwater part of plants there is the possibility to develop the natural stratification of the biomass.

In Hungary, apart from the definitely floristical approach, the vertical distribution of the coating was studied only by Szemes (1950). Felföldy (1958) performed related studies in the Lake Balaton, mainly by measuring the chlorophyll-*a* content. Uherkovich (1984) also studied the Lake Balaton in the form of semi-

quantitative measurements concerning the vertical distribution of periphyton and its relation to algal dominance data.

In the two largest sodic lakes of Hungary, *i.e.* the Lake Fertő and the Lake Velence, the vertical zonation of the periphyton has not been studied yet. The detailed description of algological research in the Lake Fertő and the summary of the algological changes of the last 13 years there were summarised by Padisák (1993).

The dramatic changes which have been taking part in the Lake Velence (decrease of water level, *Cladophora* invasion, *Microcystis* waterbloom, sometimes the several cm of foam, means and consequences of extra water supply etc.) resulted in the concentration of attention. In spite of this, the algological investigation of the lake did not receive much publicity. On the periphyton of the Lake Velence we have more publications (Lakatos and Bartha 1989, Lakatos and Ács 1990, Ács *et al.* 1991, Lakatos *et al.* 1991); than on the phytoplankton of lake which is very unusual in algological research.

Pieczynska and Banas (1984) demonstrated that on the concrete blocks in the distance of a few centimetres coating of widely different taxonal composition can be formed. At the same time no information has been available on the details of these transitions, *i.e.* is the observed change discrete or gradual and, what sort of categories can be separated within the coating.

According to the comprehensive categories of Jónsson (1987), the verticalisation of periphytic algae can be explained by the following factors:

- (1) light penetration,
 - (2) substrate type,
 - (3) stability (waves),
 - (4) algal growth form (attachment capacity, longevity size),
 - (5) light requirements,
- other authors mentioned the importance of nutrient (6) and temperature (7) summarised in Hoagland and Peterson 1990.

In course of the present investigations, the vertical distribution of the periphyton was studied in two shallow lakes where the water mass is regularly mixed till the bottom. In both lakes, similar substrates were used as sampling points (*Phragmites australis*). The regular mixing excludes the lasting stratification by temperature and nutrients, thus these factors can be omitted from the evaluation. At the same time, the eufotic zone extends to the very bottom of the lakes at both places.

Thus we can exclude from the parameters mentioned by Jónsson the following: light penetration (1), substrate type (6) differences of nutrient supply (6) and effects of the differences of temperature (7).

Our study aimed at answering the following questions:

- what sort of qualitative and quantitative changes can be found in the composition of the periphyton;
- do the changes in the periphyton represent a monotonous transition or can distinct “threshold values” be found within the periphyton composition;
- how does the relative frequency of the species vary;
- do the individual species have light preferences, *i.e.* which species can be preferentially found in the well-lit upper parts and which taxa tolerate shade better.

MATERIAL AND METHODS

Study area (Fig. 1): Lake Fertő, situated at the border of Hungary and Austria. Area: 300 km², average depth 1.3 m, pH = 7.5–10, electrical conductivity 1000–2300 μS. Lake Velence is situated in the West-Central parts of Hungary, its area is 24.5 km², average water depth 1.2 m, conductivity 1500–3500 μS cm⁻². The colour of the open water surface of both lakes is regularly grey due to the unorganic particles in the constantly mixed water.

Methods: Collecting spots were planted on the reed-side parts facing the open water surface from both lakes. The sampling point in the Lake Fertő was exposed more to waves than that of the Lake Velence; the latter sampling point was exposed to waves only in stormy wind. Sampling was performed in the Lake Fertő on 16th September 1992 in the vicinity of the Austrian–Hungarian



Fig. 1. The sampling points at the Lake Fertő and at the Lake Velence. The location of the lakes in Hungary

border, in the Lake Velence on 19th July 1992 from a site called Rigya-mellék. The water depth at the sampling points was 70 cm (Lake Fertő) and 55 cm (Lake Velence), respectively.

The reed was cut at the bottom and each 5 cm phase from under the water was put into different glass containers. Five reed stems at both sampling points were collected.

The coating was washed into water of known volume, which was later homogenised and separated into two parts. From the first part of the resulting samples the chlorophyll-*a* content was determined, the taxonomic classification was performed on the other part of the sample was counted by Utermöhl-method (1958) by taking the statistical ranges of Lund *et al.* (1958) into consideration.

The diatoms were treated with H₂O₂, after this, slides embedded into Styrex were made. The first 400 specimens were counted and the diatoms were identified.

In course of the statistical treatment constancy was calculated on the basis of the function:

$$K = N/S \times 100$$

where N = the number of samples where the taxon had occurred and S = was the total number of samples. (This way, constancy value 5 was assigned to species occurring in 80–100% of all samples, value 4 where the species was found in 60–80% etc.). Species considered dominant were the taxa which made up at least in one sample 5% relative abundance among the algae. Cluster analysis was performed using the program package SYN-TAX III (Podani 1988), with WPGM fusion algorithm, based on Czekanowski-index (Czekanowski 1909).

RESULTS AND DISCUSSION

There were 57 taxa identified from the Lake Fertő and 59 ones from the Lake Velence, respectively (Table 1). The species number within the Lake Fertő sam-

Table 1
List of taxa with their constancy

	Constancy		Constancy	
	Lake Fertő	Lake Velence	Lake Fertő	Lake Velence
CYANOPHYTA				
<i>Anabaena</i> sp.	+	+	1	2
<i>Chroococcus minutus</i> (Kütz.) Näg.	+		1	
<i>Merismopedia glauca</i> (Ehrbg.) Näg.		+		1
<i>Oscillatoria pseudogeminata</i> G. Schmid.		+		1
<i>Oscillatoria</i> sp.	+		1	
<i>Pseudanabaena catenata</i> Lauterb.		+		2
<i>Snowella lacustris</i> Chod.		+		1
<i>Spirulina subtilissima</i> Kütz.		+		3
CHRYSTOPHYTA Bacillariophyceae				
<i>Achnanthes minutissima</i> Kütz.	+	+	3	5
<i>Amphora coffeaeformis</i> (Ag.) Kütz.		+		1
<i>Amphora ovalis</i> (Kütz.) Kütz.	+	+	1	1
<i>Amphora pediculus</i> (Kütz.) Grun.		+		2

Table 1 cont.

	Constancy		Constancy	
	Lake Fertő	Lake Velence	Lake Fertő	Lake Velence
<i>Amphora veneta</i> Kütz.		+		2
<i>Aulacoseira granulata</i> (Ehr.) Sim.	+		1	
<i>Campylodiscus clypeus</i> Ehr.	+	+	4	5
<i>Campylodiscus hibernicus</i> Ehr.	+		2	
<i>Centrales</i> sp.	+	+	3	3
<i>Chaetoceros müllerii</i> Lemm.	+	+	1	5
<i>Cocconeis placentula</i> Ehr.	+	+	3	5
<i>Cyclotella comta</i> (Ehr.) Kütz.	+		1	
<i>Cyclotella meneghiniana</i> Kütz.	+	+	3	1
<i>Cymbella affinis</i> Kütz.	+	+	5	1
<i>Cymbella aspera</i> (Ehr.) Cl.	+	+	3	1
<i>Cymbella cistula</i> (Ehr.) Kirchner	+	+	5	3
<i>Cymbella cymbiformis</i> Ag.	+		1	
<i>Cymbella delicatula</i> Kütz.	+		1	
<i>Cymbella lacustris</i> (Ag.) Cl.	+	+	5	5
<i>Cymbella microcephala</i> Grun.		+		1
<i>Cymbella minuta</i> Hilse		+		1
<i>Cymbella pusilla</i> Grun.	+	+	1	5
<i>Diatoma tenuis</i> Ag.	+	+	1	3
<i>Entomoneis alata</i> (Ehr.) Ehr.	+		1	
<i>Epithemia adnata</i> (Kütz.) Bréb.	+		1	
<i>Fragilaria brevistriata</i> Grun.	+		5	
<i>Fragilaria capucina</i> var. <i>vaucheriae</i> (Kütz.) Lange-Bert.	+		1	
<i>Fragilaria construens</i> (Ehr.) Grun.	+	+	5	2
<i>Fragilaria pinnata</i> Ehr.	+		3	
<i>Fragilaria pulchella</i> (Ralfs) Lange-Bert.		+		5
<i>Fragilaria ulna</i> (Nitzsch) Lange-Bert.	+	+	5	5
<i>Fragilaria ulna</i> var. <i>acus</i> (Kütz.) Lange-Bert.	+	+	5	1
<i>Gomphonema olivaceum</i> (Hornemann) Bréb.	+	+	4	5
<i>Gomphonema olivaceum</i> var. <i>calcareum</i> (Cl.) Cl.	+	+	5	5
<i>Gomphonema parvulum</i> (Kütz.) Kütz.	+		1	
<i>Gomphonema truncatum</i> Ehr.		+		1
<i>Navicula capitata</i> var. <i>hungarica</i> (Grun.) Ross	+	+	1	2
<i>Navicula cincta</i> (Ehr.) Ralfs	+		1	
<i>Navicula cryptocephala</i> Kütz.	+	+	2	5

Table 1 cont.

	Constancy			
	Lake Fertő	Lake Velence	Lake Fertő	Lake Velence
<i>Navicula halophila</i> (Grun.) Cl.	+	+	1	1
<i>Navicula oblonga</i> Kütz.	+	+	1	1
<i>Navicula pseudolanceolata</i> Lange-Bert.	+		1	
<i>Navicula radiosa</i> Kütz.	+		1	
<i>Navicula rhynchocephala</i> Kütz.		+		3
<i>Navicula veneta</i> Kütz.	+	+	2	2
<i>Nitzschia amphibia</i> Grun.	+	+	3	4
<i>Nitzschia angustata</i> Grun.	+	+	1	5
<i>Nitzschia constricta</i> (Kütz.) Ralfs	+		4	2
<i>Nitzschia dissipata</i> (Kütz.) Grun.		+	3	
<i>Nitzschia frustulum</i> (Kütz.) Grun.	+	+		1
<i>Nitzschia recta</i> Hantzsch	+		1	
<i>Nitzschia</i> sp. (spine-like)	+	+	1	5
<i>Nitzschia sublinearis</i> Hust.	+		1	
<i>Rhoicosphaenia abbreviata</i> (C. Ag.) Lange-Bert.	+	+	5	5
<i>Rhopalodia gibba</i> (Ehr.) O. Müller	+	+	2	2
<i>Surirella peisonis</i> Pant.	+	+	2	1
CHRYSTOPHYTA Xanthophyceae				
<i>Goniochloris fallax</i> Fott		+		2
EUGLENOPHYTA				
<i>Euglena acus</i> Ehr.	+	+	1	1
<i>Euglena</i> sp.	+		1	
CHLOROPHYTA				
<i>Cosmarium polygonatum</i> Halász		+		1
<i>Closterium moniliferum</i> (Bory) Ehr.		+		1
<i>Closterium parvulum</i> Näg.	+		4	
<i>Crucigenia quadrata</i> Morr.	+	+	1	1
<i>Monoraphidium contortum</i> (Thur.) Kom.-Legn.	+	+		3
<i>Monoraphidium minutum</i> (Näg.) Kom.-Legn.		+		2
<i>Oedogonium</i> sp.	+	+	1	5
<i>Oocystis lacustris</i> Chod.	+		1	
<i>Pediastrum boryanum</i> (Turp.) Menegh.		+		1
<i>Scenedesmus ecornis</i> (Ehr.) Chod.		+		1
<i>Scenedesmus quadricauda</i> (Turp.) Bréb.		+		5
<i>Tetraedron caudatum</i> (Corda) Hansg.		+		1
<i>Tetraedron minimum</i> (A. Br.) Hansg.		+		1

ples was surprisingly low, especially taking into consideration the data in literature. Almost all of the publications on the benthos of the lake specially mention the unique diversity of diatoms in the lake within the European lakes (Pantocsek 1912, Hustedt 1959). In our case, the low taxon number can be partly explained by the high ratio of inorganic detritus which increased our to methodological error. On the other hand, the taxon number could be reduced due to constant wave motion and (selective) mechanical injuries caused by the sediment particles. The number of species present in both lakes was 31, most of them were diatoms. There is a marked difference in the Chlorophyta ratio of the two lakes: the periphyton collected from the Lake Velence contain always more green algae than the ones in the Lake Fertő (Figs 2, 3).

The number of constant-subconstant species in the Lake Fertő is 13, in the Lake Velence 17 (Table 1).

On the days of the sampling, the Secchi transparency of the water was measured as 57 cm in the Lake Fertő and 30 cm in the Lake Velence at the sampling points. In both lakes the reed had a coating with low abundance and chlorophyll-*a* content in the top 5 cm (Fig. 4), while proceeding downwards it was several times more. The maximal abundance was found in the Lake Fertő as 0.84×10^6 ind/cm², maximal chlorophyll-*a* content $7.99 \mu\text{g}/\text{cm}^2$ while in the Lake Velence the maximal abundance was 1.47×10^6 ind/cm², the maximal chlorophyll-*a* content $0.93 \mu\text{g}/\text{cm}^2$. Due to the differences in the date of sampling, however, these data are not directly comparable.

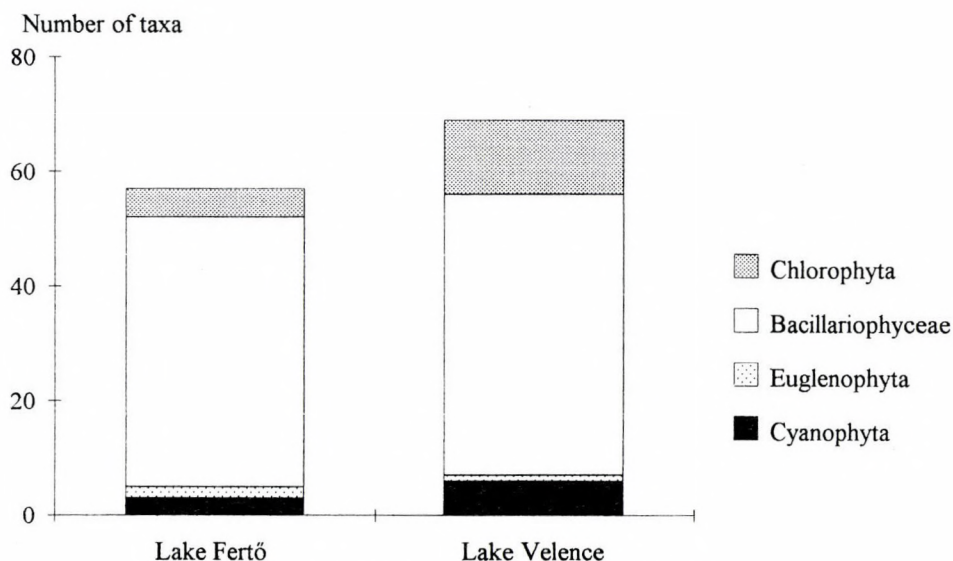


Fig. 2. Taxonomic composition of reed-periphyton

The ratio of dead cells (Fig. 4) in both lakes was around 15–20% on the average, with the exception of the top 5 cm segment in the Lake Fertő where more than the double of the above value was encountered (41%).

The vertical distribution of the coating in both lakes was characterised by the low abundance and chlorophyll-*a* content of the top 5 cm (Fig. 4). In the case of

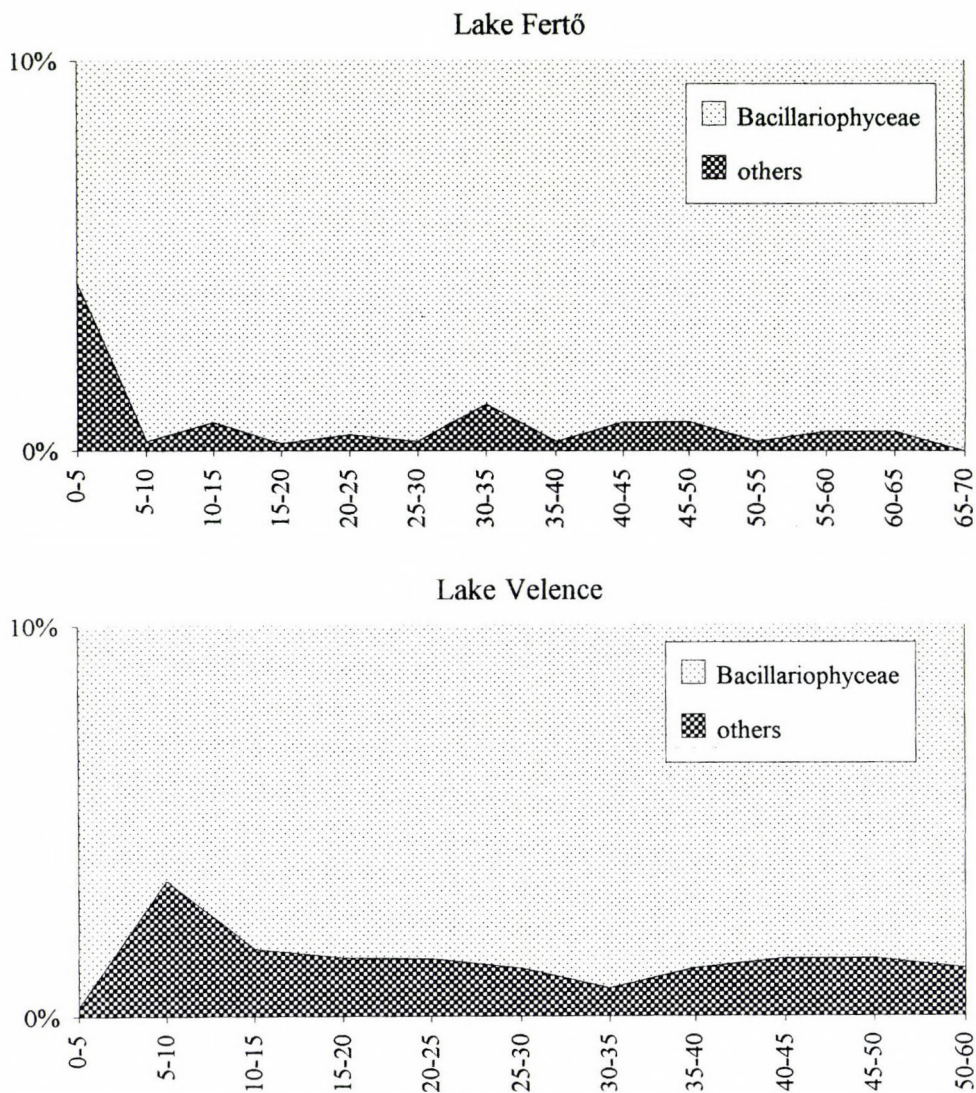


Fig. 3. The ratio of diatoms in the periphyton

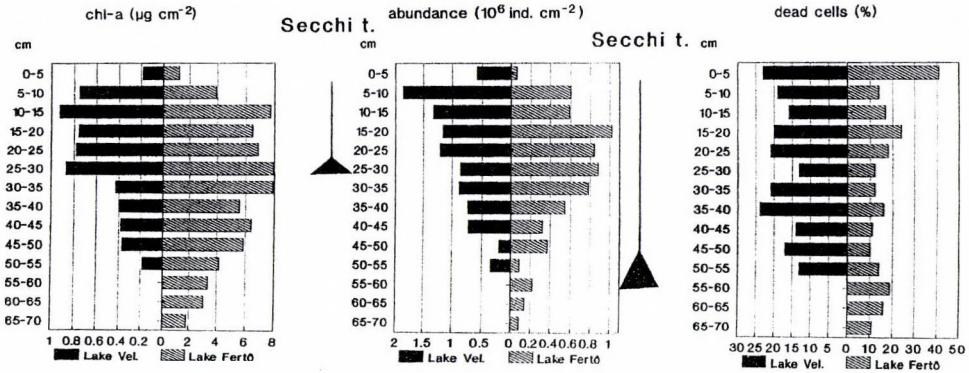


Fig. 4. The zonation of chlorophyll-*a* content, the abundance of algae and the ratio of dead cells

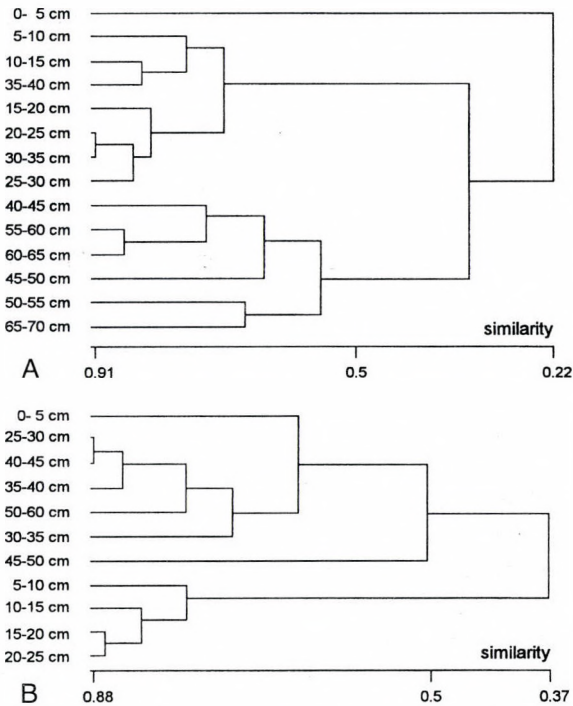


Fig. 5. Dendrogram of the samples based on the Czekanowski-index. A. Lake Fertő, B. Lake Velence

deep lakes the low abundance of the top zone is generally explained by the phenomenon of photoinhibition (Jónsson 1987). In our case, however, the differences were in the order of a few centimetres only, thus the underlying reasons must have been something different. Due to the movement of waves and the changes in the water surface these parts are generally wet but not uniformly covered by water thus probably they were the parts of the substrate most exposed to extreme circumstances. This explanation is also supported by the high ratio of dead cells here.

Vertical distribution of periphytic algae in the Lake Fertő (Fig. 5) can be divided into three main groups based cluster analysis with Czekanowski-index on 50% level of SICC (Similarity Index Community Coefficient, Chung *et al.* 1991). The samples from the top 5 cm were very different from the rest while samples from the phase 5–40 cm and 40–70 cm were ranked to the same group. Sampling procedure was performed in nice sunny weather with little wind thus the Secchi-values measured for this period were in all probability higher than the values typical for the spot. This is supported further by our other Secchi measurements. The thresholding of the upper 5 cm part is basically due to the low abundance and the dominance of *Achnanthes minutissima* and *Diatoma tenuis*, respectively.

In the Lake Velence, the dendrogram calculated on the basis of the Czekanowski-index also separated three groups. The top 5 cm again was sharply distinguished, though the distinction could be made here over the 50% level (Fig. 5). The samples collected from the depth of 5–25 cm formed the second group while the rest of the samples from below 25 cm formed the last group.

In the phase over 25 cm the samples were characterised by the dominance of 3–4 species, i.e. *Achnanthes minutissima*, *Cymbella lacustris*, *Nitzschia amphibia*, and sometimes *Gomphonema olivaceum*. Below 25 cm the relative abundance of *Cocconeis placentula* and *Rhoicosphaenia abbreviata* grew essentially while that of the *Gomphonema olivaceum* was getting low.

We can point out as specific feature of the vertical zonation of the Lake Fertő that the species *Diatoma tenuis* had a relative abundance of 6.5% in the top 5 cm, but disappeared completely from under the depth of 10 (Fig. 6, top). The relative abundance of the species *Achnanthes minutissima* was 11.5% in the top segment, and disappeared completely at 35 cm. In the case of *Gomphonema olivaceum* and *G. olivaceum* var. *calcareum* a slight decrease in the relative abundance could be observed towards the deeper lying strata. The relative abundance of *Fragilaria brevistriata* and *Rhoicosphaenia abbreviata* increased with the growing depth. In the Lake Velence, the highest relative abundance of *Achnanthes minutissima* was also measured in the top 5 cm (73.4%), but here the high relative abundance remained constant (nearly 50%) at all depth (Fig. 6, bottom). The relative abundance of the species *Gomphonema olivaceum* and *G. olivaceum* var. *calcareum* showed, similar to the Lake Fertő, a gradual decrease (the latter species, how-

ever, was not presented on the figure because its relative abundance (2.9%) was quite low). The relative abundance of the species *Rhoicosphaenia abbreviata* and *Cocconeis placentula* showed a marked increase towards the bottom.

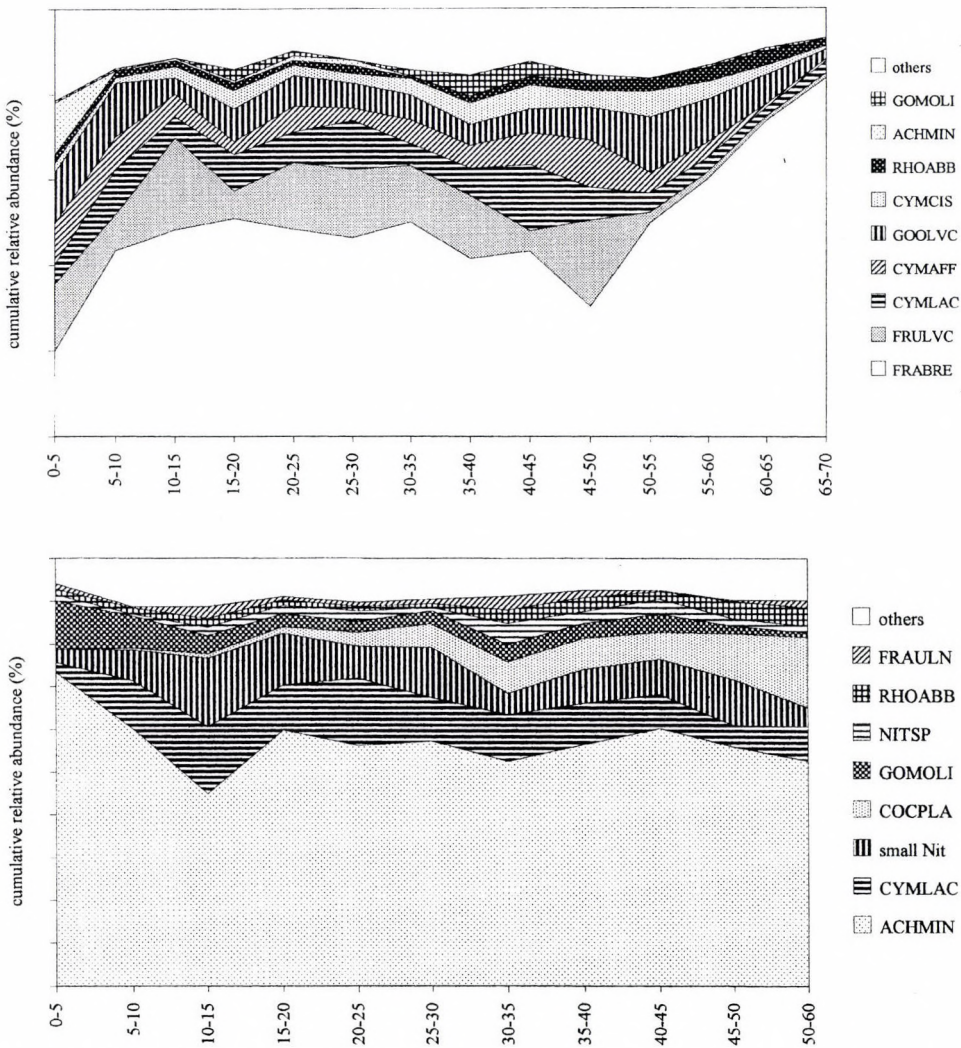


Fig. 6. The cumulative relative abundance of the most abundant taxa. Top: Lake Fertő. (FRABRE – *Fragilaria brevistriata*, FRULVC – *Fragilaria ulna* var. *acus*, CYMLAC – *Cymbella lacustris*, CYMAFF – *Cymbella affinis*, GOOLVC – *Gomphonema olivaceum* var. *calcareum*, CYMCIS – *Cymbella cistula*, RHOABB – *Rhoicosphaenia abbreviata*, ACHMIN – *Achnanthes minutissima*, GOMOLI – *Gomphonema olivaceum*). Bottom: Lake Velence. (ACHMIN – *Achnanthes minutissima*, CYMLAC – *Cymbella lacustris*, small Nit – small *Nitzschia* taxa, COCPLA – *Cocconeis placentula*, NITSP – spine-like *Nitzschia*, RHOABB – *Rhoicosphaenia abbreviata*, FRAULN – *Fragilaria ulna*)

Changes in the relative abundance indicate that the species *Cocconeis placentula*, *Rhoicosphaenia abbreviata* and *Fragilaria brevistriata* (the relative abundance of the latter surpassing in the Lake Fertő at 65 cm 84%) tolerate the significant limitations in light. This can be a good explanation for the fact that during the colonisation process of the substrates these species belong to the late colonists ones (Stevenson and Peterson 1989). This feature, however, needs further explanations. Jónsson (1987) also found one of the varieties of *Cocconeis placentula* as well as the species *Rhoicosphaenia abbreviata* having increasing abundance values towards the deeper regions. As the object of his studies was deep lake diatoms, the scale of these studies were essentially different. In case of the species *Gomphonema olivaceum* and *G. olivaceum* var. *calcareum* it is reasonable to suppose that they poorly tolerate the lack of light with the consequence that in the process of colonisation these taxa get competitively excluded from the coating (Ács and Kiss, in press). Probably the sudden disappearance of *Diatoma tenuis* in the Lake Fertő can also be explained by poor competitive abilities. These considerations also need further studies.

CONCLUSIONS

In spite of the differences in sampling dates (early autumn in the Lake Fertő and early summer in the Lake Velence) resulting in differences in the length of day-time, light intensity, temperature and other important parameters, the evidence collected from both lakes gave identical answers for the questions discussed among the aims of the present study:

- in the shallow, mixed water lakes distinct groups could be separated within the coating in the order of a few centimetres. The topmost few centimetres were definitely distinct from the rest and further on, two groups could be separated within the coating. In case of the Lake Fertő, roughly at 40 cm while in the Lake Velence at 25 cm depth we could detect essential differences. The top zone is characterised by low abundance, low chl-*a* content and a high ratio of dead cells. The second group can be characterised by a great number of individuals and high chl-*a* content. The abundance in the third group is lower (approx. half of the preceding group) with lower chl-*a* content.
- among the potential factors influencing the vertical zonation of the coating, the effect of wave movement and light relations were found the most important. Algal growth forms are also important in the formation of the complex three dimensional structure of the coating, influencing the attachment capacity as well. In the following, the analysis will be completed with SEM studies to cover this approach as well.

- in case of the future examination the top few centimetres will be omitted while samples from the upper region and from below the average Secchi value will be taken at the same time.

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REFERENCES

- Ács, É., Buczkó K. and Lakatos, Gy. (1991): A Velencei-tó és a Fertő nádbevonátának összehasonlító algológiai elővizsgálata (Comparative algological study of the reed-periphyton in Lake Velencei and Fertő). – *Bot. Közlem.* **78**(1–2): 95–111.
- Ács, É. and Kiss, K. T. (in press): Colonization process of diatoms on artificial substrate in the River Danube near Budapest (Hungary). – *Hydrobiol.*
- Borhidi, A. (1970): Ökologie, Wettbewerb und Zönologie des Schildfrohns (Phragmites communis L.) und die Systematik der Brackröhrichte. – *Acta Bot. Acad. Sci. Hung.* **16**: 1–12.
- Borhidi, A. and Balogh, M. (1970): Die Entstehung von dystrophen Schankelmooren in einem alkalischen (szik-)See. – *Acta Bot. Acad. Sci. Hung.* **16**: 13–31.
- Chung, H., Lee, H.-J. and Lee, I. K. (1991): Vertical distribution of marine algae on a Gallam rocky shore of the mid-east coast of Korea. – *Korean J. Phyc.* **6**: 55–67.
- Czekanowski, J. (1909): Zur differential Diagnose der Neandertalgruppe. – *Korrespbl. dt. Ges. Anthrop.* **40**: 44–47.
- Felföldy, L. (1958): A contribution to the ecology and biological productivity of the diatom mass-vegetation on the stony shores of lake Balaton. – *Annal. Biol. Tihany* **25**: 331–342.
- Hoagland, K. D. and Peterson, C. G. (1990): Effects of light and wave disturbance on vertical zonation of attached microalgae in a large reservoir. – *J. Phycol.* **26**: 450–457.
- Hustedt, F. (1959): Die Diatomeenflora des Neusiedler Sees im Österreichischen Burgenland. – *Öst. Bot. Z.* **106**: 390–430.
- Jónsson, G. S. (1987): The depth-distribution and biomass of epilithic periphyton in Lake Thingvallavatn, Iceland. – *Arch. Hydrobiol.* **108**: 531–547.
- Lakatos, Gy. and Bartha, Zs. (1989): Plankton- und Biotektonuntersuchungen im Velence-See (Ungarn). – *Acta Biol. Debrecina* **21**: 37–66.
- Lakatos, Gy. and Ács, É. (1990): *Nád élőbevonat vizsgálatok a Velencei-tavon (1978–88)*. [Investigations on the reed-periphyton in Lake Velence (1978–88)]. – IV. Fejér megyei Környezetvédelmi Szeminárium 1990. okt. 15–17, 2: 291–302.
- Lakatos, Gy., Ács, É. and Buchtijarova, L. N. (1991): Study on reed-periphyton in Lake Velence. – *Annls hist.-nat. Mus. natn. Hung.* **83**: 187–197.
- Lund, J. W. G., Kipling, C. and Lecren, E. D. (1958): The inverted microscope method of estimating algal numbers and the statistical basis of estimations by counting. – *Hydrobiologia* **11**: 143–170.
- Padisák, J. (1993): Species composition, spatial distribution, and the seasonal and interannual dynamics of phytoplankton in brown-water lakes enclosed with reed-belts (Neusiedler See/Fertő, Austria/Hungary). – *BFB Bericht* **79**: 13–29.

- Pantocsek, J. (1912): *A Fertő-tó kovamoszat viránya*. – Pozsony, pp. 1–43.
- Pieczynska, E. and Banas, D. (1984): Zonation in periphyton colonizing concrete blocks on the shore of Lake Zegrzynskie. – *Ekologia polska* **32**: 533–552.
- Podani, J. (1988): SYN-TAX III User's manual. – *Abstracta Botanica* (Budapest) **12**(Suppl. 1): 1–183.
- Stevenson, R. J. and Peterson, C. G. (1989): Variation in benthic diatom (Bacillariophyceae) immigration with habitat characteristics and cell morphology. – *J. Phycol.* **25**: 120–129.
- Szemes, G. (1950): Epiphyton algák mélységi tagozódása és azok fényviszonyai. (La distribution verticale des diatomées épiphytiques et leur milieu luminex). – *Ann. Biol. Univ. Debrecen.* **1**: 57–71.
- Uherkovich, G. (1984): Beiträge zur Kenntnis des Periphytons des Plattensees (Balaton Ungarn). – *Arch. Hydrobiol.* **67**(2): 159–203.
- Utermöhl, H. (1958): Zur Vervollkommnung der quantitativen Phytoplankton-Methodik. – *Mitt. int. Ver. Limnol.* **9**: 1–38.

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SOIL SEED BANKS AND VEGETATION RECOVERY ON DOLOMITE HILLS IN HUNGARY

P. CSONTOS¹, J. TAMÁS^{2,3} and T. KALAIPOS²

¹MTA–ELTE Ecological Modelling Research Group

H–1083 Budapest, Ludovika tér 2, Hungary

²Dept. Plant Taxonomy and Ecology, L. Eötvös University

H–1083 Budapest, Ludovika tér 2, Hungary

³Inst. Ecology and Botany, Hungarian Academy of Sciences

H–2163 Vácrátót, Hungary

The regeneration characteristics of the dolomite grasslands were studied from three points of view.

Greenhouse germination tests of soil samples collected from *Pinus nigra* Arn. stands planted on the dolomite slopes showed that the seed bank of the dolomite grassland becomes remarkably poor in the long run. Only few species (e.g. *Carex humilis* Leyss., *Teucrium montanum* L., *Campanula sibirica* L.) maintained seed bank for decades.

The postfire regeneration of grassland vegetation was studied by permanent quadrat method in a 0.6 km² burnt *Pinus nigra* stand surrounded by intact pine forests. The extreme sparse vegetation cover (below 2%) in the first year after the fire indicated both the low number of viable seeds in the soil and the lack of sufficient seed rain. By the second year, vegetation cover increased by 15–45 times. Successional species contributed to this change 6–7 times more than the grassland species. *Conyza canadensis* (L.) Cronq. was the main colonizer.

In a buried seed experiment the seed bank of *Scorzonera austriaca* Willd. was classified as transient. *Ferula sadleriana* Ledeb. showed a short term persistent seed bank, while further 6 species (*Carex liparicarpus* Gaud., *Dianthus pontederiae* Kern., *Inula ensifolia* L., *Silene otites* (L.) Wib., *Teucrium chamaedrys* L. and *Verbascum lychnitis* L.) maintained persistent seed bank.

Key words: dolomite vegetation, forest fire, grassland regeneration, seed bank, seed burial, seed longevity, succession

INTRODUCTION

Grassland vegetation of dolomite hills has a high conservation value in Hungary. The high number of endemics and relic species from various climatic periods, including glacial and interglacial times, gives a unique botanical character to the area (Zólyomi 1942, 1958, 1987). The number and abundance of protected vascular plant species can also be remarkably high (e.g. Csontos and Lőkös 1992, Lencsés 1996). However, extent areas of this landscape were afforested with monocultures of *Pinus nigra* Arn. in the first half of this century (Héder 1954). These planted forests destroyed the grassland communities considerably (Borhidi 1956, Bódis 1993). In recent years efforts are made to reconstruct the grasslands that characterized the vegetation prior to afforestation (MERP 1992).

Here we report the results of three distinct projects in vegetational ecology that can be important for the restoration of dolomite habitats existed prior to coniferi-

zation: I. The first project tests if there are still surviving seed banks of the grassland vegetation in the soil of old black pine plantations; II. The second program is a postfire regeneration study (on a site very similar to that investigated in I). This may reveal the role of soil seed banks – among other factors – in the secondary succession of grassland vegetation; III. The natural seed bank study, mentioned in I, may reflect the ability of species to maintain their germinability for extreme long period of time. However, the species failed to survive for decades, still could be able to maintain a seed bank for a shorter timespan and the individual species may differ in this respect. Therefore, in the third part of this paper we report on our laboratory experiments set up to determine seed longevity of some important dolomite grassland species.

MATERIALS AND METHODS

I. For a natural seed bank study soil samples were taken from the ground under the needle carpet of two 55-year-old pine plantations (at Ördög-torony and Fehér-hegy in the Buda Mts) in two replicates, in Autumn 1991. Each sample had a total volume of 8,700 cm³ soil, what is well above the minimum-volume suggested for temperate grasslands (Hayashi and Numata 1971). The total volume of a sample was composed of 18 small soil cores taken from the topmost 6 cm at random localities of a 100 m² study area. This sampling technique is widely used in seed bank studies because the distribution of seeds in the soil is highly clustered (Thompson 1986, Matlack and Good 1990, Warr *et al.* 1993). According to several analyses showing sharp fall-off in seed density along the depth profile (Harper 1977), the 6 cm deep cores used here, are expected to contain about 80% of the total seed bank. The soil samples were exposed to light and moisture in a greenhouse of the Botanical Garden of the L. Eötvös University from April to November. For seedling identification, works by Csapody (1968) and Muller (1978) were used. When it was necessary for identification, seedlings were transplanted into flower-pots and grown in the subsequent vegetation period. A more detailed description of the methods can be found in Csontos *et al.* (1996).

II. In August 1993, about 0.6 km² of *Pinus nigra* stands, close to the localities of our seed bank studies, were completely destroyed by forest fires. In 1994 and 1995, the reappearing vegetation was sampled twice a year (from 6 May to 16 June and from 27 August to 24 September) by using 5–5 permanent quadrats (2 m × 4 m each) on south- and north-facing slopes. To make the cover estimation of species more precise an 1 m × 1 m square, formed by 25 subsquares, was used during the sampling. Though the fire was serious we presume that the soil seed bank was little affected. Measurements in cerrado forest fires showed that the maximum soil temperature at 2 cm depth varied from 29 to 38 °C, whereas at 5 cm the temperature increase was negligible (Miranda *et al.* 1993).

III. For a better evaluation of the seed bank types and seed longevity of dolomite grassland components, eight species were tested in a burial experiment: *Carex liparicarpos* Gaud., *Dianthus ponderae* Kern., *Ferula sadleriana* Ledeb., *Inula ensifolia* L., *Scorzonera austriaca* Willd., *Silene otites* (L.) Wib., *Teucrium chamaedrys* L. and *Verbascum lychnitis* L. One hundred seed units of each species were buried in flower pots at 60 cm depth, in ten replicates, in Autumn 1992. This burial depth was intended to induce enforced dormancy of the seeds (Fenner 1985). Seed samples were collected during the vegetation period of 1992. Following exhumations (21.04.1993 and 28.03.1995) seeds were spread out on the surface of soil kept in plastic trays then exposed to light and moisture for at least six months. The germinating seedlings were monitored at weekly intervals and removed when identified. Here we report results of 1993 and 1995 exhumations, however data of the 1994 exhumation are also used in some cases when it is necessary for a better interpretation.

RESULTS AND DISCUSSION

I. The results of the natural seed bank study showed considerable paucity of the soil seed bank. Its average value of 66 seeds/m² is much lower than it was found in corresponding grasslands where afforestation did not take place (Ryser and Gigon 1985). The composition of the seed bank at the two studied plantations are shown in Table 1.

From the three groups distinguished, components of the original grasslands (G) comprise about half of the total seed bank in average. In this respect, *Carex humilis* Leyss., *Teucrium montanum* L., *Campanula sibirica* L., *Viola rupestris* F. W. Schm. and *Polygala amara* L. could be mentioned. These species can be considered as maintaining long term persistent seed bank (Thompson 1993). However, the rare occurrence of this group and the contribution of weeds (W) and other species (N) in the seed bank predict difficulties in quick post-disturbance occupation of the habitat by the dolomite grassland vegetation.

II. The postfire vegetation in the first year (1994) was extreme sparse on both slopes and never exceeded 2% cover (Fig. 1). This low value indicates the lack of notable colonization and agrees with the poor quantity of seeds found in the soil. Either vegetation cover (Fig. 1) or species number (Fig. 2) is considered, the roughly equal proportions of grassland components and successional (weedy) species characterize the first year after fire. These ratios are again in accordance with the seed bank results (cf Table 1).

By 1995, that is the 2nd year after the fire, the species number increased by 70% maintaining the same proportions between grassland- and successional species (Fig. 2). However, the contribution of the two groups to the increase of the vegetation cover differed dramatically in the second year (Fig. 1). While the grassland species increased their cover by 5 or 9 times only, the successional species did it by 31 or 63 times on north- and south-facing slopes, respectively.

Table 1
Composition of the soil seed bank under two *Pinus nigra* plantations

Seed bank component	Ördög-torony (92.4 seed/m ²)		Fehér-hegy (39.6 seed/m ²)		Avg. of the sites (66 seed/m ²)	
	Proportion of species	Proportion of seeds	Proportion of species	Proportion of seeds	Proportion of species	Proportion of seeds
G	57	65	29	40	43	52.5
N	21.5	23	14	10	17.75	16.5
W	21.5	12	57	50	39.25	31
Total	100	100	100	100	100	100

G = members of the original rock grassland communities, N = members of native communities other than rock grasslands, W = weeds and alien neophytes

In an extent wildfire of pine stands in SW Slovakia, the cover of higher plants were *ca* 1% in the first year and increased to 15% in the second year (Prach *et al.* 1995). During the early years of postfire succession the pronounced contribution of aliens to the vegetation cover (*e.g.* *Conyza canadensis* (L.) Cronq. and *Phytolacca americana* L.) was also characteristic of the Slovakian case study.

In our investigations also the alien *Conyza canadensis* was the absolute "winner" on both slopes. It was already present in the seed bank (according to the results of project-I) and produced few individuals in the first year after the fire. Then, owing to its short life-span and copious seed production, it overcame the other species by the second year, forming 42–44 percent of the total vegetation cover (Table 2). Further important species of the postfire vegetation were: *Lactuca serriola* L., *Carduus nutans* L., *Chaenorhinum minus* (L.) Lange, *Pimpinella saxifraga* L., *Anthyllis vulneraria* L. and *Reseda lutea* L.

III. According to the buried seed experiment the studied species can be sorted into 3 groups which form two main types:

1. Species with transient or apparently short term persistent seed bank. For *Scorzonera austriaca*, seedlings occurred only in 1993 (14%), then it failed to germinate in the subsequent years, that is a typical example of transient seed bank (Thompson and Grime 1979). *Ferula sadleriana* produced 2 seedlings (from 100) in 1993 and failed to germinate in 1995. However, it produced few seedlings in 1994, too, thus its seed bank is considered as very short term persistent.

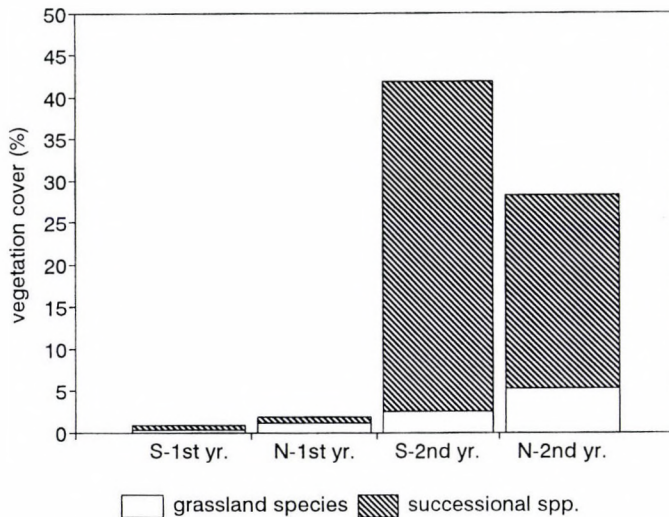


Fig. 1. Vegetation of south- and north-facing (S and N) dolomite slopes after massive pine forest fires

2a. Persistent seed bank, with decreasing number of seedlings from 1993 to 1995 (*Dianthus pontederiae*, *Silene otites* and *Inula ensifolia*, see Fig. 3);

2b. Persistent seed bank with more seedlings appearing in 1995 than 1993 (*Carex liparicarpos*, *Teucrium chamaedrys* and *Verbascum lychnitis*, see Fig. 3). This strategy can be caused by innate dormancy of the seeds what may restrict the germination considerably in the first year (Szabó 1980).

Among the tested species, the two with transient or almost transient seed bank have larger seeds than the members of the other two groups. It agrees with Thompson and his colleagues' finding that large seeded species have little ability to form persistent seed bank (Thompson *et al.* 1993). *Ferula sadleriana* of the "transient group" is protected in Hungary, and is even encountered in the "red list" of the IUCN, because it has only 4 known occurrences in the World (Slovakian Karst, Pilis Mts, Gerecse Mts in Hungary and Torda Gorge in Transsylvania). Understanding its seed bank behaviour can be important for conservation and management practices.

Our results with *Verbascum lychnitis* well agree with reported data on other mullein species (Kivilaan and Bandurski 1981, Odum 1974, 1978, Toole and Brown 1946) and support the hypothesis that all species of this genus can be characterized by extreme long lived seeds in the soil.

The seed bank type of seven species from the eight, tested in the third part of our work, are first reported here. *Silene otites* was already discussed as member of the seed bank of a steppe grassland (Virágh and Gerencsér 1988).

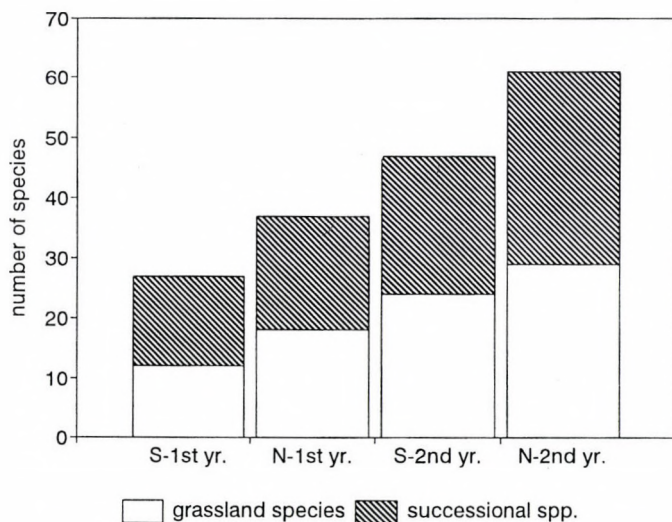


Fig. 2. Species composition on south- and north-facing (S and N) dolomite slopes after massive pine forest fires

Table 2
Dominant species in the 2nd year of postfire succession on dolomite hills

Species	Average cover in percent	Relative cover
	North-facing slope	
<i>Conyza canadensis</i> (L.) Cronq.	11.8	41.7
<i>Chaenorhinum minus</i> (L.) Lange	3.4	12
<i>Lactuca serriola</i> L.	3.3	11.7
<i>Pimpinella saxifraga</i> L.	1.2	4.2
<i>Anthyllis vulneraria</i> L.	1.1	3.9
Further 56 spp.	7.5	26.5
Total	28.3	100
	South-facing slope	
<i>Conyza canadensis</i> (L.) Cronq.	18.3	43.8
<i>Carduus nutans</i> L.	10.9	26.1
<i>Lactuca serriola</i> L.	4.3	10.3
<i>Reseda lutea</i> L.	2.4	5.7
<i>Chaenorhinum minus</i> (L.) Lange	1.3	3.1
Further 42 spp.	4.6	11
Total	41.8	100

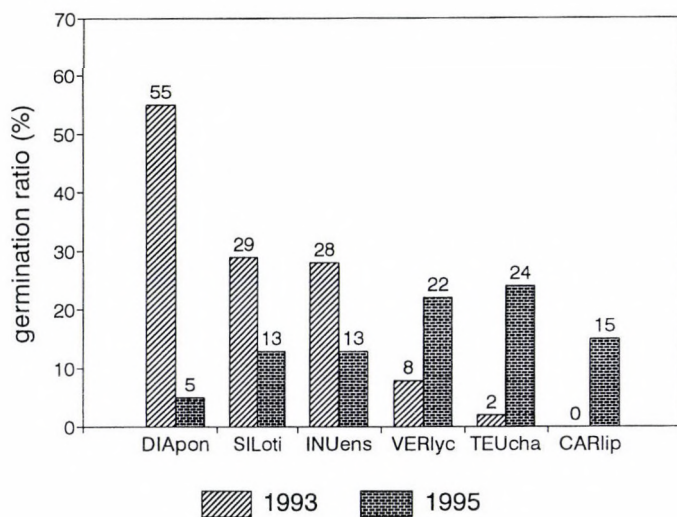


Fig. 3. Germination characteristics of some dolomite grassland species having persistent seed bank (first three species) and persistent seed bank with innate dormancy (last three species). Abbreviations: DIApon = *Dianthus pontederæ*, SILoti = *Silene otites*, INUens = *Inula ensifolia*, VERlyc = *Verbascum lychnitis*, TEUcha = *Teucrium chamaedrys*, CARlip = *Carex liparicarpus*

CONCLUSIONS

The regeneration of dolomite grassland vegetation after intense disturbances – afforestation with the alien black pine and fire – appears to be a slow and difficult process. Although several grassland components possess a persistent seed bank, most of them are unable to maintain viable seeds for decades typically spent in the soil under pine plantations. A further problem for the reestablishing grassland is that its seed bank species, yet identified, are subordinate members of the grassland communities, except *Carex humilis* which is a matrix species on south-facing slopes.

As these disturbances usually occur over large areas, seed rain from neighbouring natural grasslands probably has a limited and delayed role in vegetation recovery. Instead, weeds of high dispersal capacity occupy the dolomite slopes shortly after disturbances.

Based on these results, techniques increasing the propagule density of natural matrix species (e.g. additional sowing) are recommended for the nature conservation authorities to restrict weed invasion and enhance the restoration of dolomite grasslands. For north-facing slopes, *Bromus pannonicus* Kumm. et Sendt. or *Bromus erectus* Huds., whereas for southern exposition *Festuca pallens* Host and *Carex humilis* could be recommended.

For a better understanding of the role of seed bank in the regeneration of the dolomite grassland vegetation an extensive analysis of the seed bank strategies of its species should be performed. To complete this the predictive method proposed by Thompson *et al.* (1993) seems to be an appropriate tool.

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REFERENCES

- Bódis, J. (1993): A feketefenyő hatása nyílt dolomit sziklagyepre. I. Texturális változások. (Effect of black pine on dolomite rock grasslands. I. Textural changes). – *Bot. Közlem.* **80**: 129–139.
- Borhidi, A. (1956): Feketefenyveseink társulási viszonyai. (Zöologische Verhältnisse unserer Schwarzföhrenwälder). – *Bot. Közlem.* **46**: 275–285.
- Csapody, V. (1968): *Keimlingsbestimmungsbuch der Dicotyledonen*. – Akadémiai Kiadó, Budapest.
- Csontos, P. and Lőkös, L. (1992): Védett edényes fajok térbeli eloszlás-vizsgálata a Budai-hg. dolomitvidéken. – Szünbotanikai alapozás, természetvédelmi területek felméréséhez. (The analysis of the spatial distribution of protected vascular plant species on a dolomite region of the Budai-

- Mts., Hungary. – Synbotanical approach to evaluation of nature reserves). – *Bot. Közlem.* **79**: 121–143. (in Hungarian)
- Csontos, P., Horánszky, A., Kalapos, T. and Lőkös, L. (1996): Seed bank of *Pinus nigra* plantations in dolomite rock grassland habitats, and its implications for restoring grassland vegetation. – *Annls hist.-nat. Mus. natn. Hung.* **88**: 69–77.
- Fenner, M. (1985): *Seed Ecology*. – Chapman and Hall, London.
- Harper, J. L. (1977): *Population Biology of Plants*. – Academic Press, London.
- Hayashi, I. and Numata, M. (1971): Viable buried-seed population in the *Miscanthus*- and *Zoysia* type grasslands in Japan – Ecological studies on the buried-seed population in the soil related to plant succession VI. – *Jap. J. Ecol.* **20**(6): 243–252.
- Héder, I. (1954): Dolomit és mészkőkopárokra telepített erdők hatásvizsgálata és a kiöregedő állományok felújítása. [Effects of afforestation on karstic limestone and dolomite habitats, and the regeneration of old stands]. – *Erdészeti Kutatások* **1954**(2): 87–101. (in Hungarian)
- Kivilaan, A. and Bandurski, R. S. (1981): The one hundred year period for Dr. Beal's seed viability experiment. – *Amer. J. Bot.* **68**(9): 1290–1292.
- Lencsés, G. (1996): *A várpalotai Baglyas-hegy természeti értékei és növényvilága*. [The vegetation and the natural values of the Baglyas-hegy, near Várpalota, Hungary]. – BIO-GERO Ökocsoport, Várpalota – Nagykanizsa.
- Matlack, G. R. and Good, R. E. (1990): Spatial heterogeneity in the soil seed bank of a mature Coastal Plain forest. – *Bull. Torrey Bot. Club* **117**(2): 143–152.
- MERP (1992): *Restoration programme for the dolomite grasslands of the "Nagy-Szénás, Kis-Szénás and Kutya-hegy" and "Csiki Mountains" nature reserves and management plan*. – (Final report; manuscript) Ministry for Environment and Regional Policy, Republic of Hungary and DHV Consultants BV, The Netherlands.
- Miranda, A. C., Miranda, H. S., Dias, I. F. and De Souza Dias, B. F. (1993): Soil and air temperatures during prescribed cerrado fires in Central Brazil. – *J. of Tropical Ecol.* **9**: 313–320.
- Muller, F. M. (1978): *Seedlings of the North-Western European Lowland*. – Dr W. Junk B. V. Publishers, The Hague.
- Odum, S. (1974): *Seeds in ruderal soils, their longevity and contribution to the flora of disturbed ground in Denmark*. – Proceed. 12th British Weed Control Conference, pp. 1131–1144.
- Odum, S. (1978): *Dormant seeds in Danish ruderal soils*. – The Royal Vet. & Agric. Univ., Hørsholm Arboretum, Hørsholm, Denmark.
- Prach, K., Lukesova, A. and Frouz, J. (1995): *The colonization of wildfire-disturbed pine forests by plants and animals in Central Europe*. – Abstracts, 7th European Ecological Congress, Budapest, p. 242.
- Ryser, P. and Gigon, A. (1985): Influence of seed bank and small mammals on the floristic composition of limestone grassland (Mesobrometum) in Northern Switzerland. – *Ber. Geobot. Inst. ETH, Stiftung Rübel, Zürich* **52**: 41–52.
- Szabó, L. Gy. (1980): *A magvak nyugalmi állapota*. [The dormancy of seeds]. – In: Szabó, L. Gy. (ed.): *A magbiológia alapjai*. – Akadémiai Kiadó, Budapest, pp. 96–120.
- Thompson, K. (1986): Small-scale heterogeneity in the seed bank of an acidic grassland. – *J. Ecol.* **74**: 733–738.
- Thompson, K. (1993): *Persistence in soil*. – In: Hendry, G. A. F. and Grime, J. P. (eds): *Methods in Comparative Plant Ecology*. – Chapman & Hall, London, pp. 199–202.
- Thompson, K., Band, S. R. and Hodgson, J. G. (1993): Seed size and shape predict persistence in soil. – *Funct. Ecol.* **7**: 236–241.
- Thompson, K. and Grime, J. P. (1979): Seasonal variation in the seed banks of herbaceous species in ten contrasting habitats. – *J. Ecol.* **67**: 893–921.
- Toole, E. H. and Brown, E. (1946): Final results of the Duvel buried seed experiment. – *J. Agric. Res.* **72**: 201–210.

- Virágh, K. and Gerencsér, L. (1988): Seed bank in the soil and its role during secondary successions induced by some herbicides in a perennial grassland community. – *Acta Bot. Hung.* **34**(1–2): 77–121.
- Warr, S. J., Thompson, K. and Kent, M. (1993): Seed banks as a neglected area of biogeographic research: a review of literature and sampling techniques. – *Progr. in Physical Geography* **17**(3): 329–347.
- Zólyomi, B. (1942): A középdunai flóráválasztó és a dolomitjelenség. (Die Mitteldonau-Florenscheide und das Dolomitphänomen). – *Bot. Közlem.* **39**(5): 209–231.
- Zólyomi, B. (1958): *Budapest és környékének természetes növénytakarója*. [The natural vegetation of Budapest and its surroundings]. – In: Pécsi, M. (ed.): Budapest természeti képe. – Akadémiai Kiadó, Budapest, pp. 508–642. (in Hungarian)
- Zólyomi, B. (1987): Coenotone, ecotone and their role in preserving relic species. – *Acta Bot. Hung.* **33**(1–2): 3–18.

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VEGETACIÓN COSTERA DE LAGUNAS Y ZONAS INUNDABLES CUBA–GUERRERO, MÉXICO

N. DIEGO-PÉREZ¹, R. OVIEDO PRIETO², L. LOZADA¹ and R. M. FONSECA¹

¹*Facultad de Ciencias, Universidad Nacional Autónoma de México, México*

²*Instituto de Ecología y Sistemática, Academia de Ciencias de Cuba, Cuba*

The flora, vegetation and phytogeographical relationships of the coastal plant communities of Guerrero (Mexico) and Cuba are analyzed. Floristical inventories from both regions are compared. The results show that 45.6% of genera are common to the study sites, which confirm the high floristical affinity between the Pacific Coast of Mexico and the Antilles, and their place in the Caribbean region of the Neotropical Kingdom.

Key words: comparative floristical study, humedales, Cuba, Mexico

INTRODUCCIÓN

Es bien sabido que la flora de la costa del Pacífico en México y la región de las Antillas, guardan estrechas relaciones a nivel florístico, no en vano Good (1964), Takhtajan (1969), Rzedowski (1978) y Borhidi (1985, 1991, in: Borhidi et Muñiz 1986) las han incluido en la llamada región Caribeña dentro del Reino Neotropical, aunque existen pocos trabajos que apoyen objetivamente esta propuesta, especialmente en lo que se refiere a la costa del Pacífico.

Recientemente se ha incrementado el conocimiento de la flora de la Costa del estado mexicano de Guerrero y con ello surgió la posibilidad de realizar un estudio de las relaciones con la flora del Archipiélago Cubano, que está bastante bien estudiada. Por otra parte resulta importante entender si los elementos florísticos en estas zonas presentan patrones de distribución que ligen a ambos de una manera particular o bien se trata de elementos de amplia distribución, y si tienen un significado especial de relación o no.

DESCRIPCIÓN DE LA COSTA DE GUERRERO

Localización

El estado de Guerrero se sitúa al sur de la República Mexicana entre los 16°19' y 18°52' latitud norte y los 98°02' y 102°12' longitud oeste y la línea costera al sur del estado en contacto con el océano Pacífico, mide aproximadamente 500 km de longitud y va desde la desembocadura del río Balsas en el extremo noroeste hasta la desembocadura del arroyo Tecoyame en los límites con Oaxaca (Figueroa 1980). La zona costera se ha dividido en 2 regiones: la Costa Grande desde el límite con Michoacán en la desembocadura del río Balsas hasta Acapulco, con 325 km de longitud

y la Costa Chica con 175 km, y comprende desde Acapulco hasta el límite con Oaxaca. La zona bajo estudio se ha limitado altitudinalmente de 0 a 200 m sobre el nivel del mar.

Fisiografía y geología

La Costa de Guerrero se ubica en la provincia fisiográfica Sierra Madre del Sur, subprovincia Planicie Costera, está constituida por planicies aluviales, lomeríos, lagunas marginales, cerros aislados, planicies de inundación y franjas litorales.

La secuencia geológica de la zona de estudio tiene registros desde el Jurásico hasta el Cuaternario e incluye los dominios ígneo, sedimentario y metamórfico (Álvarez 1962), a continuación se describen:

Jurásico. Las rocas más antiguas de la Costa son metamórficas, gneis y esquistos de color gris, así como granitos y algunas granodioritas que se distribuyen sobre todo en la porción oriental en la llamada Costa Chica, en una amplia porción entre la laguna de Tres Palos y la laguna Tecomate, al norte de la laguna de Chautengo y en la región de Punta Casa de Piedra y al este de Marquelia hasta el mar. En la Costa Grande se presentan al norte de las lagunas de Mitla y Coyuca.

Cretácico. Las rocas del Cretácico son de diferentes tipos. Las sedimentarias como areniscas, lutitas y calizas cristalinas del Cretácico inferior, se presentan en los alrededores de La Unión y al este de esta población. Las ígneas intrusivas como el gabro y la diorita se localizan en Puerto Escondido, en la Bahía Papanao y cerca de El Cayacal en la Costa Grande. Las metamórficas del Cretácico se presentan en la porción noroeste de la Costa con metasedimentario que incluye filita, filonita, pizarra, arenisca y caliza metamorizadas. El metavolcánico en pequeñas porciones de la Costa Grande, como en Las Puntas, El Potosí, El Descanso, San Esteban y Bahía Papanao, constituidas por metatobas originadas por procesos de metamorfismo regional.

Cenozoico. Los granitos del terciario de color gris o blanco con vivos de diferentes tonos, se distribuyen en una amplia extensión entre Copala y Marquelia, llegando hasta el mar. En el extremo sureste y este del estado casi en los límites con Oaxaca hay rocas sedimentarias de tipo arenisca del terciario superior.

Cuaternario. Se presentan en la Costa una serie de suelos de tipo aluvial, en las riberas de los principales ríos y llanuras aluviales, que cubren gran extensión de la zona baja y plana de la llanura costera. Los depósitos de tipo lacustre se presentan rodeando a las lagunas costeras. El cordón litoral está constituido por sedimentos de tipo litoral y conglomerados en terrazas aluviales y pequeñas masas al este de Cuajinicuilapa.

Clima

El clima en la costa de Guerrero de acuerdo con García (1988) es de tipo Aw, cálido subhúmedo con lluvias en verano que empiezan en junio y terminan en noviembre, sequía intraestival, isotermal, con temperatura media anual mayor a 22 °C y la del mes más frío superior a 18 °C, con un porcentaje de lluvia invernal menor al 5% del total anual, con marcha de temperatura tipo Ganges. En la Costa Grande predomina la variante más seca de los climas cálidos subhúmedos, en los alrededores de San Jerónimo y desde Zihuatanejo hacia el noroeste del estado. En los alrededores de Tecpan y de la laguna de Nuxco se presenta la variable intermedia de humedad de los cálidos subhúmedos que es la misma que se presenta en toda la Costa Chica.

Hidrografía

La Costa de Guerrero comprende dos grandes regiones hidrológicas, la Costa Grande al noroeste y la Costa Chica al sureste de Acapulco, ambas en la vertiente del Pacífico. Los ríos más importantes de la Costa Grande son: La Unión, Petatlán, Coyuquilla, San Luis, Tecpan, Atoyac y Coyuca. En la

Costa Chica los ríos: Papagayo, Quetzala, Nexpa, Copala y Marquelia. Otros rasgos característicos son el desarrollo de lagunas litorales, entre las más importantes están: Potosí, Salinas, El Cuajo, El Tular, Nuxco, El Plan, Mitla, Coyuca, Tres Palos, Tecomate y Chautengo.

La distancia entre la orilla del mar y las diferentes lagunas varía de 20 a 1000 metros, y la comunicación con el mar se da a través de una boca o barra lagunar que se abre periódica o esporádicamente. El agua dulce proviene de ríos o arroyos cuyo aporte aumenta en la época de lluvias, es por esto que el agua salobre de las lagunas varía en lo que se refiere a salinidad y volumen en las diferentes épocas del año (Arpi *et al.* 1974). Entre junio y octubre el volumen de agua en las lagunas aumenta y las zonas adyacentes se inundan con agua salobre lo que propicia la existencia de comunidades vegetales halófilas en estas áreas. También se presentan los llamados esteros que son cuerpos de agua dulce que se forman en la desembocadura de los ríos.

Suelos

En la Costa de Guerrero se presentan diferentes tipos de suelos:

Regosol. Se observa en zonas con lomeríos o cerros rocosos sobre todo en los alrededores de Acapulco, Zihuatanejo, Copala y en Cruz Grande, extendiéndose un poco hacia la planicie litoral, las poblaciones de Ometepec y Azoyú se encuentran en esta zona. En la Costa Grande se presenta en las cercanías de Zihuatanejo. Son suelos claros, sin capas u horizontes distintos, se parecen a la roca subyacente y son de fertilidad variable.

Feozem. En la Costa Grande se encuentra en los alrededores de San Luis, San Pedro, San Jerónimo y Laguna de Coyuca; en la Costa Chica entre el río Papagayo y la laguna de Chautengo. Son suelos con una capa superficial suave rica en materia orgánica y nutrientes, se erosionan con facilidad sobre laderas con pendientes pronunciadas; sobre ellos se practica la agricultura de temporal.

Solonchak. Se desarrolla en la zona litoral tanto de Costa Grande como de Costa Chica, desde Acapulco hasta San Marcos. Son suelos con un alto contenido de sales, como los que rodean a las lagunas costeras. Su característica es la acumulación de una capa salitrosa poco susceptible a la erosión.

Cambisol. Cubren gran parte de la Costa Grande como en la Cuenca del Río Coyuca. En la Costa Chica se presentan en los alrededores de San Nicolás y Punta Maldonado. Son suelos con una capa de terrones y pueden presentar materiales como arcilla, carbonato de calcio, hierro y manganeso.

Fluvisol. Es un suelo formado por materiales acarreados por agua, son suelos poco desarrollados con capas alternas de arcilla, arena y grava, bordean los principales ríos como Ometepec, Quetzala, Santa Catarina, Coyuca, Atoyac, San Jerónimo, San Luis y Petatlán.

Litosol. Se presenta en las lomas sobre granodiorita y calcita, se erosionan rápidamente y dejan al descubierto la roca.

Arenosol. En las zonas más bajas cercanas al cordón litoral, son suelos arenosos, profundos, carecen de estructura y soportan pastizal o carecen de vegetación, se presentan en la mayor parte de la costa excepto en aquellas costas rocosas.

DESCRIPCIÓN DE CUBA

Localización

El archipiélago Cubano está localizado en el extremo noroeste de las Grandes Antillas, en el mar Caribe, a la entrada del Golfo de México, desde los 19°4' (Cabo Cruz) a 23°18' (Cayo Cruz del Padre) latitud norte y 74°8' (Punta Quemado, Maisí) a 84°57' (Cabo San Antonio) longitud oeste. Dos tercios del territorio son planos, interrumpidos por cuatro sistemas montañosos.

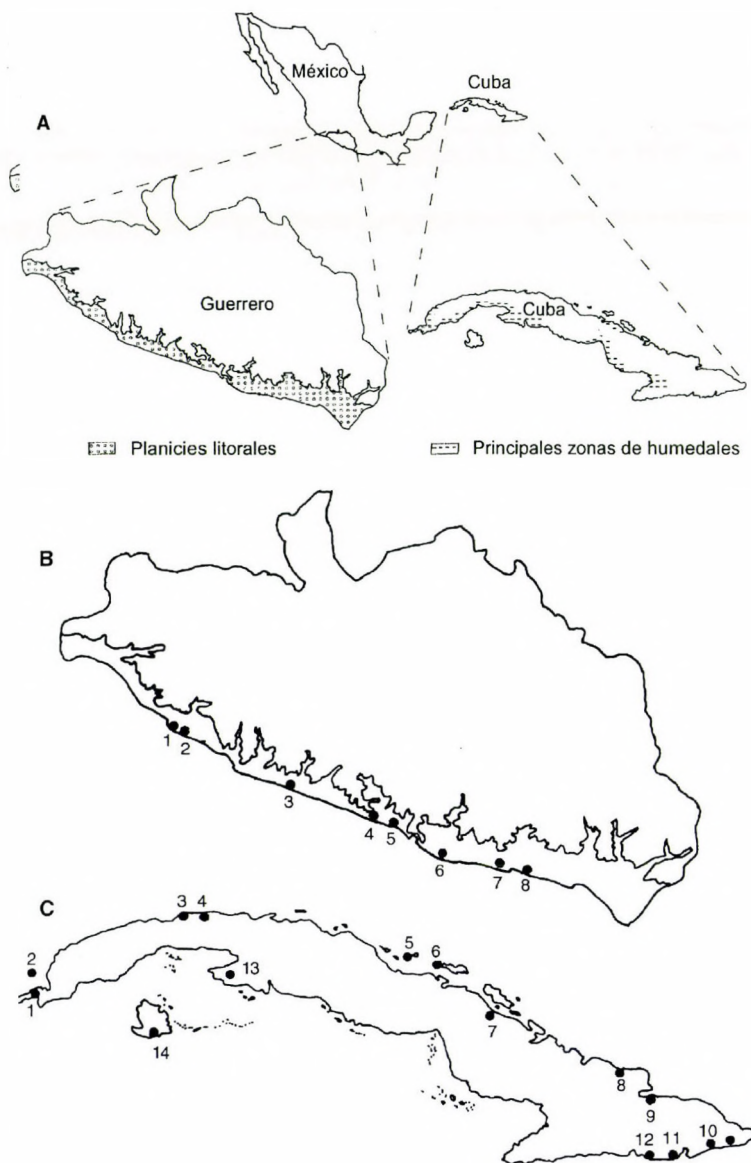


Fig. 1. A: Áreas de estudios en ambos países. B: Localidades de muestreo en la planicies litorales costera y lagunas costeras de Guerrero. 1 = Lagunas Potosí y Playa Blanca; 2 = San Valentín; 3 = Nuxco; 4 = Mitla; 5 = Coyuca; 6 = Tres Palos; 7 = Tecomate; 8 = Chautengo. C: Localidades de muestreo de las zonas de humedales y costeras de Cuba. 1 = Guanacabibes; 2 = Grupo insular los Colorados; 3 = Valle del río Cojimar; 4 = Costa Norte de La Habana; 5 = Cayo Caguanes; 6 = Cayo Coco y otros; 7 = Costa de Cubitas y Minas; 8 = Costa al norte de Las Tunas; 9 = Bahía de Nipe; 10 = Costa Maisi Guantánamo; 11 = Morrillo Chico; 12 = Daiquirí y Verraco; 13 = Costa de Zapata; 14 = Isla de Pinos (Isla de la Juventud)

Limita al norte con Estados Unidos, separado de Florida por 180 km, al oeste con la República Mexicana a 210 km de Yucatán, al este con Haití (Paso Vientos) separado por 71 km y al sur de Jamaica (estrecho Colón) a 140 km de distancia.

Fisiografía y geología

Cuba descansa sobre una plataforma sumergida que se calcula aproximadamente de 75 000 km² con 4 plegamientos causados tanto por la actividad orogénica, como por fallas e intrusiones de rocas ígneas serpentinizadas, las cuales se aprecian en diferentes partes de la isla.

Estratigráficamente en la historia geológica de la isla, se tienen registros del Jurásico hasta el Cuaternario. El Jurásico está representado por rocas sedimentarias de pizarras calcáreas negras. En el Cretácico está la formación Aptychus, de la actual región de Viñales, originándose la mayor parte de las montañas de Cuba por plegamiento. En el Eoceno (Terciario) la presión del noroeste causada sobre la parte oeste de la Isla, la colocan en la dirección que presenta de este-suroeste, este período se caracteriza por gran actividad volcánica y la presencia de basaltos. En el Oligoceno, Mioceno y Plioceno (Terciario) la isla presenta poca estabilidad, con levantamientos y sumersiones. Durante el Cuaternario (Pleistoceno y Reciente), la isla ha estado emergiendo gradualmente por movimientos tectónicos.

Las costas pueden clasificarse como de emersión, cuando al bajar el nivel marino o ascender la tierra, origina una nueva línea de costa.

Clima

Cuba posee un clima cálido tropical fuertemente influenciado por los vientos del este y la corriente del Golfo, aunque en ciertos puntos internos se presenta una cierta continentalidad. Según la clasificación de Gaussen (1954), 12 distintos tipos y subtipos de clima pueden diferenciarse, Borhidi y Muñiz (1980, 1984). El tipo más común es el clima tropical estacional con un periodo seco en invierno (termoxerocliménico). Este clima es parecido al monzónico, pero está controlado por el sistema *passat* y no por el monzón, Borhidi y Muñiz (1980), Borhidi (1991). La temperatura media anual es de cerca de 24.5 °C. El promedio mensual más frío (enero) cerca de 19 °C y el más cálido (julio) de 29 °C. Las lluvias aparecen principalmente entre mayo y octubre y alcanzan entre 1100 y 1600 mm al año en promedio, aunque los valores extremos son 300 y 3000 mm al año. Solo en el extremo noreste hay lluvias de invierno significativas. La humedad relativa del aire es muy alta, variando entre 74 y 80% durante el día y alcanzando más de 90% en la noche, aunque en algunas áreas costeras pueden alcanzarse valores de 68%.

Suelos

Los suelos son extremadamente variables, en su mayoría derivados de rocas sedimentarias calcáreas, alternando en un complejo mosaico con suelos derivados de serpentina, ácidos, básicos o rocas ígneas intermedias. La presencia de áreas de lutitas jóvenes áridas costeras y de lutitas cársicas de diferente edad, son de peculiar interés. La clasificación genética de los suelos cubanos abarca 20 grupos principales y 100 tipos genéticos. Entre ellos los suelos derivados de rocas ígneas ultrabásicas serpentinizadas con una baja relación $\text{Ca}^{++}/\text{Mg}^{++}$ y un alto contenido de aluminio y metales pesados, son los responsables del mayor porcentaje de endemismos.

Hidrografía

En la isla se tienen 2 vertientes: la septentrional y la meridional. Los ríos más importantes son aproximadamente 200, por lo general de poca longitud, estrechos y de reducido caudal; los princi-

pales son: Cauto, Sagua la Grande, Cuyaguaje, Guamá, San Felipe, Hondo, Manimani, La Mula, etc. Dentro de los ríos profundos y de poca extensión se encuentran al norte: Almendares, San Juan, Guara, Hanábana, La Palma, Martí, etc., y al sur Agabama y Zaza, Hatiguanico, Caracusey, Máximo, etc.

OBJETIVOS

- Contribuir al conocimiento de la flora de Guerrero y Cuba.
- Evaluar la similitud florística entre las costas de Guerrero (México) y Cuba.

MÉTODO

Se delimitaron las áreas a comparar teniendo en consideración que las condiciones físicas y ecológicas de las zonas fueran similares.

Se recopilaron los trabajos florísticos y de vegetación que hasta la fecha se han realizado en ambas zonas. Este estudio tuvo como base los trabajos previos que sobre las lagunas costeras del Estado de Guerrero y zonas circundantes que elaboraron Fonseca y Lozada (1993), Lozada (1994), Diego y Lozada (1994). Trabajos sobre la Flora de Cuba fueron publicados por León (1946), León y Alain (1951, 1953, 1957), Alain (1962, 1969), Borhidi y Muñiz (1971), Borhidi y Fernández (1982, 1983), Muñiz y Borhidi (1982), Bisse (1981). Datos fitogeográficos están publicados por Borhidi (1985, 1991), Borhidi y Muñiz (1986). Sobre vegetación por Borhidi y Muñiz (1980, 1983), Capote y Berazain (1985), Borhidi (1987, 1991). Sobre las asociaciones de la vegetación costera de lagunas y zonas inundables los estudios de Samek (1973), Borhidi *et al.* (1979, 1984) son fundamentales. Contribuciones adicionales fueron publicadas por Balátová-Tulácková y García (1985), Capote *et al.* (1987), Castilla *et al.* (1985), Citrón y Goenaga (1979), Chiappy *et al.* (1985), Chiappy (1988), García *et al.* (1985), Menéndez *et al.* (1987, 1989), Oviedo *et al.* (1989), Pérez *et al.* (1992), Ricardo *et al.* (1985), Villamajó y Menéndez (1987), Villamajó *et al.* (1987). Las asociaciones vegetales de Cuba han sido sistemáticamente descritas por Borhidi (1991).

Se elaboraron listas florísticas por familia, género y especie de las áreas a comparar, siguiendo el sistema de clasificación de Cronquist (1981) para las familias de angiospermas.

Las listas florísticas fueron confrontadas buscando obtener:

- número total de familias, géneros y especies registradas en cada una de las localidades,
- número de taxa exclusivos por localidad,
- lista de familias exclusivas de cada localidad.

Se juntaron las listas florísticas de ambas localidades y se investigó la distribución geográfica presente de los géneros utilizando las obras de Standley (1958–1984) y de Willis (1973). Se agruparon por afinidades los géneros para facilitar su interpretación.

Utilizando la clasificación de tipos de vegetación de Rzedowski (1978) para México y la de Capote y Berazain (1985) para Cuba se compararon las formas vegetales de cada una de las zonas para obtener correspondencia entre ellas. Esta valoración comparativa trata de forma general lo más significativo de cada formación vegetal observada en las costas de Cuba y Guerrero (México), considerando tanto referencias publicadas sobre algunas localidades, como colectas y observaciones de campo.

RESULTADOS

Los resultados se presentan en 3 secciones: vegetación, flora y fitogeografía.

VEGETACIÓN

Con base en la clasificación de Rzedowski (1978) se definió la vegetación costera de Guerrero, excepto para las plantas acuáticas en donde se adoptó a Lot (1991), ambos sistemas emarcan términos más amplios que los de Borhidi *et al.* 1979 y 1984, adoptados por Capote y Berazain (1985) en el análisis para Cuba. En este estudio se señalarán las equivalencias y diferencias entre estas localidades.

Por Cuba se analizaron los siguientes tipos de vegetación: bosque siempreverde micrófilo, bosque semidecuido mesófilo, bosque semidecuido micrófilo, bosque de ciénaga, bosque de galería, bosque de mangle (manglar), matorral xeromorfo costero y subcostero, comunidades acuáticas en agua dulce, comunidades halófitas (salinas), herbazal de ciénaga, vegetación de costa rocosa y de costa arenosa.

En tanto que para Guerrero se consideró: vegetación acuática y subacuática, vegetación halófila (marismas y costeras), bosque tropical perennifolio, bosque tropical subcaducifolio, bosque tropical caducifolio, sabana, matorral xerófilo, bosque de *Byrsonima* y *Curatella*. Dentro de la vegetación acuática se mencionan a las hidrófitas libre flotantes, hidrófitas arraigadas con hojas flotantes, hidrófitas arraigadas sumergidas e hidrófitas arraigadas emergentes. En la vegetación subacuática están: el manglar, comunidad de *Annona glabra* y bosque de galería.

Vegetación acuática

En la costa de Guerrero existen especies acuáticas que principalmente se establecen en charcas temporales de agua dulce, en la desembocadura de los ríos, en zonas tranquilas dentro del lecho de los ríos y en aquellas lagunas o esteros donde predomina el agua dulce (por ejemplo Estero El Tular, Estero San Valentín y el canal de la laguna de Coyuca). Es notorio que en las lagunas que son de agua salobre, la desembocadura de los ríos es la zona donde las plantas acuáticas se desarrollan más abundantemente.

De las zonas escogidas en Cuba para estas consideraciones, la vegetación acuática se localiza en lagunas, canales, áreas con inundaciones periódicas, generalmente cíclicas; así como en algunas zonas dentro de los ríos, que apenas reciben el efecto de la corriente.

Hidrófitas libre flotantes

Las plantas de este grupo se desarrollan especialmente en las partes tranquilas de los ríos, de los esteros y lagunas, formando tapetes móviles de diferentes tamaños, algunas especies llegan a dificultar el tránsito de embarcaciones y por ello son

eliminadas con cierta regularidad. Cuando se abren las barras las lagunas se comunican con el mar y muchas de estas plantas son arrastradas hacia el mar. En la costa de Guerrero se encontraron: *Azolla caroliniana*, *Eichhornia crassipes*, *Lemna minima*, *Ludwigia helminthorrhiza*, *Pistia stratiotes*, *Salvinia auriculata* y *Wolffia columbiana*.

Las especies de este grupo en las áreas cubanas están poco representadas tanto en taxa como en individuos, existiendo una casi total coincidencia con las especies citadas para Guerrero; solo que *Wolffia* en Cuba es muy rara y generalmente de medios más alejados de la costa. Estas especies no causan grandes molestias en la zona considerada en este estudio.

Hidrófitas arraigadas con hojas flotantes

En la Costa de Guerrero estas plantas se establecen en aguas no muy profundas, en las orillas de lagunas y esteros, aunque no es raro encontrarlas en los pequeños encharcamientos que se forman en la época de lluvias. Las especies registradas son: *Ceratopteris thalictroides*, *Heteranthera limosa*, *Limncharis flava*, *Ludwigia leptocarpa*, *L. peploides*, *Marsilea mexicana*, *Nymphaea ampla* y *N. blanda*.

En Cuba, las especies de este grupo se ubican casi con igual regularidad que la señalada para las comunidades de Guerrero. Se citan: *Nymphaea ampla*, *N. sp.*, *Nymphoides indica*, *N. grayana*, *Hydrocotyle spp.*, *Ludwigia peploides*, *Heteranthera limosa*, *Echinodorus nymphaeifolius*. Estas asociaciones generalmente se localizan en pequeñas áreas, con escasa perturbación.

Hidrófitas arraigadas sumergidas

Las hidrófitas sumergidas crecen en agua transparente, adheridas al sustrato, se mantienen debajo de la superficie del agua, solo donde el nivel no varía drásticamente durante el año, como en el estero San Valentín, y en la desembocadura del río Coyuca, a una profundidad de 1 a 2 metros. En la Costa de Guerrero se presentan *Najas guadalupensis*, *Ceratophyllum demersum*, *C. demersum* var. *echinatum*, *Potamogeton crispus*, *Utricularia gibba*. Algunas especies de *Potamogeton*, según las afectaciones en el medio, cubren mayor área que lo habitual, formando densas poblaciones que entorpecen la navegación. En Cuba, en la Ciénaga de Zapata se localizan diversas poblaciones de estas especies con buen grado de conservación. Además de las especies citadas para Guerrero, se cuenta con: *Vallisneria neotropicalis*, *Utricularia spp.*, así como *Cabomba sp.* y *Myriophyllum sp.* (Borhidi *et al.* 1983, Borhidi 1987).

Hidrófitas arraigadas emergentes

Este tipo de hidrófitas incluye el tular y el carrizal de la clasificación de Rzedowski (1978), se localiza en agua somera y suelo fangoso rico en materia orgánica, prácticamente cubren la superficie del estero San Valentín y la laguna Tenexpa, ambas zonas de escasa profundidad, forma franjas angostas en la orillas de las lagunas: Nuxco, Tecomate, Chautengo y Coyuca, así como en el estero El Tular. Esta comunidad está constituida por plantas herbáceas, con un altura de 2 ó 3 metros, como *Typha domingensis*, que crece en forma abundante por medio de rizomas, cubriendo grandes extensiones, ya sea formando asociaciones puras o mezcladas con *Phragmites australis*, el llamado carrizo, también forman parte de esta comunidad algunas especies de ciperáceas.

También se incluyen las comunidades de *Pontederia sagittata* que se distribuyen en la orilla de los ríos Nexpa y Coyuca, formando manchones uniespecíficos de hasta 90 cm por arriba del nivel del agua. En sitios donde el nivel del agua es menor, las plantas son más pequeñas.

En Cuba se trata bajo la denominación de “Herbazal de Ciénaga”, con diferentes modalidades asociadas a condiciones edáficas, mayor o menor cantidad de turba en el suelo, tiempo de inundación, así como la influencia del ambiente costero y la salinidad. Estas asociaciones son descritas y analizadas por Borhidi *et al.* (1979, 1984, 1991).

Como hierbas altas se destacan en esta formación vegetal *Cladium jamaicense*, *Typha domingensis* y *Erianthus giganteus*, los cuales indistintamente se acompañan de *Sagittaria lancifolia*, *Pontederia lanceolata*, *Solidago stricta*, *Thelypteris palustris*, así como especies de *Scirpus*, *Cyperus*, *Rhynchospora*, *Eleocharis*, *Fuirena*, *Ludwigia* y amplia representación de los géneros *Panicum*, *Paspalum*, *Paspalidium*. En algunos puntos se suma a este matiz *Oryza perennis* y *Sacciolepis striata*, entre la diversidad de especies que alberga este tipo de vegetación y que haría muy extenso este comentario.

Como un ejemplo de asociaciones particulares en este grupo se hace referencia al trabajo de Villamajó y Menéndez (1987) en Cayo Jutiár, donde cita la presencia a continuación de un manglar achaparrado un herbazal costero formado principalmente por *Eragrostis domingensis* y *Bletia purpurea*.

Manglar

Es una comunidad arbórea que se encuentra a la orilla de las lagunas y esteros. En la Costa de Guerrero, se han localizado las cuatro especies de mangle: *Rhizophora mangle* “candelilla”, *Laguncularia racemosa* “bobo”, *Conocarpus erecta* “botoncillo” y *Avicennia germinans* “saladillo”.

Rhizophora mangle se desarrolla en contacto con el agua, en suelo fangoso, reductor, con abundante materia orgánica, prefiere condiciones poco perturbadas y de agua dulce o poco salina, alcanza los 15 a 20 m de altura, en ocasiones se ve acompañado de *Bravaisia integerrima* o con individuos de *Laguncularia racemosa*, como en la laguna Potosí, o forma grupos monoespecíficos en pequeñas áreas de las lagunas Coyuca, Chautengo y Mitla y el estero San Valentín.

Laguncularia racemosa también se localiza en la orilla de las lagunas o esteros, en contacto directo con el agua, en suelo arenoso somero, como en las lagunas: Playa Blanca, Mitla, Tecomate, Nuxco y Chautengo, donde ocupa prácticamente todo el perímetro de las mismas. Es la especie más abundante en la zona estudiada, soporta temporadas de inundación y sequía, alcanza hasta 10 m de alto y por lo regular presenta pocas especies arbustivas o herbáceas acompañantes, solo se han localizado: *Sagittaria lanceifolia*, *Crinum erubescens*, *Echinodorus andreuxii*, *Acrostichum danaeifolium* y como trepadora *Sarcostemma clausum*. En algunos casos se presentan individuos de *Lonchocarpus sericeus* subsp. *palmieri*, *Annona glabra*, *Corynostylis arborea* y *Phyllanthus elsiae*.

Conocarpus erecta se desarrolla en una franja más alejada del cuerpo de agua, tierra adentro, en sitios de salinidad variable, en donde el grado y duración de las inundaciones es menor, en general forma comunidades un poco más abiertas que las de *Laguncularia* o *Rhizophora*; la altura varía de 6 a 8 metros. Comparte el terreno con *Bromelia pinguin*, *Batis maritima*, *Caesalpinia caccalaco*, *Nopalea karwinskiana* y *Crataeva tapia*. En general estas áreas de manglar son difíciles de separar de lo que se ha denominado vegetación halófila de marisma, sus terrenos por lo regular son usados para extracción de sal y la vegetación queda relegada a pequeñas elevaciones que rodean a las salinas. Abundan en los alrededores de las lagunetas El Carrizal y La Colorada, en el extremo norte de la laguna Tecomate, también se presenta en las lagunas: Coyuca, Nuxco y Chautengo, en zonas que se inundan durante poco tiempo.

Avicennia germinans "saladillo", como su nombre común lo indica, habita y forma bosques en suelos con una capa de salitre en su superficie, casi siempre es la especie más alejada del cuerpo de agua. La comunidad más extensa formada por esta especie, se sitúa en el extremo norte-oeste de la laguna de Chautengo, con árboles entre 8 y 10 m de altura, sin hierbas ni arbustos y en ocasiones como en la laguna Potosí, se le encuentra en montículos en las salinas, al igual que *Conocarpus erecta*, especie con la que frecuentemente comparte el terreno. En Chautengo, al sur del poblado, se encuentran árboles corpulentos de hasta 12 metros de altura y como especies acompañantes *Trichilia trifolia* y de manera aislada algunas leguminosas.

La distribución encontrada de las diferentes especies de mangle es la siguiente: *Rhizophora mangle* en contacto con el agua en las lagunas: Playa Blanca, Chautengo, Potosí, Coyuca, Nuxco y estero San Valentín. *Laguncularia racemo-*

sa en contacto directo con el agua formando la primera banda en las lagunas Chautengo, Tecomate y Nuxco, estero El Tular, y en seguida en terreno más firme y dependiendo de la salinidad *Conocarpus erecta* o *Avicennia germinans*. No es común encontrar las cuatro especies de mangle alineadas del cuerpo de agua hacia tierra firme, de las zonas estudiadas solo en la laguna Potosí se encontraron las cuatro especies en la disposición típica.

El bosque de mangle considerado como un tipo de comunidad siempre verde tropical, en Cuba se asienta en costas bajas, cenagosas, esteros, orillas de lagunas con influencia salina, así como en la desembocadura de algunos ríos. Los mangles se calcula que abarcan el 26% de la superficie de bosques del país, favorecidos por la gran extensión costera que posee el archipiélago. Estos bosques que en su forma más típica y conservada poseen las cuatro especies características: *Rhizophora mangle*, *Avicennia germinans*, *Laguncularia racemosa* y *Conocarpus erecta*, con el ordenamiento ecológico conocido para estos casos, con frecuencia lo encontramos en diferentes variantes.

En estas particularidades pueden influir diversos factores, como pobreza del suelo, tiempo de inundación, vientos, etc., resultando como determinante lo planteado por Citrón y Goenaga (1979) que atribuyen la complejidad estructural del bosque de mangle al grado de salinidad del suelo.

Acorde con lo antes expuesto, a lo largo de las costas del archipiélago cubano, se cuenta con manglares que oscilan desde el tipo achaparrado (1.5–3 rara vez 4 m de altura), ya sea mixto o monoespecífico, en algunas zonas de los Cayos que circundan la isla, así como en otros de la Ciénaga de Zapata. En estas mismas localidades a medida que el medio va siendo más favorable para los requerimientos de esta formación vegetal, se presenta como una vegetación compacta, con alta densidad de individuos que sobrepasan los 6 m de altura. Continuando con los ejemplos, en los sitios donde las condiciones del medio resultan propicias y la perturbación es casi nula, se observan manglares exuberantes en vigor y altura que puede sobrepasar los 20 m y le acompañan otras especies como: *Thespesia populnea*, *Dalbergia ecastophyllum*, *Hibiscus tiliaceus*, *Sarcostemma clausum*, *Rhabdadenia biflora* y *Acrostichum aureum*. Como localidad con estas características se cita la desembocadura del río Hatiguanico y de la Zanja de San Agustín en la ensenada de la Broa al sur de la provincia de Matanzas (Borhidi *et al.* 1987, Borhidi 1991).

En la medida que nos alejamos del ambiente costero, sobre todo a través de los cursos de agua, se van sustituyendo en la vegetación diferentes elementos florísticos, pudiendo aparecer palmas de los géneros *Sabal*, *Acoeloraphe* y *Roystonea*, *Chrysobalanus icaco*, *Annona glabra*, gramíneas y ciperáceas entre otras, aunque algunos taxa del manglar son capaces de persistir hasta varios km de la costa (Borhidi 1987, 1991).

Aunque la costa cubana y Guerrero comparten las cuatro especies principales de mangle, así como *Hibiscus tiliaceus*, *Sarcostemma clausum*, *Acrostichum aureum* y *Acrostichum danaifolium*, son notorias otras diferencias florísticas como la presencia en Guerrero de: *Phyllanthus elsiae*, *Trichilia trifolia* y *Bravaisia integerrima*. León y Alain (1957) reportan *Bravaisia tubiflora* para los manglares en Costa de Matanzas y Pinar del Río; pero lo cierto es que han pasado varias décadas y no ha sido recolectado, ni registrado en los numerosos estudios realizados en áreas de manglares.

En los manglares cubanos los principales elementos diferentes con relación a Guerrero, son: *Thespesia populnea*, *Dalbergia ecastophyllum* y *Rhabdadenia biflora*.

Comunidad de Annona glabra

Annona glabra “colche o colchi”, presenta un tallo ampliamente cónico, cuya base se encuentra dentro del agua, formando comunidades de poca extensión en el estero El Tular, la laguneta de “Los Colches” en la Costa Grande, pero Cuyuca es la zona donde está mejor representada. En esta comunidad hay pocas especies, solo se encuentra *Annona glabra* que puede alcanzar alturas de 4 a 5 m y en ocasiones como acompañante *Mimosa pigra*, arbusto de 1 m de alto aproximadamente.

En Cuba la *Annona glabra* está bien distribuida en zonas inundadas de temporal o permanentemente, así como asociada a lagunas, canales y ríos. No obstante en algunos casos se presenta en comunidades monoespecíficas alrededor de pequeñas lagunas como en la Ciénaga de Zapata, de manera similar a lo que se observa en reducidas localidades de Guerrero. Su distribución más frecuente en Cuba es formando parte de diferentes asociaciones vegetales de los ecosistemas acuáticos y subacuáticos.

Bosque de galería

Los diversos ríos que se presentan en la Costa de Guerrero pueden ser de corriente permanente o estacional. La vegetación que se establece en el margen y en el lecho por lo regular arenoso de los ríos Petatlán, San Jerónimo, San Luis, Tecpan, Atoyac, Cuyuca, la Estancia, Nuxco y Copala, contiene elementos típicos del llamado bosque de galería, que alcanzan tallas hasta de 20 metros (Rzedowski 1978). Las especies aunque típicamente arbóreas, en algunos sitios se encuentran en forma arbustiva. En el lecho de los ríos existen áreas que permanecen secas durante una larga temporada, en ellas se desarrollan hierbas y arbustos que se asocian a esta comunidad.

Representantes del estrato arbóreo: *Andira inermis*, *Astianthus viminalis*, *Ficus mexicana*, *Inga eriocarpa* y *Salix humboldtiana*.

Especies arraigadas al sustrato que se presentan en el curso de los ríos: *Pontederia sagittata*, *Cyperus articulatus*, *Dentella repens*, *Eragrostis ciliaris*, *Fimbristylis autumnalis*, *Heliotropium procumbens*, *Heteranthera limosa*, *Ludwigia peploides*, *Marsilea mexicana*, *Pancratium litorale*, *Polygonum punctatum*, *Rotala ramosior*, *Typha domingensis* y *Xanthosoma robustum*.

En las zonas tranquilas del río o en pequeños estancamientos están: *Azolla caroliniana*, *Ceratopteris thalictroides*, *Ludwigia helminthorhiza*, *Nymphaea ampla*, *Pistia stratiotes*, *Salvinia auriculata* y *Wolffia columbiana*.

Esta formación vegetal se desarrolla bajo condiciones bastante similares a las mencionadas para Guerrero, está bien representada en Cuba en los márgenes y lechos de ríos, arroyos, cañadas y otros cursos de agua.

Entre las especies que destacan en los tramos cercanos a las costas, dependiendo del suelo y otras condiciones del medio, se menciona a *Tabebuia angustata*, *T. shaferi*, *T. leptoneura*, *Calophyllum rivulare*, *Ficus* sp., *Lonchocarpus sericeus* var. *glabrescens*, *L. pentaphyllum*, *Roystonea regia*, *Annona glabra*, *Salix humboldtiana*, *Andira inermis*, *Bucida buceras*, *Sapindus saponaria*, *Dalbergia* spp., como los principales elementos arbóreos. Entre las lianas pueden encontrarse especies de *Serjania*, *Gouania*, *Cissus* y *Smilax*, fundamentalmente. Los arbustos son pocos, entre ellos: *Piper*, *Eugenia* y *Calythranthes*; en tanto que las epífitas están representadas por bromeliáceas de los géneros *Catopsis* y *Tillandsia*, fundamentalmente. En contacto directo con el agua se observan especies de gramíneas como: *Arundo donax*, *Gynerium sagittatum*, además de otras especies de los géneros *Panicum* y *Paspalum*, por lo general acompañados de *Cyperus* y *Scleria*. También se encuentran especies de *Ludwigia*, *Cuphea*, *Rotala* y *Polygonum*. A lo largo de los arroyos de corriente rápida, forman comunidades las especies de *Exostema*, *Rondeletia* y *Gesneria*.

Vegetación halófila

Vegetación halófila de marisma

En Guerrero esta comunidad se desarrolla principalmente en zonas planas adyacentes a las lagunas costeras, que se inundan año con año y cuyo suelo con alto contenido de sal propicia la llamada sequía fisiológica. En estos sitios predominan plantas suculentas como *Batis maritima*, *Heliotropium curassavicum*, *Sesuvium portulacastrum* y otras especies como *Glinus radiatus*, *Cyperus polystachyos* y *Fimbristylis spadicea*.

Como son áreas contiguas al manglar, en muchas ocasiones se presentan individuos aislados o en franjas de *Conocarpus erecta*, *Avicennia germinans*,

Bromelia pinguin y *Nopalea karwinskiana*. Aunque pudiera tratarse de una extensión del manglar, en realidad es una área seca durante la mitad del año, con una mayor cantidad de especies herbáceas que pueden formar tapetes homogéneos como en el caso de *Batis maritima*. El límite entre el manglar propiamente dicho y este tipo de comunidad es muy difícil de establecer, sus elementos se mezclan en franjas que varían de anchura en las diferentes zonas estudiadas.

Lo tratado bajo esta denominación para Guerrero corresponde con lo referido en Cuba como comunidades halófilas (salinas). Este tipo de formación vegetal es bastante similar tanto en extensión, composición florística y fisonómica, en ambas localidades. Se señalan entre las especies de esta formación: *Batis maritima*, *Distichlis spicata*, *Salicornia* spp., *Suaeda* sp., *Fimbristylis* spp., *Sporobolus* spp., *Cyperus* spp., *Sesuvium portulacastrum* y *Heliotropium curassavicum*. Dada su relación directa con el manglar (tanto geográfica como ecológica), en algunos puntos se pueden encontrar mezclados *Avicennia*, *Laguncularia*, *Conocarpus* y hasta *Rhizophora*; a veces acompañados de otras especies como *Opuntia dillenii*, *Pilosocereus* sp., *Lycium carolinianum*, *Cienfuegosia yucatanensis*, *Stemodia maritima*, *Aster* spp., *Jacquinia* spp., así como *Hippomane mancinella*, *Metopium brownei* y *M. toxiferum*. Esta asociación se ha observado en las salinas de la Ciénaga de Zapata, donde también se ha recolectado *Ruppia maritima*.

Vegetación halófila costera

Esta comunidad es característica de las playas arenosas, que se localizan cerca del litoral y se presenta en la mayor parte del litoral guerrerense, está formada por plantas herbáceas, muchas de las cuales son rastreras y estoloníferas, como *Ipomoea pes-caprae*, *I. stolonifera*, *Pectis arenaria*, *Canavalia maritima* y *Okenia hypogaea*, con *Lennea madreporoides* como parásita. Son especies expuestas a la movilidad de la arena, que se reproducen tanto vegetativa como sexualmente y con frecuencia se les observa semienterradas en el sustrato.

En ocasiones esta vegetación tiene el aspecto llano de un pastizal dominado por *Distichlis spicata*, acompañado por algunas especies rastreras como *Digitaria sanguinalis* y *Bouteloua repens*. Esta homogeneidad solo es interrumpida por manchones de *Prosopis juliflora*, *Opuntia velutina* y *Coccoloba liebmanii* en pequeñas hondonadas. En la zona de transición entre las dunas fijas y el matorral xerófilo, crecen manchones monotípicos de *Canavalia maritima* e individuos postrados de *Acalypha monostachya*. En las partes más fijas de las dunas, se establecen asociaciones de arbustos muy ramificados, formando mezclas compactas de *Prosopis juliflora*, *Lantana camara* y *Stegnosperma scandens*, que alcanzan de 1.5 a 2 m de altura, alternando con manchones densos de *Opuntia velu-*

tina, *O. wilcoxii*, *O. puberula* y un estrato herbáceo constituido exclusivamente por *Distichlis spicata*.

Esta formación en Guerrero corresponde a lo tratado en Cuba bajo la denominación de complejo de vegetación de costa arenosa. Aunque esta comunidad formada por diversas asociaciones (Borhidi *et al.* 1983) se desarrolla en las costas cubanas en condiciones ecológicas similares (suelo arenoso, proximidad del mar, efecto del viento, temperatura, etc.) es evidente que parte de su aspecto fisionómico y componentes florísticos tienen marcada diferencia, lo cual se comprenderá al mencionar que las principales especies que se registran en las costas cubanas, son: *Borrhchia arborescens*, *Canavalia maritima*, *Ipomoea pes-caprae*, *Suriana maritima*, *Tournefortia gnaphalodes*, así como especies de los géneros *Fimbristylis*, *Cyperus*, *Cenchrus*, *Pectis*, *Chamaesyce*, *Heliotropium*, *Atriplex* y *Cakile*. En particular se registran diferentes variantes por zona, donde se asientan elementos poco frecuentes como: *Ernodea litoralis*, *Scaevola plumieri*, *Uniola virgata*, *U. paniculata* y *Heliotropium hypogaeum*. Este tipo de vegetación se caracteriza por especies herbáceas y subfruticasas mezcladas con especies arbóreas, como: *Coccoloba uvifera*, *Thrinax radiata* y *Coccothrinax litoralis*; en ocasiones pueden encontrarse especies de mangles. En general este tipo de comunidad en Guerrero se presenta con menor altura y aspecto fisionómico diferente a lo observado en Cuba.

En el marco halófilo costero existe en Cuba otra formación vegetal denominada complejo de vegetación de costa rocosa, sobre suelo calizo con diferentes variantes. Aquí se desarrollan suculentas de diferentes tamaños, arbustos pequeños a veces achaparrados, acompañados de algunas herbáceas; las especies principales que pueden observarse en esta asociación son: *Opuntia dillenii*, *Harrisia* spp., *Erithalis fruticosa*, *Rachicallis americana*, *Strumfia maritima*, *Chamaesyce buxifolia*, *Sesuvium maritimum*, *Pectis* spp., *Heliotropium humifusum*, *Fimbristylis* spp., *Flaveria linearis*, *Philoxerus vermicularis*, *Evolvulus arbuscula*, así como algunas gramíneas pequeñas. Tanto las especies antes citadas como otras que comparten la formación de costa arenosa, se distribuyen en comunidades abiertas según las condiciones del medio. A este tipo de vegetación no se le encontró equivalente en las áreas de estudio en Guerrero.

Bosque tropical perennifolio

Esta bosque se localizó en una pequeña franja en el extremo noroeste del estero San Valentín, con suelos inundables, ricos en materia orgánica. La fisonomía está dada por 2 estratos arbóreos: el estrato arbóreo más alto formado por individuos de más de 25 metros, con dominancia de "chicozapote" *Manilkara zapota*, motivo por el cual los pobladores lo llaman El Chical. Otro estrato arbóreo de aproxi-

madamente 15 a 20 metros, está constituido por *Hymenaea courbaril*, *Pithecellobium lanceolatum*, *Bravaisia integririma* y la palma *Sabal mexicana*.

El estrato arbustivo es pobre, se reduce a pocos elementos de 2 a 3 metros de altura, entre ellos: *Casearia obovata*, *Tecoma stans* y *Jacquinia aurantiaca*. En las secciones taladas se presentan poblaciones de *Prosopis juliflora*, constituyendo un matorral secundario.

En el estrato herbáceo se presentan solo algunos individuos adultos de *Chamissoa macrocarpa*, plántulas de *Sabal mexicana* e *Hymenaea courbaril* y rosetas de *Bromelia pinguin*, esta última comúnmente llamada "timbiriche", con frutos comestibles, consumidos por los habitantes de los lugares vecinos. También son abundantes los bejucos leñosos de leguminosas, que llegan hasta la copa de los árboles.

Este tipo de bosque no tiene correspondencia florística con los conocidos para ambientes similares en Cuba. Sin embargo, desde el punto de vista ecológico y fisonómico concuerda con lo tratado en Cuba como bosque de Ciénaga, que ocupa mayores extensiones, se desarrolla sobre suelos ricos en materia orgánica, vinculados a ciénagas costeras y subcosteras, con inundaciones periódicas o permanentes. La altura y estratificación del bosque son similares en ambas regiones.

En Cuba, las especies que viven en esta formación vegetal son: *Bucida palustris*, *B. buceras*, *Fraxinus cubensis*, *Annona glabra*, *Salix caroliniana*, *Hibiscus elatus*, *Tabebuia angustata*, *Calophyllum antillanum*, *Sabal parviflora* s.l., *Ilex cassine*, *Copernicia pauciflora*, *Ficus* spp., *Guettarda combsii*; también pueden sumarse algunas especies del manglar. La representación arbustiva es pobre, pudiendo encontrarse *Ouratea nitida*, *Erythroxylum areolatum*, *Chrysobalanus icaco*, *Savia bahamensis*, *Rauvolfia cubana*. También están presentes algunas epífitas (bromeliáceas y orquidáceas) así como algunas lianas.

La principal representatividad de estos bosques se ubica en áreas de la península de Guanahacabibes, Zapata y sur de la Isla de la Juventud, así como la costa norte entre Matanzas y Camaguey.

Bosque tropical subcaducifolio

Este tipo de vegetación, que fue en el pasado probablemente el de más amplia distribución en la zona costera de Guerrero, ahora es prácticamente inexistente, debido a que se presentaba en terrenos no inundables que fueron elegidos para establecer cultivos y ganadería. En una amplia zona de la Costa Chica la vegetación fue eliminada con maquinaria, para después establecer una red de canales que regaran los cultivos anuales y permanentes. En esta zona existen vestigios de ese tipo de vegetación con árboles de hasta 20 m de altura; entre otras especies se encontraron: *Bursera simaruba*, *Pterocarpus acapulcensis*, *Luehea candida*, *Swietenia humilis* y *Hura polyandra*.

Esta formación vegetal parece corresponder a lo tratado en Cuba como bosque semideciduo en la variante mesófilo. La pobre representatividad de esta comunidad en Guerrero, deja poco margen para la comparación. No obstante, teniendo en cuenta lo planteado por Rzedowski (1978) para esta formación vegetal, se considera que por lo menos hay cierta equivalencia ecológica entre ambos, aunque a nivel florístico se denoten diferencias más acentuadas.

El bosque semideciduo mesófilo en Cuba, ocupa actualmente las mayores extensiones, aunque en varias zonas ha sufrido diferentes grados de deterioro. En las variantes relacionadas con los medios costeros y subcosteros, pueden presentarse árboles de 15–20 y en algunos casos hasta 25 m, con especies caducifolias, también algunas palmas y un estrato arbóreo inferior. Se halla generalmente sobre suelos pardos carbonatados o en diferentes tipos de rendzinas y bajo la influencia de diferentes grados de humedad.

Entre las especies de esta formación vegetal se tiene: *Bursera simaruba*, *Ceiba pentandra*, *Cedrela odorata*, *Andira inermis*, *Gossypiospermum praecox*, *Lysiloma latisiliqua*, *Roystonea regia*, *Samanea saman*, *Tabebuia* spp., *Eugenia maleolens*, *Erythroxylum havanense*, *Allophylus cominia*, *Adelia ricinella*, *Zanthoxylum fagara*, *Z. martinicense*, *Gymnanthes lucida*, *Casearia* spp., *Trichilia hirta*, *T. glabra*, *Mastichodendron foetidissimum* y *Ficus* spp.

También bajo el concepto de bosque semideciduo, pero con la variante de micrófilo, se remarca a un tipo de bosque similar al anterior, que comparte varias de las especies, con la diferencia que presenta 2 estratos y el más alto no sobrepasa los 15 m, con elementos de hojas más pequeñas, especies espinosas y palmas de hojas palmatífidas. Las especies más frecuentes son: *Belairia* spp., *Casearia aculeata*, *Malpighia* spp., *Eugenia* spp., *Peltophorum adnatum*, *Picramnia pentandra*, *Croton lucidus*, *Hypelate trifoliata*, *Copernicia* spp., *Coccolrinax* spp., *Erythroxylum* spp., *Tabebuia* spp., *Phyllostylon brasiliense*, *Piscidia havanensis*, *Pithecellobium* spp., *Behaimia cubensis*, *Allophylus cominia*. Así como otras que comparten la formación anterior.

Bosque tropical caducifolio

Se establece principalmente en las laderas de los cerros El Verde, Huamilule, Japón, El Papayo y otros, en las zonas adyacentes a Cruz Grande, ocupando en general extensiones pequeñas. En muy pocos sitios se le puede encontrar sin perturbación, por lo general sus componentes primarios han sido retirados, ya sea para utilizar su madera o han sido destruidos con fines agrícolas y ganaderos, por lo que en su lugar ha quedado una especie de matorral secundario dominado por leguminosas como *Gliricida sepium* y especies como *Salpianthus arenarius* y *Lantana camara*, que ahora constituyen el paisaje más común en la zona costera.

Sin embargo, en sitios de difícil acceso aún se conserva la vegetación original o al menos algunos elementos que indican su presencia en otras épocas. Entre los elementos arbóreos principales se encuentran: *Achatocarpus nigricans*, *Ruprechtia pallida*, *Bursera arborea*, *Spondias purpurea*, *Bursera excelsa*, *Thouinidium decandrum*, *Trichilia hirta*, *Cochlospermum vitifolium*, *Vitex mollis*, *Cordia elaeagnoides*, *Ziziphus amolle* y *Plumeria rubra*.

En el estrato arbustivo se pueden citar: *Celtis iguanaea* y *Thevetia ovata*.

El estrato herbáceo está constituido por diversas especies, pero de manera general se pueden mencionar: *Ayenia abutilifolia*, *Elytraria imbricata*, *Blechum browni*, *Ruellia albiflora*, *Cleome hemsleyana*.

Este tipo de bosque no tiene equivalente en Cuba según lo descrito por Capote y Berazain (1985), sin embargo Borhidi *et al.* (1979), Borhidi (1991), describieron la alianza *Pithecellobium lentiscifolii* como representante de los bosques deciduos, que ocupan un área de la parte oriental de la Ciénaga de Zapata. Según la descripción, sus especies características son: *Pithecellobium lentiscifolium*, *Cedrela odorata*, *Spondias mombin*, *Bursera simarouba*, *Trichilia hirta*, *Cordia gerascanthus*, así como algunos arbustos de *Cordia globosa*, *Erythroxylum havanense*, *Picramnia pentandra*, *Eugenia* spp. y algunas cactáceas, principalmente *Selenicereus*, *Harrisia* y *Opuntia*. En general este bosque se observa muy claro (poca cobertura vegetal) tanto en el sotobosque como en las copas, característica que se acentúa en la época en que sus elementos pierden sus hojas.

Sabana

Se presenta solamente al oeste de la laguna Tecomate, es una comunidad dominada por gramíneas como *Soderstromia mexicana*, *Bouteloua repens*, *Dactyloctenium aegyptium* y *Digitaria sanguinalis*. También se presentan árboles formando grupos o isletas que alcanzan 6 a 7 metros de altura, los más comunes son: *Byrsonima crassifolia* y *Curatella americana*. Un elemento característico de esta comunidad es *Bromelia pinguin*.

Sin olvidar lo controvertido que aun resulta este término, se relacionó lo tratado en Guerrero como tal, con las sabanas seminaturales citadas para Cuba. En Cuba esta comunidad reúne características comunes a las tratadas para Guerrero, como abundancia de gramíneas, algunos componentes arbóreos o arbustivos generalmente dispersos en pequeños grupos, abundancia de ciperáceas y las palmas como los elementos arbóreos más característicos. Entre las especies más abundantes están: *Sabal parviflora*, *Lonchocarpus* spp., *Crescentia cujete*, *Ceiba pentandra*, *Tabebuia* spp., así como gramíneas de los géneros: *Paspalum*, *Panicum*, *Sporobolus*, *Eragrostis*, *Setaria* y *Cynodon dactylon*, *Digitaria sanguinalis*, *Bothriochloa pertusa*, *Eleusine indica*, *Dactyloctenium aegyptium* entre otros. Estas comunidades en las áreas a evaluar se desarrollan en extensiones limitadas

y con matices particulares de acuerdo a las características del medio y a la incidencia de las afectaciones, Borhidi y Herrera (1977), Borhidi (1988).

Vale comentar que *Curatella* y *Byrsonima* son los elementos básicos de la vegetación de sabana, por lo general asociados a otras especies, en áreas fuera de los objetivos del presente trabajo, Balátová-Tulácková y Surli (1983).

Matorral xerófilo

Este tipo de vegetación cubre la franja entre las lagunas y el mar, es una comunidad muy densa, en ocasiones sus elementos se desarrollan formando una especie de islas de aproximadamente 3–5 m de diámetro, en otros casos constituye una especie de barrera paralela a la línea de costa, de distinta anchura en las diversas zonas donde se presenta, bastante difícil de penetrar, en algunos sitios se le denomina “chicarral”. La fisonomía está dada principalmente por arbustos con elementos de 1.5 a 2.5 m de altura, que pierden sus hojas en la época seca del año. Algunas especies de la vegetación costera se presentan en el matorral pero con una talla mayor como: *Opuntia velutina*, *O. wilcoxii*, *Nopalea karwinskiana* y *Prosopis juliflora*, cuya altura oscila entre 1 y 2 metros.

Son frecuentes las cactáceas columnares como *Acanthocereus occidentalis* y *Cephalocereus guerrerensis*, que alcanzan hasta 4 m de altura. Se presentan individuos aislados de *Couepia polyandra* y *Ficus mexicana*, otras especies de esta comunidad son: *Bursera arborea*, *Jatropha sympetala*, *Malpighia glabra*, *Caparis incana*, *Manihot cartaginensis*, *Diospyros verae-crucis*, *Piptadenia constricta*, *Gliricidia sepium*, *Randia guerrerensis*, *Guaiacum coulteri*, *Tabernaemontana amygdalifolia* y *Jacquinia pungens*.

Otras especies leñosas pero escandentes o trepadoras son: *Entada polystachya*, *Marsdenia* sp. y *Paullinia pinnata*. En algunos sitios se observa un estrato arbustivo menor de 1 metro, representado, entre otras especies, por *Krameria cuspidata* y *Rhacoma puberula*. En el pastizal que rodea al matorral dominan las gramíneas amacolladas, en particular *Digitaria sanguinalis*, *Eragrostis repens* y plantas postradas como *Chamaecrista flexuosa*, *Chamaecrista hispidula*, *Egletes viscosa*, *Tephrosia* sp. y *Stylosanthes viscosa*. Las epífitas son escasas, las más frecuentes son: *Tillandsia pauciflora*, *T. fasciculata* y *T. dasyliriflora* y la hemiparásita *Struthanthus cassythoides*. Un buen número de especies secundarias se hacen más conspicuas en la época de lluvias, como *Momordica charantia*, *Kosteletzkya pentasperma*, *Turnera ulmifolia* y *Salpianthus arenarius*.

En Guerrero este tipo de vegetación tiene el aspecto xeromórfico, es uno de los más ricos en especies, se desarrolla sobre arena prácticamente pura; lo que plantea cierta expectativa sobre hasta qué punto sería una continuación de la duna o no. En Cuba tiene su contrapartida en los matorrales xeromorfos costeros y sub-

costeros, con la marcada diferencia que estos se desarrollan sobre suelos calizos (rendzina) costeros o esqueléticos.

Es notorio que ambas asociaciones en Guerrero y en Cuba presentan similar aspecto fisonómico, se ubican en similar posición geográfica, crecen en semejantes condiciones ecológicas, salvando la diferencia de sustrato ya citada.

En esta formación vegetal para Cuba se cita: *Bursera glauca*, *Calliandra colletoides*, *Capparis flexuosa*, *C. grisebachii*, *Diospyros grisebachii*, *D. crassinervis*, *Randia* spp., *Agave* spp., *Caesalpinia* spp., *Catesbaea* spp., *Cordia* spp., *Guetarda* sp., *Plumeria* spp., *Lantana* spp., *Jacquinia* spp., *Croton* spp., *Leucocroton microphyllus*, *Reynosa mucronata*, *Omphalea trichotoma*, *Maytenus* spp., *Exostema spinosum*, *Oplonia* spp., *Erythroxylum* spp., *Tabebuia* spp. A la que se le suman palmas de los géneros *Coccothrinax*, *Copernicia* y *Thrinax radiata* fundamentalmente. Singular y atractivo resulta en esta formación la posibilidad de contar con diferentes cactáceas como *Opuntia*, *Melocactus*, *Dendrocereus*, *Consolea*, *Pilosocereus*, *Harrisia*, *Cylindropuntia* y *Mammillaria* entre otras, más abundantes en la costa sur de la región oriental de Cuba.

Es evidente que ambas comunidades comparten una elevada representación de familias y géneros, no así de especies, aunque ambos son ricos y diversos florísticamente. En este tipo de ambiente costero, cuando el matorral xeromorfo está ausente o como a continuación de éste, puede encontrarse en Cuba una formación denominada por Capote y Berazain (1985) bosque siempreverde micrófilo, que se localiza sobre calizas costeras. Es un bosque con altura de 5 m en adelante, con dominancia de especies de hojas relativamente pequeñas, cierta esclerofilia, espinescencia, así como algunas cactáceas y suculentas; comparte algunas especies con el tipo de vegetación antes mencionado como: *Ximenia americana*, *Bourreria* spp., *Bucida spinosa*, *Bumelia glomerata*, *Bursera simaruba*, *Capparis cynaphallophora*, *Cordia galeottiana*, *Gochnatia sagraeana*, *Krugiodendron ferreum*, *Colubrina elliptica*, *C. arborescens*, *Macrocalatpa punctata*, *Hippomane mancinella*, *Phyllanthus epiphyllanthus*, *Picrodendron macrocarpum*, *Thrinax radiata*, *Coccothrinax* spp. entre otras, así como cactáceas de diferentes géneros. Para esta comunidad vegetal, no se observó equivalente en la costa de Guerrero.

Bosque de Byrsonima y Curatella

En este bosque existe un estrato arbóreo dominado por *Byrsonima crassifolia*, *Curatella americana* y *Licania arborea*, que alcanzan tallas de 7 a 8 metros en algunos sitios; el estrato arbustivo es muy abundante y está constituido por leguminosas principalmente. No cabe duda que se trata de una vegetación secundaria. En Guerrero, al occidente de la laguna Tecomate este bosque cubre una amplia extensión.

Aunque las especies que caracterizan este bosque están presentes en Cuba, generalmente se encuentran asociados con diferentes elementos, bajo otras condiciones ecológicas, en áreas no enmarcadas en este estudio, resultando no comparable con el bosque presente en Guerrero.

Vegetación secundaria

La vegetación secundaria que se establece en diferentes puntos de las áreas consideradas para Cuba, versa sobre especies de gramíneas, asteráceas, ciperáceas, así como algunas otras familias tradicionales en este comportamiento; esto es cuanto a los elementos herbáceos, muchos de los cuales son comunes a Guerrero. En la zona de mayor degradación en Cuba, es dominante *Dichrostachys cinerea*, así como individuos de *Acacia farnesiana*. En Guerrero, en zonas con similares grados de afectación se encuentran predominando: *Acacia cochleacantha*, *A. farnesiana* y *Prosopis juliflora*.

FLORA

En total se registraron los siguientes taxa de plantas vasculares para la costa de Guerrero (México) y la costa de Cuba:

	Cuba	Guerrero	Compartidos
Especies exclusivas	913	737	408
Géneros exclusivos	243	173	345
Familias	11	17	120

En el apéndice 1, se enlistan las familias, géneros y especies encontradas en ambas zonas.

En el apéndice 2 se muestran los taxa exclusivos y los compartidos de ambas regiones.

En cuanto a las familias que crecen en las zonas costeras de Cuba y están ausentes en la costa de Guerrero (México), se tiene a Canellaceae característica de las Antillas, América del Sur y África. Aquifoliaceae, Brassicaceae, Hydrocharitaceae, Iridaceae, Myricaceae y Oleaceae, se presentan en el estado de Guerrero pero en otras condiciones ecológicas, a mayor altitud y en diferentes tipos de vegetación. En cambio Buxaceae se distribuye en otros estados de la República Mexicana.

Las familias bien representadas en la zona costera de Guerrero y ausentes en las mismas condiciones en Cuba, son: Achatocarpaceae, Basellaceae, Ceratophyllaceae, Connaraceae, Dilleniaceae, Julianaceae, Krameriaceae, Lennoaceae, Loasaceae, Opiliaceae, Parkeriaceae, Pedaliaceae, Polemoniaceae, Salviniaceae.

Cannaceae y Caricaceae solo se encuentran en Cuba bajo cultivo. Por último Begoniaceae y Thymelaeaceae crecen en las zonas más alejadas de la costa.

Con relación a las familias con el 100% de géneros comunes en Cuba y Guerrero, están: Aizoaceae, Araliaceae, Aristolochiaceae, Azollaceae, Batidaceae, Burseraceae, Campanulaceae, Commelinaceae, Connaraceae, Cuscutaceae, Cyadaceae, Ebenaceae, Elaeocarpaceae, Erythroxylaceae, Lentibulariaceae, Limncharitaceae, Marsileaceae, Menyanthaceae, Najadaceae, Ochnaceae, Oxalidaceae, Passifloraceae, Piperaceae, Plumbaginaceae, Polygalaceae, Pontederiaceae, Portulacaceae, Ranunculaceae, Rhizophoraceae, Salicaceae, Schizaeaceae, Smilacaceae, Sphenocleaceae, Thelypteridaceae, Theophrastaceae, Turneraceae, Typhaceae, Viscaceae, Zygophyllaceae.

Familias presentes en la costa de ambas localidades, pero no comparten los mismos géneros, son: Apiaceae, Celastraceae, Gesneriaceae, Myrsinaceae. Sin embargo, la mayor diferencia se expresa a nivel de especies, aunque los géneros sí se presenten compartidos en ambas regiones. Es probable que la mayor parte de los géneros comunes se hayan establecido previamente y la divergencia a nivel específico sea producto de la evolución independiente de los taxa.

Las siguientes familias presentan el mayor número de géneros y especies.

	Cuba	Guerrero	Compartidos	Total
Poaceae	15	5	28	48
Fabaceae	7	11	23	41
Rubiaceae	21	5	12	38
Euphorbiaceae	16	5	12	33

FITOGEOGRAFÍA

Se presenta la distribución geográfica a nivel de familia y género, con base en los trabajos de Willis (1973) y Standley (1958–1974).

Tropical: Begoniaceae, Bixaceae, Bombacaceae, Burseraceae, Canellaceae, Connaraceae, Hippocrateaceae, Ochnaceae, Piperaceae, Rhizophoraceae, Simaroubaceae, Sphenocleaceae.

Tropical y subtropical: Acanthaceae, Agavaceae, Aizoaceae, Amaranthaceae, Annonaceae, Araliaceae, Apocynaceae, Arecaceae, Azollaceae, Bignoniaceae, Asclepiadaceae, Caesalpiniaceae, Cannaceae, Capparaceae, Celastraceae, Chrysobalanaceae, Combretaceae, Commelinaceae, Cucurbitaceae, Dilleniaceae, Dioscoreaceae, Ebenaceae, Elaeocarpaceae, Erythroxylaceae, Gesneriaceae, Lauraceae, Limncharitaceae, Loganiaceae, Loranthaceae, Lythraceae, Malpighiaceae, Marantaceae, Meliaceae, Menispermaceae, Mimosaceae, Molluginaceae,

Moraceae, Myrsinaceae, Myrtaceae, Olacaceae, Opiliaceae, Oxalidaceae, Parke-riaceae, Passifloraceae, Phytolaccaceae, Pedaliaceae, Pontederiaceae, Rubiaceae, Sapindaceae, Sapotaceae, Smilacaceae, Sterculiaceae, Surianaceae, Tiliaceae, Urticaceae, Verbenaceae, Vitaceae, Zygophyllaceae.

Tropical y templadas: Anacardiaceae, Aquifoliaceae, Araceae, Cabombaceae, Clusiaceae, Fabaceae, Flacourtiaceae, Hydrocharitaceae, Iridaceae, Loasaceae, Myricaceae, Turneraceae, Ulmaceae.

Principalmente americanas: Batidaceae, Bromeliaceae, Cactaceae, Theophrastaceae.

Endémicas de América: Achatocarpaceae, Caricaceae, Julianiaceae, Krameriaceae, Lennoaceae.

Principalmente templadas: Aristolochiaceae, Polemoniaceae, Ranunculaceae, Salicaceae.

De distribución general, con preferencia de regiones templadas: Onagraceae, Polygonaceae.

Cosmopolitas, a excepción de las regiones polares: Adiantaceae, Apiaceae, Boraginaceae, Buxaceae, Campanulaceae, Ceratophyllaceae, Chenopodiaceae, Convolvulaceae, Cuscutaceae, Gentianaceae, Haloragaceae, Liliaceae, Malvaceae, Marsileaceae, Nyctaginaceae, Oleaceae, Orchidaceae, Plumbaginaceae, Polygalaceae, Portulacaceae, Pteridaceae, Rhamnaceae, Rutaceae, Schizaeaceae, Solanaceae, Thelypteridaceae, Violaceae, Viscaceae.

Cosmopolitas: Alismataceae, Asteraceae, Brassicaceae, Cyperaceae, Euphorbiaceae, Hydrophyllaceae, Lamiaceae, Lemnaceae, Lentibulariaceae, Menyanthaceae, Najadaceae, Nymphaeaceae, Poaceae, Potamogetonaceae, Ruppiaceae, Salviniaceae, Thymelaeaceae, Scrophulariaceae, Typhaceae.

Paleotropical: Moringaceae.

Incierta: Goodeniaceae, Cycadaceae.

Distribución fitogeográfica de los géneros registrados para la zona de estudio, según Willis (1973).*

Tropical

América–África–Asia: *Acrostichum*, *Albizzia*, *Ampelocissus*, *Aster*, *Barleria*, *Byttneria*, *Cakile*, *Calliandra*, *Calophyllum*, *Calotropis*, *Casearia*, *Cassine*, *Centella*, *Cissus*, *Cochlospermum*, *Combretum*, *Crataeva*, *Cucumis*, *Cynometra*, *Dichrostachys*, *Erianthus*, *Gochnatia*, *Hippocratea*, *Hydrolea*, *Hyparrhenia*, *Leucaena*, *Lindernia*, *Luffa*, *Maclura*, *Marsdenia*, *Melanthera*, *Omphalea*, *Oper-*

- * 1. No considerada por Rzedowski.
- 2. No considerada como tipo de vegetación por Rzedowski.
- 3. No considerada como tipo de vegetación.

culina, Ouratea, Pancratium, Paspalidium, Piper, Piriqueta, Pithecellobion, Pouzolzia, Pterocarpus, Randia, Rauvolfia, Rhynchelytrum, Rhizophora, Rourea, Sida, Spilanthes, Stemodia, Suriana, Tabernaemontana, Trianthema, Triumphetta, Vernonia, Waltheria, Wissadula, Ximenia, Xylopia, Ziziphus.

América-África: *Andira, Caperonia, Cayaponia, Chrysobalanus, Conocarpus, Desmanthus, Drypetes, Echinodorus, Erythroxylum, Haematoxylum, Heteranthera, Hildegardia, Jacaratia, Jaumea, Kosteletzkyia, Laguncularia, Lantana, Lippia, Olyra, Parkinsonia, Pitcairnia, Pityrogramma, Prosopis, Sclerocarpus, Schultesia, Sorghastrum, Swartzia, Thalia, Trichilia, Urera, Xylum.*

América-Asia: *Antirhea, Calyptranthes, Cephalanthus, Clusia, Cynoctonum, Fraxinus, Hemionitis, Hippobroma, Iresine, Kallstroemia, Nama, Parthenocissus, Phenax, Rosanthus, Sapindus, Spondias, Tetrapteris, Thalassia, Trophis, Xylosma, Zanthoxylum.*

Tropical y subtropical

Abutilon, Acacia, Acalypha, Achyranthes, Aeschynomene, Alternanthera, Allophylus, Andropogon, Anthephora, Ardisia, Aristida, Arundo, Avicennia, Azolla, Bacopa, Boehmeria, Boerhaavia, Borreria, Bouchea, Brachiaria, Buchnera, Bulbostylis, Caesalpinia, Callicarpa, Canavalia, Capparis, Ceratopteris, Chascotheca, Chloris, Cienfuegosia, Cleome, Clerodendrum, Clitoria, Cocculus, Colubrina, Commelina, Commicarpus, Corchorus, Cordia, Crinum, Crotalaria, Croton, Cynodon, Dactyloctenium, Dalbergia, Dalechampia, Desmodium, Dicliptera, Diodia, Dioscorea, Diospyros, Echinochloa, Eclipta, Elaeodendron, Eleusine, Elytaria, Entada, Eriochloa, Eriosema, Erythrina, Eugenia, Exothea, Flaveria, Ficus, Fimbristylis, Galactia, Glinus, Gossypium, Gouania, Guapira, Gynerium, Hibiscus, Homalium, Hybanthus, Hymenachne, Inga, Ixora, Jatropha, Justicia, Leersia, Leptochloa, Linociera, Lipocarpa, Lygodium, Macrocatalpa, Manilkara, Melothria, Merremia, Mollugo, Morinda, Mucuna, Myrtus, Nectandra, Neptunia, Nymphaea, Ocimum, Oplismenus, Oplonia, Paspalum, Pavonia, Pellaea, Pennisetum, Phaseolus, Philoxereus, Phyllanthus, Pilea, Pisonia, Pistacia, Pistia, Pluchea, Plumbago, Portulaca, Priva, Rhus, Rhynchosia, Rotala, Ruppia, Sacciolepis, Salvinia, Sarcostemma, Scaevola, Schoepfia, Senna, Sesbania, Sesuvium, Sideroxylon, Smilax, Sophora, Stenotaphrum, Stylosanthes, Synedrella, Talinum, Tephrosia, Tournefortia, Trema, Tribulus, Vallisneria, Vanilla, Vicia, Vitex, Wedelia.

Templado (principalmente)

Chenopodium, Conyza, Nuphar, Salix, Satureja, Spartina, Vitis.

Tropical y templado

Amaranthus, Ampelopsis, Aristolochia, Atriplex, Begonia, Canna, Cassia, Celosia, Cenchrus, Chamaecrista, Cladium, Cyperus, Cuscuta, Datura, Enydra, Eryngium, Fuirena, Heliotropium, Hydrocotyle, Ipomoea, Lycianthes, Lycium, Marsilea, Nymphaea, Nymphoides, Panicum, Salvia, Salicornia, Salvinia, Sapium, Sceleria, Securinega, Setaria, Solanum, Sporobolus, Stevia, Utricularia, Wolffia.

Cosmopolita

Ambrosia, Ammania, Ammannia, Bidens, Ceratophyllum, Chamaesyce, Clematis, Eleocharis, Eragrostis, Euphorbia, Ilex, Lemna, Lepidium, Lophotocarpus, Lythrum, Myrica, Myriophyllum, Najas, Oxalis, Phragmites, Polygala, Polygonum, Potamogeton, Rhynchospora, Sagittaria, Scirpus, Spirodela, Suaeda, Teucrium, Thelypteris, Typha.

América

Adenocalymma, Agave, Amoreuxia, Anacardium, Anemopaegma, Anredera, Asclepias, Baccharis, Bixa, Bourreria, Bouteloua, Centrosema, Cephalocereus, Clytostoma, Consolea, Cydista, Cylindropuntia, Distichlis, Echinopepon, Enallagma, Eupatorium, Gonolobus, Heliopsis, Hohenbergia, Mirabilis, Montanoa, Opuntia, Pachira, Paragonia, Phoradendron, Physalis, Polymnia, Porophyllum, Stachytarpheta, Stenandrium, Trixis, Verbesina, Zinnia.

Tropical americano

Acrocomia, Achantocereus, Achimenes, Adelia, Agalinis, Ageratum, Alibertia, Alvaradoa, Amyris, Angelonia, Anguria, Anisomeris, Aniseia, Anoda, Annona, Anthurium, Antigonon, Arrabidaea, Ateleia, Ayenia, Aspidosperma, Bactris, Banara, Banisteria, Banisteriopsis, Bastardia, Batis, Bauhinia, Belotia, Bernardia, Blechnum, Bletia, Bravaisia, Bomarea, Borreria, Borrichia, Bothriochloa, Bouchetia, Bromelia, Brunfelsia, Buchenavia, Bunchosia, Bursera, Calopogonium, Canella, Capraria, Cardiospermum, Castela, Catopsis, Chamissoa, Chione, Chiococa, Chrysophyllum, Cecropia, Ceiba, Cestrum, Cionosicyos, Cissampelos, Cladocolea, Clowesia, Cnidoscolus, Coccoloba, Condalia, Copernicia, Cormonema, Corynostylis, Couepia, Coursetia, Crescentia, Crossopetalum, Cucurbita, Cupania, Cuphea, Curatella, Cyclanthera, Cyrtopodium, Dalea, Dendropepon, Digitaria, Ditaxis, Dorstenia, Duranta, Eichhornia, Encyclia, Enterolobium, Esenbeckia, Evolvulus, Exogonium, Exostema, Faramaea, Forestiera,

Furcraea, *Genipa*, *Gliricidia*, *Guaiacum*, *Guarea*, *Guazuma*, *Guettarda*, *Guzmania*, *Helicteres*, *Herissantia*, *Heteropteris*, *Hieraea*, *Hyperbaena*, *Hyptis*, *Indigofera*, *Ionopsis*, *Iva*, *Jacquemontia*, *Jacquinia*, *Karwinskia*, *Krameria*, *Lasiacis*, *Leiphaimos*, *Licaria*, *Limnocharis*, *Lonchocarpus*, *Ludwigia*, *Luehea*, *Luziola*, *Lysiloma*, *Macroptilium*, *Malachra*, *Malpighia*, *Malvastrum*, *Mammillaria*, *Manihot*, *Maranta*, *Matayba*, *Maytenus*, *Melampodium*, *Melocactus*, *Melochia*, *Mentzelia*, *Metastelma*, *Mikania*, *Mimosa*, *Neea*, *Neomacfadya*, *Nicotiana*, *Odon-tonema*, *Oncidium*, *Oryza*, *Oxandra*, *Palicourea*, *Passiflora*, *Paullinia*, *Pectis*, *Pelthophorum*, *Peperomia*, *Pera*, *Pereskia*, *Petiveria*, *Petrea*, *Philodendrum*, *Pi-cramnia*, *Pilocarpus*, *Pilosocereus*, *Pimenta*, *Poeppigia*, *Polypremum*, *Pontede-ria*, *Pouteria*, *Prockia*, *Pseudelephantopus*, *Pseudoconyza*, *Psidium*, *Psittacan-thus*, *Psychotria*, *Quassia*, *Ravenia*, *Rheedia*, *Rhodocactus*, *Rivina*, *Roystonea*, *Ruellia*, *Sabal*, *Scoparia*, *Schaefferia*, *Schistophragma*, *Schrankia*, *Securidaca*, *Serjania*, *Simarouba*, *Sisyrinchium*, *Spermacoce*, *Spigelia*, *Stenorrhynchos*, *Stig-maphyllon*, *Struthanthus*, *Strychnos*, *Swietenia*, *Syngonium*, *Tecoma*, *Teramnus*, *Terminalia*, *Thespesia*, *Thevetia*, *Thryallis*, *Tillandsia*, *Trichostigma*, *Triopteris*, *Turbina*, *Turnera*, *Uniola*, *Viguiera*, *Vigna*, *Wigandia*, *Zamia*, *Zornia*.

México–Sudamérica

Achatocarpus, *Agonandra*, *Adenaria*, *Aegopogon*, *Aldama*, *Amphipterygium*, *Apo-planesia*, *Arachnothryx*, *Astronium*, *Blepharodon*, *Byrsonima*, *Cedrela*, *Citharexy-lum*, *Cymbopetalum*, *Egletes*, *Forstonia*, *Gomphrena*, *Gronovia*, *Hamelia*, *He-liocarpus*, *Hemidiodia*, *Hura*, *Hylocereus*, *Hymenaea*, *Hymenostephium*, *Isocarpha*, *Loeselia*, *Machaerium*, *Machaonia*, *Malvaviscus*, *Mitracarpus*, *Morisonia*, *Muntingia*, *Nelumbo*, *Nissolia*, *Odontonema*, *Orbignya*, *Parmentiera*, *Pedilanthus*, *Pfaffia*, *Piptadenia*, *Pithecoctenium*, *Prestonia*, *Pseudobombax*, *Rhabdadenia*, *Rhacoma*, *Rhipsalis*, *Richardia*, *Ritterocereus*, *Rochefortia*, *Rogiera*, *Ruprechtia*, *Russelia*, *Salvia*, *Selenicereus*, *Staelia*, *Tabebuia*, *Tridax*, *Xanthosoma*.

México–Centroamérica

Achimenes, *Anoda*, *Anguria*, *Astianthus*, *Ateleia*, *Bastardia*, *Bletia*, *Bomarea*, *Borreria*, *Bothriochloa*, *Brunfelsia*, *Bucida*, *Buchenavia*, *Calopogonium*, *Came-raria*, *Canella*, *Carlowrightia*, *Chrysophyllum*, *Cecropia*, *Cestrum*, *Cissampelos*, *Clowesia*, *Comocladia*, *Coursetia*, *Crusea*, *Cucurbita*, *Cupania*, *Cuphea*, *Cyrto-podium*, *Dalea*, *Dendropemon*, *Ditaxis*, *Dorstenia*, *Dyssodia*, *Echites*, *Encyclia*, *Exogonium*, *Fernaldia*, *Forchhameria*, *Gayoides*, *Guarea*, *Henrya*, *Hieraea*, *Hippomane*, *Hyperbaena*, *Indigofera*, *Ionopsis*, *Javorkaea*, *Krameria*, *Lennoa*, *Limnocharis*, *Luziola*, *Mandevilla*, *Maytenus*, *Melopium*, *Neea*, *Nopalea*, *Okenia*,

Oncidium, Oryza, Pelthophorum, Peniocereus, Pera, Pimenta, Piscidia, Poeppigia, Pontederia, Prionosciadium, Psittacanthus, Rheedia, Rhodocactus, Salmea, Salpianthus, Samyda, Sapranthus, Schaefferia, Schrankia, Securidaca, Spigelia, Stemmadenia, Stenorrhynchos, Stigmaphyllon, Strychnos, Swietenia, Teramus, Terminalia, Tetramerium, Thespesia, Thouinia, Thouinidium, Thryalis, Tithonia, Trichostigma, Triopteris, Turbina, Urechites, Vallesia, Wigandia, Zamia, Zornia.

México

Hintonia, Ixophorus, Marina, Martynia, Neobuxbaumia, Pachycereus, Recchia, Riesenbachia, Schizocarpum, Soderstromia, Stuessya, Yucca.

América templada

Aphelandra.

Norteamérica

Oxypolis.

Antillas

Acidocroton, Atkinsia, Auerodendron, Barleriola, Bellonia, Bonania, Brya, Cameraria, Cattleyopsis, Chascotheca, Cionosicyos, Cubanola, Dendrocereus, Grimmeodendron, Isidorea, Krugiodendron, Lasiocroton, Leptocereus, Leucocroton, Nashia, Neobracea, Pheidonocarpa, Phialanthus, Picrodendron, Plethadenia, Pseudocarpidium, Rajania, Rhachicallis, Rhytidophyllum, Scolosanthus, Strumfia, Strempeleopsis, Suberanthus, Thrinax, Wallenia.

Cuba

Behaimia, Belairia, Caribeia, Doerpfeldia, Espadaea, Goerziella, Henoonia, Kodalyodendron, Platygyne, Phyllacanthus.

Paleotropical

Beaumontia, Buxus, Carpodiptera, Cassytha, Celtis, Cryptostegia, Dentella, Dichanthium, Ehretia, Emilia, Lawsonia, Melia, Momordica, Myrsine, Petitia, Phyllacanthus, Ricinus, Sphenoclea, Tragus.

Sur de Florida–Antillas

Borrichia, Casasia, Catesbaea, Coccothrinax, Erithalis, Ernodea, Harrisia, Hypelate, Monanthochloe, Reynosia.

América del Sur y Antillas

Argythamnia, Gossypiospermum, Macfadyena, Myrcianthes, Phyllostylon, Rondeletia.

Europa–Asia Tropical

Cynanchum.

América–Europa

Solidago.

México–Antillas

Acoeloraphe, Daphnopsis, Distictis, Ginoria, Opizia, Oxycaryum, Pictetia, Zuelania.

África

Spathodea.

A continuación se presenta el porcentaje de distribución fitogeográfica de las familias en las costas de Guerrero y Cuba.

Distribución	Géneros	Porcentaje
Tropical América-África-Asia	101	12.7
Tropical América-África	30	3.8
Tropical América-Asia	21	2.6
Tropical y subtropical	141	17.9
Templado	7	1.1
Tropical y templado	38	4.8
Cosmopolita	31	3.9
América	38	4.8
Tropical americano	177	26.6
México (endémicos)	12	1.5
México-Sudamérica	56	7.1
México-Centroamérica	99	12.6
México-Antillas	7	1.1
Antillas	35	3.3
Antillas-sur de Florida	2	0.2
Antillas-América del Sur	6	0.5
Cuba	10	0.8
Paleotropical	19	2.0
Otras	3	0.3

DISCUSIÓN

Standley (1936) hace referencia a la gran similitud entre la flora de Cuba y la flora de la costa sur del Pacífico en México, pero no se habían realizado trabajos que corroboraran este hecho, generalmente se comparaba Cuba y Yucatán, así que el presente estudio es el primer caso de comparación entre Cuba y Guerrero, en su zona costera.

Es significativo que sean 259 géneros compartidos, o sea el 45.6% del total registrado en ambas zonas, lo que demuestra la gran afinidad en la composición florística de las costa de Guerrero y la costa de Cuba, lo que confirma el gran vínculo entre ambas regiones y hace pensar en un pasado común para dichas áreas. Estos hechos nos enfrentan directamente con la necesidad de buscar una explicación, una de las más tradicionales sería la dispersión; para valorar esta posibilidad se debe tomar en cuenta que si bien en las dos zonas se trata de zonas costeras aproximadamente con tipos de clima parecidos y con terrenos cuyos sustratos pueden o no ser semejantes, son áreas que en la actualidad y probablemente desde el Eoceno están separadas por más de 1500 km, pero aún más,

una de ellas se sitúa en la vertiente del Pacífico y la otra se presenta del otro lado de América, en el mar Caribe, así que la dispersión pudiera explicar algunos casos de taxa compartidos, pero en la mayoría se debe buscar otra explicación. La historia geológica del Caribe y de México ha sido estudiada por diversos investigadores, sin que en la actualidad se haya llegado a un acuerdo, por ejemplo los estudios de Pindell y Dewey (1982) y el de Sykes y otros (1982, en Rosen 1985). Aunque al parecer hay divergencias, los diversos autores coinciden en señalar detalles como los siguientes:

- Desplazamiento longitudinal de las Antillas en el Cenozoico.
- Que ha habido enlace entre América del Sur y Norteamérica, vía proto Grandes Antillas.
- Aproximación del este de Cuba con Florida y del oeste de Cuba con Yucatán, en alguna época.

Sin embargo, existen teorías como la de Nagel (1971, en Rosen 1985) en la cual se propone que Jamaica, Puerto Rico, Hispaniola y Cuba, fueron parte del sur de México, antes de su traslado y rotación hacia su posición más al este. Si esto fuera verdad, la afinidad a nivel de familias y de géneros encontrada entre las costa de Cuba y de Guerrero y las divergencias en especies quedaría explicada por el período de unión y posterior aislamiento de las dos regiones.

Durante un breve período en el Cretácico Inferior, América del Sur y del Norte estuvieron separadas por una franja de mar. Tal vez para el Aptiano-Albiano (Cretácico Medio) un arco volcánico submarino entre el sur de México, Colombia y Venezuela, proporcionó un enlace vía islas volcánicas espaciadas. Parte de ese arco fue arrojada hacia el noreste, formando las Grandes Antillas. Las Grandes Antillas entonces quedaron más cerca de Norteamérica vía Yucatán y la colisión con la Florida. América Central creció submarinamente en el sur de Norteamérica como un complejo arco volcánico, que eventualmente constituyó el puente terrestre por colisión en el Plioceno.

Posteriormente la abertura entre Norte y Sudamérica se cerró en el Plioceno, por un complejo sistema que se desarrolló al sur de Norteamérica. Este arco Cretácico es de interés biogeográfico, ya que las islas volcánicas pudieron servir de puente entre las dos Américas y llevar flora y fauna hacia la presente posición de las Antillas.

Coney (1982) mencionó que si este modelo es correcto, la placa Caribeña debe haber estado casi 700 km al oeste de su posición presente, esto significa que la proto América Central estaba al sur de México y las Antillas Menores al sureste de la plataforma de Bahama.

Con base en el registro fósil hasta ahora conocido, Rzedowski (1991) menciona que las características fundamentales de la actual flora fanerogámica de México, estaban ya bien establecidas desde el Terciario Medio y muchas de ellas posiblemente desde tiempos anteriores. Tal información nos permite extrapolar que

la comunicación entre la Costa del Pacífico al sur de México y las Antillas es muy antigua y que la afinidad que se encuentra entre las floras de los dos sitios es también antigua, lo que hablaría de familias y géneros afines pero no de especies, lo cual concuerda con nuestros resultados. Las especies comunes por tanto pueden ser o especies cuyo método de dispersión sea larga distancia o bien especies pancrónicas.

Estudiando el trabajo de Sykes (1982) también para el Caribe, se ve que ya para el Eoceno las islas que ahora corresponden a las Antillas estaban muy próximas a Yucatán, al oriente de esta península, este contacto más reciente explicaría la mayor afinidad entre Yucatán y las Antillas. Al respecto Miranda (1958) encontró que muchas de las especies comunes con Cuba, están limitadas a la faja costera del norte de la península yucateca, son al parecer de introducción relativamente reciente y citó a los siguientes géneros: *Acoelorhappe*, *Cameraria*, *Coccothrinax*, *Drejerella*, *Erithalis*, *Ernodea*, *Metopium*, *Pseudophoenix*, *Rachicallis*, *Strumfia* y *Thrinax*, todos ellos ausentes en la costa de Guerrero.

Es probable que los estudios acerca de la historia geológica sigan afinándose en el futuro cercano, también es posible que la información de distribución geográfica de organismos en la región corrobore o ponga a prueba las propuestas geológicas. En las áreas estudiadas se observa a nivel de familia y de género que el elemento tropical es el mejor representado, por otro lado es significativo que sean 259 géneros comunes a las costas de Cuba y de Guerrero, o sea el 45.6%, lo cual confirma que las áreas de estudio, al igual que el sur de México, las Antillas y parte de América Central, pertenecen a la región Caribeña, dentro del reino Neotropical (Rzedowski 1978).

Se sabe poco sobre el origen de la flora tropical, se piensa que tiene un origen sudamericano y antillano. Acerca del elemento neotropical existen pocos trabajos sobre su migración a México, Rzedowski (1978) propone que este se llevó a cabo por lo menos desde el Oligoceno, dado que el territorio mexicano emergió a fines del Mesozoico y las conexiones con Centroamérica se rompieron más de una vez durante el Cenozoico; por otro lado Went (1989) sugiere la existencia en el Mioceno de elementos con posibles afinidades sudamericanas, aún antes de que existiera el istmo de Panamá. Él mismo continúa diciendo que para el Plioceno se completó la conexión terrestre a Sudamérica y que por períodos se facilitó la expansión de la vegetación tropical de América del Sur, de tal forma que durante los últimos 10 000 años el bosque tropical húmedo se ha extendido rápidamente.

Rzedowski (1991) con el objeto de plantear una idea general sobre las afinidades geográficas de la flora fanerogámica de México, señala que su vinculación con el sur es cuatro veces más importante que con el norte y aclara que esto no significa que una mayoría de plantas mexicanas sea de derivación meridional directa, ya que deben haberse originado en México o en otras partes del mundo,

como las Antillas, África, Eurasia o Norteamérica. En especial en la zona costera de Guerrero, se presentan los siguientes géneros: *Bourreria*, *Jacquinia*, *Malpighia*, *Exostema*, *Pisonia*, *Rondeletia*, *Zamia* y *Sabal* que Rzedowski (1991) señala como de origen antillano.

El hecho de que la proporción de géneros y especies tropicales y autóctonos se modifique de un sitio a otro, depende de la latitud (Guerrero 16°19' a 18°52') y Cuba (19°4' a 23°1'), clima y suelo. Aunque los componentes florísticos sean similares, varían en la dominancia y asociaciones en los diferentes tipos de vegetación.

El elemento cosmopolita está poco representado, se considera como producto de una migración gradual, vinculado a las actividades humanas y posiblemente más reciente. Es notorio, además, que las especies que se comparten son elementos de ambientes acuáticos y subacuáticos.

En el análisis por tipo de vegetación, se observa que en la vegetación halófila de marismas, vegetación acuática y subacuática con sus variantes, son las comunidades que presentan el mayor número de elementos comunes. Comparten algunos elementos florísticos, formando patrones diferentes de asociación en la vegetación acuática emergente, bosque de galería, sabana y bosque de *Byrsonima* y *Curatella*.

Con la vegetación halófila costera se presentan diferencias en fisonomía y composición florística, no obstante que crecen en sustratos similares en ambas regiones. En cuanto al bosque tropical caducifolio, es significativo que no haya equivalente en Cuba. En el matorral xerófilo se observa cierta convergencia con el que crece en las costas de Cuba, tienen igual fisonomía y comparten un elevado número de familias y géneros, sin embargo, se desarrollan en diferentes sustratos.

En especial el bosque tropical perennifolio en la zona costera de Guerrero, se puede considerar como una vegetación relictual, por los elementos que lo componen, con dominancia de *Hymenaea* y *Manilkara* y menos abundante *Brosimum*, géneros considerados por Toledo (1982) con tolerancia ecológica amplia, dominantes en selvas marginales.

En los manglares situados al norte de la isla, como en el grupo insular Los Colorados, en su composición intervienen básicamente las mismas 4 especies de mangle que se encuentran en Guerrero, en cambio en la llanura costera de la provincia de las Tunas, también al norte, el bosque tropical perennifolio de Guerrero y su equivalente en Cuba, el bosque de ciénaga, solo comparten el género *Sabal*.

La información florística de las regiones comparadas ha permitido que se comparen las dos regiones, obteniéndose con ello un mejor entendimiento de la historia de la flora de ambos sitios: costa de Cuba y costa de Guerrero.

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REFERENCIAS

- Alain, H. (1962): *Flora de Cuba*. Vol. 5. – University of Puerto Rico, Río Piedras, 362 pp.
- Alain, H. (1969): *Suplemento de la Flora de Cuba*. – Ed. Sucre, Caracas, 150 pp.
- Álvarez, M. J. R. (1962): *Apuntes de la clase de Geología, Paleogeografía y Tectónica de México*. – 5°. Año, carrera de Ing. Geol. Fac. de Ingeniería. Univ. Nal. Autón. México. México, D. F.
- Arpi, B., González, I., Vázquez, A., Ortega, A. A. y Martínez, V. (1974): *Informe sobre la preinvestigación hidrográfica en las lagunas costeras del Estado de Guerrero*. – Centro de Ciencias del Mar y Limnología. Univ. Nal. Autón. México. México, D. F., 43 pp., 15 tablas, 48 mapas.
- Balátová-Tulácková, E. y García, E. E. (1985): Contribución acerca de las comunidades secundarias de gramíneas en Cuba. – *Memorias Primer Simposio de Botánica*, pp. 159–174.
- Balátová-Tulácková, E. y Surli, M. (1983): Contribution to the knowledge of some savanna and forb-rich communities of the Isla de la Juventud, Cuba. – *Folia Geobot. Phytotax.* **20**: 17–39.
- Bisse, J. (1981): *Árboles de Cuba*. – Ed. Científico-Técnica, La Habana, 384 pp.
- Borhidi, A. (1985): Phytogeographic survey of Cuba I. – *Acta Bot. Hung.* **31**: 3–34.
- Borhidi, A. (1987): The main vegetation units of Cuba. – *Acta Bot. Hung.* **33**: 151–185.
- Borhidi, A. (1988): Vegetation dynamics of the savannization process of Cuba. – *Vegetatio* **77**: 177–183.
- Borhidi, A. (1991): *Phytogeography and vegetation ecology of Cuba*. – Akadémiai Kiadó, Budapest, 858 pp.
- Borhidi, A. y Fernández, M. (1982): Studies in Rondeletieae II. A new genus: *Suberanthus*. – *Acta Bot. Hung.* **28**: 313–316.
- Borhidi, A. y Fernández, M. (1983): Revisión del género *Machaonia* en Cuba. – *Acta Bot. Hung.* **29**: 396–412.
- Borhidi, A. y Herrera, R. (1977): Génesis, características y clasificación de los ecosistemas de sabana en Cuba. – *Cien. Biol. Acad. Cien. Cuba* **1**: 115–130.
- Borhidi, A. y Muñiz, O. (1971): New plants in Cuba I. – *Acta Bot. Hung.* **17**: 1–36.
- Borhidi, A. y Muñiz, O. (1980): Die Vegetationskarte von Kuba. – *Acta Bot. Hung.* **26**: 25–53.
- Borhidi, A. y Muñiz, O. (1984): *Mapa de Vegetación Potencial de Cuba*. – Imp. Inceplan, Habana, Cuba, pp. 1–45.
- Borhidi, A. y Muñiz, O. (1986): The phytogeographic survey of Cuba II. – *Acta Bot. Hung.* **32**: 3–48.
- Borhidi, A., Muñiz, O. y Del Risco, E. (1979): Clasificación fitocenológica de la vegetación de Cuba. – *Acta Bot. Hung.* **25**: 263–301.
- Borhidi, A., Muñiz, O. y Del Risco, E. (1983): Plant communities of Cuba, I. Fresh and salt water, swamp and coastal vegetation. – *Acta Bot. Hung.* **29**: 337–376.
- Capote, R. y Berazaín, R. (1984): Clasificación de las formaciones vegetales de Cuba. – *Rev. J. Bot. Nac.* **5**(2): 1–49.
- Capote, R. et al. (1987): Flora y Vegetación de la zona costera entre Daiquirí y Verraco, Parque Baconao, Santiago de Cuba. – *Acta Bot. Cub.* **48**: 1–28.
- Castilla, R. et al. (1985): Comparación de la flora y la vegetación de dos zonas xerófitas del Parque Baconao. – *Memorias Primer Simposio de Botánica*, pp. 99–110.

- Chiappy, C. *et al.* (1985): Algunos aspectos de la flora y vegetación de Cayo Caguanes, provincia Sancti-Spíritus, Cuba. – *Memorias Primer Simposio de Botánica*, pp. 59–98.
- Chiappy, C. *et al.* (1988): Aspectos botánicos y valores para la conservación de la naturaleza de la llanura costera del norte de la provincia de Las Tunas, Cuba. – *Acta Bot. Cub.* **69**: 1–8.
- Citrón, G. y Goenaga, C. (1979): Observaciones sobre el desarrollo del manglar en costas áridas. Estudio científico e impacto humano en el ecosistema de manglares. – *Informes de la Unesco sobre Ciencias del Mar*. Cali, Colombia, pp. 25–26.
- Coney, P. J. (1982): Plate Tectonic constraints on the biogeography of Middle America and the Caribbean Region. – *Ann. Missouri Bot. Gard.* **69**: 432–443.
- Cronquist, A. (1981): *An integrated system of classification of flowering plants*. – Columbia University Press, New York, 1261 pp.
- Diego, N. y Lozada, L. (1994): *Laguna Tres Palos*. – Estudios Florísticos en Guerrero, No. 1, UNAM, México, 29 pp.
- Figueroa de Cotín, E. (1980): *Atlas geográfico e histórico del Estado de Guerrero, México*. – 171 pp.
- Fonseca, R. M. y Lozada, L. (1993): *Laguna de Coyuca*. – Estudios Florísticos en Guerrero, No. 1, UNAM, México, 23 pp.
- García, E. (1988): *Modificaciones al sistema de clasificación climática de Köppen, para adaptarlo a las condiciones climáticas de la República Mexicana*. – Instituto de Geografía, Univ. Nal. Autón. México, México, D. F.
- García, E. *et al.* (1985): Flora y vegetación del área de Morrillo Chico, Santiago de Cuba. – *Memorias Primer Simposio de Botánica*, La Habana, Cuba, pp. 1–24.
- Good, R. (1964): *The geography of the flowering plants*. – Longmans Green and Co.
- León, H. (1946): Flora de Cuba. – *Contrib. Ocas. Mus. Hist. Nat. Colegio de la Salle* **8**(1): 441 pp.
- León, H. y Alain, H. (1951): Flora de Cuba. – *Contrib. Ocas. Mus. Hist. Nat. Colegio de la Salle* **10**(2): 456 pp.
- León, H. y Alain, H. (1953): Flora de Cuba. – *Contrib. Ocas. Mus. Hist. Nat. Colegio de la Salle* **13**(3): 502 pp.
- León, H. y Alain, H. (1957): Flora de Cuba. – *Contrib. Ocas. Mus. Hist. Nat. Colegio de la Salle* **16**(4): 556 pp.
- León, H. y Alain, H. (1974): *Flora de Cuba*. – Instituto Cubano del Libro, La Habana, suplemento, 150 pp.
- Lot, A. (1991): *Vegetación y Flora Vascular Acuática del Estado de Veracruz*. – Tesis doctoral. Facultad de Ciencias, Univ. Nal. Autón. México, México, D. F.
- Lozada, L. (1994): *Laguna de Milla*. – Estudios Florísticos en Guerrero, No. 2, UNAM, México, 44 pp.
- Menéndez, L. (1987): Flora y Vegetación de la cayería del norte de Matanzas, Cuba. – *Acta Bot. Cub.* **39**: 1–20.
- Menéndez, L. *et al.* (1989): Nuevas asociaciones en cayos al norte de Matanzas, Cuba. – *Acta Bot. Cub.* **80**: 1–10.
- Miranda, F. (1958): *Estudio acerca de la vegetación*. – In: Los Recursos Naturales del Sureste y su aprovechamiento. Ed. Inst. Mex. Rec. Nat. Renov. México, D. F.
- Muñiz, O. y Borhidi, A. (1982): Catálogo de las palmas de Cuba. – *Acta Bot. Hung.* **28**: 309–345.
- Oviedo, R. *et al.* (1988): Flora del Valle del Río Cojímar, Provincia Ciudad de la Habana, – *Acta Bot. Cub.* **73**: 1–17.
- Pérez Carreras, E. *et al.* (1992): Flora y vegetación de la zona costera de los municipios Sierra de Cubitas y Minas, Camagüey, Cuba. – *Acta Bot. Cub.* **87**: 1–26.
- Ricardo, N. *et al.* (1985): Contribución al estudio de las comunidades ruderales. – *Memorias Primer Simposio de Botánica*, pp. 127–136.

- Rosen, D. E. (1985): Geological hierarchies and biogeographic congruence in the Caribbean. – *Ann. Missouri Bot. Gard.* **72**: 636–659.
- Rzedowski, J. (1978): *Vegetación de México*. – Limusa, México.
- Rzedowski, J. (1991): Diversidad y orígenes de la flora fanerogámica de México. – *Acta Bot. Mexicana* **14**: 3–21.
- Samek, V. (1973a): Regiones fitogeográficas de Cuba. – *Acad. Cien. Cuba*, ser. Forestal, **15**: 1–60.
- Samek, V. (1973b): La vegetación costera de la provincia Habana. – *Acad. Cien. Cuba*, ser. Forestal, **16**: 1–48.
- Standley, P. C. (1936): Las relaciones geográficas de la Flora Mexicana. – *Ann. Inst. Biol. Mex.* **7**: 9–16.
- Standley, P. C. y Steyermark, J. A. (1958–1976): Flora of Guatemala. – *Fieldiana* **24**(I–XII).
- Sykes, L. R. *et al.* (1982): Motion of Caribbean plate during last 7 million years and implications for earlier Cenozoic movements. – *J. Geophys. Res.* **87**: 10656–10676.
- Takhtajan, A. (1969): *Flowering plants. Origin and dispersal*. – Smithsonian Institution Press, Washington, D.C.
- Toledo, V. M. (1982): *Pleistocene changes of vegetation in tropical Mexico*. – In: Prance, G. T. (ed.): Biological diversification in the Tropics. Columbia Univ. Press, New York, pp. 93–111.
- Villamajó, D. y Menéndez, L. (1987): Flora y vegetación del grupo insular Los Colorados, Cuba. – *Acta Bot. Cub.* **38**: 1–14.
- Villamajó, D. *et al.* (1987): La vegetación entre Herradura y Bacunayagua, costa norte de la Provincia de La Habana, Cuba. – *Acta Bot. Cub.* **49**: 1–15.
- Went, T. (1989): Las selvas de Uxpanapa, Veracruz-Oaxaca, México: Evidencia de refugios florísticos Cenozoicos. – *Ann. Inst. Biol. Mex.*, UNAM, Ser. Bot. (Núm. único) **58**: 29–54.
- Willis, J. C. (1973): *A dictionary of the flowering plants and ferns*. – Cambridge University Press, Cambridge.

Apéndice I

Lista de especies

ACANTHACEAE

- Aphelandra aurantiaca* (Scheidw.) Lindl. – G
- Aphelandra deppeana* Schldtl. et Cham. – G
- Baleriola solanifolia* (L.) Oerst. – C
- Baleriola satirejoides* (Griseb.) Maza. – C
- Barleria micans* Nees – G
- Blechum brownei* Juss. – G, C
- Bravaisia integerrima* (Spreng.) Standl. – G
- Carlowrightia arizonica* A. Gray – G
- Dicliptera resurpinata* (Vahl) Pers. – G
- Elytraria bromoides* Oerst. – G
- Elytraria imbricata* (Vahl) Pers. – G
- Henrya insularis* Nees – G
- Justicia campechiana* Standl. – G
- Justicia corynimorpha* D. N. Gibson – G
- Justicia furcata* Schldtl. – G
- Justicia multicaulis* Donn. Sm. – G
- Justicia pringlei* Robins. – G
- Odontonema callistachyum* (Schldtl. et Cham.) Kuntze – G
- Oplonia cubensis* Borhidi – C
- Oplonia polyce* (Stearn) Borhidi – C
- Oplonia tetrastichia* (W. ex Griseb.) Stearn – C
- Ruellia albiflora* Fernald – G
- Ruellia foetida* Willd. – C
- Ruellia* aff. *hookeriana* (Nees) Hemsl. – G
- Ruellia inundata* Kunth – G
- Ruellia nudiflora* (Engelm. et A. Gray) Urb. – G, C
- Ruellia paniculata* L. – G, C
- Ruellia* sp. – G
- Stenandrium pedunculatum* (J. D. Smith) Leonard – G
- Tetramerium nervosum* Nees – G

ACHATOCARPACEAE

Achatocarpus nigricans Triana – G

ADIANTACEAE

Pellaea sp.

AGAVACEAE

Agave albescens Trel. – C
Agave brachystachys (Cav.) Rose – G
Agave legrelliana Jacobi – C
Agave underwoodii Trel. – C
Agave sp. – G
Furcraea macrophylla Baker – C

AIZOACEAE

Sesuvium portulacastrum L. – G, C
Sesuvium maritimum (Walter) Britton – C
Trianthema portulacastrum L. – G, C

ALISMATACEAE

Echinodorus andrieuxii (Hook. et Arn.) Small – G
Echinodorus grandiflorus (Cham. et Schltdl.) Micheli – G, C
Echinodorus ovalis Wr. ex Souy – C
Echinodorus nymphaefolius (Griseb.) Buch. – C
Echinodorus tenellus (Mart.) Buch. – G, C
Lophotocarpus guayanensis (Kunth) J. G. Smith – G
Sagittaria lancifolia L. – G, C

AMARANTHACEAE

Achyranthes aspera L. – G, C
Achyranthes indica (L.) Miller – G, C
Alternanthera ficoidea (L.) R. Br. – C
Alternanthera repens (L.) Kuntze – G, C
Alternanthera paronychioides St. Hil. – C
Alternanthera sp. – C
Amaranthus australis (A. Gray) J. D. Sauer – C

Amaranthus caudatus L. – G, C
Amaranthus dubius Mart. – G, C
Amaranthus hybridus L. – G, C
Amaranthus lepturus Blake – G
Amaranthus polygonoides L. – G, C
Amaranthus scariosus Benth. – G
Amaranthus spinosus L. – G, C
Celosia nitida Vahl – G, C
Chamissoa altissima (Jacq.) Kunth – G, C
Chamissoa macrocarpa Kunth – G
Gomphrena decumbens Jacq. – G, C
Gomphrena dispersa Standl. – G, C
Gomphrena hispida Willd. – G
Gomphrena nana (Stuebel) Standl. – G
Iresine angustifolia Euphrasen – G, C
Iresine celosia L. – G
Iresine diffusa Willd. – C
Iresine flavescens Kunth – C
Iresine nigra Uline et Bray – G
Iresine sp. – G
Pfaffia hookeriana (Hemsl.) Greenman – G
Philoxerus vermicularis (L.) R. Br. – C

ANACARDIACEAE

Anacardium occidentale L. – G, C
Astronium graveolens Jacq. – G
Comocladia dentata Jacq. – C
Comocladia engleriana Loes – G
Comocladia palmeri Rose – G
Comocladia platyphylla A. Rich. – C
Metopium brownei (Jacq.) Urb. – C
Metopium toxiferum (L.) Krug et Urb. – C
Pistacia mexicana Kunth – G
Rhus terebinthifolia Schltdl. et Cham. – G
Spondias mombin L. – G
Spondias purpurea L. – G

ANNONACEAE

Annona cherimola Mill. – G
Annona diversifolia Saff. – G
Annona glabra L. – G, C
Annona havanensis R. E. Fries – C
Annona muricata L. – G, C
Annona primigenia Standl. et Steyererm. – G
Annona reticulata L. – G
Annona squamosa L. – G, C

Cymbopetalum stenophyllum Donn. Sm. – G
Oxandra lanceolata (Sw.) Baill. – G
Sapranthus foetidus (Rose) Saff. – G
Xylopia obtusifolia (A. DC.) A. Rich. – C

APIACEAE

Centella erecta (L. f.) Fern. – C
Eryngium carlianae Del. f. – G
Hydrocotyle umbellifera L. – C
Hydrocotyle verticillata Thunb. – C
Oxypolis filiformis (Walt.) Britton – C
Prionosciadium thapsoides (DC.) Mathias – G

APOCYNACEAE

Aspidosperma megalocarpon Muell. Arg. – G
Beaumontia grandiflora Wall – G
Cameraria latifolia L. – C
Echites umbellata Jacq. – C
Fernaldia pandurata (A. DC.) Woodson – G
Forsteronia corymbosa (Jacq.) G. Meyer – C
Mandevilla oaxacana (A. DC.) Hemsl. – G
Mandevilla tubiflora (Martens et Galeotti)
 Woodson – G
Mesechites rosea (A. DC.) Miers – C
Neobrcea angustifolia Britton – C
Neobrcea martiana Borhidi et Muñiz – C
Plumeria filifolia Griseb. – C
Plumeria lanata Britton – C
Plumeria obtusa L. – C
Plumeria rubra L. – G
Plumeria sericifolia Wr. ex Griseb. – C
Plumeria stenophylla Urb. – C
Prestonia aff. *ipomoeaeifolia* A. DC. – G
Prestonia mexicana DC. – G
Rhabdadenia biflora (Jacq.) Muell. – C
Rauvolfia cubana A. DC. – C
Rauvolfia ligustrina Roem. et Schult. – G, C
Rauvolfia nitida Jacq. – C
Rauvolfia tetraphylla L. – G, C
Stemmadenia galeottiana (A. Rich.) Miers – G
Stemmadenia glabra Benth – G
Stemmadenia grandiflora (Jacq.) Miers – G
Stemmadenia obovata (Hook. et Arn.) Schum.
 – G
Tabernaemontana amblyocarpa Urb. – C
Tabernaemontana amygdalifolia Jacq. – G

Thevetia ovata (Cav.) A. DC. – G
Thevetia peruviana (Pers.) Schum. – G, C
Tonduzia pittieri Donn. Sm.
Urechites lutea (L.) Britton – C
Vallesia antillana Woodson – C
Vallesia mexicana Muell. Arg. – G

AQUIFOLIACEAE

Ilex cassine L. – C
Ilex ligustrina Jacq. – C

ARACEAE

Anthurium nizandense Matuda – G
Anthurium recusatum Schott. – C
Philodendrum lacerum (Jacq.) Schott. – C
Philodendrum krebsii Schott. – C
Pistia stratiotes L. – G, C
Syngonium podophyllum Schott. – G
Xanthosoma robustum Schott. – G

ARALIACEAE

Dendropanax arboreus (L.) Decne. et Planch.
 – C, G

ARECACEAE

Acoeloraphe wrightii (Griseb. et H. Wendl.) H.
 Wendl. ex Becc. – C
Acrocomia mexicana Karwinski ex Mart. – G
Bactris aff. *balanoidea* (Oerst.) Wendl. – G
Coccothrinax alexandri León – C
Coccothrinax borhidiana Muñiz – C
Coccothrinax cupularis (León) Muñiz et Bor-
 hidi – C
Coccothrinax litoralis León – C
Coccothrinax miraguama (HBK.) Becc. – C
Coccothrinax muñizii Borhidi – C
Copernicia brittonorum León – C
Copernicia glabrescens Wendl. ex Becc.
 var. *havanensis* León – C
Copernicia hospita Mart. – C
Copernicia pauciflora – C
Copernicia rigida Britton et Wilson – C

Gastrococos crista (Kunth) M. E. Moore – C
Orbignya cohune (Mart.) Dahlgren ex Standl. – G
Pseudophoenix sargentii Wendl. – C
Roystonea regia (Kunth) O. K. Cook. – C
Sabal japa Wr. ex Becc. – C
Sabal maritima Burret – C
Sabal mexicana Mart. – G
Thrinax radiata Lodd. ex Schult. – C

ARISTOLOCHIACEAE

Aristolochia glandulosa Kickx – C
Aristolochia inflata Kunth – G
Aristolochia peltata L. – C
Aristolochia pentandra Jacq. – C
Aristolochia taliscana Hook. et Arn. – C
Aristolochia tentaculata L. – G
Aristolochia tigrina A. Rich. – C
Aristolochia sp. – G

ASCLEPIADACEAE

Asclepias auriculata Kunth – G
Asclepias curassavica L. – G, C
Asclepias glaucescens Kunth – G
Asclepias nivea L. – C
Blepharodon mucronatum (Schltdl.) Decne. – G
Calotropis procera (Ait.) R. Br. – C
Cryptostegia grandiflora (Roxb.) R.Br – G, C
Cynanchum caribaeum Alain – C
Cynanchum salinarum (Wr. ex Griseb.) Alain – C
Cynanchum sp. – C
Gonolobus barbatus Kunth – G
Marsdenia clausa R. Br. – C
Marsdenia edulis S. Watson – G
Marsdenia fusca Wr. ex Griseb. – C
Marsdenia lanata (P. G. Wilson) M. D. Stevens – G
Marsdenia mexicana Decne. – G
Marsdenia trivirgulata Bartlett – G
Matelea alainii Roods. – C
Matelea quirosii (Standl.) Woodson – G
Matelea pavonii (Decne.) Woodson – G
Matelea sp. – C
Metastelma lanceolatum Schltdl. – G
Metastelma multiflorum S. Wats. – G
Sarcostemma clausum (Jacq.) Roem. et Schult. – G, C

ASTERACEAE

Ageratum conyzoides L. – C
Ageratum houstonianum Mill. – G, C
Ageratum maritimum Kunth – C
Aldama dentata La Llave et Lex. – G
Ambrosia hispida Pursh. – C
Ambrosia paniculata Michaux var. *peruviana* Willd. – C
Ambrosia velutina O. E. Schulz. – C
Aster bahamensis Britton – C
Aster bracei Britton ex Small – C
Aster exillis Ell. – C
Baccharis halimifolia L. var. *angustior* – C
Bidens laevis (L.) B. S. P. – C
Bidens pilosa L. – C
Bidens riparia Kunth – G
Borrchia arborescens (L.) DC. – C
Borrchia cubana Britton et Blake – C
Conyza bonariensis (L.) Cronquist – G, C
Dyssodia aurantia (L.) Robins. – G
Eclipta alba (L.) Hassk. – C
Eclipta prostrata (L.) L. – G
Egletes viscosa (L.) Less. – G, C
Emilia sonchifolia (L.) DC. – C
Enydra sesiles (Sw.) DC. – C
Eupatorium capillifolium (Lam.) Small – C
Eupatorium coelestinum L. – C
Eupatorium glaberrimum DC. – C
Eupatorium havanense Kunth – C
Eupatorium leucocephalum Benth. – G
Eupatorium litorale Alain – C
Eupatorium odoratum L. – G, C
Eupatorium villosum Sw. – C
Flaveria linearis Lag. – C
Flaveria trinervia (Spreng.) C. Mohr. – C
Gochnatia calcicola (Britton) Jervis et Alain – C
Gochnatia elliptica (León) Alain var. *elliptica* – C
Gochnatia ilicifolia Less. – C
Gochnatia microcephala (Griseb.) Jervis et Alain – C
Gochnatia sagraeana Jervis et Alain – C
Heliopsis buphthalmoides (Jacq.) Dunal – G
Hymenostephium sp. – G
Isocarpha atriplicifolia (L.) R. Br. – G
Isocarpha glabrata Blake – C
Isocarpha oppositifolia (L.) R. Br. – C
Iva cheirantifolia Kunth – C
Iva imbricata Walt. – C

Jaumea mexicana Benth. et Hook. ex Hemsl.
– G

Lasiantha helianthoides DC. – G

Melampodium americanum L. – G

Melampodium divaricatum (L. Rich. ex Pers.)
DC. – G, C

Melampodium longipilum Rob. – G

Melampodium microcephalum Less. – G

Melampodium paniculatum Gardner – G

Melanthera deltoidea L. C. Rioch ex Michx.
– C

Mikania cordifolia (L. f.) Willd. – G, C

Mikania crispiflora Wr. ex Sauv. – C

Mikania micrantha Kunth – C

Mikania ranunculifolia A. Rich. – C

Pectis arenaria Benth. – G

Pectis caymanensis (Urb.) Rydb. – C

Pectis ciliaris L. – C

Pectis cubensis (A. Rich.) Griseb. – C

Pectis domingensis Urb. – C

Pectis floribunda A. Rich. – C

Pectis multiflosculosa (DC.) Sch. Bip. – G

Pectis saturejoides (Mill.) Sch. Bip. – G

Pluchea carolinensis (Jacq.) G. Don – C

Pluchea purpurascens Sw. – G, C

Pluchea rosea Godfrey – C

Polymnia maculata Cav. – G

Porophyllum punctatum (W. T. Mill.) Blake – G

Porophyllum ruderales var. *macrocephalum*
(DC.) Cronquist – G, C

Pseudoconyza viscosa (P. L. Mill.) D'Arcy – G

Pseudelephantopus spicatus (Aubl.) R. Br.
– G, C

Salmea petrobioides Griseb. – C

Sclerocarpus sp. – G

Solidago sempervirens L. – C

Solidago stricta Ait. – C

Spilanthes urens Jacq. – C

Stevia ovata Willd. – G

Stuessya perennans B. L. Turner et F. Davies
– G

Synedrella nodiflora (L.) Gaertn. – G, C

Tithonia rotundifolia (W. T. Mill.) Blake – G, C

Tithonia tubaeformis (Jacq.) Cass. – G

Tridax procumbens L. – G, C

Trixis chiapensis C. Andersen – G

Trixis radialis (L.) Kuntze – G

Verbesina alata L. – C

Verbesina angulata Urb. – C

Verbesina sp. – G

Vernonia complicata Griseb. – C

Vernonia corallophila Gleas – C

Vernonia deppeana Less. – C

Vernonia gnaphaliifolia A. Rich. – C

Vernonia menthaefolia (Poepp. ex Spreng.)
Less. – C

Viguiera dentata (Cav.) Spreng – C

Wedelia acapulcensis Kunth – G

Wedelia gracilis L. C. Rich. – G

Wedelia trilobata (L.) Hitch. – G, C

Zinnia americana (P. L. Mill.) Olorode et
Torres – G

Zinnia flavicoma (DC.) Olorode et Torres – G

Zinnia elegans Jacq. – G

Zinnia maritima Kunth – G

AZOLLACEAE

Azolla caroliniana Willd. – G, C

BASELLACEAE

Anredera vesicaria (Lamb.) Gaertner f. – G

BATIDACEAE

Batis maritima L. – G, C

BEGONIACEAE

Begonia palmeri S. Watson – G

Begonia uruapensis Sesse et Moçino – G

BIGNONIACEAE

Adenocalymma fissum Loes. – G

Adenocalymma inundatum Mart. ex DC. – G

Anemopaegma chrysoleucum (Kunth) Sandw.
– G

Arrabidaea litoralis (Kunth) Standl. – G

Astianthus viminalis (Kunth) Baill. – G

Clytostoma binatum (Thunb.) Sandw. – G

Crescentia alata Kunth – G

Crescentia cujete L. – G, C

Crescentia mirabilis Ekm. ex Urb. – C

- Cydista aequinoctialis* (L.) Miers var. *hirtella* (Benth.) A. Gentry – G, C
Cydista diversifolia (Kunth) Miers – G, C
Cydista heterophylla Seibert – G
Distictis gnaphalanthia (A. Rich.) Urb. – C
Enallagma latifolia (Mill.) Small – C
Macfadyena unguis-cati (L.) A. Gentry – C
Macrocatalpa punctata Griseb. – C
Macrocatalpa purpurea Britton – C
Neomacfadya podopogon (DC.) Baill. – C
Paragonia pyramidata (L. C. Rich.) W. A. Burm. – G
Parmentiera aculeata (Kunth) Seem. – G
Pithecoctenium echinatum (Aubl.) K. Schum. – C, G
Spathodea campanulata P. Beauv. – G
Tabebuia angustata Britton – C
Tabebuia capotei Borhidi – C
Tabebuia leptoneura Urb. – C
Tabebuia libanensis Urb. – C
Tabebuia myrtifolia (Griseb.) Urb. – C
Tabebuia petrophila Greenman – C
Tabebuia polymorpha Urb. – C
Tabebuia rosea (Bertol.) A. DC. – G
Tabebuia shaferi Britton – C
Tabebuia trachycarpa (Griseb.) K. Schum. – C
Tecoma stans (L.) Juss. ex Kunth – G, C
- BIXACEAE**
- Amoreuxia palmatifida* (DC.) Moc. et Sessé – G
Bixa orellana L. – G, C
Cochlospermum vitifolium (Willd.) Spreng. – G, C
- BOMBACACEAE**
- Ceiba pentandra* (L.) Gaertner – G, C
Pachira aquatica Aublet – G
Pseudobombax ellipticum (Kunth) Dugand – G
- BORAGINACEAE**
- Bourreria cuneifolia* O.E. Schulz – C
Bourreria hintonii I. M. Johnston – G
Bourreria mollis Standl. – G
Bourreria obovata Eastman – G, C
Bourreria ovata Miers – C
Bourreria succulenta Jacq. var. *succulenta* – C
Bourreria sp. – G
Cordia alliodora (Ruiz et Pavón) Oken – G, C
Cordia boissieri A. DC. – G
Cordia collococca L. – G, C
Cordia coyucana J. D. Mill. – G
Cordia dentata Poir. – G, C
Cordia dodecandra A. DC. – G, C
Cordia dumosa Alain – C
Cordia elaeagnoides DC. – G
Cordia foliosa Martens et Galeotti – G
Cordia galeottiana Rich. – C
Cordia gerascanthus L. – G, C
Cordia globosa (Jacq.) Kunth subsp. *humilis* (Jacq.) Borhidi – C
Cordia inermis (Miller) I. M. Johnston – G
Cordia leucosebestena Griseb. – C
Cordia microsebestena Loes. – G
Cordia nitida Vahl – C
Cordia oaxacana A. DC. – G
Cordia pulverulenta (Urb.) Alain – C
Cordia salvadorensis Standl. – G
Cordia sebestena L. – C
Cordia seleriana Fernald – G
Ehretia tinifolia L. – G, C
Heliotropium angiospermum Murray – G, C
Heliotropium curassavicum L. – G, C
Heliotropium fruticosum L. – G, C
Heliotropium humifusum Kunth – C
Heliotropium hypogaeum Urb. – C
Heliotropium indicum L. – G, C
Heliotropium lagoense (Warm.) Garcke – G
Heliotropium microphyllum Sw. – C
Heliotropium myriophyllum Urb. – C
Heliotropium pringlei Robins. – G
Heliotropium procumbens J. D. Mill. – G, C
Rochefortia cubensis Britton et Wilson – C
Rochefortia stellata Britton et Wilson – C
Tournefortia acutiflora Martens et Galeotti – G
Tournefortia glabra L. – G, C
Tournefortia gnaphaloides (L.) Br. – C
Tournefortia hirsutissima L. – G, C
Tournefortia hirsutissima L. f. *bicolor* (Sw.) D. Nash – G
Tournefortia polyochros Spreng. – C
Tournefortia scabra Lam. – C
Tournefortia stenophylla Urb. – C
Tournefortia volubilis L. – G, C

BRASSICACEAE

- Cakile lanceolata* (Willd.) O. E. Schulz. – C
Lepidium virginicum L. – C

BROMELIACEAE

- Bromelia pinguin* L. – G, C
Catopsis floribunda L. B. Smith – C
Guzmania monostachya (L.) Rusby ex Mez. – C
Hohenbergia penduliflora (A. Rich.) Mez. – C
Pitcairnia macrochlamys Mez. – G
Tillandsia argentea Griseb. – C
Tillandsia balbisiana Schult. – C
Tillandsia bulbosa Hook. – C
Tillandsia circinata Schldtl. – C
Tillandsia dasylyriifolia Baker – G
Tillandsia fasciculata Sw. – G, C
Tillandsia flexuosa Sw. – C
Tillandsia paucifolia Baker – G
Tillandsia pruinosa Sw. – C
Tillandsia recurvata L. – G, C
Tillandsia usneoides L. – C
Tillandsia valenzuelana A. Rich. – C

BURSERACEAE

- Bursera arborea* (Rose) Riley – G
Bursera discolor Rzed. – G
Bursera excelsa (Kunth) Engl. – G
Bursera glauca Griseb. – C
Bursera inaguensis Britton – C
Bursera instabilis McVaugh et Rzed. – G
Bursera longipes (Rose) Standl. – G
Bursera schlechtendalii Engl. – G
Bursera simarouba (L.) Sarg. – G, C

BUXACEAE

- Buxus acunae* Borhidi – C
Buxus bahamensis Baker – C
Buxus glomerata Muell. Arg. – C

CABOMBACEAE

- Cabomba* sp. – C

CACTACEAE

- Acanthocereus occidentalis* Britton et Rose
 – G
Acanthocereus pentagonus Britton et Rose
 – G, C
Cephalocereus guerreronis (Backeb.) Buxb.
 – G
Consolea macracantha (Griseb.) Berger – C
Consolea millspaughii (Britton) Berger – C
Cylindropuntia hystrix (Lehm.) Griseb. – C
Dendrocereus nudiflorus (Engelm.) Britton et
 Rose – C
Harrisia eriophora (Pfeifer) Britton et Rose
 – C
Harrisia taetra Areces – C
Hylocereus ocamponis Salm-Dick – G
Leptocereus arboreus Britton et Rose – C
Leptocereus wrightii León – C
Mammillaria prolifera (Mill.) Haw. – C
Melocactus acunai León – C
Melocactus borhidii Mészáros – C
Melocactus evae Mészáros – C
Melocactus harlowii (Britton et Rose) – C
Neobuxbaumia multiareolata Scheinvar, Bravo
 et Sánchez Mejorada – G
Nopalea karwinskiana (Salm-Dyck) Schum.
 – G
Opuntia decumbens Salm-Dyck – G
Opuntia dillenii (Ker-Gowl.) Haw. – C
Opuntia puberula Pfeifer – G
Opuntia velutina Weber var. *velutina* – G
Opuntia wilcoxii Britton et Rose – G
Pachycereus pecten-aboriginum (Engelm.) Brit-
 ton et Rose – G
Peniocereus fosterianus Cutak var. *fosterianus*
 – G
Peniocereus maculatus (Weingart) Cutak – G
Pereskia lychnidiflora DC. – G
Pilosocereus brooksianus (Britton et Rose)
 Kunth – C
Pilosocereus collinsii (Britton et Rose) Byles
 et Rowley – C
Pilosocereus robinii Lem. – C
Rhipsalis baccifera (J. Miller) Stearn – C
Rhodocactus cubensis (Britton et Rose) Kunth
 – C
Ritterocereus hystrix Britton et Rose – C
Selenicereus grandiflorus (L.) Britton et Rose
 – C

CAESALPINIACEAE

- Bauhinia andrieuxii* Hemsl. – G
Bauhinia cumanensis Kunth – C
Bauhinia divaricata L. – G, C
Bauhinia rotundifolia Cav. – G
Bauhinia unguolata L. – G
Caesalpinia acapulcensis Standl. – G
Caesalpinia bahamensis Lam. – C
Caesalpinia bonduc (L.) Roxb. – C
Caesalpinia cacalaco Kunth – G
Caesalpinia coriaria (Jacq.) Willd. – G, C
Caesalpinia crista L. – G, C
Caesalpinia eriostachys Benth. – G
Caesalpinia major (Medic.) Dandy et Exell – C
Caesalpinia pauciflora (Griseb.) C. Wr. – C
Caesalpinia platyloba S. Watson – G
Caesalpinia pulcherrima (L.) Sw. – G
Caesalpinia sclerocarpa Standl. – G
Caesalpinia velutina (Britton et Rose) Standl. – G
Caesalpinia vescicaria L. – C
Caesalpinia violacea (G. S. Mill.) Standl. – G, C
Cassia bahamensis Mill – C
Cassia lineata Sw. – C
Chamaecrista diphylla (L.) E. Greene – G, C
Chamaecrista flexuosa (L.) E. Greene – G, C
Chamaecrista hispidula (Vahl) Irwin et Barneby – G, C
Chamaecrista nictitans Moench – G, C
Chamaecrista rotundifolia (Pers.) Greene – G, C
Cynometra cubensis A. Rich. – C
Cynometra oaxacana Brandegee – G
Haematoxylum brasiletto Karst. – G
Haematoxylum campechianum L. – C
Hymenaea courbaril L. – G, C
Hymenaea torrei León – C
Parkinsonia aculeata L. – G, C
Pelthophorum adnatum Griseb. – C
Poeppigia procera C. Presl – G, C
Senna atomaria (L.) Irwin et Barneby – G
Senna emarginata (L.) Irwin et Barneby – C
Senna fruticosa (Mill.) Irwin et Barneby – G
Senna holwayana (Rose) Irwin et Barneby – G
Senna ligustrina (L.) Irwin et Barneby – C
Senna mollissima var. *glabrata* (Benth.) Irwin et Barneby – G
Senna obtusifolia (L.) Irwin et Barneby – G, C

- Senna occidentalis* (L.) Irwin et Barneby – G, C
Senna pallida (Vahl) Irwin et Barneby – G
Senna papillosa (Britton et Rose) Irwin et Barneby – G
Senna pendula var. *ovalifolia* Irwin et Barneby – G
Senna skinneri (Benth.) Irwin et Barneby – G
Senna spectabilis (DC.) Irwin et Barneby var. *spectabilis* – C
Senna stenophylla (Benth.) Irwin et Barneby – G
Senna uniflora (Willd.) Irwin et Barneby – G, C

CAMPANULACEAE

- Hippobroma longiflora* (L.) G. Don – G, C
Sphenoclea zeylonica Gaertn. – G, C

CANELLACEAE

- Canella winterana* (L.) Gaertn. – C

CANNACEAE

- Canna edulis* Gaertn. – G

CAPPARACEAE

- Capparis asperifolia* J. Presl – G
Capparis baducca L. – G, C
Capparis cynophallophora L. – C
Capparis ferruginea L. – C
Capparis flexuosa L. – G, C
Capparis grisebachii Eichl. in Mart. – C
Capparis incana Kunth – G
Capparis pachaca Kunth subsp. *oxiseipala* (Wright ex Radlk.) Iltis – G
Cleome gynandra L. – G, C
Cleome hemsleyana (Bullock) Iltis – G
Cleome pilosa Benth. – G
Cleome serrata Jacq. – G, C
Cleome spinosa Jacq. – C
Cleome viscosa L. – G, C

Crataeva tapia L. – G
Forchhammeria pallida Liebm. – G
Forchhammeria trifoliata Radlk. – C
Morisonia americana L. – G
Polanisia viscosa (L.) DC. – G

CARICACEAE

Jacaratia mexicana (A. DC.) L. – G

CELASTRACEAE

Cassine cubensis (Bisse) Borhidi – C
Crossopetalum aquifolium (Griseb.) A. S.
 Hitchc. – C
Crossopetalum rhacoma Crantz – C
Crossopetalum rostratum (Urb.) Rothm.
 – C
Cuervea integrifolia (A. Rich.) A. C. Sm.
 – C
Elaeodendron trichotomum (Turcz.) Lundell
 – G
Gyminda latifolia (Sw.) Urb. – C
Gyminda orbicularis Borhidi et Muñiz – C
Maytenus buxifolia (A. Rich.) Griseb. – C
Maytenus cochlearifolius Griseb. – C
Maytenus elaeodendroides Griseb. – C
Maytenus lineata Wr. – C
Rhacoma puberula (Lundell) Standl. et
 Steyerl. – G
Schaefferia frutescens Jacq. – C

CERATOPHYLLACEAE

Ceratophyllum demersum L. – G
Ceratophyllum echinatum A. Gray – G

CHENOPODIACEAE

Atriplex pentandra (Jacq.) Standl.
 – C
Chenopodium sp. – G
Salicornia bigelovii Torr. – C
Salicornia perennis Mill. – C
Salicornia sp. – G
Suaeda linearis (Ell.) Moq. – C

CHRYSOBALANACEAE

Chrysobalanus icaco L. – G, C
Couepia polyandra (Kunth) Rose – G
Licania arborea Seem. – G

CLUSIACEAE

Calophyllum brasiliense Camb. – G
Calophyllum antillanum Britton – C
Clusia rosea Jacq. – C
Rheedia aristata Griseb. – C
Rheedia edulis Triana et Planch. – G

COMBRETACEAE

Bucida buceras L. – C
Bucida palustris Borhidi et Muñiz – C
Bucida spinosa Jennings – C
Buchavia capitata (Vahl) Eichl. – C
Combretum farinosum Kunth – G
Combretum fruticosum (Loef.) Stuntz – G
Conocarpus erecta L. – G, C
Laguncularia racemosa (L.) Gaertn. – G, C
Terminalia neglecta Bisse – C

COMMELINACEAE

Commelina coelestis Willd. – G
Commelina erecta L. – G, C
Commelina erecta L. var. *angustifolia*
 (Michx.) Fernald – G, C

CONNARACEAE

Rourea schippii Standl. – G
Rourea glabra Kunth – G, C

CONVOLVULACEAE

Aniseia martinicensis (Jacq.) Choisy – G, C
Evolvulus alsinoides (L.) L. – G, C
Evolvulus arbuscula Poir. – C
Evolvulus nummularius (L.) L. – G, C
Evolvulus ovatus Fernald – G

Evolvulus sericeus Sw. – G, C
Exogonium bracteatum (Cav.) Choisy – G
Ipomoea acuminata (Vahl) Roem. et Schult. – C
Ipomoea aquatica Forssk. – C
Ipomoea aristolochifolia (Kunth) G. Don – G
Ipomoea asarifolia (Desr.) Rose et Standl. – C
Ipomoea costellata Torr. – G
Ipomoea fistulosa Mart. – G
Ipomoea hederifolia L. – G
Ipomoea indica (Burm. f.) Merr. – G
Ipomoea leucotricha Donn. Sm. – G
Ipomoea minutiflora (Martens et Galeotti) House – G
Ipomoea pauciflora Martens et Galeotti – G
Ipomoea perplexa L. – G
Ipomoea pes-caprae (L.) R. Br. – G, C
Ipomoea quamoclit L. – G
Ipomoea sagittata Lam. – C – C
Ipomoea signata House – G
Ipomoea silvicola House – G
Ipomoea stolonifera (Cyrill) Gmelin – G, C
Ipomoea tiliacea (Willd.) Choisy – C
Ipomoea trifida (Kunth) G. Don – G, C
Ipomoea triloba L. – G, C
Ipomoea tuba (Schltdl.) G. Don – C
Ipomoea sp. – G
Jacquemontia azurea (Desr.) Choisy – G
Jacquemontia havanensis (Jacq.) Urb. – C
Jacquemontia hirtiflora (Martens et Galeotti) O'Donnell – G
Jacquemontia jamaicensis (Jacq.) Hall. f. – C
Jacquemontia mexicana (Loes.) Standl. – G
Jacquemontia nodiflora (Ders.) G. Don – G, C
Jacquemontia tamnifolia (L.) Griseb. – G, C
Merremia aegyptia (L.) Urb. – G, C
Merremia dissecta (Jacq.) Hallier – G, C
Merremia quinquefolia (L.) Hallier f. – G, C
Merremia umbellata (L.) Hallier f. – G, C
Operculina pinnatifida (Kunth) O'Donnell – G
Operculina pteripes (G. Don) O'Donnell – G
Turbina corymbosa (L.) Raf. – G, C

CUCURBITACEAE

Anguria pedata (L.) Jacq. – C
Cayaponia racemosa (Miller) Cogn. – C
Cionosicyos macranthus (Pittier) C. Jeffrey – G
Cucurbita radicans Naud. – G
Cyclanthera pedata (L.) Schrader – G

Echinopepon paniculatus (Cogn.) Dieterle – G
Luffa cylindrica (L.) Roem. – G
Luffa operculata (L.) Cogn. – G
Melothria guadalupensis (Spreng.) Congn. – C
Melothria pendula L. – G, C
Melothria trilobata Cogn. – G
Momordica charantia L. – G, C
Schizocarpum reflexum Rose – G

CUSCUTACEAE

Cuscuta americana L. – C
Cuscuta campestris Yunc. – G, C
Cuscuta corymbosa Ruiz et Pavón var. *grandiflora* Engelm. – G
Cuscuta costaricensis Yunc. – G
Cuscuta globulosa Benth. – C
Cuscuta obtusiflora Kunth var. *glandulosa* Engelm. – C
Cuscuta saccharata (Engelm.) Yunc. – G

CYCADACEAE

Zamia loddigesii Miq. – G
Zamia aff. *pygmaea* Sims. emend. Schust. – C

CYPERACEAE

Bulbostylis capillaris (L.) Clarke – G, C
Bulbostylis pubescens (J. Presl et C. Presl) Svenson – G
Cladium jamaicense Crantz – C
Cyperus alternifolius L. – C
Cyperus amabilis Vahl – G
Cyperus articulatus L. – G, C
Cyperus ciliatus Jungh – G
Cyperus compressus L. – G, C
Cyperus digitatus Roxb. – G, C
Cyperus eggersii Boeck. – G, C
Cyperus elegans L. – G, C
Cyperus esculentus L. – G, C
Cyperus flavicomus Michx. – G
Cyperus fugax Liebm. – G
Cyperus giganteus Vahl – C
Cyperus hermaphroditus (Jacq.) Standl. – G
Cyperus laxus Lam. – G
Cyperus ligularis L. – G, C

Cyperus luzulae (L.) Retz. – G
Cyperus odoratus L. – G, C
Cyperus oxylepis Nees – G
Cyperus pallens (Liebm.) Standl. et Steyermark. – G
Cyperus panamensis (C. B. Clarke) Britton ex Standl. – G
Cyperus polystachyos Rottb. – G
Cyperus rotundus L. – G, C
Cyperus surinamensis Rottb. – G, C
Cyperus tenerrimus J. Presl et C. Presl – G
Cyperus tenuis Sw. – G
Eleocharis cellulosa Torrey – C
Eleocharis elegans (Kunth) Roem. et Schult. – G, C
Eleocharis filiculmis Kunth – G
Eleocharis geniculata Roem. et Schult. – G, C
Eleocharis interstincta (Vahl) Roem. et Schult. – C
Eleocharis minima Kunth – G, C
Eleocharis mutata (L.) Roem. et Schult. – G, C
Fimbristylis autumnalis (L.) Roem. et Schult. – G
Fimbristylis castanea (Michx.) Vahl – G, C
Fimbristylis cymosa R. Br. – G, C
Fimbristylis dichotoma (L.) Vahl – G, C
Fimbristylis litoralis Gaudich. – G, C
Fimbristylis pallidula Kral – G
Fimbristylis spadicea (L.) Vahl – G, C
Fuirena breviseta Coville – C
Fuirena umbellata Rottb. – C
Lipocarpha micrantha (Vahl) G. Tucker – G
Oxycaryum cubense Lye – G, C
Rhynchospora contracta (Nees) Raynal – G
Rhynchospora corymbosa (L.) Britton – C
Rhynchospora eximia (Nees) Boeckel – G
Rhynchospora filifolia Torr. var. *filifolia* – C
Rhynchospora globosa (Kunth) R. et S. var. *globosa* – C
Scirpus lacustris L. – G, C
Scirpus olneyi A. Gray – C
Scleria lacustris Wright – C
Scleria latifolia Sw. – G
Scleria lithosperma (L.) – G, C
Scleria melanoleuca Rch. ex Schldl. et Cham. – C
Scleria phylloptera Wright – C

DILLENIACEAE

Curatella americana L. – G

DIOSCOREACEAE

Dioscorea aguilarii Standl. et Steyermark – G
Dioscorea lobata Uline – G
Dioscorea macrostachya Benth. – G
Dioscorea remotiflora Kunth – G
Dioscorea ulinei Greenman – G
Dioscorea sp. – C
Rajania sp. – C

EBENACEAE

Diospyros acapulcensis Kunth – G
Diospyros albens (Presl) Hiern – G
Diospyros anisandra Blake – C
Diospyros crassinervis (Krug et Urb.) Standl. – C
Diospyros digyna Jacq. – G, C
Diospyros grisebachii (Hiern.) Standl. – C
Diospyros johnstoniana Standl. et Steyermark. – G
Diospyros oleonis (Britton et Wilson) Borhidi – C
Diospyros aff. *oaxacana* Standl. – G
Diospyros riojae Gómez-Pompa – G
Diospyros verae-crucis (Standl.) Standl. – G

ELAEocarpaceae

Muntingia calabura L. – G, C

ERYTHROXYLACEAE

Erythroxylum alaternifolium A. Rich. – C
Erythroxylum areolatum L. – C
Erythroxylum armatum Borhidi et Oviedo – C
Erythroxylum compactum Rose – G
Erythroxylum confusum Britton – C
Erythroxylum havanense Jacq. – G, C
Erythroxylum roigii Britton et Wilson – C
Erythroxylum rotundifolium Lunan – C
Erythroxylum spinescens A. Rich. – C

EUPHORBIACEAE

Acalypha arvensis Poepp. et Engl. – G
Acalypha coryloides Rose – G

- Acalypha cumbrae* Boiss. – G
Acalypha cuspidata Jacq. – G
Acalypha ferdinandii Hoffm. – G
Acalypha goiretii Spreng. – G
Acalypha minutiflora (Standl.) Radcliffe-Smith – G
Acalypha monostachya Cav. – G
Acalypha polystachya Jacq. – G
Acalypha schiedeana Schltld. – G
Acalypha setosa A. Rich. – G
Acalypha subviscida W. Watson – G
Acalypha trachyloba Muell. – G
Acidocroton adelioides – C
Acidocroton oligostemon Urb. – C
Adelia ricinella L. – C
Argythamnia candicans Sw. var. *serratifolia* Urb. – C
Argythamnia cubensis Britton et Wilson – C
Bernardia yucatanensis Lundell – G
Bonania acunae Borhidi – C
Bonania cubana – C
Bonania microphylla – C
Bonania spinosa – C
Caperonia castaneifolia (L.) St. Hil. – C
Caperonia cubana Pax et Hoffm. – C
Caperonia palustris (L.) St. Hil. – G, C
Chamaesyce adenoptera (Bertol.) Millsp. – C
Chamaesyce Berteriana (Balbis) Millsp. – C
Chamaesyce buxifolia (Lam.) Small – C
Chamaesyce centunculoides Millsp. – C
Chamaesyce hyssopifolia (L.) Small – C
Chamaesyce mendezi (Boiss.) Millsp. – C
Chamaesyce paredonensis Millsp. – C
Chamaesyce torralbasii (Urb.) Millsp. – C
Chascothea neopeltandra (Griseb.) Urb. – C
Cnidoscolus aconitifolius (G. S. Mill.) I. M. Johnston – G
Cnidoscolus multilobus (Pax.) I. M. Johnston – G
Cnidoscolus tubulosus (Muell. Arg.) I. M. Johnston – G
Cnidoscolus urens (L.) Arthur – G, C
Croton glandulosus L. – G, C
Croton litoralis Urb. – G, C
Croton lobatus L. – G, C
Croton lucidus L. – C
Croton micradenus Urb. – C
Croton muñizii Borhidi – C
Croton myricifolius Griseb. – C
Croton niveus Jacq. – G, C
Croton reflexifolius Kunth – G
Croton repens Schltld. – G
Croton rosmarinoides Millsp. – C
Croton sonora Torr. – G
Croton stenophyllus Griseb. – C
Croton suberosus Kunth – G
Croton sp. nov. – G
Daleschampia scandens L. – G, C
Daleschampia tiliifolia Lam. – G
Ditaxis guatemalensis (Muell.) Pax. et Hoffm. – G
Drypetes alba Poit. – C
Drypetes lateriflora (Sw.) Krug et Urb. – C
Drypetes mucronata Griseb. – C
Euphorbia brasiliensis Lam. – G
Euphorbia cassythoides Boiss. – C
Euphorbia cumbrae Boiss. – G
Euphorbia densiflora Klotzsch – G
Euphorbia dioica (Kunth) Millsp. – G
Euphorbia glomerifera (Millsp.) Wheeler – G
Euphorbia heterophylla L. – G, C
Euphorbia hirta L. – G, C
Euphorbia hyssopifolia L. – G, C
Euphorbia indivisa Tidestrom – G
Euphorbia oaxacana Robins. et Greenman – G
Euphorbia thymifolia L. – G
Euphorbia villifera Scheele – G
Grimmeodendron eglandulosum (A. Rich.) Urb. – C
Gymnathes lucida Sw. – G, C
Hippomane mancinella L. – G, C
Hura polyandra Baill. – G
Jatropha curcas L. – G, C
Jatropha cf. *ortegae* Standl. – G
Jatropha sympetala Standl. et Blake – G
Lasiocroton bahamensis Pax et Hoffm. – C
Leucocroton microphyllus (A. Rich.) Pax et Hoffm. – C
Manihot carthaginensis (Jacq.) F. Muell. – G
Manihot cf. *chlorosticta* Standl. et Goldman – G
Manihot dulcis (J. F. Gmelin) Pax. – G
Manihot ludibunda Croizat – G
Manihot rhomboidea Muell. Arg. – G
Manihot cf. *rubricaulis* – G
Manihot sp. nov. – G
Omphalea trichotoma Muell. Arg. – C
Pedilanthus tithymaloides (L.) A. Poit. – G, C
Pera bumeliaefolia Griseb. – C
Phyllanthus elsiae Urb. – G
Phyllanthus epiphyllanthus L. – C
Phyllanthus lathyroides Kunth – G

Phyllanthus niruri Schum. et Thonn. – G, C
Phyllanthus nobilis (L. f.) Muell. Arg. – G, C
Picrodendron macrocarpum (A. Rich.) Britton
 – C
Platygyne hexandra (Jacq.) Muell. Arg. – C
Ricinus communis L. – G, C
Sapium daphnoides Griseb. – C
Sapium macrocarpum Muell. Arg. – G
Savia bahamensis Britton – C
Savia sessiliflora (Sw.) Willd. – C
Securinega acidoton (L.) Fawc. et Rendle – C

FABACEAE

Aeschynomene americana L. var. *flabellata*
 Rudd – G, C
Aeschynomene fluminensis Vell. var. *tuberculata* (Griseb.) Rudd. – G, C
Aeschynomene hispida Willd. – G, C
Aeschynomene paucifoliata Micheli – G
Aeschynomene paucifoliolata Micheli – G
Aeschynomene rudis Benth – G
Aeschynomene sensitiva Sw. – G, C
Aeschynomene virginica (L.) Britton, Stearn et
 Poeggenb. – G, C
Andira inermis (W. Wright) Kunth ex DC.
 – G, C
Apoplanesia paniculata Presl – G
Ateleia gummifera (DC.) Dietr. var. *cubensis* – C
Behaimia cubensis Griseb. – C
Behaimia roigi Borhidi – C
Belairia angustifolia (Griseb.) Bisse – C
Belairia mucronata Griseb. – C
Belairia parvifolia Britton – C
Calopogonium caeruleum (Benth.) Hemsl. – C
Calopogonium mucronatum – G
Calopogonium mucunoides Desv. – G, C
Canavalia aff. brasiliensis Mart. ex Benth.
 – C, G
Canavalia nitida (Cav.) Piper – C
Canavalia obtusifolia (Sw.) DC. – G
Canavalia rosea (Sw.) DC. – G, C
Centrosema plumieri (Pers.) Benth. – G, C
Centrosema pubescens Benth. – G, C
Centrosema virginianum (L.) Benth. – G, C
Clitoria ternatea L. – G, C
Coursetia caribaea (Jacq.) Lavin – G
Coursetia glandulosa A. Gray – G
Coursetia mollis Robins. et Greenman – G
Crotalaria acapulcensis Hook. et Arn. – G
Crotalaria incana L. – G, C
Crotalaria longirostrata Hook. et Arn. – G
Crotalaria maypurensis Kunth – G, C
Crotalaria micans Link – G
Crotalaria mollicula Kunth – G
Crotalaria pumila Ortega – G, C
Dalbergia brownei (Jacq.) Urb. – C
Dalbergia congestiflora Pittier – G
Dalbergia ecastophyllum (L.) Taub. – C
Dalbergia glomerata Hemsl. – G
Dalea cliffortiana Willd. – G
Dalea foliosa (Ait.) Barneby – G
Desmodium adscendens (Sw.) DC. – G, C
Desmodium angustatum (Rose et Standl.)
 Standl. – G
Desmodium angustifolium (Kunth) DC. – G
Desmodium canum (J. F. Gmelin) Schinz et
 Thellung – G, C
Desmodium cinereum (Kunth) DC. – G
Desmodium infractum DC. – G
Desmodium procumbens (G. S. Mill.) A. S.
 Hitchc. var. *longipes* (Schind.) Schubert – G
Desmodium procumbens (G. S. Mill.) A. S.
 Hitchc. var. *procumbens* (Mill.) Hitchc. – G, C
Desmodium scorpiurus (Sw.) Desv. – G, C
Desmodium triflorum (L.) DC. – G, C
Diphysa racemosa Rose – G
Diphysa robinoides Benth. – G
Eriosema grandiflorum (Schltdl. et Cham.) G.
 Don – G
Eriosema pulchellum (Kunth) G. Don – G
Erythrina lanata Rose subsp. *lanata* – G
Erythrina occidentalis Standl. – G
Erythrina standleyana Krukoff – C
Galactia acapulcensis Rose – G
Galactia acunana Borhidi et Muñiz – C
Galactia cuneata Alain – C
Galactia maisiana Alain – C
Galactia monophylla Griseb. – C
Galactia rotundata Alain – C
Galactia striata (Jacq.) Urb. – G, C
Gliricidia sepium (Jacq.) Steud. – G, C
Indigofera acutifolia – G
Indigofera hirsuta L. – G
Indigofera jamaicensis Spreng. – G
Indigofera lespedezioides Kunth – G
Indigofera mucronata Spreng. – G, C
Indigofera sabulicola Benth. – G
Indigofera suffruticosa Mill. – G, C

- Lonchocarpus atropurpureus* Benth. – G
Lonchocarpus cochleatus – G
Lonchocarpus constrictus Pittier – G
Lonchocarpus eriocarinalis Micheli – G
Lonchocarpus guatemalensis Benth. – G
Lonchocarpus lanceolatus Benth. – G
Lonchocarpus pentaphyllus (Poiret) DC. – C
Lonchocarpus rugosus Benth. – G
Lonchocarpus sericeus (Poiret) DC. var. *glabrescens* Benth. – G
Lonchocarpus sericeus (Poiret) DC. subsp. *palmeri* (Rose) M. Sousa – G
Lonchocarpus sericeus (Poiret) DC. subsp. *sericeus* – G
Machaerium salvadorens – G
Macroptilium atropurpureum (DC.) Urb. – G
Macroptilium lathyroides (L.) Urb. – C
Marina nutans (Cav.) Barneby – G
Mucuna pruriens (L.) DC. – G, C
Mucuna urens (L.) Fawcett et Rendle – C
Nissolia fruticosa (Jacq.) Enum. – G
Nissolia leiogyne Sandw. – G
Nissolia microptera Poir – G
Phaseolus lunatus L. – G, C
Phaseolus microcarpus Mart. – G
Pictetia arborescens Borhidi – C
Pictetia cubensis Bisse – C
Piscidia carthagenensis Jacq. – G
Piscidia grandifolia (Donn. Sm.) Johnston – G
Piscidia havanensis Urb. et Ekman – C
Piscidia piscipula (L.) Sarg. – G, C
Pterocarpus acapulcensis Rose – G
Rhynchosia minima (L.) DC. – G, C
Rhynchosia precatoria DC. – G
Rhynchosia reticulata (Sw.) DC. – C
Rhynchosia tarphanta – G
Sesbania emerus (Aubl.) Urb. – C
Sesbania herbacea McVaugh – G
Sesbania sesban (L.) Fawcett et Rendle – C
Sophora tomentosa L. – C
Stylosanthes guyanensis (Aubl.) Sw. – G
Stylosanthes hamata (L.) Taubert – C
Stylosanthes viscosa Sw. – G, C
Swartzia cubensis (Britton et Wilson) Standl. – C
Swartzia simplex (Sw.) Spreng. – G
Tephrosia cinerea (L.) Pers. – G, C
Tephrosia clementis Alain – C
Tephrosia multifolia Rose – G
Tephrosia nitens Benth. ex Seeman – G
Tephrosia sp. – G
Teramnus uncinatus (L.) Sw. – G, C
Vicia acutifolia Ell. – C
Vigna adenantha (F. G. Mey.) Maréchal – G
Vigna luteola (Jacq.) Benth. – C
Vigna strobilophora B. L. Rob. – G
Vigna vexillata (L.) A. Rich. – C
Zornia diphylla (L.) Pers. – G, C
- FLACOURTIACEAE
- Banara brittonii* Roig – C
Banara reticulata Griseb. – C
Banara wilsoni Alain – C
Casearia aculeata Jacq. – G, C
Casearia arguta Kunth – G
Casearia comocladifolia Vent. – C
Casearia corymbosa Kunth – G
Casearia guianensis (Aubl.) Urb. – C
Casearia hirsuta Sw. – C
Casearia obovata Schldtl. – G
Casearia spinescens (Sw.) Griseb. – C
Casearia sylvestris Sw. – G, C
Gossypiospermum praecox (Griseb.) P. Wilson – C
Homalium senarium Blake – G
Prockia crucis P. Browne ex L. – G, C
Samyda campanulata Borhidi et Muñiz – C
Samyda mexicana Rose – G
Samyda microphylla Urb. – C
Xylosma buxifolium A. Gray – C
Xylosma flexuosum (Kunth) Hemsl. – G
Xylosma intermedium (Seemann) Triana et Planchon – G
Xylosma rhombifolium Britton et Wilson – C
Xylosma roigiana Borhidi et Muñiz – C
Zuelania guidonia (Sw.) Britton et Millsp. – C
- GENTIANACEAE
- Eustoma exaltatum* (L.) Salisb. – C
Leiphaimos parasitica Schldtl. et Cham. – C
Schultesia guianensis (Aublet) Malme – G, C
- GESNERIACEAE
- Achimenes candida* Lindley – G
Bellonia spinosa Sw. – C

Gesneria sp. – C

Pheidonocarpa cubensis (Morton) Borhidi – C

Rhytidophyllum acunae Morton – C

Rhytidophyllum crenulatum DC. – C

GOODENIACEAE

Scaevola plumierii Vahl – C

HALORAGACEAE

Myriophyllum sp. – C

HIPPOCRATEACEAE

Cuervea integrifolia (A. Rich.) A. C. Sm.
– C

Hippocratea celastroides Kunth – G

Hippocratea excelsa Kunth – G

Hippocratea volubilis L. – C

HYDROCHARITACEAE

Thalassia testudinum Banks ex König – C

Vallisneria neotropicalis M. Vict. – C

HYDROPHYLLACEAE

Hydrolea nigricaulis Wr. ex Griseb. – C

Hydrolea ovata Nutt. – G

Hydrolea spinosa L. – G, C

Nama jamaicense L. – C

Wigandia urens Kunth – G

IRIDACEAE

Sisyrinchium graminoides Bickn. – C

JULIANACEAE

Amphipterygium adstringens (Schltdl.) Schiede
– G

KRAMERIACEAE

Krameria cuspidata Presley – G

LAMIACEAE

Hyptis armillata Epl. – C

Hyptis brevipes Poit. – G

Hyptis capitata Jacq. – C

Hyptis mociniana Benth. – G

Hyptis pectinata (L.) Poit. – C

Hyptis suaveolens (L.) Poit. – G, C

Hyptis urticoides Kunth – G

Hyptis verticillata Jacq. – C

Hyptis sp. – G

Micromeria brownei (Sw.) Benth. – G, C

Micromeria suborbicularis (Alain) Borhidi – C

Ocimum micranthum Willd – G, C

Salvia micrantha Vahl – G

Salvia misella Kunth – G

Salvia polystachya Ortega – G

Salvia serotina L. – C

Teucrium canadense L. var. *angustatum* A.
Gray – C

Teucrium cubense L. – C

LAURACEAE

Cassytha filiformis L. – C

Nectandra coriacea (Sw.) Griseb. – C

Nectandra sp. – G

LEMNACEAE

Lemna minima Philip. – G

Lemna minor L. – C

Lemna minuscula Herter – G

Lemna perpusilla Torr. – C

Lemna sp. – G

Spirodela polyrrhiza (L.) Schleid. – G, C

Wolffia columbiana Karsten – G

LENNOACEAE

Lennea madreporoides Lex. – G

LENTIBULARIACEAE

- Utricularia cornuta* Michx. – C
Utricularia foliosa L. – G, C
Utricularia gibba L. – G
Utricularia juncea Vahl – C
Utricularia mixta Barnh. – C

LILIACEAE

- Bessera elegans* Schult. – G
Bomarea hirtella (Kunth) Herb. – G
Crinum erubescens Aiton – G, C
Pancratium arenicolum (Northrop) Alain – C
Pancratium litorale Jacq. – G
Pancratium praticolum (Britton et Wilson)
 Alain – C
Yucca sp. – G

LIMNOCHARITACEAE

- Limnocharis flava* (L.) Buchenau – G, C

LOASACEAE

- Gronovia scandens* L. – G
Mentzelia aspera L. – G

LOGANIACEAE

- Cynoctonum mitreola* (L.) Britton – C
Polypremum procumbens L. – G, C
Spigelia anthelmia L. – C
Strychnos grayi Griseb. – C
Strychnos tabascana Sprague et Sandwith
 – G

LORANTHACEAE

- Cladocolea microphylla* (Kunth) Kuijt – G
Dendropemon emarginatus (Sw.) Steud. – C
Dendrophthora mancinellae (Wr.) Eich. – C
Psittacanthus calyculatus (DC.) G. Don – G
Struthanthus cassythoides Millsp. – G
Struthanthus venetus (Kunth) Blume – G

LYTHRACEAE

- Adenaria floribunda* Kunth – G
Ammannia auriculata Willd. – C
Ammannia coccinea Rottb. – G, C
Cuphea aequipetala Cav. – G
Cuphea carthagenensis (Jacq.) Macbr. – G
Cuphea grisebachiana Koehne – C
Cuphea parsonsia (L.) R. Br. – C
Ginoria americana Jacq. – C
Ginoria ginorioides (Griseb.) Britton – C
Ginoria koehneana Urb. – C
Lawsonia inermis L. – G, C
Lythrum lineare L. – C
Rotala ramosior (L.) Koehne – C

MALPIGHIACEAE

- Banisteria beecheyana* (Juss.) C. B. Robins. – G
Banisteria laurifolia L. – G, C
Banisteriopsis pauciflora (Kunth) C. B. Robins. – C
Bunchosia lancifolia Niedenzu – G
Bunchosia lindeniana A. Juss. – G
Bunchosia media (Ait.) DC. – C
Bunchosia nitida (Jacq.) DC. – C
Bunchosia palmeri S. Watson – G
Bunchosia pilosa Kunth – G
Bunchosia swartziana Griseb. – C
Byrsonima crassifolia Kunth – G, C
Byrsonima lucida (Sw.) DC. – C
Byrsonima roigii Urb. – C
Heteropterys beecheyana Juss. – G
Heteropterys bicolor – G
Hiraea quapara (Aublet) Morton – G
Malpighia cubensis Kunth – C
Malpighia glabra L. – G, C
Malpighia mexicana Juss. – G
Malpighia pallens Small – C
Malpighia puniceifolia L. – G, C
Malpighia suberosa Small – C
Malpighia subglabrata (Niedzv.) Small – G
Malpighia umbellata Rose – G
Malpighia wrightiana Acuña et Roig – C
Rosanthus subverticillatus – G
Stigmaphyllon diversifolium – C
Stigmaphyllon lineare Wr. – C
Stigmaphyllon microphyllum Griseb. – C
Stigmaphyllon sagraeanum A. Juss. – C

Tetrapteryx mexicana Hook. et Arn. – G
Tetrapteryx nelsonii Rose – G
Triopteris jamaicensis L. – C
Triopteris ovata Cav. – C
Triopteris rigida Sw. – C
Thryallis glauca (Cav.) Kuntze – G, C

MALVACEAE

Abutilon andrieuxii Hemsl. – G
Abutilon americanum (L.) Sweet – C
Abutilon barrancae M. E. Jones – G, C
Abutilon permolle (Willd.) Sweet – C
Abutilon trisulcatum (Jacq.) Urb. – G
Abutilon umbellatum (L.) Sweet – C
Anoda acerifolia Cav. – G, C
Anoda crenatiflora Ortega – G
Anoda cristata (L.) Schltdl. – G
Anoda sp. – G
Atkinsia cubensis (Britton et Wilson) Howard – C
Bastardia viscosa L. Kunth – G, C
Cienfuegosia yucatanensis Millsp. – C
Gossypium barbadense L. – G, C
Gossypium lanceolatum Todaro – G
Gossypium hirsutum L. – G
Herissantia crispa (L.) Briz. – G, C
Hibiscus costatus A. Rich. – C
Hibiscus cryptocarpus A. Rich. – C
Hibiscus cubensis A. Rich. – C
Hibiscus diversifolius Jacq. – G
Hibiscus elatus Sw. – C
Hibiscus furcellatus Desr. – G, C
Hibiscus phoeniceus Jacq. – C
Hibiscus tiliaceus L. – G, C
Kosteletzkia depressa (L.) Blanchard – G
Kosteletzkia pentasperma (Bert.) Griseb. – G, C
Kosteletzkia virginica (L.) A. Gray – C
Malachra alceaefolia Jacq. – G, C
Malachra fasciata Jacq. – G, C
Malvastrum americanum (L.) Torrey – G, C
Malvastrum coromandelianum (L.) Garcke – G, C
Malvaviscus arboreus Cav. – G
Pavonia fruticosa (Mill.) Fawc. et Rendle – C
Pavonia spicata Cav. – C
Pavonia spinifex (L.) Cav. – C
Pseudoabutilon spicatum (Kunth) R. E. Fries – G
Sida acuta Burman f. – G, C
Sida ciliaris L. – G, C

Sida cordifolia L. – G, C
Sida glutinosa Commers. – G, C
Sida linifolia Juss. ex Cav. – G, C
Sida nesogena I. M. Johnston – G
Sida rhombifolia L. – G, C
Sida salviifolia C. Presl – G
Sida urens L. – C
Thespesia populnea (L.) Sol. ex Correa – C
Wissadula amplissima (L.) R. E. Fries – G, C
Wissadula periplocifolia (L.) C. Presl ex Thwaites – G, C

MARANTACEAE

Maranta divaricata Roscoe – G
Thalia geniculata L. – G, C

MARSILEACEAE

Marsilea mollis B. L. Robr. et Fernald – G, C

MELIACEAE

Cedrela odorata Sw. – C
Guarea glabra Vahl – G
Guarea guidonia (L.) Sleumer – C
Melia azedarach L. – G, C
Swietenia humilis Zucc. – G
Swietenia mahagoni (L.) Jacq. – C
Trichilia glabra L. – C
Trichilia hirta L. – G, C
Trichilia pungens Urb. – C
Trichilia trachyantha (Griseb.) C. DC. – C
Trichilia trifolia L. – G

MENISPERMACEAE

Cissampelos pareira L. – G, C
Cocculus diversifolius DC. – G
Hyperbaena racemosa Urb. – C

MENYANTHACEAE

Nymphoides grayanum (Griseb.) Arthur – C
Nymphoides indica (L.) Kuntze – G, C

MIMOSACEAE

- Acacia angustissima* (Mill.) Kuntze – G
Acacia choriophylla Benth. – C
Acacia cochliacantha Humb. et Bonpl. ex Willd. – G
Acacia collinsi Saff. – G
Acacia cowellii (Britton et Rose) León – C
Acacia farnesiana (L.) Willd. – G, C
Acacia hirtipes Saff. – G
Acacia macracantha Humb. et Bonpl. ex Willd. – G, C
Acacia riparia Kunth – G
Acacia roigi León – C
Acacia tenuifolia (L.) Willd. – G, C
Acacia zapatensis Urb. – C
Acacia sp. – G
Albizzia cubana Britton et Wilson – C
Albizzia tomentosa (Micheli) Standl. – G
Calliandra acapulcensis (Britton et Rose) – G
Calliandra calothyrsus Meisn. – G
Calliandra colletioides Griseb. – C
Calliandra rusbyi Britton – G
Desmanthus virgatus (L.) Willd. – G, C
Dichrostachys cinerea (L.) Wright et Arn. – C
Entada monostachya DC. – C
Entada polystachya (L.) DC. – G
Enterolobium cyclocarpum (Jacq.) Griseb. – G, C
Inga eriocarpa Benth. – G
Leucaena leucocephala (Lam.) De Wit. – G, C
Leucaena macrophylla Benth. – G
Lysiloma acapulcense (Kunth) Benth. – G
Lysiloma divaricata (Jacq.) J. F. Macbride – G
Lysiloma latisiliqua (L.) Benth. – C
Lysiloma microphyllum Benth. – G
Lysiloma sabicu A. Rich. – C
Mimosa acantholoba (Willd.) Poir. – G
Mimosa acapulcensis Robins – G
Mimosa albida Humb. et Bonpl. ex Willd. – G
Mimosa arenosa (Willd.) Poir. – G
Mimosa catalinae León – C
Mimosa dormiens Humb. et Bonpl. ex Willd. – G
Mimosa ervendbergii A. Gray – G
Mimosa pigra L. – G, C
Mimosa pudica L. – G, C
Mimosa sesquijugata Donn. Sm. – G
Neptunia natans (L. f.) Druce – G, C
Neptunia plena (L.) Benth. – G, C
Piptadenia constricta (Micheli) T. Macbr. – G

- Piptadenia flava* (DC.) Benth. – G
Pithecellobion albicans (Kunth) Benth. – G
Pithecellobion bahamense Northrop. – C
Pithecellobion circinale (L.) Benth. – C
Pithecellobion dulce (Roxb.) Benth. – G, C
Pithecellobion hystrix (A. Rich.) Benth. – C
Pithecellobion keyense Britton – C
Pithecellobion lanceolatum (Willd.) Benth. – G
Pithecellobion lentiscifolium (A. Rich.) C. Wright – G, C
Pithecellobion leucospermum Brandegee – G
Pithecellobion mangense (Jacq.) Macbr. – G
Pithecellobion mucronatum Britton – C
Pithecellobion oblongum Benth. – G
Pithecellobion platylobum (DC.) Urb. – G
Pithecellobion unguis-cati (L.) Mart. – G, C
Prosopis juliflora (Sw.) DC. – G, C
Prosopis laevigata (Willd.) M. C. Johnst. – G
Samanea saman (Jacq.) Merrill – C
Schrankia distachya Moçño et Sessé – G
Zapoteca formosa (Kunth) H. Hern. subsp. *rosei* (Wiggins) H. Hern. – G, C

MOLLUGINACEAE

- Glinus radiatus* (Ruiz et Pavón) Rohrb. – G
Mollugo cuneifolius – C
Mollugo verticillata L. – G

MORACEAE

- Cecropia peltata* L. – G, C
Dorstenia drakena L. – G
Ficus aurea Nutt. – C
Ficus costarricana (Liebm.) Miq. – G
Ficus crassinervia Willd. – C
Ficus hemsleyana Standl. – G
Ficus insipida Willd. – G
Ficus jimenezii Standl. – G
Ficus aff. kellermanii Standl. – G
Ficus laevigata Vahl – C
Ficus lentiginosa Vahl – G
Ficus maxima Miller – G
Ficus mexicana Miquel – G
Ficus perforata L. – C
Ficus pertusata L. – G
Ficus subscabrida Warb. – C
Ficus tuerkheimi Standl. – G

Ficus sp. – G

Maclura tinctoria (L.) D. Don ex Steud. – C

Trophis racemosa (L.) Urb. – G, C

MYRICACEAE

Myrica cerifera L. – C

MYRSINACEAE

Ardisia densiflora Krug et Urb. – G

Wallenia laurifolia (Jacq.) Sw. – C

MYRTACEAE

Calyptanthus decandra Griseb. – C

Calyptanthus pallens (Poir.) Griseb. – C

Calyptanthus rotundata Griseb. – C

Calyptanthus syzygium (L.) Sw. – C

Eugenia acapulcensis Steud. – G, C

Eugenia acutissima Urb. et Ekm. – C

Eugenia axillaris (Sw.) Willd. – G, C

Eugenia capuli (Schltdl. et Cham.) O. Berg
– G

Eugenia cyphophloea Griseb. – C

Eugenia farameoides A. Rich. – C

Eugenia glabrata (Sw.) DC. – C

Eugenia maleolens Poir. – C

Eugenia matudae Lundell – G

Eugenia melanadenia Krug et Urb. var. *melanadenia* – C

Eugenia oaxacana Standl. – G

Eugenia oerstedeana O. Berg – G

Eugenia rekoii Standl. – G

Eugenia rhombea (O. Berg) Krug et Urb. ex
Urb. – C

Eugenia sauvallei Krug et Urb. ex Urb. – G, C

Myrcianthes fragrans (Sw.) McVaugh – C

Myrtus ligustrina (Sw.) Willd. – C

Myrtus oonophylla (Urb.) – C

Pimenta adenoclada (Urb.) Burret – C

Pimenta filipes (Urb.) Burret – C

Psidium guajava L. – G, C

Psidium munizianum Borhidi – C

Psidium sartorianum (O. Berg) Ndzu. – G, C

NAJADACEAE

Najas guadalupensis (Spreng.) Morong – G, C

Najas wrightiana A. Br. – C

NYCTAGINACEAE

Boerhavia coccinea Miller – G, C

Boerhavia diffusa L. – G, C

Boerhavia erecta L. – G, C

Caribea litoralis Alain – C

Commicarpus scandens (L.) Standl. – G, C

Guapira discolor – C

Guapira fragrans – C

Guapira insularis – C

Guapira obtusata (Jacq.) Little – C

Mirabilis jalapa L. – G, C

Neea psychotoides J. D. Smith – G

Neea shaferi Standl. – C

Neea stenophylla Standl. – G

Okenia hypogaea Schltdl. et Cham. – G

Pisonia aculeata L. – G, C

Pisonia rotundata Griseb. – C

Pisonia macranthocarpa Donn. Sm. – C

Salpianthus arenarius Kunth – G

Salpianthus purpurascens (Cav. ex Lag.)
Hook. et Arn. – G

NYMPHAEACEAE

Nymphaea ampla (Salisb.) DC. – G, C

Nymphaea blanda G. Meyer – G

Nymphaea odorata – C

Nelumbo lutea (Willd.) Pers. – C

Nuphar luteum (L.) Sibth. et Sm. subsp. *macrophyllum* (Small) Beal – C

OCHNACEAE

Ouratea ilicifolia (DC.) Baillon – C

Ouratea mexicana (Kunth) Engl. – G

Ouratea nitida (Sw.) Engl. – G, C

Ouratea pallida Standl. – G

Ouratea xavannarum (Britton et Wilson)
Borhidi – C

OLACACEAE

- Schoepfia chrysophylloides* (Rich.) Planch. – C
Schoepfia didyma C. Wr. – C
Ximenia americana L. – G, C
Ximenia roigii León – C

OLEACEAE

- Forestiera rhamnifolia* Griseb. – C
Forestiera segregata (Jacq.) Krug et Urb. – C
Fraxinus cubensis Griseb. – C
Linociera bumelioides Griseb. – C
Linociera ligustrina Sw. – C

ONAGRACEAE

- Ludwigia erecta* (L.) Hara – C
Ludwigia helminthorrhiza (Mart.) Hara – G
Ludwigia leptocarpa (Nutt.) Hara – G, C
Ludwigia microcarpa Mich. – C
Ludwigia octovalvis (Jacq.) Raven var. *octofila* (DC.) Alain – G, C
Ludwigia octovalvis (Jacq.) Raven subsp. *octovalvis* – G, C
Ludwigia peduncularis (Wr. ex Griseb.) G. Maza – C
Ludwigia peploides (Kunth) Raven subsp. *peploides* – G, C
Ludwigia peruviana (L.) Hara var. *peruviana* – C
Ludwigia repens Forst. var. *repens* – C
Ludwigia repens Forst. var. *rotundata* (Griseb.) G. Maza – C
Riesenbachia racemosa Presl – G

OPILIACEAE

- Agonandra racemosa* (DC.) Standl. – G

ORCHIDACEAE

- Bletia purpurea* (Lam.) DC. – C
Cattleyopsis lindenii (Lindl.) Cogn. – C
Cattleyopsis ortgiesiana (Rchb. f.) Cogn. – C
Clowesia dadsoniana Aguirre – G
Cryptopodium punctatum (L.) Lindl. – C

- Encyclia lancifolia* (Lindl.) Dressler et Pollard – G
Encyclia sp. – C
Ionopsis utricularioides (Sw.) Lindl. – C
Oncidium guttatum (L.) Rchb. f. – C
Oncidium lemonianum Lindl. – C
Oncidium leiboldi Rchb. f. – C
Oncidium variegatum Sw. – C
Stenorrhynchos lanceolatus (Aubl.) Sprengl. – G
Vanilla barbellata Rchb. f. – C
Vanilla dilloniana Correll – C
Vanilla pheacantha Rchb. f. – C

OXALIDACEAE

- Oxalis eggersii* Urb. – C
Oxalis rombifolia Jacq. – G
Oxalis sepium St. Hil. – G
Oxalis tetraphylla Cav. var. *gueroensis* Denton – G
Oxalis yucatanensis (Rose) Riley – G

PARKERIACEAE

- Ceratopteris thalitroides* (L.) Brong – G

PASSIFLORACEAE

- Passiflora biflora* Lam. – G
Passiflora coriacea Juss. – G
Passiflora cuprea L. – C
Passiflora filipes Benth. – G
Passiflora foetida L. var. *ciliata* (Dryand) Mast. – G, C
Passiflora foetida L. var. *gossypifolia* (Desv.) Mast. – C
Passiflora foetida L. var. *hibiscifolia* (Lam.) Killip – G
Passiflora holosericea L. – G, C
Passiflora mexicana Juss. – G
Passiflora multiflora L. – C
Passiflora penduliflora Bert. – C
Passiflora porphyretica Mast. – G
Passiflora santiagana (Killip) Borhidi – C
Passiflora suberosa L. – C
Passiflora triniloba T. M. MacDoug. – G
Passiflora viridiflora Cav. – G
Passiflora sp. – G

PEDALIACEAE

Martynia annua L. – G

PHYTOLACCACEAE

Petiveria alliacea L. – G, C

Rivina humilis L. – G, C

Stegnosperma cubense A. Rich. – C

Stegnosperma scandens (Lunán) Standl. – G, C

Trichostigma octandrum (L.) H. Walt. – C

PIPERACEAE

Peperomia campylotropa A. W. Hill – G

Peperomia glabella (Sw.) A. Dietr. – C

Peperomia rotundifolia (L.) Kunth – G, C

Piper aduncum L. – C

Piper amalago L. – G, C

Piper articulatum A. Rich. – C

Piper cojimaranum Trel. – C

Piper guahacabibensis Borhidi – C

Piper medium Jacq. – C

Piper ossanum Trel. – C

Piper pseudoasperifolium DC. – G

Piper richardianum C. DC. – C

Piper tuberculatum Jacq. – G

Piper umbellatum L. – G, C

PLUMBAGINACEAE

Plumbago scandens L. – G, C

POACEAE

Aegopogon cenchroides Humb. et Bonpl. – G

Andropogon bicornis L. – C

Andropogon glomeratus (Walt.) B. S. P. – C

Andropogon gracilis Spreng. – C

Andropogon virginicus L. – C

Antheophora hermaphrodita (L.) Kuntze – G

Aristida egersii Hitchc. – C

Aristida orizabensis Fourn. – G

Aristida ternipes Cav. – C

Arundo donax L. – C

Bouteloua curtipendula (Minchx.) Torr. – G

Bouteloua juncea (Desv.) Hitchc. – C

Bouteloua repens (Kunth) Scribner et Merr. – G

Bothriochloa pertusa (L.) Willd. – C

Brachiaria fasciculata (Sw.) Parodi – G, C

Brachiaria mollis (Sw.) L. Parodi – G, C

Brachiaria mutica (Forsskal) Stapf – G, C

Cenchrus brownii R. et S. – G, C

Cenchrus ciliaris L. – G

Cenchrus echinatus L. – G, C

Cenchrus incertus M. Curtis – G, C

Cenchrus myosuroides Kunth – G

Cenchrus tribuloides L. – G, C

Cynodon dactylon (L.) Pers. – G, C

Chloris ciliata Sw. – C

Chloris inflata Link – C

Chloris petraea Sw. – C

Chloris virgata Sw. – G, C

Dactyloctenium aegyptium (L.) Willd. – G, C

Dichanthium annulatum (Forssk.) Stapf – C

Dichanthium caricosus – C

Digitaria biformis Willd. var. *biformis* – G

Digitaria horizontalis Willd. – C

Digitaria sanguinalis (L.) Scop. – G, C

Digitaria sp. – G

Distichlis spicata (L.) Greene – G, C

Echinochloa colonum (L.) Link. – G, C

Echinochloa crus-galli (L.) Beauv. – C

Echinochloa crus-pavonis (Kunth) Schult.

– G, C

Echinochloa polystachya (Kunth) Hitchc.

– G, C

Eleusine indica (L.) Gaertn. – G, C

Eragrostis ciliaris (L.) R. Br. – G, C

Eragrostis domingensis (Pers.) Steud. – C

Eragrostis pectinacea (Michx.) Nees – G

Eragrostis prolifera (Sw.) Steud. – C

Eragrostis reptans (Michx.) Nees – G

Eragrostis tenella (L.) Beauv. – C

Erianthus giganteus (Walt.) Muhl. – C

Eriochloa aristata Vasey – G

Eriochloa polystachya Kunth – C

Eriochloa punctata (L.) Desv. – C

Gynerium sagittatum (Aubl.) Beauv. – C

Hymenachne amplexicaulis (Rudge) Nees

– G, C

Hyparrhenia rufa (Nees) Stapf. – G, C

Ixophorus unisetus (Presl) Schldt. – G, C

Lasiacis divaricata (L.) Hitchc. – G, C

Lasiacis papillosa Swallen – G

Lasiacis procerrima (Hack.) Hitchc. – G

- Lasiacis rhizophora* (Four.) Hitchc. – G
Lasiacis rugelii (Griseb.) Hitchc. – C
Lasiacis ruscifolia var. *ruscifolia* (Kunth) Hitchc. – G, C
Lasiacis scabrior Hitchc. – G
Lasiacis sloanei (Griseb.) Hitchc. – C
Lasiacis sp. – G
Leersia hexandra Sw. – C
Leptochloa domingensis Trin. – C
Leptochloa fascicularis (Lam.) A. Gray – C
Leptochloa filiformis (Lam.) Beauv. – G, C
Leptochloa panicoides (Presl) Hitchc. – G
Leptochloa virgata (L.) Beauv. – G, C
Luziola subintegra Swallen – C
Monanthochloe litoralis Engelm – C
Olyra latifolia L. – G, C
Opizia stolonifera Presl – G, C
Oplismenus burmanni (Retz.) Beauv. – G
Oplismenus hirtellus (L.) Beauv. – G, C
Oplismenus setarius (Lam.) Roem. et Schult. – G, C
Oryza perennis Moench. – C
Panicum adspersum Trin. – C
Panicum aquaticum Poir. – C
Panicum bartowense Scribner – G
Panicum caeruleum Hack. – C
Panicum elephantipes Nees – C
Panicum geminatum Forsskal – G, C
Panicum gouini Fourn. – C
Panicum maximum Jacq. – G, C
Panicum parvum Hitchc. et Chase – G
Panicum plicatum Michau – G
Panicum trichanthum Nees – G, C
Paspalum acuminatum Raddi – G
Paspalum caespitosum Fluegge – C
Paspalum conjugatum Bergius var. *conjugatum* – G, C
Paspalum densum Poir. – C
Paspalum fimbriatum Kunth – C
Paspalum fluitans (Ell.) Kunth – G
Paspalum lividum Trin. – G, C
Paspalum longicuspis Nash. – G
Paspalum microstachyum Presl – G
Paspalum milligrana Schrad. – C
Paspalum plicatum Michau – G, C
Paspalum propinquum Nash. – C
Paspalum repens Bergius – G, C
Paspalum reptatum Hitchc. et Chase – C
Paspalum vaginatum Sw. – G, C
Paspalum virgatum L. – C
Paspalidium geminatum (Forssk.) Stapf – G
Pennisetum ciliare (L.) Link. – G
Pennisetum purpureum Schum. – G, C
Pennisetum setosum (Sw.) L. Rich. – G, C
Phragmites australis (Cav.) Trin. ex Steud. – G
Rhynchelytrum repens (Willd.) Hubbard – G, C
Sacciolepis striata (L.) Nash. – C
Setaria chapmani (Vasey) Pilger – C
Setaria geniculata (Lam.) Beauv. – C
Setaria leonis (Ekm.) León – C
Setaria liebmannii Fourn. – G
Setaria verticillata (L.) Beauv. – G, C
Soderstroemia mexicana (Scribn.) Smith – G
Sorghastrum incompletum (Presl) Nash. – G
Sorghastrum stipoides (Kunth) Nash. – C
Spartina patens (Ait.) Muhl. – C
Sporobolus domingensis (Trin.) Kunth – C
Sporobolus indicus (L.) R. Br. – C
Sporobolus pyramidatus (Lam.) Hitchc. – G, C
Sporobolus splendens Small – G
Sporobolus virginicus (L.) Kunth – C
Sporobolus wrightii Munro ex Scribn. – G
Stenotaphrum secundatum (Walt.) Kuntze – C
Tragus berteronianus Schult. – C
Uniola paniculata L. – C
Uniola virgata (Poir) Griseb. – C
- POLEMONIACEAE
- Loeselia ciliata* L. – G
- POLYGALACEAE
- Polygala bryozoides* St. Hil. – G, C
Polygala carterii Small – C
Polygala cuneata (Griseb.) Blake – C
Polygala floribunda L. – G
Polygala guantanamana Blake – C
Polygala leptocaulis Torr. et Gray – G, C
Polygala paniculata L. – C
Polygala scabridula Blake – C
Polygala stipitata Blake – C
Polygala sp. – G
Securidaca elliptica Turcz. – C
Securidaca sylvestris Schltr. – G
Securidaca virgata Sw. – C

POLYGONACEAE

Antigonon cinerascens Martens et Galeotti
– G

Antigonon flavescens S. Watson – G

Antigonon leptopus Hook. et Arn. – G, C

Antigonon sp. – G

Coccoloba acapulcensis Standl. – G

Coccoloba acuna Howard – C

Coccoloba barbadensis Jacq. – G

Coccoloba diversifolia Jacq. – C

Coccoloba floribunda (Benth.) Lindau – G

Coccoloba liebmanii Lindau – G

Coccoloba retusa Griseb. Cat. – C

Coccoloba schiedeana Lindau – G

Coccoloba uvifera L. – C

Coccoloba venosa L. – G

Podopterus mexicanus Humb. et Bonpl.
– G

Polygonum acuminatum Kunth – G, C

Polygonum densiflorum Meisn. – C

Polygonum mexicanum Small – G

Polygonum punctatum Ell. – G, C

Polygonum sp. – G

Ruprechtia costata Meissner – G

Ruprechtia fusca Fern. – G

Ruprechtia pallida Standl. – G

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms-Laub.
– G, C

Eichhornia diversifolia (Vahl) Urb. – C

Eichhornia paniculata (Spreng.) Small – C

Heteranthera limosa (Sw.) Willd. – G, C

Heteranthera reniformis Ruiz et Pavón – C

Pontederia lanceolata Nutt. – C

Pontederia sagittata Presl – G

PORTULACACEAE

Portulaca oleracea L. – G, C

Portulaca pilosa L. – G, C

Portulaca rubricaulis Kunth – C

Portulaca teretifolia Kunth var. *teretifolia* – C

Portulaca tuberculata León – C

Talinum paniculatum (Jacq.) Gaertner – G, C

Talinum triangulare (Jacq.) Willd. – G

POTAMOGETONACEAE

Potamogeton crispus – G

Potamogeton illinoensis Morong – C

Potamogeton nodosus Poir. – C

Potamogeton pectinatus L. – G

PTERIDACEAE

Acrostichum danaifolium Langsd. et Fisch.
– G

Acrostichum aureum L. – G, C

Pityrogramma calomelanos (L.) Link – G

Pityrogramma sp. – G

RANUNCULACEAE

Cienfuegosia yucatanensis – C

Clematis acapulcensis Hook. et Arn. – G, C

RHAMNACEAE

Auerodendron cubense (Britton et Wilson)
Urb. – C

Auerodendron northropianum (Urb.) Urb. – C

Colubrina arborescens (Mill.) Sarg. – C

Colubrina asiatica (L.) Brongn. – C

Colubrina cubensis (Jacq.) Brongn. – C

Colubrina elliptica (Sw.) Brizicki et Stern. – C

Colubrina heteroneura (Griseb.) Standl. – G

Condalia sp. – G

Cormonema biglandulosa (Sessá et Moçño)
Standl. – G

Doerpfeldia cubensis (Britton) Urb. – C

Gouania lupuloides (L.) Urb. – G, C

Gouania polygama (Jacq.) Urb. – G, C

Gouania stipularis DC. – G

Karwinskia humboldtiana (Roem. et Schult.)
Zucc. – G

Krugiodendron ferrum (Vahl) Urb. – C

Reynosia camagueyensis Britton – C

Reynosia mucronata Griseb. subsp. *azulensis*
Borhidi et Muñoz – C

Reynosia mucronata Griseb. subsp. *mucronata*
– C

Reynosia revoluta (Griseb.) Urb. – C

Reynosia septentrionalis Urb. – C

Ziziphus acuminata Benth. – G
Ziziphus amole (Sessé et Moçño) M. Johnston
 – G
Ziziphus havanensis Kunth subsp. *bullata*
 (Urb.) Borhidi – C
Ziziphus havanensis Kunth subsp. *havanensis*
 – C
Ziziphus mauritiana Lam. – G
Ziziphus ovata (Urb.) M. C. Johnst. – C

RHIZOPHORACEAE

Rhizophora mangle L. – G, C

RUBIACEAE

Alibertia edulis (L. C. Rich.) A. Rich. ex DC. – C
Anisomeris protracta (Bartl.) Standl. – G
Antirhea aristata (Britton) Urb. – C
Antirhea lucida (Sw.) Benth. et Hook. – C
Antirhea myrtifolia (Griseb.) Urb. – C
Antirhea occidentalis Urb. – C
Arachnothryx leucophylla (HBK.) Planch – G
Borreria laevis (Lam.) Griseb. – C
Borreria ocimoides (Burm. f.) DC. – C
Borreria verticillata (L.) G. Meyer – G, C
Casasia calophylla A. Rich. – C
Casasia clusiifolia (Jacq.) Urb. var. *clusiifolia*
 – C
Casasia clusiifolia (Jacq.) Urb. var. *hirsuta*
 Borhidi – C
Catesbaea flaviflora Urb. – C
Catesbaea holocantha Wr. ex Sauv. – C
Catesbaea macracantha Wr. ex Sauv. – C
Catesbaea parviflora Sw. – C
Catesbaea spinosa Sw. – C
Cephalanthus occidentalis L. – C
Crusea longiflora (Willd. ex Roem. et Schult.)
 W. R. Anderson – G
Crusea parviflora Hook. et Arn. – G
Chiococca alba (L.) Hitchc. – G, C
Chione cubensis A. Rich. – C
Chione myrtifolia Griseb. – C
Dentella repens (L.) Forster – G
Diodia serrulata (P. Beauv.) G. Tayl. – C
Diodia simplex Sw. – C
Diodia teres Walter – G, C
Diodia virginiana L. – C

Erithalis fruticosa L. – C
Erithalis vacciniifolia (Griseb.) Wr. ex Sauv.
 – C
Ernodea litoralis Sw. – C
Exostema caribaeum (Jacq.) Roem. et Schult.
 – G, C
Exostema cordifolium Borhidi et Fernández
 – C
Exostema lucidum Borhidi et Fernández – C
Exostema microcarpum Borhidi et Fernández
 – C
Exostema pervestitum Borhidi et Fernández –
 C
Exostema salicifolium Griseb. – C
Exostema spinosum (Le Vavass.) Krug et Urb.
 – C
Exostema velutinum Standl.
Famea occidentalis (L.) A. Rich. – C
Genipa americana L. – C
Guettarda calyptata A. Rich. – C
Guettarda combsii Urb. – G, C
Guettarda coxiana Britton – C
Guettarda cueroensis Britton – C
Guettarda elliptica Sw. – C
Guettarda gaumeri Standl. – G
Guettarda rigida A. Rich. – C
Guettarda scabra (L.) Lam. – C
Guettarda semipilosa – G
Guettarda undulata Griseb. – C
Guettarda valenzuelana A. Rich. – C
Hamelia patens Jacq. – G, C
Hamelia patens Jacq. var. *glabra* Oerst. – G
Hemidiodia ocimifolia (Willd.) Schum. – G, C
Hintonia latiflora (Sessé et Moçño ex DC.)
 Bullock – G
Isidorea elliptica Alain – C
Isidorea leonis Alain – C
Isidorea microphylla Borhidi – C
Isidorea rheedioides Borhidi – C
Ixora floribunda (A. Rich.) Griseb. – C
Machaonia havanensis (Jacq.) Alain subsp.
havanensis – C
Machaonia havanensis (Jacq.) Alain subsp.
orientalis Borhidi et Fernández – C
Machaonia micrantha Borhidi et Fernández – C
Machaonia microphylla Griseb. – C
Machaonia pauciflora Urb. – C
Machaonia urbaniana Standl. – C
Mitracarpus sagraeanus DC. – C
Morinda royoc L. – C

Palicourea domingensis (Jacq.) DC. – C
Phialanthus acunae Borhidi – C
Phialanthus linearis Alain – C
Phialanthus myrtilloides Griseb. – C
Phyllacanthus grisebachianus Hook. f. ex Hook. – C
Psychotria horizontalis Sw. – G, C
Psychotria nutans Sw. – C
Psychotria pubescens Sw. – G, C
Psychotria revoluta DC. – C
Psychotria sulzneri Small – C
Psychotria undata Jacq. – C
Psychotria sp. – G
Rachicallis americana (Jacq.) Hitchc. – C
Randia aculeata L. – G, C
Randia ciliolata Wr. ex Sauv. – C
Randia cinerea (Fern.) Standl. – G
Randia costata Borhidi – C
Randia cubana Borhidi – C
Randia guerrerensis Lorence et Rodríguez – G
Randia montana Benth. – G
Randia spinifex (R. et S.) Standl. – C
Randia thurberi S. Watson – G
Randia sp. – G
Richardia scabra L. – G, C
Rondeletia acunae Borhidi – C
Rondeletia apiculata Urb. – C
Rondeletia baracoensis Britton – C
Rondeletia combsii Greenman – C
Rondeletia ingrata Standl. – G
Rondeletia odorata Jacq. – C
Rondeletia rugelii Urb. – C
Rondeletia sevilensis Borhidi – C
Scolosanthus bahamensis Britton – C
Scolosanthus hirsutus Borhidi – C
Scolosanthus hispidus Borhidi – C
Scolosanthus maisianus Borhidi – C
Scolosanthus moanus Borhidi – C
Shaferocharis multiflora Borhidi et Muñiz – C
Spermacoce confusa Rendle – C
Spermacoce riparia Cham. et Schltdl. – G, C
Staelia alba (L.) Hitch. – G
Strumfia maritima Jacq. – C
Suberanthus nerifolius (A. Rich.) Borhidi et Fernández – C

RUPPIACEAE

Ruppia maritima L. – C

RUTACEAE

Amyris balsamifera L. – C
Amyris diatrypa Spreng. – C
Amyris elemifera L. – G, C
Amyris polymorpha Urb. – C
Amyris polyneura Urb. – C
Esenbeckia acapulcensis Rose – G
Kodalyodendron cubense Borhidi et Acuña – C
Pilocarpus racemosus Vahl – C
Plethadenia cubensis Urb. – C
Ravenia leonis M. Viet. – C
Ravenia spectabilis (Lindl.) Planchon – C
Zanthoxylum curbelloi Alain – C
Zanthoxylum elephantiasis Macf. – G, C
Zanthoxylum fagara (L.) Sarg. – G, C
Zanthoxylum flavum Vahl – C
Zanthoxylum martinicense (Lam.) DC. – G, C
Zanthoxylum pistacifolium Griseb. – C
Zanthoxylum spinosum (L.) Sw. – C
Zanthoxylum taediosum A. Rich. – C

SALICACEAE

Salix caroliniana Michx. – C
Salix humboldtiana Willd. – G, C

SALVINIACEAE

Salvinia auriculata Aubl. – G

SAPINDACEAE

Allophylus cominia (L.) Sw. – C
Allophylus roigii Lippold – C
Cardiospermum halicacabum L. – G, C
Cupania glabra Sw. var. *glabra* – C
Cupania macrophylla A. Rich. – C
Exothea paniculata (Juss.) Radlk. – C
Hypelate trifoliata Sw. – C
Matayba oppositifolia (A. Rich.) Britton – C
Matayba spondioides Standl. – G
Paullinia clavigera Schltr. – G
Paullinia cururu L. – G
Paullinia fuscescens Kunth – G, C
Paullinia pinnata L. – G, C
Paullinia aff. *turbacensis* Kunth – G

Sapindus saponaria L. – G, C
Serjania albopunctata Wr. in Griseb. – C
Serjania crassinervis Radlk. – C
Serjania diversifolia (Jacq.) Radlk. – C
Serjania linearifolia Lippold – C
Serjania occidentalis Lippold – C
Serjania schiedeana Schltdl. – G
Serjania subdentata Juss. – C
Serjania triquetra Radlk. – G
Serjania sp. – G
Thouinia acuminata S. Watson – G
Thouinia elliptica Radlk. – C
Thouinia hypoleuca Borhidi – C
Thouinia leonis Alain – C
Thouinia paucidentata Radlk. – G
Thouinia pseudopunctata Lippold – C
Thouinia stricta Lippold – C
Thouinidium decandrum (Kunth) Radlk. – G
Thouinidium pulverulentum (Griseb.) Radlk. – C

SAPOTACEAE

Chrysophyllum oliviforme L. – C
Manilkara jaimiqui (Wr. in Griseb.) Dubard – C
Manilkara zapota (L.) Van Royen – G, C
Myrsine coriacea DC. – C
Sideroxylon aff. *americanum* (Miller) Pennington – G, C
Sideroxylon capiri (DC.) Pittier subsp. *capiri* – G
Sideroxylon celastrinum (Kunth) Pennington – G, C
Sideroxylon foetidissimum Jacq. subsp. *foetidissimum* – C
Pouteria aristata (Britton et Wilson) Baehni – C
Pouteria campechiana (Kunth) Baehni – G, C
Pouteria dictyoneura (Griseb.) Radlk. – C
Pouteria domingensis (Gaertner) Baehni – C

SCHIZAEACEAE

Lygodium cubense HBK. – C
Lygodium venustum Sm. – G, C

SCROPHULARIACEAE

Agalinis maritima (Raf.) Raf. var. *grandiflora* (Benth.) Schinners – C

Agalinis purpurea (L.) Pennell – C
Angelonia angustifolia Benth. – G, C
Bacopa monnieri (L.) Wettst. – G, C
Bacopa repens (Swartz) Wettst. – G
Bacopa sp. – G
Buchnera longifolia Kunth – C
Buchnera pusilla Kunth – G
Capraria biflora L. – G, C
Lindernia diffusa (L.) Werrst – G, C
Lindernia dubia (L.) Penn. – C
Russelia chiapensis Lundell – G
Russelia floribunda Kunth – G
Russelia humilis (Sw.) Urb. – C
Russelia sarmentosa Jacq. – C
Russelia sp. – G
Schistophragma pusilla Benth – G
Scoparia annua Schltdl. et Cham. – G
Scoparia dulcis L. – G, C
Stemodia durantifolia (L.) Sw. – G, C
Stemodia maritima L. – C

SIMAROUBACEAE

Alvaradoa amorphoides Liebm. subsp. *psilophylla* (Urb.) Cronquist – C, G
Castela calcicola (Britton et Small) Ekm. – C
Castela spinosa Cronquist – C
Castela victorinii Acuña et Roig – C
Picramnia pentandra Sw. – C
Quassia amara L. – G
Recchia mexicana Moçño et Sessé – G
Simarouba glauca DC. – G, C
Suriana maritima L. – C

SMILACACEAE

Smilax havanensis Jacq. – C
Smilax lanceolata L. – G, C
Smilax laurifolia L. – C
Smilax spinosa Mill. – G

SOLANACEAE

Bouchetia sp. – G
Brunfelsia cestroides A. Rich. – C
Brunfelsia nitida Benth. – C
Capsicum annuum L. – G, C

Capsicum frutescens L. var. *baccatum* (L.)

Irish – C

Capsicum frutescens L. var. *frutescens* – C

Capsicum sp. – G

Cestrum daphnoides Griseb. – C

Cestrum diurnum L. – C

Cestrum nitidum Martens et Galeotti – G

Datura discolor Benth. – G

Datura stramonium L. – G, C

Espadea amoena A. Rich. – C

Henoonia myrtifolia Griseb. – C

Lycianthes armentalis J. Gentry – G

Lycianthes lenta (Cav.) Bitter – G, C

Lycium carolinianum Walt – G, C

Lycium twedianum Griseb. var. *chrysocarpum* (Urb. et Ekm.) Hitchc. – C

Nicotiana glauca Grah. – C

Physalis angulata var. *lanceifolia* (Nees) Waterfall – G, C

Physalis cordata Miller – G

Physalis lagascae Roem. et Schult. var. *glabrescens* Schultz – G, C

Physalis maxima Miller – G

Physalis minuta Griggs – G

Physalis nicandroides Schltdl. – G

Physalis pubescens L. – C

Physalis sp. – G

Solanum aculeatum (Jacq.) O. E. Schulz – C

Solanum americanum Miller – G, C

Solanum angustifolium Miller – G

Solanum antillarum O. E. Schulz – C

Solanum axillifolium Rose – G

Solanum bahamense L. – C

Solanum boldoense A. DC. – C

Solanum campechiense L. – G, C

Solanum candidum Lindl. – G

Solanum chamaeacanthum Griseb. – C

Solanum ciliatum Lam. – C

Solanum didymacanthum – C

Solanum diflorum Vell. – G

Solanum diphyllum L. – G

Solanum erianthum D. Don – C

Solanum havanense Jacq. – C

Solanum hazenii Britton – G

Solanum lanceifolium Jacq. – G

Solanum lignescens Fern. – G

Solanum madreense Fern. – G

Solanum oaxacanum Dunal – G

Solanum tampicense Dunal – G, C

Solanum tequilense A. Gray – G

Solanum torvum Sw. – C

Solanum umbellatum Miller – C

STERCULIACEAE

Ayenia abutilifolia (Turcz.) Turcz. – G

Ayenia euphrasifolia Griseb. – C

Ayenia jaliscana Watson – G

Ayenia manzanilloana Rose – G

Ayenia pusilla L. – G, C

Ayenia virgata Urb. et Ekm. – C

Byttneria aculeata Jacq. – G

Byttneria microphylla Jacq. – C

Guazuma ulmifolia Lam. – G, C

Helicteres baruensis Jacq. – G

Helicteres guazumaefolia Kunth – G, C

Helicteres jamaicensis Jacq. – C

Helicteres semitriloba Bertero – C

Hildegardia cubensis (Urb.) Kostermans – C

Melochia glandulifera Standl. – G

Melochia hirsuta Cav. – G

Melochia nodiflora Sw. – G, C

Melochia pyramidata L. – G, C

Melochia tomentosa L. – G, C

Melochia aff. *urticaefolia* Standl. – G

Waltheria indica L. – G, C

Waltheria operculata Rose – G

Waltheria preslii Walp. – G

SURIANACEAE

Suriana maritima L. – C

THELYPTERIDACEAE

Thelypteris palustris Schott – G, C

THEOPHRASTACEAE

Jacquinia aculeata (L.) Mez. – C

Jacquinia aurantiaca Aiton – G, C

Jacquinia axillaris Oerst. – G

Jacquinia berterii Spr. subsp. *acutifolia* (Griseb.) Borhidi – C

Jacquinia berterii Spr. subsp. *berterii* – C

Jacquinia brevifolia (Griseb.) Urb. – C

Jacquinia curtissii Britton – C
Jacquinia keyensis Mez. – C
Jacquinia maisiana Borhidi et Muñiz – C
Jacquinia moana Borhidi – C
Jacquinia pungens Gray – G
Jacquinia stenophylla Urb. – C
Jacquinia stenophylloides Borhidi – C

THYMELAEACEAE

Daphnopsis ficina Standl. et Steyerl. – G

TILIACEAE

Belotia mexicana (DC.) Schum. – G
Carpodiptera cubensis Griseb. – C
Corchorus aestuans L. – G, C
Corchorus hirsutus L. – C
Corchorus hirtus L. – G, C
Corchorus siliquosus L. – G, C
Heliocarpus mexicanus (Turcz.) Sprage – G
Heliocarpus reticulatus Rose – G
Luehea candida (DC.) Mart. – G
Luehea speciosa Willd. – C
Triumfetta bogotensis DC. – G, C
Triumfetta lappula L. – G, C
Triumfetta semitriloba Jacq. – G, C
Triumfetta sp. – G

TURNERACEAE

Turnera diffusa Willd. ex Schultes – G, C
Turnera ulmifolia L. – G, C
Piriqueta caroliniana (Walt.) Urb. – C
Piriqueta sp. – G

TYPHACEAE

Typha domingensis Pers. – G, C

ULMACEAE

Celtis iguanaea (Jacq.) Sarg. – G, C
Celtis pallida Torr. – G
Celtis trinervia Lam. – C

Phyllostylon brasiliense Capanema ex Benth et Hook. f. – C
Trema lamarckiana (R. et S.) Blume – C
Trema micrantha (L.) Blume – G, C
Trema micrantha (L.) Blume var. *floridana* (Britton) Standl. – G

URTICACEAE

Boehmeria cylindrica (L.) Sw. – C
Fleura cuneata (A. Rich.) Wedd. – C
Phenax rugosus (Poir.) Wedd. – G
Pilea microphylla (L.) Liebm. – C
Pouzolzia nivea S. Watson – G
Urera alceifolia Gaud. – G
Urera baccifera (L.) Gaud. – C
Urera caracasana (Jacq.) Griseb. – G
Urera elata (Sw.) Griseb. – G

VERBENACEAE

Aegiphila elata Sw. – C
Avicennia germinans (L.) L. – G, C
Bouchea prismatica (L.) Kuntze – G, C
Callicarpa bucheri Mold. – C
Callicarpa cubensis Urb. var. *cubensis* – C
Callicarpa grisebachii – C
Callicarpa roigii Britton – C
Citharexylum affine D. Don – G
Citharexylum bourgeaunianum Greenman – G
Citharexylum caudatum L. – C
Citharexylum fruticosum L. – C
Citharexylum pterocladum Donn. – G
Citharexylum spinosum L. – C
Clerodendrum aculeatum (L.) Schltdl. var. *aculeatum* – C
Clerodendrum tuberculatum A. Rich. – C
Duranta repens L. – C
Lantana arida Britton – C
Lantana bahamensis Britton – C
Lantana camara L. – G, C
Lantana canescens Kunth – C
Lantana insularis Mold. – C
Lantana involucrata L. – C
Lantana parvifolia Desf. – C
Lantana reticulata Pers. – C
Lippia alba (Mill.) Britton et Wilson – G, C
Lippia dulcis Trev. – G, C

Lippia micromera Schav. var. *Helleri* (Britton)

Mold. – C

Lippia nodiflora (L.) Michaux – G, C*Lippia stoechadifolia* (L.) Kunth – C*Lippia* sp. – G*Nashia armata* (Urb.) Mold. – C*Nashia cayensis* Britton – C*Petitita domingensis* Jacq. – C*Petitita urbanii* Ekm. – C*Petrea volubilis* L. – G, C*Priva aspera* Kunth – G*Priva lappulacea* (L.) Pers. – G, C*Pseudocarpidium avicennioides* (A. Rich.)

Millsp. – C

Pseudocarpidium multident (Urb.) Mold. – C*Pseudocarpidium neglecta* Bisse – C*Pseudocarpidium shaferei* Britton – C*Stachytarpheta angustifolia* (Miller) Vahl
– G, C*Stachytarpheta frantzii* Polak – G*Stachytarpheta jamaicensis* (L.) Vahl – G, C*Vitex acunae* Borhidi – C*Vitex clementis* Britton et Wilson – C*Vitex cooperi* Standl. – G*Vitex divaricata* Sw. subsp. *cubensis* (Urb.)
Borhidi – C*Vitex guanahacabibensis* Borhidi – C*Vitex hemsleyi* Brig. – G*Vitex mollis* Kunth – G*Vitex praetervisa* Borhidi – C*Vitex tomentulosa* Moldenke – C

VIOLACEAE

Corynostylis arborea (L.) Blake – G*Hybanthus attenuatus* (Humb. et Bonpl.)
Schultz-Menz – G*Hybanthus havanensis* Jacq. – C

VISCACEAE

Phoradendron commutatum Trel. – G*Phoradendron hexastichum* (DC.) Griseb. – C*Phoradendron piperoides* (Kunth) Trel. – C*Phoradendron quadrangulare* (Kunth) Krug et
Urb. – G*Phoradendron randie* (Bello) Britton – C*Phoradendron tamaulipense* Trel. – G

VITACEAE

Ampelocissus acapulcensis Kunth – G*Ampelopsis arborea* (L.) Rusby – C*Ampelopsis mexicana* Rose – G*Cissus cacuminis* Standl. – G*Cissus caustica* Tuss. – C*Cissus formosa* Standl. – C*Cissus rhombifolia* Vahl – G, C*Cissus salutaris* Kunth – G*Cissus sicyoides* L. – G, C*Cissus trifoliata* L. – C*Cissus tuberculata* Jacq. – C*Parthenocissus quinquefolia* (L.) Planchon – C*Vitis tiliaefolia* (Humb. et Bonpl.) R. et S. – C*Vitis bourgaeana* Planchon – G

ZYGOPHYLLACEAE

Guaiacum coulteri A. Gray – G*Guaiacum officinale* L. – C*Guaiacum sanctum* L. – C*Kallstroemia brachystylis* Vail. – G*Kallstroemia maxima* (L.) Torrey et A. Gray
– G, C*Kallstroemia pubescens* (G. Don) Dandy – G*Tribulus cistoides* L. – G, C

Apéndice II

Taxa exclusivos de Guerrero (G) y Cuba (C) y compartidos (GC)

Familias	Géneros			Especies		
	G	C	GC	G	C	GC
Acanthaceae	11	1	3	21	6	3
Achatocarpaceae	1	0	0	1	0	0
Adiantaceae	1	0	2	1	0	2

Familias	Géneros			Especies		
	G	C	GC	G	C	GC
Agavaceae	0	1	1	2	4	0
Aizoaceae	0	0	2	0	1	2
Alismataceae	1	0	2	2	2	3
Amaranthaceae	1	1	7	9	6	13
Anacardiaceae	4	1	2	7	4	1
Annonaceae	3	1	1	7	2	3
Apiaceae	2	3	0	2	4	0
Apocynaceae	6	7	6	15	15	4
Aquifoliaceae	0	1	0	0	2	0
Araceae	2	1	2	3	3	1
Araliaceae	0	0	1	0	0	1
Arecaceae	3	8	1	4	18	0
Aristolochiaceae	0	0	1	3	5	0
Asclepiadaceae	3	2	6	12	9	2
Asteraceae	14	16	16	34	54	12
Azollaceae	0	0	1	0	0	1
Basellaceae	1	0	0	1	0	0
Batidaceae	0	0	1	0	0	1
Begoniaceae	1	0	0	2	0	0
Bignoniaceae	8	5	5	12	16	5
Bixaceae	1	0	2	1	0	2
Bombacaceae	2	0	1	2	0	1
Boraginaceae	0	1	5	16	21	15
Brassicaceae	0	2	0	0	2	0
Bromeliaceae	1	3	2	3	5	3
Burseraceae	0	0	1	6	2	1
Buxaceae	0	1	0	0	3	0
Cabombaceae	0	1	0	0	1	0
Cactaceae	6	13	2	13	21	1
Caesalpiniaceae	0	2	9	21	16	14
Campanulaceae	0	0	1	0	0	1
Canellaceae	0	1	0	0	1	0
Cannaceae	1	0	0	0	1	0
Capparaceae	3	0	3	9	4	5
Caricaceae	1	0	0	1	0	0
Celastraceae	2	6	0	3	10	0
Ceratophyllaceae	1	0	0	2	0	0
Chenopodiaceae	1	2	1	2	4	0

Familias	Géneros			Especies		
	G	C	GC	G	C	GC
Chrysobalanaceae	2	0	1	2	0	1
Clusiaceae	0	1	2	2	3	0
Combretaceae	1	2	3	2	4	3
Commelinaceae	0	0	1	1	0	2
Connaraceae	0	0	1	1	0	2
Convolvulaceae	2	0	6	20	9	15
Cucurbitaceae	7	2	2	9	3	2
Cuscutaceae	0	0	1	3	3	1
Cycadaceae	0	0	1	1	1	0
Cyperaceae	1	2	8	21	13	23
Dilleniaceae	1	0	0	1	0	0
Dioscoreaceae	0	1	1	5	1	0
Ebenaceae	0	0	1	6	4	1
Elaeocarpaceae	0	0	1	0	0	1
Erythroxylaceae	0	0	1	1	7	1
Euphorbiaceae	5	16	12	45	42	17
Fabaceae	11	7	23	65	33	30
Flacourtiaceae	1	3	4	7	14	3
Gentianaceae	0	2	1	0	2	1
Gesneriaceae	1	4	0	1	5	0
Goodeniaceae	0	1	0	0	1	0
Haloragaceae	0	1	0	0	1	0
Hippocrateaceae	0	1	1	2	2	0
Hydrocharitaceae	0	2	0	0	2	0
Hydrophyllaceae	1	1	1	2	2	1
Iridaceae	0	1	0	0	1	0
Julianaceae	1	0	0	1	0	0
Krameriaceae	1	0	0	1	0	0
Lamiaceae	1	1	3	8	8	3
Lauraceae	0	1	1	1	2	0
Lemnaceae	1	0	2	4	2	1
Lennoaceae	1	0	0	1	0	0
Lentibulariaceae	0	0	1	1	3	1
Liliaceae	3	0	2	4	2	1
Limnocharitaceae	0	0	1	0	0	1
Loasaceae	2	0	0	2	0	0
Loganiaceae	0	2	2	1	3	1
Loranthaceae	4	2	0	3	3	0

Familias	Géneros			Especies		
	G	C	GC	G	C	GC
Lythraceae	1	3	3	3	8	2
Malpighiaceae	4	3	5	14	17	5
Malvaceae	2	4	11	14	16	19
Marantaceae	1	0	1	1	0	1
Marsileaceae	0	0	1	0	0	1
Meliaceae	0	1	4	3	7	2
Menispermaceae	1	1	1	1	1	1
Menyanthaceae	0	0	1	0	1	1
Mimosaceae	3	2	13	34	18	13
Molluginaceae	1	0	1	2	1	0
Moraceae	1	1	3	12	6	2
Myricaceae	0	1	0	0	1	0
Myrsinaceae	1	1	0	1	1	0
Myrtaceae	0	4	2	5	17	5
Najadaceae	0	0	1	0	1	1
Nyctaginaceae	2	1	6	5	7	6
Nymphaeaceae	0	2	1	1	3	1
Ochnaceae	0	0	1	2	2	1
Olacaceae	0	1	1	0	3	1
Oleaceae	0	3	0	0	4	0
Onagraceae	1	0	1	2	6	4
Opiliaceae	1	0	0	1	0	0
Orchidaceae	2	6	1	3	13	0
Oxalidaceae	0	0	1	4	1	0
Parkeriaceae	1	0	0	1	0	0
Passifloraceae	0	0	1	9	6	2
Pedaliaceae	1	0	0	1	0	0
Phytolaccaceae	0	1	3	0	2	3
Piperaceae	0	0	2	3	8	3
Plumbaginaceae	0	0	1	0	0	1
Poaceae	5	15	28	34	55	40
Polemoniaceae	1	0	0	1	0	0
Polygalaceae	0	0	2	3	8	2
Polygonaceae	2	0	3	15	5	3
Pontederiaceae	0	0	3	1	4	2
Portulacaceae	0	0	2	1	3	3
Potamogetonaceae	0	0	1	2	2	0
Pteridaceae	0	0	1	1	0	1

Familias	Géneros			Especies		
	G	C	GC	G	C	GC
Ranunculaceae	0	0	1	0	0	1
Rhamnaceae	3	4	3	8	16	2
Rhizophoraceae	0	0	1	0	0	1
Rubiaceae	6	22	12	17	87	12
Ruppiaceae	0	1	0	0	1	0
Rutaceae	1	4	2	1	14	4
Salicaceae	0	0	1	0	1	1
Salviniaceae	1	0	0	1	0	0
Sapindaceae	0	4	7	10	19	4
Sapotaceae	0	2	3	1	7	4
Schizaeaceae	0	0	1	0	1	1
Scrophulariaceae	1	1	8	8	7	6
Simaroubaceae	2	3	2	2	5	2
Smilacaceae	0	0	1	1	2	1
Solanaceae	1	5	7	21	23	8
Sphenocleaceae	0	0	1	0	0	1
Sterculiaceae	0	1	6	10	6	7
Surianaceae	0	1	0	0	1	0
Thelypteridaceae	0	0	1	1	1	0
Theophrastaceae	0	0	1	2	10	1
Thymelaeaceae	1	0	0	1	0	0
Tiliaceae	2	1	3	5	3	6
Turneraceae	0	0	2	1	1	2
Typhaceae	0	0	1	0	0	1
Ulmaceae	0	1	2	2	3	2
Urticaceae	2	3	1	5	4	0
Verbenaceae	0	7	9	12	34	10
Violaceae	1	0	1	2	1	0
Viscaceae	0	0	1	3	3	0
Vitaceae	1	1	3	5	7	2
Zygophyllaceae	0	0	2	3	2	2

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POLLEN VIABILITY OF PEAR CULTIVARS*

Á. FARKAS¹, ZS. OROSZ-KOVÁCS¹, T. BUBÁN² and J. FEJES²

¹Dept. Botany, Janus Pannonius University

H-7624 Pécs, Ifjúság u. 6, Hungary

²Research Station for Fruitgrowing

H-4244 Újfehértó, Pf. 38, Hungary

The determination of pollen viability of cultivated fruit tree varieties is often required by practical horticulture. Pollen viability of several pear cultivars was examined by a quick staining method based on the proline content of pollen grains. The cultivars were classified into five groups concerning their suitability as pollinators. This study indicates to what extent pollen viability may vary even within a species.

Key words: pollen, pear, proline

INTRODUCTION

Pear (*Pyrus communis*) is an autosterile, entomogamous species (Waite 1894: cit. Nyéki 1980). For this reason pollen donor cultivars in orchards should possess a good pollen viability. When only a low percentage of pollen is viable, successful pollination is not ensured. In breeding it is necessary to know the pollen viability of the individual pear cultivars. The quick staining method based on proline concentration (Gulyás and Pálfi 1986) shows the degree of vitality for each pollen grain on the basis of the amount or the absence of proline. As much as 33 local cultivars were examined by this method and classified concerning their suitability as pollinators.

Stanley and Linskens (1974), and Dashek and Mills (1981) pointed out that proline, one of the free amino acids, showed a positive correlation with the vitality and fertility of pollen grains. The proline concentration of pollen grains in itself is higher than the total concentration of all the other protein amino acids, and may even reach 1.5-2.5 percent of the dry matter of pollens (Tupy 1963, Zhang *et al.* 1982).

Pálfi *et al.* (1987) divided the angiospermous species into two groups according to the proline content of their pollen. In "proline-type species" the proline of mature and viable pollen grains reaches 1.0 percent of the dry matter. In these species the proline content of the pollen grains is proportionate to their fertility. This fact was supported by pollen germination experiments with the given species and proline concentration determinations from the amino acid extracts.

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These examinations showed correlation with the results of the isatin staining reaction. The other group of angiosperms was given the name of "nonproline-type species", in which the pollen viability cannot be determined by the isatin staining method, since in these species the proline concentration of the mature pollen grains does not reach 0.2 percent of the dry matter. According to Gulyás and Pálfi (1986), pear belongs to the "proline-type species".

Proline plays an important role in the energetic transformation of the germinating pollen and in the interactions with the style. Proline is also an effective activator of the Krebs cycle and regulates the water economy of the pollen and also the activity of certain enzymes (Dashek and Harwood 1974, Linskens 1974: cit. Pálfi and Gulyás 1987, Zhang *et al.* 1982). Other authors add that the role of proline is particularly important in the synthesis of glycoproteins that are rich in hydroxy-proline and indispensable during the elongation of the cell-wall and of the wall of the pollen tube (Tupy 1963, Stanley and Linskens 1974, Dashek and Mills 1981).

The most advantageous feature of proline is its high degree of water solubility. Proline is the only amino acid being solute and chemically active even if the water content of the pollen grain is extremely low, around 20–30%. At the same time proline increases the water-binding capacity and draught-resistance of pollen significantly by its strong hydrophilicity (Pálfi *et al.* 1974: cit. Gulyás and Pálfi 1989).

MATERIAL AND METHODS

The studied pear cultivars are listed in Table 1. Pollen was collected in April 1994, at the Research Station for Fruitgrowing, Újfehértó. In order to exclude the effects of the year, pollen samples were collected at the same time, from the same place and the same microclimatic conditions. Pollen viability could not have been affected by climatic factors.

Pollen samples were collected from undehiscent anthers of opening flower buds. After dehiscing of anthers pollen grains were fixed at 90 °C for 10 minutes. Following this treatment samples were kept in dark.

Among amino acid reagents isatin is reported to give the most intensive colouring with proline (blue or dark-blue) in paper chromatography. At the same time this isatin reagent is giving only a light pink or light brown colour even with tenfold amount of all the other amino acids. If the proline concentration of the pollen grain is high, the dark-blue or black colouring produced by isatin suppresses the faint colours of other amino acids.

Staining of pollen grains was carried out by the quick staining method based on proline concentration (Gulyás and Pálfi 1986).

Staining is evaluated by light microscope at hundredfold magnification. Around 500 pollen grains are counted in different fields of sight. An average value is calculated for differently coloured pollen grains and the result is expressed in percentages.

The advantage of the method is that it can be carried out quickly, contrasted with the lengthy procedure of extracting amino acids. Besides, it can be used for determining viability in both living and lifeless (fixed) pollen grains. Fixed pollen grains can be stained even a year after collecting the samples, because proline content of the pollen grains will not change after heat treatment.

Table 1
Percentage of pollen viability of pear cultivars

Number	Cultivar	Pollen viability % (dark staining)	Classification
1	PB 242	97	excellent
2	Újfehértó 101	92	excellent
3	Véres körte	85	good
4	Újfehértó PG 242	85	good
5	Ráckeve	83	good
6	Kieffer körte	82	good
7	Bicskei vérbélű	82	good
8	Izambert	80	good
9	Horváth körte	79	good
10	Árki vadkörte	71	good
11	Körte II/B	69	medium
12	Nyakas körte Noszvaj	69	medium
13	Gilles vajkörte	65	medium
14	Fillér körtéje	64	medium
15	Gerjén nyári körte	61	medium
16	Clapp körte	61	medium
17	Jégkörte	55	medium
18	Cinderi körte	54	medium
19	Bönschbunel kobakja	52	medium
20	Hertich bergamottja	47	weak
21	Talpas körte	42	weak
22	Körte B3	38	weak
23	Serres Olivér	35	weak
24	Citromízű körte	30	bad
25	Fülöp körte	27	bad
26	Hosszú zöld leveles	24	bad
27	Móri császári körte	19	bad
28	Bonnefond asszony	19	bad
29	Bitkéli nyári körte	14	bad
30	Lőrinci komócs körte	10	bad
31	Téli zöldkörte	10	bad
32	Egervári II	8	bad
33	Orient	0	male sterile

RESULTS

Pollen samples stained by isatin reagent were evaluated. Pollen grains were classified into 3 groups according to the degree of colouring. Dark staining pollen grains were of black or dark-blue colour. Their proline concentration is high, which shows that these are the viable pollen grains capable of developing a pollen tube. Medium staining pollen grains showed a light-blue colour. The proline concentration of these grains is lower, and it cannot be decided, whether they were viable or not. Non-staining pollen grains kept their original yellow colour or took a light-purple or light-brown colour. These grains are not viable, because their proline content is very small or they contain no proline at all.

On the basis of the distribution of differently coloured pollen classes the individual pear cultivars could be classified concerning their suitability as pollinators. Since only dark-blue pollen grains can be considered as surely viable, i.e. able to grow a pollen tube (Gulyás and Pálfi 1986), evaluation was based on the proportion of dark stained pollen grains.

Classification was done on the basis of the following percentage values:

Percentage of dark-staining pollen grains	Classification
91–100%	excellent
71–90%	good 51–70%
medium 31–50%	weak
< 30%	bad

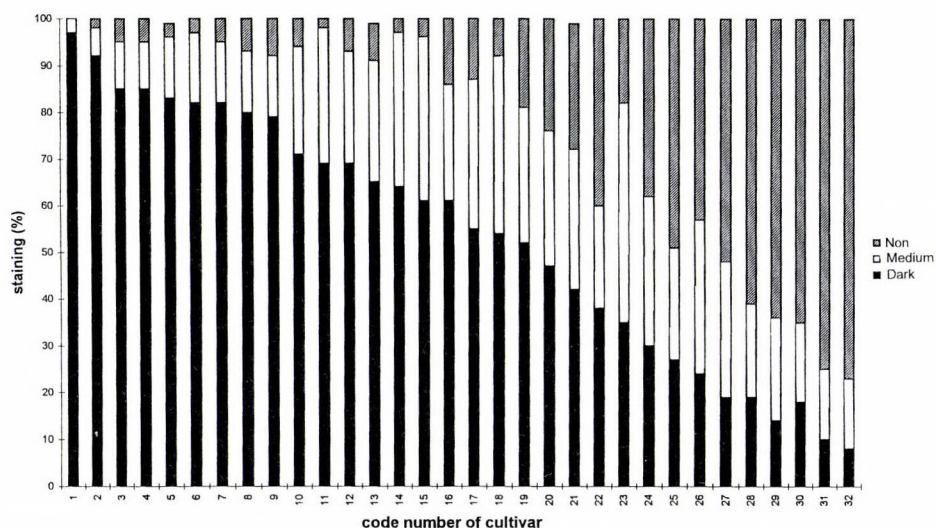


Fig. 1. Pollen viability of pear cultivars (for name of cultivars see Table 1)

Classification of each studied cultivar can be found in Table 1 (see also Fig. 1).

'Pb 242' and 'Újfehértó 101' cultivars can be mentioned among those of excellent pollen viability. 'Véres körte', 'Kieffer körte' and 'Horváth körte' belong to the group of good pollen vitality. The class with medium degree of pollen vitality includes 'Gilles vajkörte', 'Clapp körte' and 'Cinderi körte'. 'Talpas körte' and 'Serres Olivér' were classified as weak pollinators. 'Egervári II' and 'Téli zöldkörte' cannot be recommended as pollinators because of their small degree of pollen viability.

CONCLUSION

Since pollen samples were collected at the same time, from the same place and the same microclimatic conditions, pollen viability could not be affected by climatic factors. Further studies are being carried out in order to investigate the effects of different climatic and microclimatic conditions.

Categories for pollen viability are only suggestions, on the basis of which certain cultivars can be recommended as pollen donors, whereas others cannot be. Fertilisation studies have to justify yet that cultivars with the highest degree of pollen viability are the most suitable as pollen donors, while others with a small degree of pollen viability cannot be successfully used in pollination.

At the same time the present study illustrates how great diversity can be found among cultivars even within the same species. The reason behind the various degree of pollen viability can only be the different genetic constitution of the given cultivars. The examined cultivars are part of a gene bank, so the information gained from this study can be used in breeding.

REFERENCES

- Dashek, W. V. and Harwood, H. I. (1974): Hydroxyproline and lily pollen tube elongation. – *Acta Bot.* **38**: 947–959.
- Dashek, W. V. and Mills, R. R. (1981): Proline metabolism by germinating *Lilium longiflorum*. Labelling of cytoplasmic wall and culture medium molecules. – *Acta. Soc. Bot. Pol.* **50**: 51–66.
- Gulyás, S. and Pálfi, G. (1986): Proline-type pollens and their vitality in the Rosaceae and the species of other families. – *Acta Biol. Szeged.* **32**: 9–18.
- Gulyás, S. and Pálfi, G. (1989): A zárvatermő fajok felosztása a pollenszemek prolin értékei alapján. – *Bot. Közlem.* **76**: 241–251.
- Nyéki, J. (1980): *Gyümölcsfajták virágzásbiológiája és termékenyülése*. (Flower biology and fertilisation of fruit tree cultivars). – Mezőgazdasági Kiadó, Budapest.
- Pálfi, G. and Gulyás, S. (1987): Supplementary investigations into the range of relation of angiospermous species on the basis of the proline concentration of pollen. – *Acta Bot. Hung.* **33**: 317–324.

- Pálfi, G., Gulyás, S. and Szöllősi, I. (1987): Concentration of proline in pollens: a new taxonomical index. – *Acta Biol. Szeged.* **33**: 25–34.
- Stanley, R. G. and Linskens, H. F. (1974): *Pollen Biology, Biochemistry, Management*. – Springer Verlag. Berlin, Heidelberg, New York, pp. 154–159.
- Tupy, J. (1963): Free amino acids in apple pollen from the point of view of its fertility. – *Biol. Plantarum* **5**: 154–159.
- Zhang, H. Q., Croes, A. F. and Linskens, H. F. (1982): Protein synthesis in germinating pollen of *Petunia*: role of proline. – *Planta* **154**: 199–202.

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TEMPORAL CHANGES OF ALGAL COMMUNITIES IN THE “MÉLY-MOCSÁR” (HUNGARY)

A. KISS¹ and J. NÉMETH²

¹Hungarian Danube Research Station, Hungarian Academy of Sciences
H–2163 Vácátót, Alkotmány u. 2–4, Hungary

²Institute for Water Pollution Control, Water Resources Research Centre Plc.
H–1095 Budapest, Kvassay Jenő út 1, Hungary

Qualitative and quantitative algological investigations were carried out in a small swamp between July 1995 and April 1996. The Mély-mocsár (Deep-swamp) is located in the Pilis Biosphere Reserve (Visegrád Mts, Hungary). The swamp lies in a cavity and except the rain water it has no other water supply. The water of the swamp is slightly acidic and typical brown coloured water of marshland.

As a result of the qualitative algological investigations 56 taxa were determined (Cyanophyta: 1, Chrysophyceae: 2, Bacillariophyceae (Pennales): 7, Cryptophyta: 1, Dinophyta: 1, Euglenophyta: 28, Chlorophyta (Volvocales): 8, Chlorophyta (Chlorococcales): 4, Chlorophyta (Ulotrichales): 1, Chlorophyta (Desmidiaceae): 3).

The dominant species of the swamp was *Euglena texta*. The following species were also frequently found: *Euglena spirogyra*, *Phacus acuminatus*, *P. orbicularis*, *Trachelomonas stokesiana*, *Pinnularia viridis* and *Pandorina morum*.

In the course of the quantitative investigation, population density, biomass, relative abundances of the different taxa and the diversity of algal communities were determined.

The structure of algal communities was strongly influenced by the fluctuation of the water level, the thickness of ice and the density of submers vegetation. In spite of the fluctuation of these, the seasonal patterns of algal associations were clearly distinguishable with the following dominant taxa:

- spring: Cryptophyta, Dinophyta, Euglenophyta, Chlorophyta (Volvocales),
- summer: Euglenophyta, Chlorophyta (Desmidiaceae),
- autumn: Bacillariophyceae (Pennales), Cyanophyta, Euglenophyta,
- winter: Bacillariophyceae (Pennales), Cryptophyta, Chlorophyta (Volvocales).

Key words: swamp, algal community, population density, biomass, diversity, multivariate analysis

INTRODUCTION

Qualitative and quantitative algological investigations in the protected landscape areas of Hungary started at the turn of this century. Several research projects have been carried out by Palik (1940, 1941) and Uherkovich (1979, 1982) were focused the description of algal flora of several swampy areas of Hungarian mountain ranges.

The primary aim of this study was to fill the existing information gaps in relation to the algological aspects of the Hungarian shallow water bodies. In addition to the research and development conducted on the greater lakes during the

past few decades, the ecological importance of the smaller stagnant water bodies have been rapidly gaining attention.

STUDY AREA

The selected site of our investigations is located in the middle northern part of Hungary in a mountain range. In general, there are only limited number of shallow stagnant water bodies in the Pilis and Visegrád Mts.

The Mély-mocsár is located within the Visegrád Mts (Pilis Biosphere Reserve), at the south-eastern area of the Király-völgy, 350 m above the sea level (Fig. 1). The average surface area of this swamp is approximately 50 m × 20 m. The swamp lies in a cavity and its only water supply is the rainwater. The bottom of the swamp was covered by 60–70 cm sludge layer. From December to end of March the swamp was covered by ice and when the ice melted the water surface was doubled.

There is a dense population of *Carex gracilis* Curt. that extended gradually towards to the middle part of the swamp. Among the sedges the specimens of *Urtica dioica* L., *Oenanthe aquatica* (L.) Poir., *Lycopus europaeus* L., *Myriophyllum verticillatum* L., *Callitriche polymorpha* L. and *Ranunculus aquatilis* L. were found. The dense population of *Lemna minor* L., *Spirodela polyrrhiza* (L.) Schleiden and *Riccia fluitans* L. was observed on the water surface during the summer period.

On basis of the two chemical analysis of water samples (August 1995 and April 1996) the water of the swamp was slightly acidic and soft (Calcium 8 mg/l, Magnesium 3 mg/l) beta-oligohalobic water (Felföldy 1987) with the dominance of Ca^{2+} , HCO_3^- (34 mg/l), and SO_4^{2-} (22 mg/l) ions. The total mineral nitrogen was 0.89 mg/l and there was considerable soluble orto-phosphate value (0.21 mg/l) because of the fecal intake of wild boars and roe-deer.

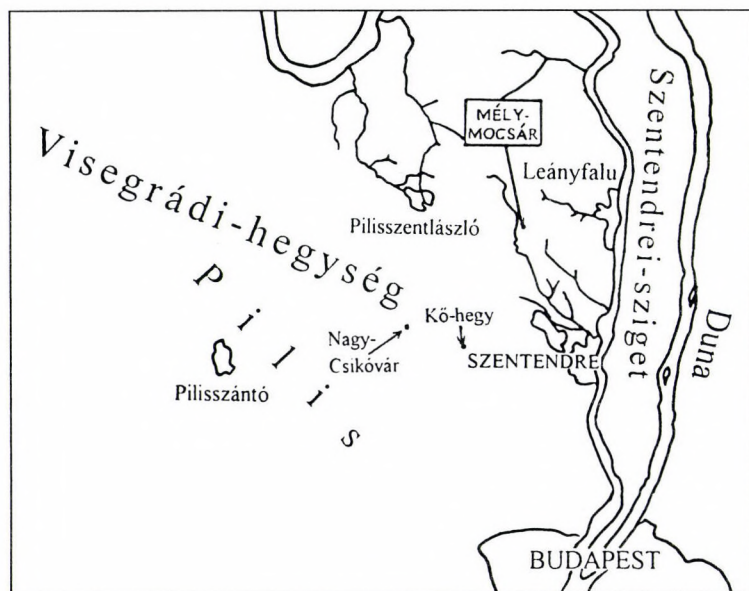


Fig. 1. Map of the study area

METHODS

Samples were collected at approximately two weekly intervals between July 1995 and April 1996. Samples were taken from the upper 2–3 cm water layer at the deepest point of the swamp.

The population density and biomass of the algal communities as well as the relative abundance of the different taxa were estimated using an inverted microscope (OPTON). Samples fixed in situ with Lugol's iodine and conserved with formaldehyde. The qualitative microscopical examination of samples was made by means of photomicroscope (Zeiss Docuval) using phase contrast optics as well. Centrifuged (1000 rpm) living material was used for determination of Euglenophyta phylum.

The following taxonomic works were used as the main reference text for identification of taxa: Bartha *et al.* 1976, Ettl 1983, Felföldy 1972, 1981, 1985, Hortobágyi 1964, Huber-Pestalozzi 1950, 1955, Hustedt 1930a, b, 1959, 1961–66, Kalbe 1973, Komárek 1974, Komárek and Fott 1983, Krammer and Lange-Bertalot 1986, 1988, 1991a, b, Németh 1980, Pochmann 1942, Popovsky and Pfister 1990, Pringsheim 1956, Starmach 1966, 1985, Uherkovich 1966.

The chemical investigation of the water samples was made by the laboratory of VITUKI Plc. according to the methods of Hungarian Standards.

For the measurement of the seasonal changes in the abundance of the different taxa and the composition of algal communities the successional rate was calculated from the population density and biomass data respectively. The summed-difference index was determined according to Lewis (1978) as follows:

$$SD = \sum_i \{ [b_i(t_1)/B(t_1)] - [b_i(t_2)/B(t_2)] \} / (t_2 - t_1)$$

where $b_i(t)$ is the abundance (population density) of the i^{th} taxon, $B(t) = \sum_i b_i(t)$ is the size of the community and $(t_2 - t_1)$ is the time interval between the two consecutive samplings. The summed difference index has the dimension of time^{-1} . The use of this index quantifies the extent of change in the individual time intervals.

Quantitative data were processed also by cluster- and correspondence analysis using the PRINCOMP program of the SYN-TAX III. program-package (Podani 1988). Numerical classification based on the population density and biomass data of the different group was performed by hierarchical agglomerative clustering. Percentage- and Gower-similarity coefficients (in distance form $D = 1 - S$) and chord-distance were used for the pairwise comparison of the samples.

RESULTS AND DISCUSSION

QUALITATIVE ALGOLOGICAL INVESTIGATIONS

The qualitative algological investigations revealed the presence of the next taxa:

CYANOPHYTA

Pseudanabaena sp. – It was frequent taxon from September to November.

CHRYSPHYCEAE

Chromulina sp. – Its mass production was observed from March to April.

Codosiga sp. – It was a rare taxon in July.

BACILLARIOPHYCEAE

Pennales

Eunotia bilunaris (Ehr.) Mills – It was observed in every sample.

Achnanthes hungarica (Grun.) Grun. – In September and the winter months.

Navicula sp. – It was often found except in March and April.

Pinnularia braunii (Grun.) Cleve – It was often found in September, November and February.

Pinnularia viridis (Nitzsch) Ehr. – It was often found in every month.

Stauroneis phoenicenteron (Nitzsch) Ehr. – Between September and February.

Nitzschia tryblionella Hantzsch – Between September and February.

CRYPTOPHYTA

Cryptomonas spp. – It was often found in December, March and April.

DINOPHYTA

Gymnodinium spp. – It was sporadically observed from November to March.

EUGLENOPHYTA

The number of the species was considerable contrast with the nearby Tólaki and Kőhegyi lake where from only a few species (especially *Phacus*) were described by Palik (1940, 1941).

Euglenales

Euglenaceae

Euglena allorgei Defl. – In July and August.

Euglena clara Skuja – In July.

Euglena limnophila Lemm. – In July and August.

Euglena mutabilis Schmitz – It was found in a few samples in September.

Euglena nana Johnson – It was found only one occasion in July.

Euglena pisciformis Klebs – From September to January. Its mass production was observed in the end of November.

Euglena sanguinea Ehr. – It was observed in large numbers from July to November.

Euglena spirogyra Ehr. var. *spirogyra* – Except September, November and February it was observed in every month.

Euglena texta (Duj.) Huebn. var. *texta* – Except the end of March and in early April it was often found in every month. There was the most frequent species of the “Mély-mocsár”.

Euglena tripteris (Duj.) Klebs – From September to December.

Euglena vermicularis Proschk.-Lavr. – In November.

Euglena viridis Ehr. – It was often found between July and October and in April.

Menoidium tortuosum (Stokes) Senn – It was often observed from November to January.

Phacus acuminatus Stokes var. *acuminatus* – From July to end of March. It was the most frequent *Phacus* species of the “Mély-mocsár”.

Phacus aenigmaticus Drez. – It was seldom observed in summer samples.

Phacus alatus Klebs – In September and December.

Phacus orbicularis Huebn. – It was often found in July, August, October, November, March and April.

Phacus oscillans Klebs – In July and August.

Phacus plataleus Drez. – In July and October.

Phacus cf. *undulatus* (Skv.) Pochm. – In September.

Trachelomonas globularis (Awer.) Lemm. – In July, October and November.

Trachelomonas hispida (Perty) Stein emend. Defl. – Between July and November and February and April.

Trachelomonas stokesiana Palmer – In every month except December.

Trachelomonas volvocinopsis Swir var. *volvocinopsis* – From July to November and April.

Trachelomonas volvocina Ehr. var. *volvocina* – In August.

Astasia sp. – It was seldom observed in a few winter samples.

Eutreptiaceae

Distigma sp. – It was seldom observed in April.

Peranematales

Peranema trichophorum (Ehr.) Stein – In July and August.

CHLOROPHYTA

The number of the Chlorophyta species (especially Desmidiaceae) was rather poor compare with the Tólaki and the Kőhegyi lake (Palik 1940, 1941).

Volvocales

Carteria sp. – It was often found in September.

Chlorogonium spp. – It were a frequent taxa from December to April.

Chlamydomonas spp. – It were a frequent taxa from November to April.

Eudorina elegans Ehr. – In August and September.

Gonium pectorale O. F. Muell. – It was seldom found from July to September.

Pandorina morum (O. F. Muell.) Bory – In every sample, except winter months.

Phacotus sp. – It was often observed from December to March. Its mass production was in December.

Pteromonas angulosa (Cart.) Lemm. – In April.

Chlorococcales

Coelastrum sp. – It sporadically observed in a few samples.

Hyaloraphidium sp. – It was often found in autumn and winter samples. Its mass production was in April. On the basis of Bourrelly's system it was classified as alga.

Scenedesmus acuminatus (Lagerh.) Chod. – In July, August and October.

Terastrum spp. – It were often found in March and April.

Ulotrichales

Koliella longiseta Hind. – Its mass production was in April.

Zygnematales

Cosmarium spp. – It was sporadically observed in summer and autumn.

Closterium ehrenbergi Menegh. – Between July and November and January.

Closterium idiosporum W. et G. S. West – In September, October and February.

QUANTITATIVE INVESTIGATION OF THE ALGAL COMMUNITIES

The community size and the abundance of the different taxa were characterized by the population density (ind ml⁻¹) and the biomass as well. Specific biomass of the dominant taxa were determined also in all of the samples investigated.

Temporal variations of community size and relative abundance of the dominant taxa calculated from the algal counts

The values of the abundance were 310 ind ml⁻¹ (5th October) and 92,430 ind ml⁻¹ (11th April) in the observation period (Fig. 2). The following seasonal changes of population density and structure of algal communities were identified:

- From July to the end of November the Pennales and Euglenophyta groups were amounted to the 50–80% of population density.
- In December, when the ice layer gradually thickened the above-mentioned groups disappeared and were replaced by Volvocales, Cryptomonas and *Chromulina* groups.
- The spring samples were dominated by the Cryptophyta, Chrysophyta and Chlorococcales groups, especially *Chromulina* sp. and *Hyaloraphidium* sp. with 90% relative abundance in end of April.

Temporal variations of community size and relative abundance of the dominant taxa calculated from the biomass data

The values of biomass were 3.15 mg l⁻¹ (2nd November) and 45.24 mg l⁻¹ (7th March) (Fig. 3). The following seasonal changes of biomass and structure of algal communities were identified:

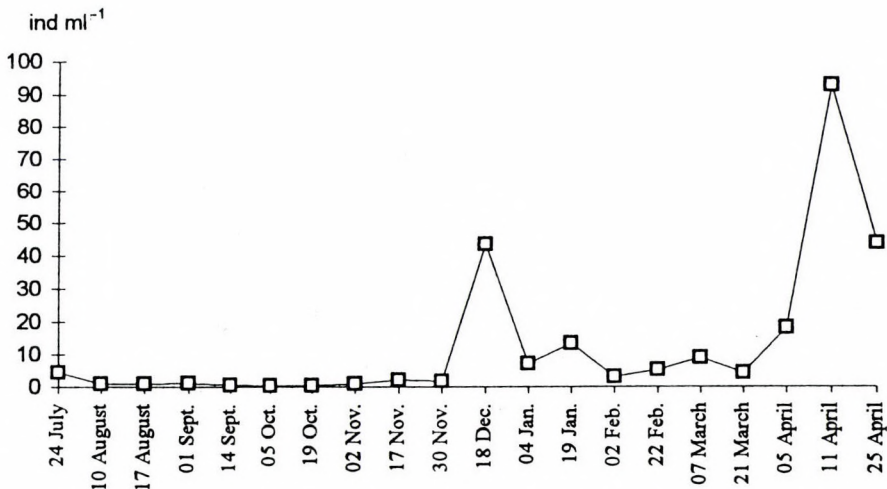


Fig. 2. Temporal variations in the abundance of algal community

- From July to end of November the most frequent group was the Euglenophyta with 30–97% relative abundance values. The following dominating summer and autumn group was the Desmidiaceae, especially the *Closterium ehrenbergi* Menegh.
- During the ice covered period 70–80% of the biomass was represented by *Pinnularia* taxa (especially *Pinnularia viridis*) with considerable specific biomass values (26–41 ng/ind).

Temporal variations of specific biomass of several dominant taxa

The specific biomass of the determined species remarkably changed during the observation period. For example, the specific biomass values of the most frequent species (*Euglena texta*) ranged from 15.88 ng/ind to 46.92 ng/ind (Fig. 4).

Temporal variations in the structure of the algal communities

Multivariate methods were used for analysing the temporal variations in the taxonomic composition of the algal communities. Quantitative data sets, population density and biomass data were processed by cluster- and correspondence analysis

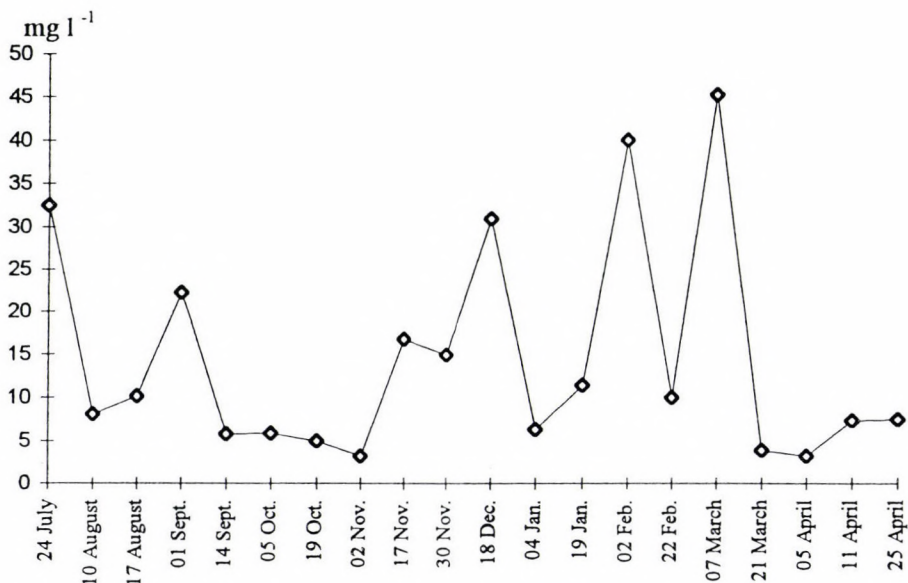


Fig. 3. Temporal variations in the biomass of algal community

separately. On the basis of the structure of the algal communities characteristic time intervals were distinguishable.

Results of cluster analysis

The groupings of sampling times according to the individual distance (similarity) coefficients are given by the following bracketed representation (see Németh 1994):

Groupings of sampling times based on the population density data

PERCENT:

(((((1,14)((4,8)(9,10))(((2,3)5)7)6))(((15,16)12)(13,18))11)17))(19,20))

CHORD:

(((((1,5)(2,3))6)((4,7)(9,10))8)14))(((13,18)15)12)16)11)17))(19,20))

GOWER (double zeros excluded):

(((((((((((((2,5)7)(3,6))17)10)8)(4,14)9)15)18)1)((11,12)13))16)20)19)

Groupings of sampling times based on the biomass data

PERCENT:

(((((((((3,6)9)1)((2,5)7)4)((8,20)((11,15)(12,13))))((14,16)10))((17,18)19))

CHORD:

(((((3,6)1)((2,7)5)4))(((8,9)((14,15)11))16)(12,13)))10((17,18)(19,20)))

GOWER (double zeros excluded):

(((((((((((((3,8)2)((5,7)6))14)17)10)9)1)((11,13)12))15)(16,18))20)4)19)

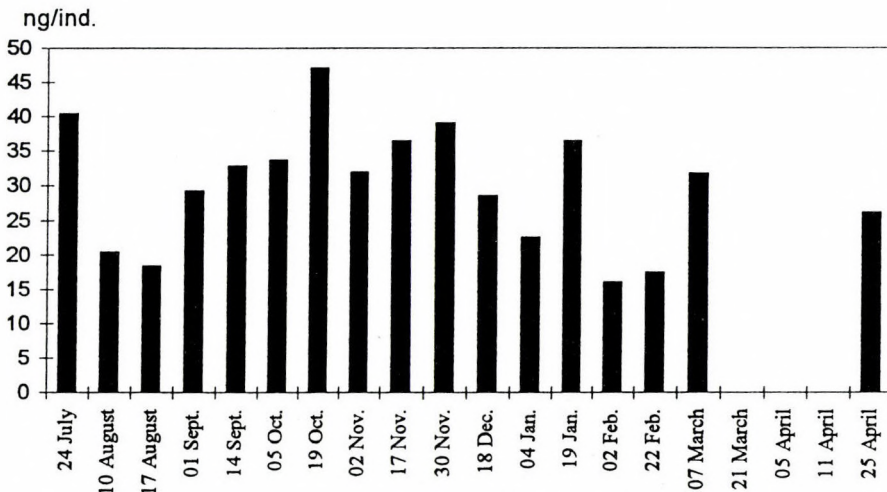


Fig. 4. Temporal variations of specific biomass of *Euglena texta* (Duj.) Huebn.

The application of the percentage- and chord-distances and agglomerative hierarchical (group average) clustering to population density data, roughly three time intervals were distinguishable: (1): summer and autumn (24 July–30 November 1995), (2): winter and early spring (18 December 1995–19 January 1996 and 22 February–05 April 1996), (3): late spring (11–25 April 1996). One point of time (08 February 1996) falls apart from the groups it was assigned to. The use of Gower resemblance index, there were only a few interpretable clusters in the dendrogram (*e.g.* three point representing the time interval from 21 March to 11 April 1996).

The application of identical methods in the clustering to the biomass data, the analyses yielded only a few recognisable clusters using different indices for pair-wise comparison of samples (*e.g.* 04–19 January and 21 March–11 April 1996 (PERCENT), 04–19 January and 21 March–25 April 1996 (CHORD), 18 December 1995–19 January 1996 (GOWER).

Results of correspondence analysis

Correspondence analysis was applied to create an ordination biplot for the representation of the groupings of the sampling times according to the population density and biomass data separately.

Figures 5a and b clearly depicts the following groupings among the sampling times and the corresponding characteristic taxa based on the patterns of the temporal alterations in the population densities:

(1) summer–autumn–winter: 24 July 1995–22 February 1996 continuous changes in the structure of the community (Euglenophyta (Pennales) → Volvocales), (2) an outlier: 18 December 1995 (Flagellatae and *Phacotus* spp.), (3) early spring: 21 March–05 April 1996 (*Cryptomonas* spp. and *Gymnodinium* spp.), (4) late spring: 11–25 April 1996 (*Chromulina* spp., *Hyaloraphidium* spp., *Koliella longiseta*).

According to the correspondence analysis based on the biomass data the whole investigation period was divided into two less sharply separable major groups (Figs 6a and b).

(1) summer–autumn–winter–early spring: 24 July 1995–07 March 1996 continuous community changes (Euglenophyta (Pennales, Desmidiaceae) → Volvocales (Flagellatae)), (2) spring: 21 March–25 April 1996 (*Gymnodinium*, *Cryptomonas* (Volvocales) → (*Chromulina* spp., *Hyaloraphidium* spp., *Koliella longiseta*).

Successional rate

The values of the SD calculated from the population density data ranged from 0.041 d^{-1} (24 July 1995–10 August 1995) to 0.260 d^{-1} (05 April 1996–11 April 1996). The order of magnitude of measured values corresponded to the data from the literature (Reynolds 1984). The representation of community changes are

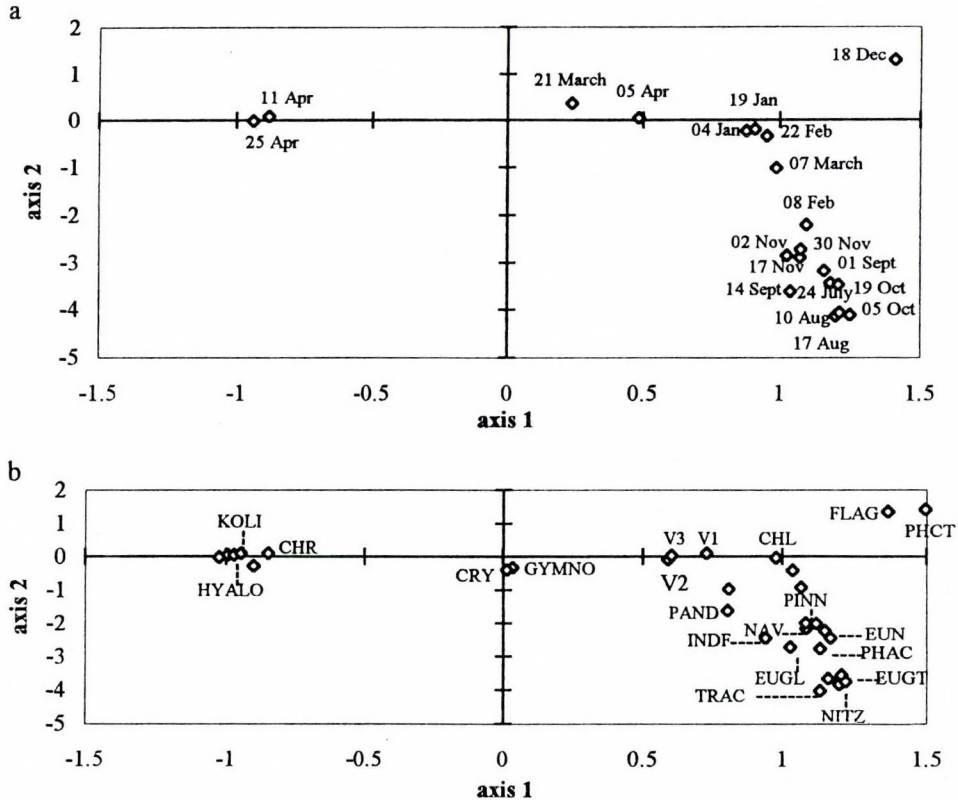


Fig. 5. Results of the correspondence analysis based on the population density data: simultaneous ordination of the sampling times (a) and the taxa (b). For the evaluation of the quantitative data the algal communities were divided into the following groups: 1. *Pseudanabaena* spp. (PS), 2. *Gymnodinium* spp. (GYMN), 3. *Cryptomonas* spp. (CRYP), 4. *Astasia* spp. (AST), 5. *Distigma* spp. (DIST), 6. *Euglena* spp. (EUG), 7. *Euglena texta* (EUGT), 8. *Menoidium tortuosum* (MEN), 9. *Phacus* spp. (PHAC), 10. *Trachelomonas* spp. (TRA), 11. *Chromulina* spp. (CHR), 12. *Eunotia* spp. (EUN), 13. *Navicula* spp. (NAV), 14. *Nitzschia* spp. (NITZ), 15. *Pinnularia* spp. (PINN), 16. *Carteria* spp. (CART), 17. *Chlorogonium* spp. (CHL), 18. *Pandorina morum* (PAND), 19. *Phacotus* spp. (PHAC), 20. *Pteromonas angulosa* (PTER), 21–23. unicellular green flagellates (mainly *Chlamydomonas* spp.) belonging to different size classes: V1 ($d = 4\text{--}8 \mu\text{m}$), V2 ($d = 8\text{--}16 \mu\text{m}$), V3 ($d = 16\text{--}32 \mu\text{m}$), 24. *Coelastrum* spp. (COEL), 25. *Hyaloraphidium* spp. (HYAL), 26. *Tetrastrum* spp. (TETR), 27. *Cosmarium* spp. (COSM), 28. *Closterium* spp. (CLOST), 29. *Koliella longiseta* (KOLI), 30. Flagellatae (FLAG), 31. Indeterminate (mainly filamentous greens)

shown in Figure 7. The SD values representing the changes in the community structure were averaged for a given time interval and these averages were plotted against the interval-mean. The graph also serves to illustrate a number of cardinal points (peaks exceeding 0.1 d^{-1}).

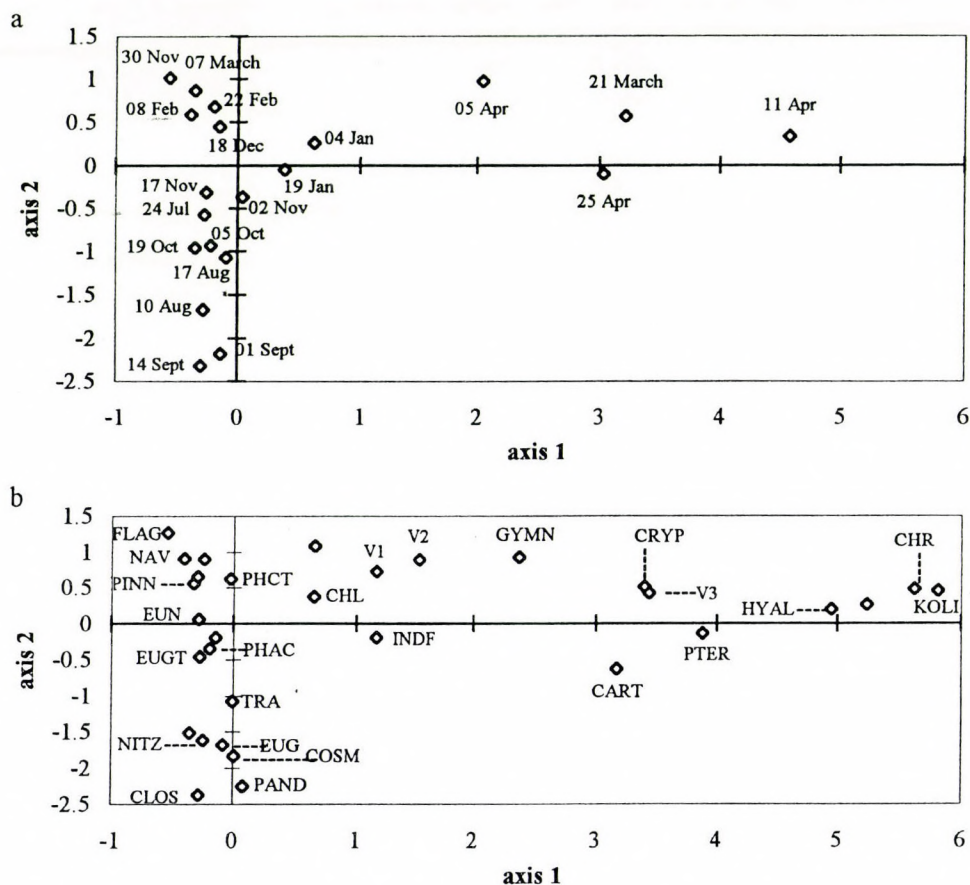


Fig. 6. Results of the correspondence analysis based on the biomass data: simultaneous ordination of the sampling times (a) and the taxa (b). For the evaluation of the quantitative data the algal communities were divided into the following groups: 1. *Pseudanabaena* spp. (PS), 2. *Gymnodinium* spp. (GYMN), 3. *Cryptomonas* spp. (CRYP), 4. *Astasia* spp. (AST), 5. *Distigma* spp. (DIST), 6. *Euglena* spp. (EUG), 7. *Euglena texta* (EUGT), 8. *Menoidium tortuosum* (MEN), 9. *Phacus* spp. (PHAC), 10. *Trachelomonas* spp. (TRA), 11. *Chromulina* spp. (CHR), 12. *Eunotia* spp. (EUN), 13. *Navicula* spp. (NAV), 14. *Nitzschia* spp. (NITZ), 15. *Pinnularia* spp. (PINN), 16. *Carteria* spp. (CART), 17. *Chlorogonium* spp. (CHL), 18. *Pandorina morum* (PAND), 19. *Phacotus* spp. (PHAC), 20. *Pteromonas angulosa* (PTER), 21–23. unicellular green flagellates (mainly *Chlamydomonas* spp.) belonging to different size classes: V1 ($d = 4\text{--}8 \mu\text{m}$), V2 ($d = 8\text{--}16 \mu\text{m}$), V3 ($d = 16\text{--}32 \mu\text{m}$), 24. *Coelastrum* spp. (COEL), 25. *Hyaloraphidium* spp. (HYAL), 26. *Tetrastrum* spp. (TETR), 27. *Cosmarium* spp. (COSM), 28. *Closterium* spp. (CLOST), 29. *Koliella longiseta* (KOLI), 30. Flagellatae (FLAG), 31. Indeterminate (mainly filamentous greens)

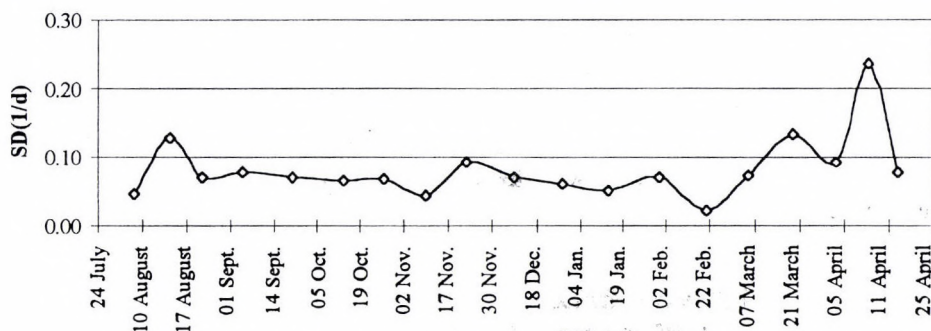


Fig. 7. Temporal variations of the summed-difference (SD) index calculated from the population density data

Two high compositional changes are shown in the graph: (1) 30 November–18 December ($SD = 0.109 \text{ d}^{-1}$) and (2) 07 March 1996–11 April 1996 ($SD = 0.104\text{--}0.260 \text{ d}^{-1}$). The first period refers to the development of ice cover and the second one characterise melting and water level increase, respectively. The results indicate the primary importance of the hydrological conditions in this marshland area which is basically lacking in allochthonous nutrient load.

The values of the SD calculated from the biomass data ranged from 0.021 d^{-1} (08 February 1996–22 February 1996) to 0.236 d^{-1} (05 April 1996–11 April 1996). The tendencies in the temporal variations of SD index was highly similar using either population density or biomass data (Fig. 8).

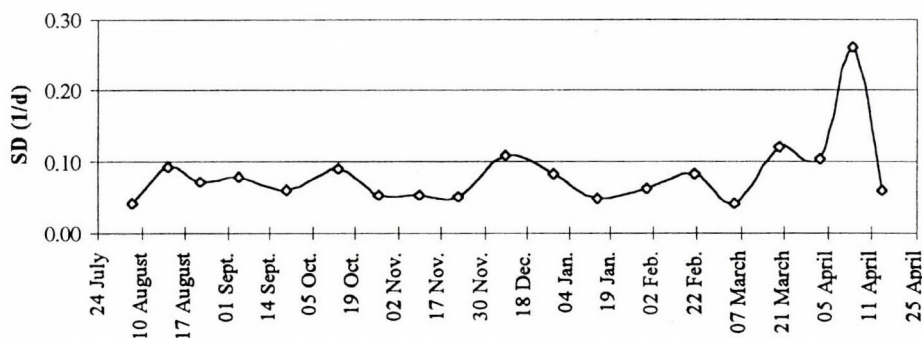


Fig. 8. Temporal variations of the summed-difference (SD) index calculated from the biomass data

Diversity

The **Shannon–Weaver-index** (H) (1949), as well as the number of taxa (S), $H_{\max} = \log_2 S$, and equitability ($J = H/H_{\max}$) were used as a measure of community diversity. The diversity was calculated from the population density and biomass data, respectively.

Temporal variations of the community diversity calculated from the population density data

The seasonal changes of the H , $H_{\max}$ and J were characterised by curves with 3–5 peaks (Fig. 9). From July to November the curves were run nearly parallel together. The values of H decreased from December due to the increasing population density of a few planktonic taxa, especially the *Hyaloraphidium* after ice melting in April. At the same time, the $H_{\max}$ increased due to the occurrence of typical summer taxa (the representatives of Euglenophyta phylum).

Temporal variations of the community diversity calculated from the biomass data

The temporal alterations of diversity and its relative indices was different because only a few group consist of the biomass (Euglenophyta, Pennales, Desmidiaceae). In February both values of J and H sharply decreased, because almost the whole biomass was represented by the Pennales taxa. From the end of February the values of H , J and $H_{\max}$ increased, the distribution biomass became

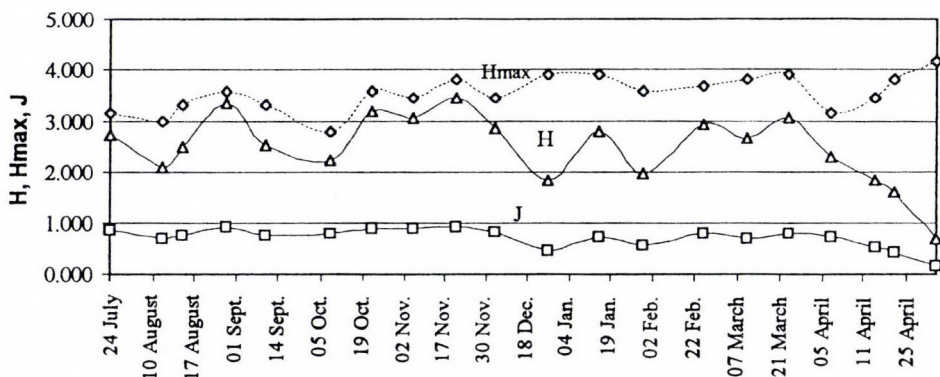


Fig. 9. Temporal variations of the community diversity calculated from the population density data

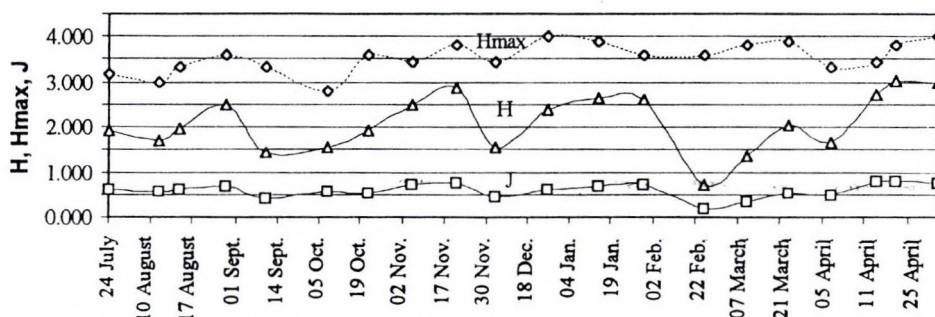


Fig. 10. Temporal variations of the community diversity calculated from the biomass data

equable, because the biomass was formed by group with little specific biomass (Volvocales, Chlorococcales, Cryptophyta) (Fig. 10).

CONCLUDING REMARKS

During the ten month observation period 20 samples were examined from qualitative and quantitative algological aspects. According to the observations, the following qualitative statements are taken:

1. The algal communities were characterised by the dominance of the Euglenophyta Pennales and taxa. Twenty-eight taxa belong to the phylum Euglenophyta from the 56 determined ones.

2. The results indicate the primary importance of the hydrological conditions in this marshland area which is basically lacking in allochthonous nutrient load. It was pointed out that all of the biological events observed was strongly affected by the variations of the fluctuation of the water level, the thickness of ice cover and the density of submers vegetation.

3. In spite of the fluctuating environment, seasonal succession was found, dominated by the following taxa:

summer: Pennales, Euglenophyta (mainly *Euglena texta*), Desmidiaceae,
autumn: Cyanophyta, Pennales, Euglenophyta,
winter: Pennales, Cryptophyta, Dinophyta, Volvocales,
spring: Pennales, Cryptophyta, Euglenophyta, Volvocales.

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REFERENCES

- Bartha, Zs., Felföldy, L., Hajdú, L., Horváth, K., Kiss, K. T., Schmidt, A., Tamás, G., Uherkovich, G. and Vörös, L. (1976): A zöldalgák (Chlorococcales) rendjének kishatározója. – *Vízügyi Hidrobiológia* **4**: 1–343. VIZDOK, Budapest.
- Ettl, H. (1983): Chlorophyta I. Phytomonadina. – *Süßwasserflora von Mitteleuropa* **9**: 1–807. Gustav Fischer Verlag, Stuttgart, New York.
- Felföldy, L. (1972): A kékgalgák (Cyanophyta) kishatározója. – *Vízügyi Hidrobiológia* **1**: 1–257. VIZDOK, Budapest.
- Felföldy, L. (1981): A zöldalgák Desmidiáles rendjének kishatározója. – *Vízügyi Hidrobiológia* **10**: 1–276. VIZDOK, Budapest.
- Felföldy, L. (1985): A zöldalgák Phytomonadina csoportjának kishatározója. – *Vízügyi Hidrobiológia* **14**: 1–161. VGI, Budapest.
- Felföldy, L. (1987): A biológiai vízminősítés (3. javított és bővített kiadás). – *Vízügyi Hidrobiológia* **9**: 1–263. VIZDOK, Budapest.
- Hortobágyi, T. (1964): Neue Euglenophyten- und Chrysophytenarten. – *Acta Bot. Acad. Sci. Hung.* **10**: 145–158.
- Huber-Pestalozzi, G. (1950): *Cryptophyceen, Chloromonadinen, Peridineen. Das Phytoplankton des Süßwassers*. 3. – In: Thienemann, A. (ed.): Die Binnengewässer 16(3): 1–310. E. Schweizererbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Stuttgart.
- Huber-Pestalozzi, G. (1955): *Euglenophyceen. Das Phytoplankton des Süßwassers*. 4. – In: Thienemann, A. (ed.): Die Binnengewässer 16(4): 1–606. E. Schweizererbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Stuttgart.
- Hustedt, F. (1930a): Bacillariophyta (Diatomeae) (zweite Auflage). – *Paschers Süßwasserflora* **10**: 1–460.
- Hustedt, F. (1930b): Die Kieselalgen Deutschlands, Österreichs und der Schweiz. – *Rabenhorst's Kryptogamenflora* **7**(1): 1–920. Akad. Verlagsgesellschaft m.b.H., Leipzig.
- Hustedt, F. (1959): Die Kieselalgen Deutschlands, Österreichs und der Schweiz. – *Rabenhorst's Kryptogamenflora* **7**(2): 1–847. Reprint. O. Koeltz Sci. Publ., Koenigstein, 1977.
- Hustedt, F. (1961–66): Die Kieselalgen Deutschlands, Österreichs und der Schweiz, unter Berücksichtigung der übrigen Länder Europas sowie der abgrenzenden Meeresgebiete. – *Rabenhorst's Kryptogamenflora* **7**(3): 1–816. Reprint. O. Koeltz Sci. Publ., Koenigstein, 1977.
- Kalbe, L. (1973): *Kieselalgen in Binnengewässern. Diatomeen*. – Die Neue Brehm-Bücherei 467. A. Ziemsen Verlag, Wittemberg Lutherstadt, pp. 1–206.
- Komárek, J. (1974): Taxonomische Bemerkungen zu einigen Arten der Mikroflora der Teich Böhmen. – *Acta sci. nat. Mus. Bohem. merid.*, České Budejovice, **14**: 161–190.
- Komárek, J. and Fott, B. (1983): *Chlorophyceae (Grünalgen), Ordnung: Chlorococcales*. – In: Thienemann, A. (begr.): Die Binnengewässer Band 16: Das Phytoplankton des Süßwassers, 7(1): 1–1044. Schweizererbart'sche Verlagsbuchhandlung (Nägele u. Obermiller).
- Krammer, K. and Lange-Bertalot, H. (1986): *Bacillariophyceae. 1. Naviculaceae*. – Süßwasserflora von Mitteleuropa 2(1): 1–876. Gustav Fischer Verlag, Stuttgart, New York.
- Krammer, K. and Lange-Bertalot, H. (1988): *Bacillariophyceae. 2. Bacillariaceae, Epithemiaceae, Surirelliaceae*. – Süßwasserflora von Mitteleuropa 2(2): 1–596. Gustav Fischer Verlag, Stuttgart, New York.
- Krammer, K. and Lange-Bertalot, H. (1991a): *Bacillariophyceae. 3. Centrales, Fragilariaceae, Eunoeciaceae*. – Süßwasserflora von Mitteleuropa 2(3): 1–576. Gustav Fischer Verlag, Stuttgart, New York.

- Krammer, K. and Lange-Bertalot, H. (1991b): *Bacillariophyceae. 4. Achnanthaceae: Gesamtliteraturverzeichnis Teil: 1–4.* – Süßwasserflora von Mitteleuropa 2(4): 1–437. Gustav Fischer Verlag, Stuttgart, Jena.
- Lewis, W. M. (1978): Analysis of succession in a tropical phytoplankton community and a new measure of succession rate. – *American Naturalist* **112**: 401–414.
- Németh, J. (1980): Az ostoros algák (Euglenophyta) kishatározója. – *Vízügyi Hidrobiológia* **8**: 1–294. VIZDOK, Budapest.
- Németh, J. (1994): *Hydrobiological research of the River Danube between Rajka and Budapest. III. Phytoplankton.* – XVIIth Conference of the Danube Countries on Hydrological Forecasting and Hydrological Bases of Water Management. Budapest, 5–9 September, 1994, pp. 727–733.
- Palik, P. (1940): A hazai tőzeglápok algái. II. A tölaki tőzeges láp Pomáz mellett. – *Index Horti Botanici Universitatis Budapestinensis* **4**: 17–42.
- Palik, P. (1941): Adatok Budapest környékének algaflórájához. – *Kőhegyi-tó. – Borbásia* **3**: 37–58.
- Pochmann, A. (1942): Synopsis der Gattung Phacus. – *Arch. f. Protistenkunde* **95**: 81–252.
- Podani, J. (1988): SYN-TAX III. Users Manual. – *Abstracta Botanica* **12**(Suppl. 1): 1–183.
- Popovsky, J. and Pfister, L. (1990): *Dinophyceae (Dinoflagellida).* – Süßwasserflora von Mitteleuropa 6: 1–272. Gustav Fischer Verlag, Stuttgart, Jena.
- Pringsheim, E. G. (1956): Contributions towards a monograph of the genus Euglena. – *Nova Acta Leopoldina*, N.F., **18**(125): 1–168.
- Reynolds, C. S. (1984): *The ecology of freshwater phytoplankton.* – Cambridge Univ. Press, Cambridge, 384 pp.
- Shannon, C. E. and Weaver, W. (1949): *The mathematical theory of communication.* – Univ. of Illinois Press, Urbana.
- Starmach, K. (1966): *Cyanophyta, Glaucophyta.* – Flora Ślaskowa Polski, 2: 1–807. Państwowe Wydawnictwo Naukowe, Warszawa.
- Starmach, K. (1985): *Chrysophyceae und Haptophyceae.* – Süßwasserflora von Mitteleuropa 1: 1–515. Gustav Fischer Verlag, Stuttgart, New York.
- Uherkovich, G. (1966): *Die Scenedesmus-Arten Ungarns.* – Akadémiai Kiadó, Budapest, 173 pp.
- Uherkovich, G. (1979): Az öcsi Nagytó limnológiája. – *Veszprém Megyei Múzeumok Közleményei* **14**: 25–53.
- Uherkovich, G. (1982): A Fekete-hegy (Balaton-felvidék) Kerek-tava algavegetációja. – *A Bakonyi Természettudományi Múzeum Közleményei* **1**: 81–110.

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DISTRIBUTION OF SPECIES ATTRIBUTES IN SECONDARY SUCCESSION OF AN OVERGRAZED PASTURE IN EAST HUNGARY

G. MATUS

*Dept. Botany, Kossuth Lajos University
H-4010 Debrecen, Pf. 14, Hungary. E-mail: matus@tigris.klte.hu*

Distribution of species attributes was studied on the vegetation of permanent plots during the first six years of a secondary succession on an abandoned farm in the "Nyírség" region (East Hungary). Test of homogeneity (G-test) was used to reveal significant changes in pattern of five attribute systems. Distribution of Raunkiaer's and Ujvárosi's life-form categories, that of social behaviour types, coenological groups and N indicator values was studied. Comparisons were made on pairs of successional years and on pairs of sampling units as well.

The results were highly dependent on the attribute to be tested. Significant differences between years were more frequent in longer-terms while less of them were found between subsequent dates of sampling. Most of the significant changes of attribute patterns was detected in the first three years.

Numerous spatial inhomogeneities were found between plots. A connection was detected between frequency of inhomogeneities in pairs of plots and in similarities of the initial vegetation of plots. Attribute patterns of successional plots were the most distinct from that of the control one. Experimental removal of topsoil had a definite effect on attribute pattern of vegetation and enhanced establishment of pre-disturbance species.

Key words: species attributes, social behaviour type, secondary succession, grazing, Nyírség

INTRODUCTION

Vegetation dynamics in grasslands is highly influenced by fluctuating intensity of animal keeping. Spatiotemporal distribution of grazing related to the pattern of site relief conditions can be an important factor in shaping natural vegetation patchiness and diversity at the landscape level (Précsényi *et al.* 1991, Nagy *et al.* 1991a, b). In our earlier studies (Matus and Tóthmérész 1990, 1991a) changing distribution of life-forms was already detected at different intensities of cattle grazing which is the traditional use of dry grasslands in the study area.

On the other hand extreme overgrazing is a serious disturbing factor in grasslands often initiating degrading. Uncontrolled exploitation of dry sandy grasslands by geese is a widespread practice in East Hungarian pastures. In nature reserves overgrazing by ten thousands of geese promotes weed invasions and leads to persistent problems in management (Matus and Tóthmérész 1991b, Tóthmérész and Matus 1991). The aim of our study was to describe vegetation dynamics after the abandonment of goose farming on such an overgrazed area.

There are attempts to characterize successions through the changing distribution of species attributes. This type of interpretation gains its origin from the concept of indication. In succession species replacements are thought to be driven by changing environmental conditions and one can find certain commonalities in life cycles and other attributes of species typical in a given phase of the process. According to this concept systems of ecological indicator values (Ellenberg 1950a, b, 1974, Ellenberg *et al.* 1991, Zólyomi and Précsényi 1964, Zólyomi *et al.* 1967) are widely used to enlighten vegetation state and change.

Changing dominance of indicator values and of phytosociological groups were already detected in early ruderal successions in experimental gardens (Bornkamm 1981, 1985, Bornkamm and Hennig 1982, Schmidt 1988) but no statistical analyses were carried out to demonstrate significance. These studies as well as similar ones in Hungary (Ujvárosi 1952, Ubrizsy 1957) also revealed the importance of life-forms in description of fallow successions but without considering methods to test distributions of these attributes.

Inhomogeneity of the distribution of W (humidity) and R (soil reaction) indicator values was already tested in a primary series on sand of the Hungarian Lowlands (Zólyomi *et al.* 1988). No such study was however carried out in secondary successions and for species attributes other than indicator values.

I was out to test the relevance of five attribute systems in an early secondary succession under field conditions. Attributes referring to the plant strategy types and to phytosociological character were involved together with two life-form systems and an ecological indicator value.

MATERIAL AND METHODS

STUDY AREA

Field data were collected at the "Nyírség" region of the Great Hungarian Plain, near the village Vámospércs (Hajdú-Bihar County). The site called "Villongó-dűlő" (47°32'N, 21°58'E) is situated 25 km East of Debrecen. It is characterized with immobile inland sand dunes of the Pleistocene. The dominant size class of the coarse-grained sand in the region is between 0.1–0.3 mm (Borsy 1961). Topsoil of the site is calcium free, moderately acidic-acidic (pH_{KCl}: 4.1–5.8). Humus contents of the A1 horizon is usually under 1% (AK < 30). Genetic soil type of the site can be considered as loose sand of low humus contents (Stefanovits 1981). Climate of the region is moderately continental with a mean annual temperature of 10.0 °C and 600 mm of annual precipitation (Pécsi 1969).

The pre-disturbance vegetation of the site was a perennial grassland *Cynodonto-Festucetum pseudovinae* (Soó 1980) exploited only extensively by cattle from May to October and occasionally by hare throughout the year. The former vegetation of the dune-top was mostly devastated by intensive goose breeding in 1989.

More details on site characteristics, prehistory and on the climatic events of the study period can be found at Matus and Tóthmérész (1994, 1995).

VEGETATION SURVEY

Vegetation of five permanent plots was surveyed. Plot arrangement followed the apparent pattern of first year vegetation. Patches of thick goose dropping layer with no surviving perennials (plot A), with some surviving perennials and thick dropping layer (plot B), and total denudation, no goose droppings (plot C) were distinguished. In plot D, similar to plot A at the beginning, dropping layer was removed in spring 1990. Undisturbed vegetation in the close vicinity of the site was sampled in plot E in 1995 while field data for the four successional plots were collected three times a year (April, June, September) between 1990–1995. In this paper early summer relevés are only discussed.

Species lists of vascular plants were compiled and cover estimates per species were made using the percentage scale (1–100%). Manuals of Hortobágyi (1968) and of Simon (1992) were used in identification. Vegetative grasses were specified according to Behrendt and Hanf (1979) while work of Csapody (1968) was used to identify forb seedlings.

DATA PROCESSING AND ANALYSIS

Data analyses were carried out on five attributes: life-form categories according to Raunkiaer (RAU) and to Ujvárosi (UJV), coenological distribution (COE), social behaviour types (SBT) and nitrogen values (N). Changes of weighted T, W and R values were also studied (Matus 1995), but showed no apparent alteration during the whole period therefore were omitted from statistical analyses.

The categorization of the Raunkiaer system (Raunkiaer 1934, Soó 1980) is widely used. The Ujvárosi system (Ujvárosi 1952, 1973, Hunyadi 1988) was originally elaborated for practical purposes, *e.g.* to classify life strategy types in arable and pasture weeds. Categories for the phytosociological character, and that of the nitrogen values are based on the system of Ellenberg (1950*a*, *b*, 1974, Ellenberg *et al.* 1991) adapted to our geographic conditions (*e.g.* continental climate) by Borhidi (1995).

The system for the social behaviour types is based on the theory of Grime (1977, 1979) on the three basic strategy types in vascular plants. The Borhidi system (1995) uses a more refined categorization considering the role of species in natural and secondary vegetation of the Pannonian Basin with special respect to successional, degradational processes. Regional differences in indicator characters and phytosociological behaviour in European weeds, composing most of the species set in this study, was presented by Holzner (1978).

We used the test of homogeneity (G-test) to compare observed frequencies of species attributes (Zar 1984). G-values in all cases were corrected according to the Williams method (Sokal and Rohlf 1981; p. 746) as $G_{adj}=G/q_{min}$. The correction has been processed with the formula as follows:

$$q_{min} = 1 + (a+1)(b+1)/6n,$$

where “ q_{min} ” is a simple (lower bound) estimate of the correction quotient, “ a ” is the number of columns, “ b ” is the number of rows in the table and “ n ” is the sample size. G_{adj} -values were compared with χ^2 distribution with $df = (a-1)(b-1)$ degrees of freedom. Significance was given at 0.1, 0.05, 0.01, 0.005 and 0.001 levels, respectively.

Frequencies of categories were often under 5, the value minimally required for the test, therefore fusions were necessary to gain statistically reliable results. Fusion of attribute categories were carried out in a way to maintain the biological relevance.

Raunkiaer's life-forms were fused into two groups as therophytes plus biennials and perennials. We distinguished three categories in the Ujvárosi system: summer annuals, winter annuals plus biennials and perennials. Coenological units were also fused into three groups, such as weeds (including segetal and ruderal ones), grasslands species (involving species of dry grasslands and of meadows), and finally phytosociologically indifferent species. In social behaviour types again three

Table 1
Categories of the attribute systems used in the test of homogeneity

Attribute/ Category	RAU df = 1	UJV df = 2	COE df = 2	SBT df = 2	N df = 2
I	Th, TH	T4	3.3, 3.4, 3.5, 3.6	AC, RC, I	1–3
II	H, G	T2, T3, HT	5.2, 5.3, 5.4, 5.5	W, DT	4–6
III	–	H1, H2, H3, H4, H5, G1, G3, G4	9.1	NP, G, S, C	7–9

RAU = Raunkiaer's life forms, UJV = Ujvárosi's life-forms, COE = coenological groups, SBT = social behaviour types, N = nitrogen values; df = degree of freedom, Th – annuals, TH – biennials, H – hemicryptophyte, G – geophyte perennials (Raunkiaer 1934). T4 – summer annuals, T2 – overwintering annuals (autumn germination), T3 – facultative overwintering annuals (autumn and/or spring germination), H1–H5 – hemicryptophytes, G1, G2, G4 – geophytes (Ujvárosi 1952, 1973). 3.3 – Chenopodietea, 3.4 – Secalietea, 3.5 – Artemisietea, 3.6 – Agropyretea, 5.2 – Sedo-Scleranthetia, 5.3 – Festuco-Brometia, 5.4 – Molinio-Arrhenatheretia, 5.5 – Festuco-Puccinellietea, 9.1 – indifferent species. AC – aggressive competitors, RC – ruderal competitors, I – indigenous (cultivated), W – weeds, DT – disturbance tolerants, NP – natural pioneers, G – generalists, S – specialists, C – competitors (Borhidi 1995)

categories were established. Firstly competitors of secondary habitats, including subspontaneous cultivated species (AC, RC, I), secondly weeds and disturbance tolerant species of natural habitats (W, DT) and finally a group indicating the most natural conditions, such as natural pioneers (NP), stress tolerants (G, S) and competitors (C). In N values categories called "low" (1, 2, 3), "medium" (4, 5, 6) and "high" (7, 8, 9) were used. Categories of attribute systems and their groupings in the tests are enlisted in Table 1.

Altogether 125 tests of homogeneity representing two ways of testing were carried out. At first pairs of years were compared in 75 tests ($6 \times 5/2 = 15$ ones per attribute). In this case we have pooled frequency data of all successional plots in the given year. Secondly we tested homogeneity on pairs of plots fusing frequency data on the given plot for the whole study period (six years). In these tests the control plot was also involved therefore 50 tests ($5 \times 4/2 = 10$ ones per attribute) were carried out.

RESULTS

Attribute distribution differed significantly from the homogeneous in 30 cases (40%) out of the 75 tests comparing years. Inhomogeneity was rare and uncertain between subsequent years of successional plots (A–D). We found only 5 significant changes (20%) in pattern of attributes ($p < 0.1$ – 0.05) for 25 cases (5 attributes and 5 pairs of years). Four inhomogeneities out of the 5 were detected until the third year suggesting that the change was much more intensive in the first half of the study period.

Frequency of inhomogeneities in successional plots was higher when pairs of non-subsequent years were tested. Frequency increased with the time. The highest ones were between the first–second years (pioneer phase) and the last two

ones, respectively. Number of significant inhomogeneities was maximal between the first and final years' vegetation. Moreover, inhomogeneities were also more certain (often $p < 0.01$ – 0.001).

Out of the 50 G-test comparing plots 26 ones (58%) were significant. Omitting comparisons with the control one only 10 tests out of the remaining 30 (33%) were still significant. We found no significant inhomogeneities between those successional plots which had similar prehistories. Tests did not prove inhomogeneity between the intensively disturbed ones (A and B) and similarly no significant difference was found between the less disturbed and managed plots (C and D). On the other hand more inhomogeneities of definite significance were shown between the plots of the above two groups (such as $A \leftrightarrow C$ and $B \leftrightarrow D$).

Inhomogeneities were the most frequent when successional plots and the control ones were compared. Sixteen tests out of 20 (80%) turned out significant at levels ($p < 0.005$ – 0.001). Another proof for the distinction of the control's vegetation was that the highest G_{adj} -values were found in these tests.

Results of the test on different attributes were often dissimilar both when comparing years and plots. For example definite inhomogeneities ($p < 0.001$) were shown comparing distribution of N values and of Ujvárosi's life-forms for years 1990 and 1993. For the same pair of years, on the other hand, distribution of coenological groups did not differ significantly. Comparison did not reveal difference in patterns of N values in plots C and E but resulted in a sure inhomogeneity ($p < 0.001$) when coenological groups were tested (Tables 2–3).

DISCUSSION

RATE OF CHANGE IN TIME

We found that vegetation development measured in dominance weighted attributes was especially abrupt in the initial phase (Matus and Tóthmérész 1995) and kept relatively fast up to the sixth year. On the other hand results of the homogeneity tests were more conservative, significant changes were rare between consecutive years. Definite alteration of attribute patterns required 2–5 years in most cases.

The reason is that changes in species composition are more slower than in dominance conditions. Major alteration of cover conditions was related to one or a few annual species. Most of the species set of a given year is composed of the subordinated survivors of the former dominants and outposts of the preceding phases.

It was also found that change of the dominance relations was decreasing with time (Matus and Tóthmérész 1995). The same was found in distribution of attrib-

ute patterns. A slowing rate of change was proved. Most of the significant changes were concentrated on the first three years.

The results are in accordance with literal examples. Quick community replacements were reported to slow down in Pannonian ruderal successions (Ubrizsy 1955, 1957). Numata (1969) proved similar trends by calculation of the so-called "degree of succession", a measure based on valuing life- and growth forms. In-

Table 2

Results of the homogeneity test in comparing years of the study. Frequencies were summarized for successional plots A–D while significant inhomogeneities and G_{adj} -values were pooled for 5 attributes

	1990	1991	1992	1993	1994	1995
Raunkiaer's life forms						
1990	×	ns	ns	0.1	0.05	0.1
1991	0.0502	×	0.05	0.05	0.001	0.05
1992	2.3023	4.7270	×	ns	ns	ns
1993	3.0048	5.6412	0.1285	×	ns	ns
1994	6.5997	11.6741	1.9243	0.9082	×	ns
1995	3.2451	3.2451	0.1745	0.0022	0.8611	×
Ujvárosi's life forms						
1990	×	0.05	0.005	0.001	0.005	0.01
1991	6.6209	×	0.1	0.005	0.005	0.1
1992	12.7254	5.3197	×	ns	ns	ns
1993	20.5810	11.1478	2.1188	×	0.1	ns
1994	10.8514	10.6003	2.5376	4.8666	×	ns
1995	9.9400	5.3846	0.3491	3.1228	1.0852	×
Coenological groups						
1990	×	ns	ns	ns	ns	0.05
1991	0.2976	×	ns	ns	ns	0.05
1992	1.7480	1.1995	×	ns	ns	ns
1993	0.7302	0.8705	0.7730	×	ns	0.1
1994	3.7107	3.6072	0.8065	1.7832	×	ns
1995	7.0770	7.0038	2.8773	5.3743	1.1984	×
Social behaviour types						
1990	×	ns	0.1	0.005	0.05	0.05
1991	3.1937	×	ns	ns	ns	ns
1992	5.2013	0.3385	×	ns	ns	ns
1993	12.1925	4.5881	2.6755	×	ns	ns
1994	6.8703	1.7173	1.0371	2.2159	×	ns
1995	7.8625	1.6768	0.5949	0.8347	0.5753	×

Table 2 cont.

	1990	1991	1992	1993	1994	1995
Nitrogen values						
1990	×	0.1	0.1	0.001	0.005	0.001
1991	4.9650	×	ns	ns	ns	ns
1992	5.0997	0.6665	×	ns	ns	0.1
1993	13.9511	3.9787	4.0976	×	ns	ns
1994	10.6684	1.7959	2.8529	0.7834	×	ns
1995	14.2513	3.8645	5.4734	0.7843	0.3957	×
Significant inhomogeneities and ΣG_{adj} on 5 attributes						
1990	×	2	3	4	4	5
1991	15.1274	×	2	2	2	3
1992	27.0767	12.2512	×	0	0	1
1993	50.4596	26.2263	9.7934	×	1	1
1994	38.7005	29.3948	9.1584	10.5573	×	0
1995	42.3759	24.0834	9.4692	10.1183	4.1157	×

ns = non significant

creasing intervals between replacements of consecutive dominants were reported from North-American old-fields (Pickett 1982). Lepš (1987) observed a decreasing floristical distinction of subsequent years of an abandoned Bohemian arable land. Decreasing rate of change was detected in floristical composition and dominance conditions of numerous ruderal communities (Bornkamm 1981). Early secondary successions are characterized with a slowing speed of change irrespective of the methods used.

SPATIAL INHOMOGENEITIES AND MANAGEMENT

The six years' pooled attribute pattern of the successional plots and that of the control differed significantly in most of the cases. Distinction was the most pronounced in intensively disturbed plots (A, B). Distribution of all attributes turned out non-homogeneous ($p < 0.005$ – 0.001). On the other hand in case of the less intensively disturbed plot (C) we found less significant inhomogeneities ($p < 0.01$ – 0.001).

Distinction was also pronounced between successional plots. It means that pre-history (patchiness of disturbance, certain elements of initial composition) can play an important role on the later development of vegetation.

Topsoil removal in plot D brought about a relative success in promotion of vegetation development. On one hand experimental management had a definite effect on the attribute pattern of the vegetation. That of the managed plot differed much less from the control one than from the similarly disturbed but unmanaged ones (A and B). Post-denudation vegetation became apparently more similar to the control than to the overgrazed neighbours.

On the other hand attribute pattern of plot D differed from the control in more tests than from that of the less intensively disturbed but unmanaged plot. Another proof for it can be that G_{adj} -values between plots D and E were also higher than for the pair C and E. The rank of G_{adj} -values was $A > B > D > C$ for the pooled data set of the full study period (Table 3).

We may conclude that removal of topsoil is able to enhance recolonization of pre-disturbance vegetation but it is superimposed by other factors determining vegetation development, *e.g.* propagule availability, soil parameters.

THEORETICAL OUTCOMES AND METHODOLOGICAL NOTES

The above two statements may be interesting additions to the dispute on the role of the so-called "initial floristical composition". The idea of Egler (1954) suggests that presence or absence of later dominants may be decisive in the forecoming secondary succession of old-fields. Absence of climax dominants at the disturbance may for example lead to the establishment of stable grasslands under a forest climate. The importance of this factor was also emphasized in connection with vegetation management. For this experiments using selective herbicides are good examples (Virágh 1982). An apparently opposite view was articulated by Lepš (1987) who found a very weak effect of the initial floristical composition of annual-dominated old-fields on later vegetation development.

Our results suggest that both opinions are true in some respect. It cannot be proved statistically that the initial floristical composition as a whole would effect later development. There are, however, some elements in the pioneer composition the presence of which is decisive in the succession. This effect works clearly even if these species are in a suppressed position after disturbance. The presence of some individuals of long-lived perennials was crucial in the studied example.

The test results were quite different for each attribute in the same comparison suggesting that reliability of single characteristics may not be absolute. The conclusion is that we may not define surely the number of spatial patch-types based on a single attribute. It also means that we can establish different number and length of successional periods therefore we cannot give a definite description of the process. A more satisfactory patch and phase distinction is possible if we rely

Table 3

Result of the homogeneity tests in comparing plots A–E. Frequencies were summarized for years 1990–1995 while significant inhomogeneities and G_{adj} -values were pooled for 5 attributes

	A	B	C	D	E
Raunkiaer's life forms					
A	×	ns	0.1	ns	0.001
B	0.0401	×	0.1	ns	0.001
C	3.0548	2.8918	×	ns	0.01
D	1.0479	0.8240	0.4790	×	0.005
E	17.7108	19.4175	6.9753	10.2468	×
Ujvárosi's life forms					
A	×	ns	0.1	ns	0.005
B	0.3692	×	ns	ns	0.005
C	4.6915	3.7999	×	ns	ns
D	0.7672	0.1904	1.9364	×	0.005
E	12.2472	10.6722	2.8210	6.9473	×
Coenological groups					
A	×	ns	0.05	ns	0.001
B	2.0298	×	ns	ns	0.001
C	6.3553	2.9501	×	ns	0.001
D	1.8850	0.4042	1.3322	×	0.001
E	36.8562	25.9059	20.8433	24.4621	×
Social behaviour types					
A	×	ns	0.01	0.01	0.005
B	0.5784	×	0.05	0.05	0.005
C	9.6355	8.0396	×	ns	ns
D	9.2327	6.8859	0.8438	×	ns
E	13.6411	11.5236	0.7559	0.4208	×
Nitrogen values					
A	×	ns	0.1	ns	0.001
B	1.6073	×	0.05	ns	0.001
C	4.9372	6.1008	×	ns	ns
D	2.2316	2.0767	0.7874	×	0.05
E	16.2514	17.6745	3.7821	6.6945	×
Significant inhomogeneities and ΣG_{adj} on 5 attributes					
A	×	0	5	1	5
B	4.6248	×	3	1	5
C	28.6743	23.7822	×	0	2
D	15.1644	10.3812	5.3788	×	4
E	96.7067	85.1937	35.1776	48.7715	×

ns = non significant

on more species attributes and use the frequencies of significant inhomogeneities or summed G-values gained from numerous tests.

*

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REFERENCES

- Behrendt, S. and Hanf, M. (1979): *A szántóföldek gyompázsitfüvei. Meghatározás virágnélküli állapotban.* – BASF Aktiengesellschaft, Ludwigshafen.
- Borhidi, A. (1995): Social behaviour types, the naturalness and relative ecological indicator values of the higher plants of the Hungarian Flora. – *Acta Bot. Hung.* **39**: 97–182.
- Bornkamm, R. (1981): Rates of change in vegetation during secondary succession. – *Vegetatio* **47**: 213–220.
- Bornkamm, R. (1985): *Vegetation changes in herbaceous communities.* – In: White, J. (ed.): The Population Structure of Vegetation. – Dr. W. Junk Publishers, Dordrecht, pp. 89–109.
- Bornkamm, R. and Hennig, U. (1982): Experimentell-ökologische Untersuchungen zur Sukzession von ruderalen Pflanzengesellschaften auf unterschiedlichen Böden. I. Zusammensetzung der Vegetation. – *Flora* **172**: 267–316.
- Borsy, Z. (1961): *A Nyírség természet földrajza.* – Földrajzi monográfiák 5. Akadémiai Kiadó, Budapest.
- Csapody, V. (1968): *Keimlingsbestimmungsbuch der Dikotyledonen.* – Akadémiai Kiadó, Budapest.
- Egler, F. E. (1954): Vegetation science concepts. I. Initial floristic composition – a factor in old-field vegetation development. – *Vegetatio* **4**: 412–417.
- Ellenberg, H. (1950a): *Unkrautgemeinschaften als Zeiger für Klima und Boden.* Landwirtschaftliche Pflanzensoziologie I. – Ulmer, Stuttgart.
- Ellenberg, H. (1950b): Physiologisches und ökologisches Verhalten derselben Pflanzenarten. – *Ber. Dtsch. Bot. Ges.* **65**: 350–361.
- Ellenberg, H. (1974): *Zeigerwerte der Gefäßpflanzen Mitteleuropas.* – Scripta Geobotanica 9. Goltze Verlag, Göttingen.
- Ellenberg, H., Weber, H. E., Düll, R., Wirth, V. and Paulissen, D. (1991): *Zeigerwerte von Pflanzen in Mitteleuropa.* – Scripta Geobotanica 18, Goltze Verlag, Göttingen.
- Grime, J. P. (1977): Evidence for the existence of three primary strategies in plants and its relevance to ecological and evolutionary theory. – *Amer. Nat.* **111**: 1169–1194.
- Grime, J. P. (1979): *Plant strategies and vegetation processes.* – Wiley, Chichester.
- Holzner, W. (1978): Weed species and weed communities. – *Vegetatio* **38**(1): 13–20.
- Hortobágyi, T. (ed.) (1968): *Növényhatározó II. Harasztok-virágos növények.* – Tankönyvkiadó, Budapest.
- Hunyadi, K. (ed.) (1988): *Szántóföldi gyomnövények és biológiájuk.* – Mezőgazdasági Kiadó, Budapest.
- Lepš, J. (1987): Vegetation dynamics in early old field succession: a quantitative approach. – *Vegetatio* **72**: 95–102.

- Matus, G. and Tóthmérész, B. (1990): The effect of grazing on the structure of a sandy grassland. – In: Krahulec, F., Agnew, A. D. Q., Agnew, S. and Willems, J. H. (eds): *Spatial processes in plant communities*. Academia, Prague and SPB Academic Publishing, The Hague, pp. 23–30.
- Matus, G. and Tóthmérész, B. (1991a): The effect of cattle grazing on a sandy grassland. – *Acta Biol. Debrecina* (Suppl.) **22**: 67–68.
- Matus, G. and Tóthmérész, B. (1991b): Study of the vegetation on a sandy grassland after goose breeding: A preliminary study. – *Acta Biol. Debrecina* (Suppl.) **22**: 77–78.
- Matus, G. and Tóthmérész, B. (1994): Correlation of indicator values with climatic and soil data in a ruderal succession. – *Abstracta Botanica* **18**(1): 7–12.
- Matus, G. and Tóthmérész, B. (1995): Pioneer phase of succession in a ruderal weed community. – *Acta Bot. Hung.* **39**(1–2): 51–70.
- Nagy, M., Papp, M. and Tóthmérész, B. (1991a): Mapping of sandy grassland communities on degraded area in Hungary. – *Phytocoenosis* (Suppl. Cartogr. Geobot.) **3**: 257–261.
- Nagy, M., Papp, M., Tóthmérész, B. and Précsényi, I. (1991b): Classification and mapping of sand grassland communities on a protected area in Eastern Hungary. – *Acta Biol. Debrecina* (Suppl.) **22**: 25–35.
- Numata, M. (1969): Progressive and retrogressive gradient of grassland vegetation measured by degree of succession. Ecological judgement of grassland condition and trend IV. – *Vegetatio* **19**: 96–127.
- Pécsi, M. (ed.) (1969): *A Tiszai Alföld*. – Magyarország tájféldrajza 2. Akadémiai Kiadó, Budapest.
- Pickett, S. T. A. (1982): Population patterns through twenty years of old-field succession. – *Vegetatio* **49**: 45–59.
- Précsényi, I., Papp, M. and Nagy, M. (1991): Comparative analysis of *Potentillo-Festucetum pseudovinae* and *Festuco vaginatae-Corynephoretum* communities. – *Acta Biol. Debrecina* (Suppl.) **22**: 57–67.
- Raunkiaer, C. (1934): *The life forms of plants and statistical plant geography*. – Clarendon, Oxford.
- Schmidt, W. (1988): An experimental study of old-field succession in relation to different environmental factors. – *Vegetatio* **77**: 103–114.
- Simon, T. (1992): *A magyarországi edényes flóra határozója*. – Tankönyvkiadó, Budapest.
- Sokal, R. R. and Rohlf, F. J. (1981): *Biometry*. – W. H. Freeman, New York.
- Soó, R. (1980): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve VI*. – Akadémiai Kiadó, Budapest, 557 pp.
- Stefanovits, P. (1981): *Talajtan*. – Mezőgazdasági Kiadó, Budapest.
- Tóthmérész, B. and Matus, G. (1991): The effect of goose breeding on a sandy grassland. – *Acta Biol. Debrecina* (Suppl.) **22**: 69–76.
- Ubrizsy, G. (1949): Magyarország ruderális növénytársulásoka, tekintettel a mezőgazdasági vonatkozásokra. – *Mezőgazd. Tud. Közl.* **1**: 87–123.
- Ubrizsy, G. (1955): Magyarország ruderális növénytársulásai, II. Ökológiai és szukcesszió tanulmányok. (Ruderal weed associations in Hungary, II. Studies on ecology and succession). – *Növénytermelés* **4**: 109–126.
- Ubrizsy, G. (1957): Cönológiai vizsgálatok ugarterületeken. (Zöologische Untersuchungen auf Brachlandarealen). – *Bot. Közlem.* **47**(1–2): 343–347.
- Ujvárosi, M. (1952): Die Unkrautarten der ungarischen Ackerböden und ihre Lebensformanalyse. – *Acta Agronomica Acad. Sci. Hung.* **2**: 237–274.
- Ujvárosi, M. (1973): *Gyomnövények*. (Weeds). – Mezőgazdasági Kiadó, Budapest.
- Virágh, K. (1982): Vegetation dynamics induced by some herbicides in a perennial grassland community. I. – *Acta Bot. Acad. Sci. Hung.* **28**: 427–447.
- Zar, J. H. (1984): *Biostatistical Analysis*. – Prentice Hall, London.

- Zólyomi, B. and Précsényi, I. (1964): Methode zur ökologischen Charakterisierung der Vegetationseinheiten und zum Vergleich der Standorte. – *Acta Bot. Hung.* **10**: 377–416.
- Zólyomi, B., Précsényi, I., Bodnár, T. and Vadkerti, E. (1987): Az ökológiai indikátorszámok min-tázatának változása szukcesszió alatt. (Changes in pattern of ecological indicator values during succession). – *Bot. Közlem.* **74–75**(1–2): 101–109.
- Zólyomi, B., Baráth, Z., Fekete, G., Jakucs, P., Kárpáti, I., Kárpáti, V., Kovács, M. and Máthé, I. (1967): Einreichung von 1400 Arten der ungarischen Flora in ökologischen Gruppen nach TWR-Zachlen. – *Fragmenta Botanica* **4**: 101–142.

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BRYOPHYTE FLORA OF THE BRANCH-SYSTEMS OF THE DANUBE IN SZIGETKÖZ IN 1991–92

B. PAPP and M. RAJCZY

*Dept. Botany, Hungarian Natural History Museum
H-1476 Budapest, Pf. 222, Hungary*

The riparian bryophyte flora of two branch-systems of the Danube was studied. Altogether 55 species (7 hepatics) were collected from various substrates (excl. stones). Cluster analyses were performed on 35 branchlets using the bryophyte flora as well as the life strategy and European distribution spectra. The groups formed by the analyses proved to represent different habitat types (e.g. sites with stagnant water, isolated from the river; disturbed sites with eroding banks etc.).

Key words: bryophytes, river Danube, Szigetköz, water quality

INTRODUCTION

An important distributary branches out from the Danube before it reaches the Hungarian border. This is the “Mosoni-Duna” (total length 125 km) which flows back into the Danube at Vének. The big island surrounded by this branch and the main one (“Öreg-Duna”) is called “Szigetköz”. Though there are several valuable territories on this island and a part of it is a nature protection landscape area we knew very little of the bryophyte flora. Only a few data are published in three papers (Boros and Vajda 1955, Boros and Zólyomi 1934, Polgár 1941). The area is mentioned only in Boros’s comprehensive work in the chapter on the bryoflora of the inundation area of the Danube (Boros 1968). These few papers report altogether 5 species from the branch-systems which are the subject of the present study. Our aim was to register the status of the bryophyte flora of the branch-systems before the diversion of the river to the Gabčíkovo water power station.

THE INVESTIGATED AREA

The Danube enters the Carpathian Basin at Bratislava. From this place downstream its velocity decreases, so it cannot keep its load. Consequently, it begins to ramify to many branches and to build shelves and islands. The network of branches was in continuous change, from year to year islands were destroyed and new shelves were built on other places. This stretch of the Danube have been hindered the navigation on the river for centuries. This was the reason (and the danger of the floods) why an artificial bed was built (following the widest and more or less straight branches) for the river at the end of the last century. The dams isolated 5 separate branch-systems on the right (Hungarian) side of the Danube. Since this time these branch-systems have got much water only above the mean water level. The stream gradient of the Danube from Bratislava to Szap is 25–35 cm/km, from Sap to Vének is 12–15 cm/km, while downstream of Vének it is only 8–10 cm/km

(Göcsei 1979). The plans of the Gabčíkovo water power station have been based on the gradient of the first, steepest stretch. From the autumn of 1992 a channel brings the water from the Danube at Cunovo to the power station and back to the Danube at Sap.

Besides the artificial main branch where the water traffic went, the branch-systems remained almost intact till the early seventies when the construction works of the Gabčíkovo water power station began. During this process the biggest and uppermost branch-system had been practically destroyed. In the remaining 4 systems several dams had been built with the aim to keep the water in them. We studied the branch-systems near Cikolasziget and Ásványráró (Fig. 1). The remaining two systems are smaller than these.

In both branch-systems the net of branches is very dense. One could see big branches with direct connection with the Danube, smaller branches with good water supply and small branches with almost stagnant water and without any connection with the Danube.

METHODS

We began our work in 1991. Since the spring of this year till the late summer of 1992 we thoroughly collected the moss flora in the above-mentioned two branch-systems during several field trips. We used 23 sampling points (branches) in Cikolasziget branch-system and 12 points at Ásványráró (Fig. 2). We studied only the water and the water-close habitats, i.e. the banks, the dams, as well as the decaying trees floating in the water. In this paper we do not use the data originated from the stones of the dams. The epilithic flora could not be used for the comparison of the branches and

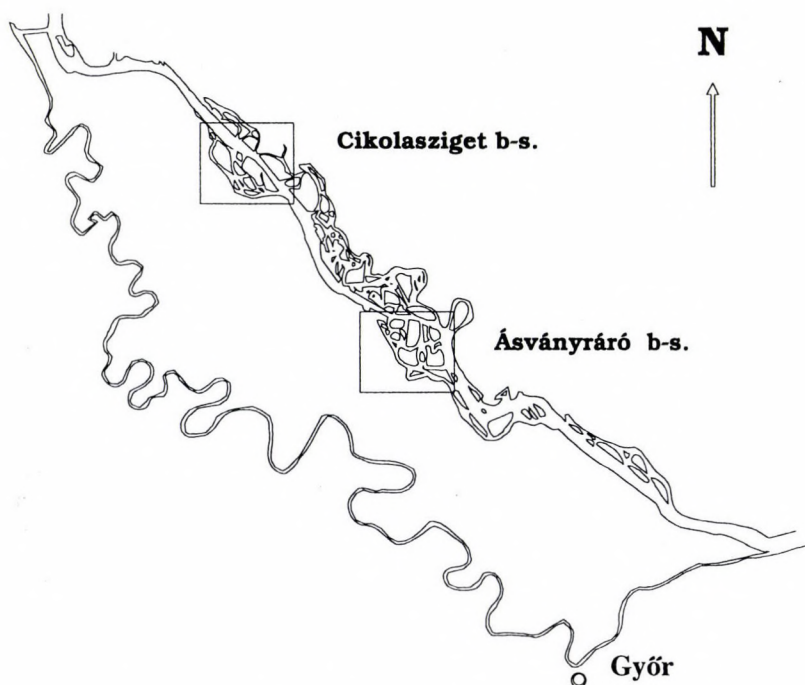


Fig. 1. Location of the investigated branch-systems in Szigetköz

branch-systems here as the dams were of very different age, the most of them were not old enough to have a well developed bryophyte flora. Therefore only the samplings from soil and from living or rotten wood are dealt with. On the basis of the collected material an abundance-frequency value (1–4) was given to each species in each sampling point. To classify the branches (sampling points) we performed a hierarchical cluster analysis (UPGMA) on these data using the chi-square measure (Podani 1993). For the comparison of the sites we used European distribution and life strategy plots. The European distribution (i.e. the primary centre of distribution) values are taken from Düll (1983, 1984, 1985). The life strategy (During 1979) values for the Hungarian bryophytes were published by Orbán (1984). In both analyses the species numbers in the categories are weighted with their abundance-frequency values.

RESULTS AND DISCUSSION

As we mentioned 5 species had been reported from the Ásványráró branch-system (*Amblystegium riparium*, *Physcomitrium pyriforme*, *Plagiomnium cuspidatum*, *Pohlia melanodon*, *P. wahlenbergii*). We recognised that these species are very frequent and abundant in the studied area except of *P. cuspidatum* which was found sporadically in both branch-systems with low abundance. Now the

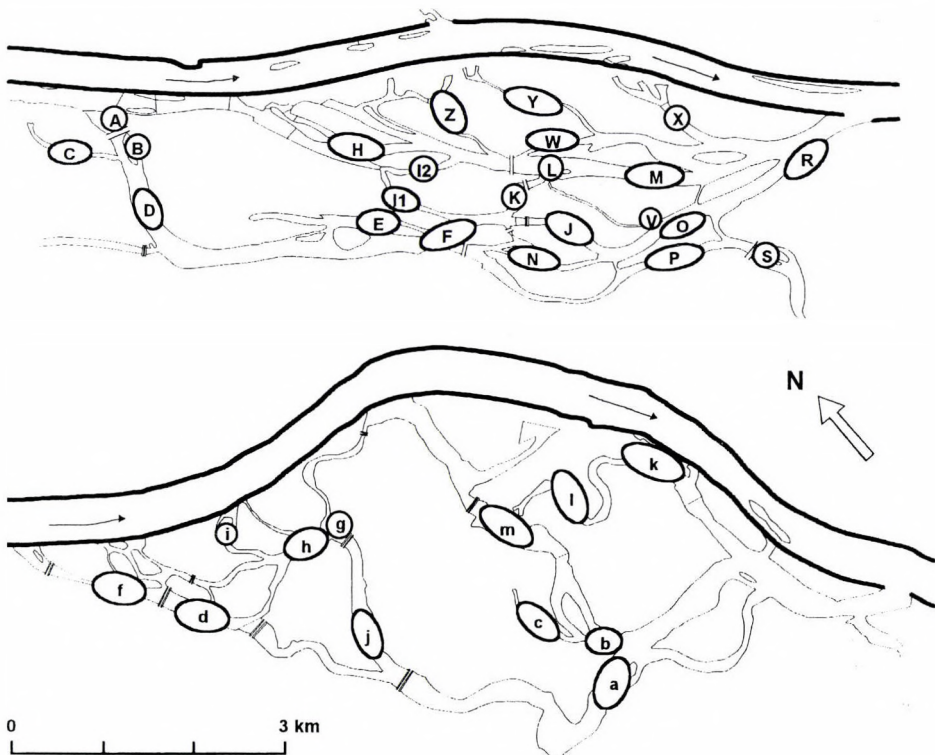


Fig. 2. Location of the sampling sites in the Cikolasziget (upper map) and Ásványráró (lower map) branch-systems

bryoflora of the territory consists of 7 liverworts and 48 mosses (Table 1). The following species are rare in Hungary or in the Hungarian lowland:

Conocephalum conicum – It is a montane species. In the Hungarian lowland it was collected once, 80 years ago on the Danube bank at Göd. We found its well-

Table 1

The check-list of the bryophyte flora of the two branch-systems. The data regarding the life strategy of the species are taken from Orbán (1984) the "flora element" (i.e. the primary centre of distribution) character follows Düll (1983, 1984, 1985)

Species	Life strategy	Flora element
<i>Conocephalum conicum</i> (L.) Lindb.	SL	subbor-mont
<i>Lunularia cruciata</i> (L.) Lindb.	C	oc-med
<i>Marchantia polymorpha</i> L.	C	temp
<i>Pellia endiviifolia</i> (Dicks.) Dum.	SL	temp
<i>Riccia fluitans</i> L.	AS	temp
<i>Riccia cavernosa</i> Hoffm.	AS	temp
<i>Riccia glauca</i> L.	AS	submed
<i>Amblystegium humile</i> (P. Beauv.) Crundwell	P	temp
<i>Amblystegium riparium</i> (Hedw.) B., S. et G.	P	temp
<i>Amblystegium serpens</i> (Hedw.) B., S. et G.	P	temp-subbor
<i>Amblystegium varium</i> (Hedw.) Lindb.	P	temp
<i>Barbula unguiculata</i> Hedw.	C	temp
<i>Brachythecium rivulare</i> B., S. et G.	P	subbor
<i>Brachythecium rutabulum</i> (Hedw.) B., S. et G.	P	temp
<i>Brachythecium salebrosum</i> (Web. et Mohr) B., S. et G.	P	subbor
<i>Brachythecium velutinum</i> (Hedw.) B., S. et G.	P	temp
<i>Bryum argenteum</i> Hedw.	C	temp
<i>Bryum barnesii</i> Wood	C	submed
<i>Bryum</i> cf. <i>capillare</i> Hedw.	C	temp
<i>Bryum laevifilum</i> Syed	C	temp
<i>Bryum pseudotriquetrum</i> (Hedw.) Gaertn., Meyer et Scherb.	P	temp
<i>Bryum turbinatum</i> (Hedw.) Turn.	C	temp
<i>Calliergonella cuspidata</i> (Hedw.) Loeske	P	temp
<i>Ceratodon purpureus</i> (Hedw.) Brid.	C	temp
<i>Cratoneuron filicinum</i> (Hedw.) Spruce var. <i>filicinum</i>	P	temp
<i>Dicranella rufescens</i> (With.) Schimp.	C	temp
<i>Dicranella varia</i> (Hedw.) Schimp.	C	temp
<i>Didymodon fallax</i> (Hedw.) Zander var. <i>fallax</i>	C	temp
<i>Didymodon luridus</i> Hornsch.	C	submed

Table 1 cont.

Species	Life strategy	Flora element
<i>Didymodon vinealis</i> (Brid.) Zander var. <i>flaccida</i> (Bruch et Schimp.) Zander	C	submed-suboc
<i>Ditrichum cylindricum</i> (Hedw.) Grout	C	subbor
<i>Drepanocladus aduncus</i> (Hedw.) Warnst. var. <i>aduncus</i>	P	temp
<i>Eurhynchium hians</i> (Hedw.) Sande Lac.	P	temp
<i>Fissidens crassipes</i> Wils. ex B., S. et G.	C	suboc-submed
<i>Fissidens taxifolius</i> Hedw.	C	temp
<i>Funaria hygrometrica</i> Hedw.	F	temp
<i>Hygroamblystegium fluviatile</i> (Hedw.) Loeske	P	suboc
<i>Hygroamblystegium tenax</i> (Hedw.) Jenn.	P	temp
<i>Hypnum cupressiforme</i> Hedw.	P	temp
<i>Leptobryum pyriforme</i> (Hedw.) Wils.	C	temp
<i>Leskea polycarpa</i> Hedw.	P	temp
<i>Mnium ambiguum</i> H. Müll.	LS	bor-mont
<i>Mnium marginatum</i> (With.) Brid. ex P. Beauv.	LS	suboc-subbor
<i>Mnium stellare</i> Hedw.	LS	bor-mont
<i>Physcomitrium pyriforme</i> (Hedw.) Brid.	AS	temp
<i>Plagiomnium cuspidatum</i> (Hedw.) T. Kop.	LS	subbor
<i>Plagiomnium elatum</i> (B. et S.) T. Kop.	LS	bor
<i>Plagiomnium ellipticum</i> (Brid.) T. Kop.	LS	bor
<i>Plagiomnium rostratum</i> (Schräd.) T. Kop.	LS	temp
<i>Plagiomnium undulatum</i> (Hedw.) T. Kop.	LS	temp
<i>Pohlia bulbifera</i> (Warnst.) Warnst.	C	suboc
<i>Pohlia melanodon</i> (Brid.) J. Shaw	C	temp
<i>Pohlia wahlenbergii</i> (Web. et Mohr) Andr.	C	subbor-sub-med-suboc
<i>Rhizomnium punctatum</i> (Hedw.) T. Kop.	LS	suboc
<i>Rhynchostegium murale</i> (Hedw.) B., S. et G.	P	temp

developed thalli at the best, undisturbed sampling point (L) at Cikolasziget together with several other rarities.

Cratoneuron filicinum – It is very rare on the Hungarian lowland. The only locations were at the springs along the left side of the Danube from Vác to Budapest. In both branch-systems it can be seen sporadically with low abundance. Sometimes it is only mixed in the patches of other species.

Didymodon luridus – A rare calciphilous species in Hungary, very rare in the lowland. It was found in both branch-systems sporadically with low abundance.

Fissidens crassipes – It is rare on the Hungarian lowland. From the Danube it was known only downwards from Gönyü. It occurs in both branch-systems sometimes with remarkable abundance.

Hygroamblystegium fluviatile – It is a rare species in Hungary. Earlier it was collected from the Danube at Szigetköz. We found it in some branches at Cikolasziget with low abundance.

Hygroamblystegium tenax – It is rare along the Danube. We found its little patches in two sampling points at Cikolasziget.

Lunularia cruciata – It is an oceanic-mediterranean species. We collected its thalli in the same site (L) as *Conocephalum conicum*. This is its first natural occurrence in Hungary otherwise it lives only in greenhouses.

Mnium ambiguum – It is a rare montane species in Hungary. This is its first occurrence on the Hungarian lowland. One well-developed patch was found at the above-mentioned undisturbed site L.

Pohlia bulbifera – A very rare species in Hungary (two localities: Zempléni-hegység and Vendvidék). We found it in some points in both branch-systems with low abundance.

Rhizomnium punctatum – This is its first occurrence in the Hungarian lowland. We collected it in one branch at Cikolasziget.

Rhynchostegium murale – A more or less rare montane species in Hungary. On the lowland it is known only from the Danube between Rajka and Budapest. We collected it in the above-mentioned undisturbed site L.

The cluster analysis formed 6 clusters from the sampling sites on the basis of the abundance-frequency values of the species (Table 2, Fig. 3). The first cluster (I) is the biggest comprising 71% of the sites. The moss flora of these sampling points consists of many *Amblystegium* species, namely *A. riparium*, *A. varium*, *A. humile*, *A. serpens* and robust *Brachythecium* species (*B. rutabulum* and *B. salebrosum*). On the humid soil big patches of *Eurhynchium hians*, *Barbula unguiculata* and *Pohlia* species (*P. melanodon* and *P. wahlenbergii*) can be found frequently. On the trees which are occasionally covered by water *Leskea polycarpa* and *Bryum pseudotriquetrum* are the most abundant species. This flora can be regarded as the “basic” moss flora of the branch-systems in the Szigetköz.

The quantity of species requiring more or less undisturbed environment as perennials is high (68%). But the proportion of colonists, which are adapted to the fluctuation of environmental conditions, is also remarkable (Fig. 4). Species of temperate areas of Europe are in the highest number (72%) and beside a considerable proportion of subboreal species (16%), the quantity of submediterranean (6%) and suboceanic (5%) species is noteworthy (Fig. 6).

The sampled branches of this group can be characterized by running water and they are slightly disturbed by forestry activity, willow and alder trees cover still

Table 2
The abundance-frequency values of the species in the sampling sites
(sites A to Z – Cikolasziget branch-system, sites a to m – Ásványráró branch-system)

	A	B	C	D	E	F	H	I	I2	J	K	L	M	N	O	P	R	S	V	W	X	Y	Z	a	b	c	d	f	g	h	i	j	k	l	m	
CONCON												2																								
LUNCRU												2																								
MARPOL																2		1																		
PELEND										1				2																						
RICFLU																			1																	
RICCAV																																	2		1	
RICGLA																																1				
AMBHUM			2	1	2	1		1	2	2			1	3	2	2		3	2	1		1	2	3		3		1		1	1		3		1	
AMBRIP	4	1	4	3	3	4	4	4	4	4	4	3		4	4	3	4	4	4	2	4	3	4	4	3	4	4	4	4	4	3	4	3	4	3	4
AMBSER	3		4	3	3	4	2	3	3	4	4	2	3	4	2		4	1	3	3	3	1	3	3	3	4	4	4		3	3	4	4	4	3	
AMBVAR	2		2	2		3		1	1	3	4	1	1	2	1	2	3	3	3		2	4	4	2	3	3	4	2	2	3	1	3	1		3	
BARUNG	4	2	3	3	2	2	4	3		1	2	3	3	2	1	2	3	2		4		2		2	3	1	1	2	4	1		3	2	2	2	
BRARIV								1										1																		
BRARUT	3	4	3	3	3	1		3	1	1	2	3	3	4	2		1	3		4		3					2	1		1		2	1	1	4	
BRASAL			2	2				2	1		3		1	2					2	3		4		1	3	3				1		3	2	1	3	
BRAVEL																																1				
BRYARG	1			1			1	1	1	1							1	1								1		1		1		2	1		1	
BRYBAR				2		1		1				1	1		1	1	1	2		2		1	1	1	1	1	1	1	1			2	1		1	
BRYCAP								1			1		1													2							1		1	
BRYFLA																									1								1			
BRYPSE	2		2			2	1	3	3	3	2		2	2			2	2	4	1	2	3	3	2	1	3	3	1		3	3	3	3	4	1	
BRYTUR																															1					

Table 2 cont.

	A	B	C	D	E	F	H	I1	I2	J	K	L	M	N	O	P	R	S	V	W	X	Y	Z	a	b	c	d	f	g	h	i	j	k	l	m
CALCUS												1											2												
CERPUR	2		1	1				2						2					2			1													
CRAFIL	2		1							1			1	1				1								1			1				1	1	
DICRUF	2			1		1												2									1								
DICVAR												1					1														1	1			
DIDFAL			1	1		1	1					1						1		1									1					1	1
DIDLUR							1					1		1													1	1						1	
DIDVIN															1																				
DITCYL							1																												
DREADU										1	2								2	3		1	2	3			2	3				2		1	2
EURHIA	4	3	1	1	1	3		2	3		2	2	3	4				3		1		4	2	3		4	3			4	2	1	3	4	3
FISCRA			1							3			1				3			1		1		3		1	1	1							
FISTAX		2				1		2	1				1	2			1	1				1	3												2
FUNHYG	1		1	2			1	1	1	1					1	2	1	1	1					2											
HYGFLU								1						1																					
HYGTEN			1			1																													
HYPUP																							1												
LEPPYR	2						1				1				1					1	1		1		3	1	3	3							2
LESPOL			3	3	2	2		3	2	3		3	3		3		4			4	4	2		2	4	4	3	4		2	3	3	2		
MNIAMB												2																							
MNIMAR	2	4	1					3		2		2	2					1				2		1											1
MNISTE											1	1										1									1	1			
PHYPPYR	3		1	2	1	1	2	1								2	1	3				1		2			1	1	1		1		3		1

Table 2 cont.

[illegible]

a part of the banks giving shadow for mosses and protecting the bank from the erosion. This is the characteristic state now in the branch-systems.

The first group can be divided into four subgroups. The first subgroup (I/a) contains the branches where the moss flora consists of more colonists species (30%) and more submediterranean elements (8.5%) than the average of the group (Figs 5, 7). These branches are bigger and their banks are not too shady, greater parts of them are covered by poplar trees.

At the sampling points of the second subgroup (I/b) the quantity of colonist species is smaller (19%), but the diversity in life strategy pattern decreases. Perennial species dominate the flora. The diversity is smaller in the European distribution pattern, too. While the quantity of subboreal species (15%) is about the same as the average, the proportion of temperate species increases (77%) to the detriment of submediterranean and suboceanic species. At these sampling points the remarkable abundance of *Drepanocladus aduncus* is very conspicuous.

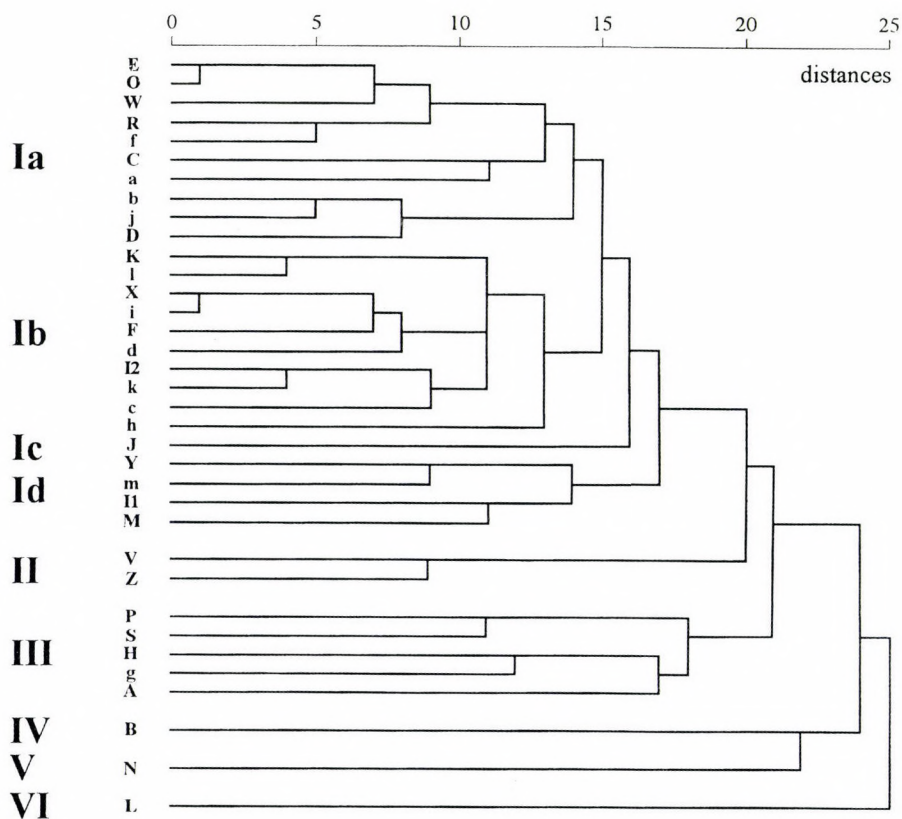


Fig. 3. Dendrogram of the sampling sites

This species indicates lower flow velocity. In these branches the shady places are more frequent and the banks are mostly covered by willow trees.

The third subgroup consists of one sampling point, which is more diverse than the others. The quantity of colonists is much more lower (16%) than the average of group. The bigger proportion of long lived shuttle species (LS = 9%) is men-

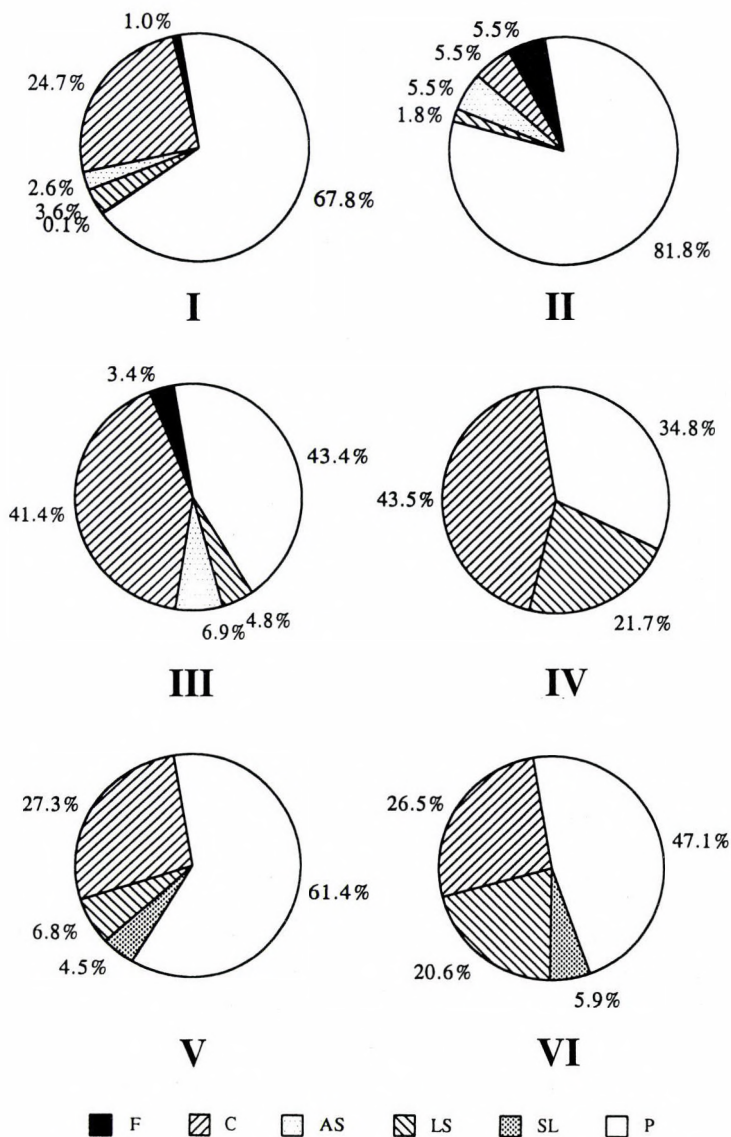


Fig. 4. Life strategy pattern of the bryophyte flora of the clusters

tionable which is due to the presence of Mniaceae species. In the European distribution pattern the much more higher proportion of suboceanic species (12%) is noteworthy. This branch is a smaller, less disturbed one.

The moss flora of the sampling points belonging to the fourth subgroup (I/d) contains colonists in the same high proportion as I/a, but it is counterbalanced by the bigger quantity of long lived shuttle species (LS = 9%). It means that the species requiring constant environmental conditions as perennial and long lived shuttle species, are in high percentage (69%). The higher quantity of suboceanic (7%) and boreal species (3%) compared with average of the group separates it from the other groups. At these sampling points *Mnium marginatum* was found with great abundance and other Mniaceae species are also frequent. These branches are also more natural, narrow ones.

As we can see at the more natural, undisturbed, shady places the above-mentioned basic moss flora is completed by *Mnium* and *Plagiomnium* species as *M. marginatum*, *M. stellare*, *P. elatum*, *P. ellipticum*, *P. cuspidatum* (Table 2).

The second group (II) consists of two sampling points. *Amblystegium* species can be found here with greater abundance as in the basic flora. From the *Brachy-*

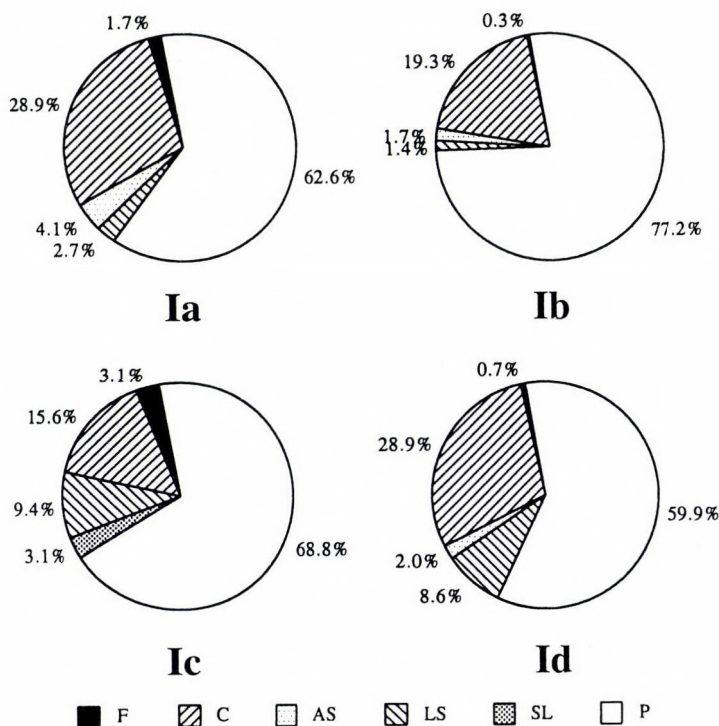


Fig. 5. Life strategy pattern of the bryophyte flora of the subgroups of cluster I

thecium species only *Brachythecium salebrosum* occurs in one branch. The ter-ricolous species of the basic flora such as the *Pohlia* species and *Barbula un-guiculata* are practically lacking. The indicator species of the slow current, *Dre-panocladus aduncus* is present in great mass. The abundance of *Bryum pseudo-triquetrum* on trees is high. But the other abundant, characteristic epiphytic

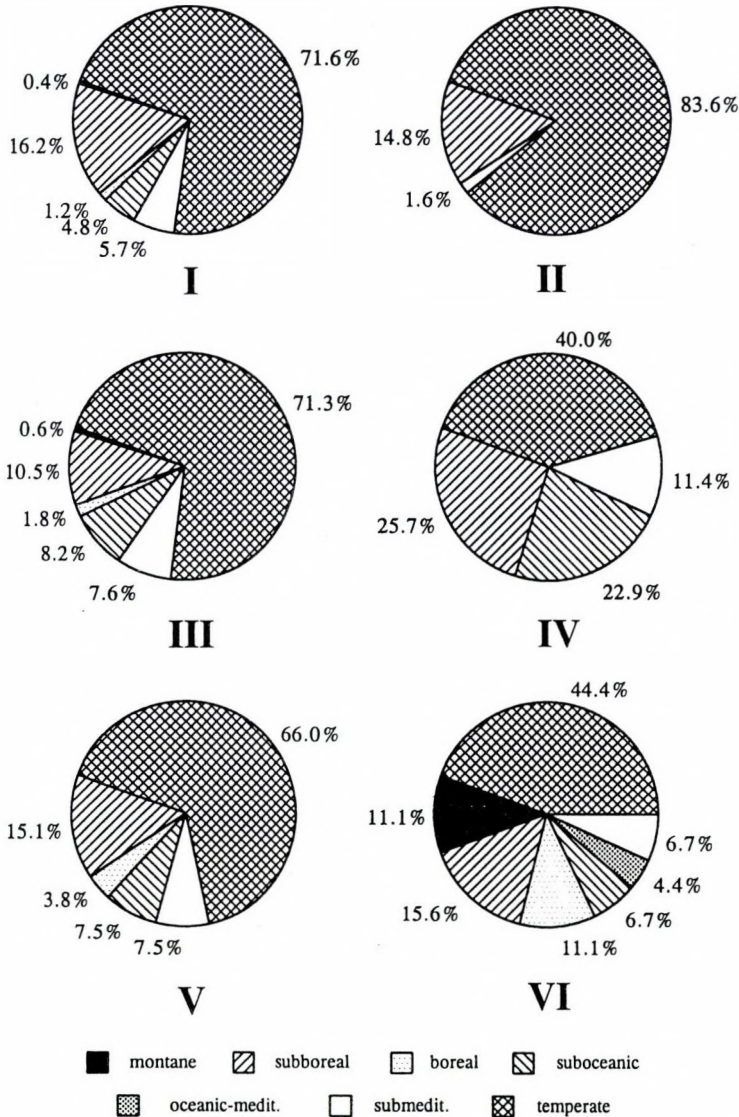


Fig. 6. European distribution pattern of the bryophyte flora of the clusters

species, *Leskea polycarpa* is absent. This species abundantly covers the living tree trunks near water in other branches.

These branches are small and narrow with almost stagnant water, isolated from the Danube and from the running water of the bigger branches. Their water supply is unpredictable, sometimes the water level is very low. Floating tree trunks frequently accumulate in these branches, serving a very special habitat for mosses. The moss flora of these branches is not diverse. This diversity decrease can be seen on life strategy and European distribution patterns, too (Figs 4, 6). The abundance of perennial species is very high (82%) due to the many pleurocarpous species living on rotting trees. Temperate species of Europe dominate the flora and the proportion of subboreal species (15%) is also noteworthy. These branches are not really disturbed by forestry activity, but the slowly moving or standing water lead to the impoverishment of the moss flora.

The third group (III) is formed by the sampling points characterized by the considerable abundance of many terricolous acrocarpous species as *Physcomyrium pyriforme*, *Funaria hygrometrica*, *Leptobryum pyriforme*, *Barbula unguicu-*

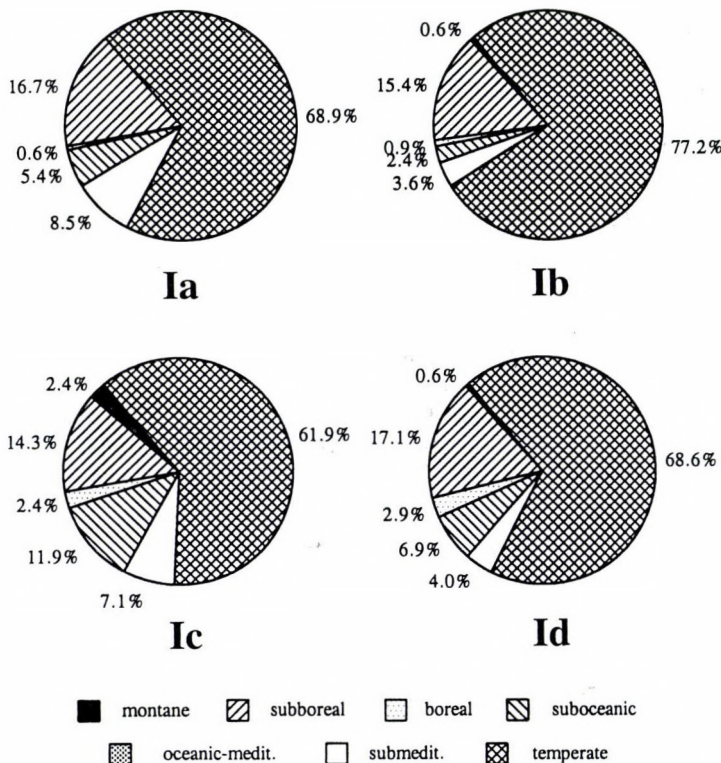


Fig. 7. European distribution pattern of the bryophyte flora of the subgroups of cluster I

lata, and *Pohlia* species. The *Amblystegium* species of the basic flora are also frequent, mainly *A. riparium* and *A. varium*. In some places *Brachythecium rutabulum* is abundant as well.

The quantity of colonists is almost twice as high (41%) while the proportion of perennials is very reduced (43%) in comparison with the earlier mentioned groups. The rate of temperate species is about the same as in the basic flora (I), but the quantity of subboreal species is lower (11%) and the proportion of sub-mediterranean and suboceanic species is a bit higher (Fig. 6).

Along these branches the forestry activity is very intensive, most of the willow trees are cut and poplar trees cover the banks. The erosion of banks, and the decrease of the proportion of shady places can be recognized. The moss flora became poor, number of species is low and the high proportion of colonists indicates the great disturbance. Only tolerant species of the basic flora can survive in these places, but their cover is also reduced.

The fourth group (IV) contains one sampling point, whose flora is very poor. The number of species is the lowest here. Terricolous species of the basic flora can be found here with high abundance as *Brachythecium rutabulum*, *Eurhynchium hians*, and *Pohlia* species. The high abundance of *Mnium marginatum* shows that it was not a disturbed place, but now the flora is not diverse.

In the life strategy plot (Fig. 4) the increase of quantity of colonists species (43.5%) indicates disturbance, but the species requiring constant environmental conditions as perennial and long lived shuttle species still live also with remarkable abundance here (P+LS = 57%).

The European distribution plot (Fig. 6) is also very different from the above-mentioned groups. The quantity of temperate species is very low (40%). The proportion of subboreal species is high (26%), but the quantity of submediterranean (12%) and suboceanic species (30%) are also high compared with the other groups.

The flora composition of the fifth group (V) containing also only one sampling point is very diverse. Pleurocarpous mosses of the basic flora occur with great abundance as *Amblystegium riparium*, *A. serpens*, *Brachythecium rutabulum*, and *Eurhynchium hians*. Two *Plagiomnium* species live here (*P. elatum*, *P. undulatum*), which reflect the good, natural condition of the habitat. Some species being rare in the area were found here as *Hygroamblystegium fluviatile* and *Pellia endiviifolia*. The number of species is high (20).

The proportion of colonists (27%) and perennials (61%) is similar to that of the basic flora (Fig. 4). The difference is in the higher quantity of long lived shuttle species (7%) resembling to that of the I/c and I/d subgroups. The higher proportion of the boreal species (4%) is noteworthy (Fig. 6), while the pattern of the other categories is similar to that of the basic flora (I).

The floral diversity of the sixth group (VI) is the highest. The number of species is as high as in the fifth group. Beside the large abundance of many pleurocarpous species of the basic flora several rarities were collected here as *Lunularia cruciata*, *Conocephalum conicum*, *Rhynchostegium murale*, and *Mnium ambiguum*. The occurrence of other Mniaceae species as *Mnium marginatum*, *M. stellare* and *Plagiomnium elatum* also indicate good, undisturbed environmental conditions.

Examining the life strategy pattern (Fig. 4), the great diversity is striking. The high quantity of long lived shuttle species (LS = 21%) is conspicuous and the considerable proportion of short lived shuttle (SL) species (6%) due to some liverworts make also a difference from the other groups. Though the quantity of perennial species is low (47%) the total proportion of species requiring constant conditions (P+LS) is high (69%).

On the European distribution plot (Fig. 6) we can see the same high diversity. The subboreal, boreal and montane species are significant. The quantity of boreal (11%) and montane species (11%) is very high in comparison with the other groups. But there is a category, which is lacking in other groups, the oceanic-Mediterranean species, which gives the 4% of the flora.

This site is on the bank of a very little and old island along a wide branch with good water supply. We think that it was so little that it was not worth to go there and cut the wood, therefore this island retained its shady, undisturbed banks covered by willow trees. This bank might represent the original, natural picture of the flora in the Szigetköz branch-systems.

CONCLUSION

It is dismal that in 1991–1992 we could find only two places which really represent the earlier status of the bryophyte flora in the investigated territory. The moss flora of the largest, basic group (I) indicates slight disturbance, which is perceptibly present in all of the branch-systems with the unconsidered forestry activity. Its third and fourth subgroup (I/c and I/d) show a characteristic resemblance with the most natural places regarding either their flora compositions or the European distribution and life strategy compositions. The most deteriorated, disturbed places are in the third group. The lack of shady places and the erosion of banks due to the cutting of willow trees lead to the decrease of moss cover and the appearance of many colonist species. At the sampling points of second group there is no forestry activity but the flow velocity decrease causes reduction in floral diversity. Only a special flora living on rotting trees will survive. Looking at the maps (Fig. 8) we can easily recognise, that

- the worst, most disturbed sites are close to the Danube (A and H) or downstream from the village (P and S) at the Cikolasziget branch-system, which might indicate the role of the water quality;
- the best, more or less undisturbed (J, I, M, Y and m) or almost natural sites (L and N) are in the middle of both branch-systems on the places hardly affected by forestry.

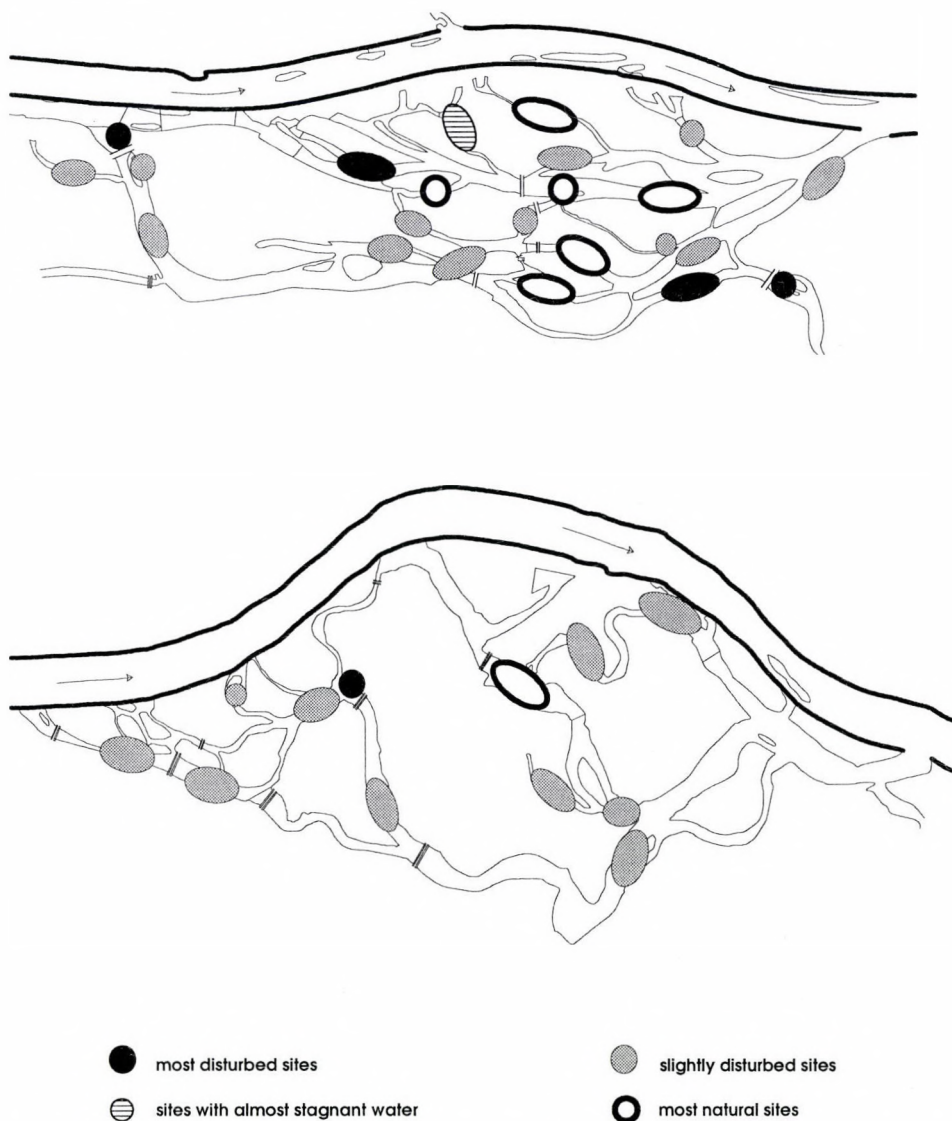


Fig. 8. The result of the cluster analysis representing the approximative disturbance state of the sampling sites

Our study on the branch-systems of the Danube at Szigetköz was a part of a project, which registered the natural values of the area before the installation of the Gabčíkovo water power station. The operation of this power station caused a radical decrease of water level in this area, mainly in the uppermost branch-system (Cikolasziget). This might mean the disappearance of many natural habitat types near water and changes in environmental conditions. As we can see, several bryophyte rarities were still living in the investigation period on the banks of the branch-systems. Nevertheless, these habitats were seriously endangered by the forestry activity. This activity causes the destruction of the natural banks by cutting the willow and alder trees which protected the bank from the erosion and supplied shadow and planting poplar trees, which cannot stop the erosion and cannot overshadow the banks.

*

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REFERENCES

- Boros, Á. (1968): *Bryogeographie und Bryoflora Ungarns*. – Akadémiai Kiadó, Budapest, 466 pp.
- Boros, Á. and Vajda, L. (1955): Für die Flora Ungarns neue und interessante Moose. – *Annls hist.-nat. Mus. natn. Hung.*, S.N., **6**: 155–165.
- Boros, Á. and Zólyomi, B. (1934): Adatok a Hanság mohafldrájához. (Beiträge zur Moosflora des “Hanság”). – *Bot. Közlem.* **31**: 271–272.
- Düll, R. (1983): Distribution of the European and Macaronesian liverworts (Hepaticophytina). – *Bryologische Beitrage* **3**: 1–114.
- Düll, R. (1984): Distribution of the European and Macaronesian mosses (Bryophytina) I. – *Bryologische Beitrage* **4**: 1–109.
- Düll, R. (1985): Distribution of the European and Macaronesian mosses (Bryophytina) II. – *Bryologische Beitrage* **5**: 110–232.
- During, H. (1979): Life strategies of Bryophytes: a preliminary review. – *Lindbergia* **5**: 2–18.
- Göcsei, I. (1979): *A Szigetköz természetföldrája*. [The geography of Szigetköz]. – Akadémiai Kiadó, Budapest, 120 pp.
- Orbán, S. (1984): A magyarországi mohák stratégiái és T, W, R értékei. [Life strategies and TWR values of Hungarian bryophytes]. – *Egri Ho Si Minh Tanárképző Főiskola Füzetek* **17**: 755–765.
- Podani J. (1993): *SYN-TAX-pc. Computer programs for multivariate analysis in ecology and systematics*. Version 5.0. User's guide. – Scientia, Budapest.
- Polgár, S. (1941): Győr vármegye flórája. (Flora Comitatus Jaurinensis). – *Bot. Közlem.* **38**: 201–352.

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FLORISTICAL AND PHYTOCOENOLOGICAL STUDIES ON THE PASTURE OF VILLAGE PENÉSZLEK (NORTHEAST HUNGARY)

M. PAPP, M. HAMVAS-MIKÓ and M. NAGY

*Dept. Botany, Kossuth Lajos University
H-4010 Debrecen, Pf. 14, Hungary*

The paper presents the vegetation of a pasture and its surroundings near the village Penészlek in northeast Hungary. It shows a quick vegetation change on community level owing to human activities and warming climate. It calls the attention how the consequences of thoughtless measures (namely water management, cutting and replantation) can create irreversible processes altering the diverse vegetation into monotonous, man-made and weedy one. It shows how important and urgent the active nature conservation is in the future. The diverse vegetation of the pasture is presented by studying the states of both dry and wet succession series. The vascular flora list and the tables of phytocoenological data are evaluated using phytocoenological and nature conservation respects according to Simon (1988) and Borhidi (1993). A vegetation map is also enclosed.

Key words: plant communities of dunes and valleys, flora list, naturalness values of the communities, vegetation map

INTRODUCTION

At the beginning of the century Nyírség belonged to those geographical regions in Hungary where natural and seminatural vegetation patches dominated the landscape (Boros 1932, Soó 1934, 1937, 1938, 1939 etc.). By today, the water-table in the soil have decreased considerably owing to a too successful drainage programme in the region. The negative tendencies in water balance in the soil have been forced by the warming climate of the last two decades. These effects have accelerated the succession and seemingly have provided more space to agricultural activities destroying the wetlands. Newer data on the flora becoming year by year poorer can be found in the works of Papp and Dudás (1989, 1990). The changes are even more unfavourable considering the dry habitats. The natural forests of the dunes practically disappeared, the sandy grasslands have been overgrazed, overfertilized or cultivated. Recently, false acacia plantations as sand binders and weedy grasses characterise the region on the drier surfaces. Similar degradation processes accompanied by alkalisiation in sandy region are discussed by Bagi (1988) in the Kiskunság National Park in Hungary.

The boundary of the village Penészlek has remained relatively rich in botanical values partly because of traditional natural private field management, and partly owing to the close vicinity of the border which almost everywhere proved to be

a good natural conservation factor during the forty years of communism. Despite the picturesque sight and rich flora around this small village, there are no recent data about the flora and vegetation in literature, only some mentions from the far past (Aszód 1936, Boros 1932, Soó 1937b). Therefore we present here the botanical values of a small area selected, hoping in the protection and active management of it by authorised experts for the future.

MATERIAL AND METHOD

Penészlek is situated close to the Romanian border in the northeast of Nyírség. The pasture, called Veresrét, is to the East of the village, just at the border with its southern end. A long-shaped area of about 130 ha was selected for the study, two sand dune series of about 3–15 m in relative height (the highest point is 154 m above the sea level) running to the frontier and the deeper lowland between them. It belongs to the history of the area, that the human activities described under Introduction can be studied here well. Namely, the chosen area is between two drainage canals, therefore the area might have been wetter in the past. The natural forests of the dunes were cut and the lowland between the dunes has been used as a pasture, the slides of the dunes have served as resting places for the herd and as route for its moving. As a consequence, grazing, trampling, loosening of the sand and manuring altogether have affected and modified the vegetation. Despite these effects the vegetation of the area is still so diverse and rich in unique species and communities, that worth studying and would be worth for conservation for the future.

The relief map of 1 : 10 000 scale used for mapping is presented in Figure 1. The communities were identified by the help of phytocoenological surveys made in 4 m × 4 m quadrats with the estimation of the cover of the species occurring. Quadrates were taken in 5 or 10 repetitions in each community depending on the diversity and extension of their stands. To characterise the species in the phytocoenological tables we used Soó (1964–73, life forms and flora elements), Simon (1988, nature conservation rank – NCR categories) and Borhidi (1993, social behaviour types – SBT and naturalness values – VAL) works. At the discussion of communities we preferred the categories of Borhidi (1993) and at the evaluation of the vascular flora list we used the work of Simon (1988). We have been collecting the data through all seasons since 1990. The community names follow the system and nomenclature of Soó (1980). The nomenclature of the species in the case of vascular flora is after the work of Priszter (1985). The list of abbreviations used in figures and tables can be seen in Appendix 1.

DISCUSSION

COMMUNITIES AND COMMUNITY COMPLEXES

The area of about 130 ha is very rich in habitats owing to the varied surface conditions (Fig. 1). The top and side of the dunes, the potential habitats of *Festuco-Quercetum* forest are in better cases covered with grasses as the result of the secondary succession or in worse cases with false acacia forest, which is the most aggressive artificial community of the whole region. As you can see on the vegetation map (Fig. 2), dry grasses dominate these habitats. The moving of the herd has been loosening the soil surface practically preventing the grass communities

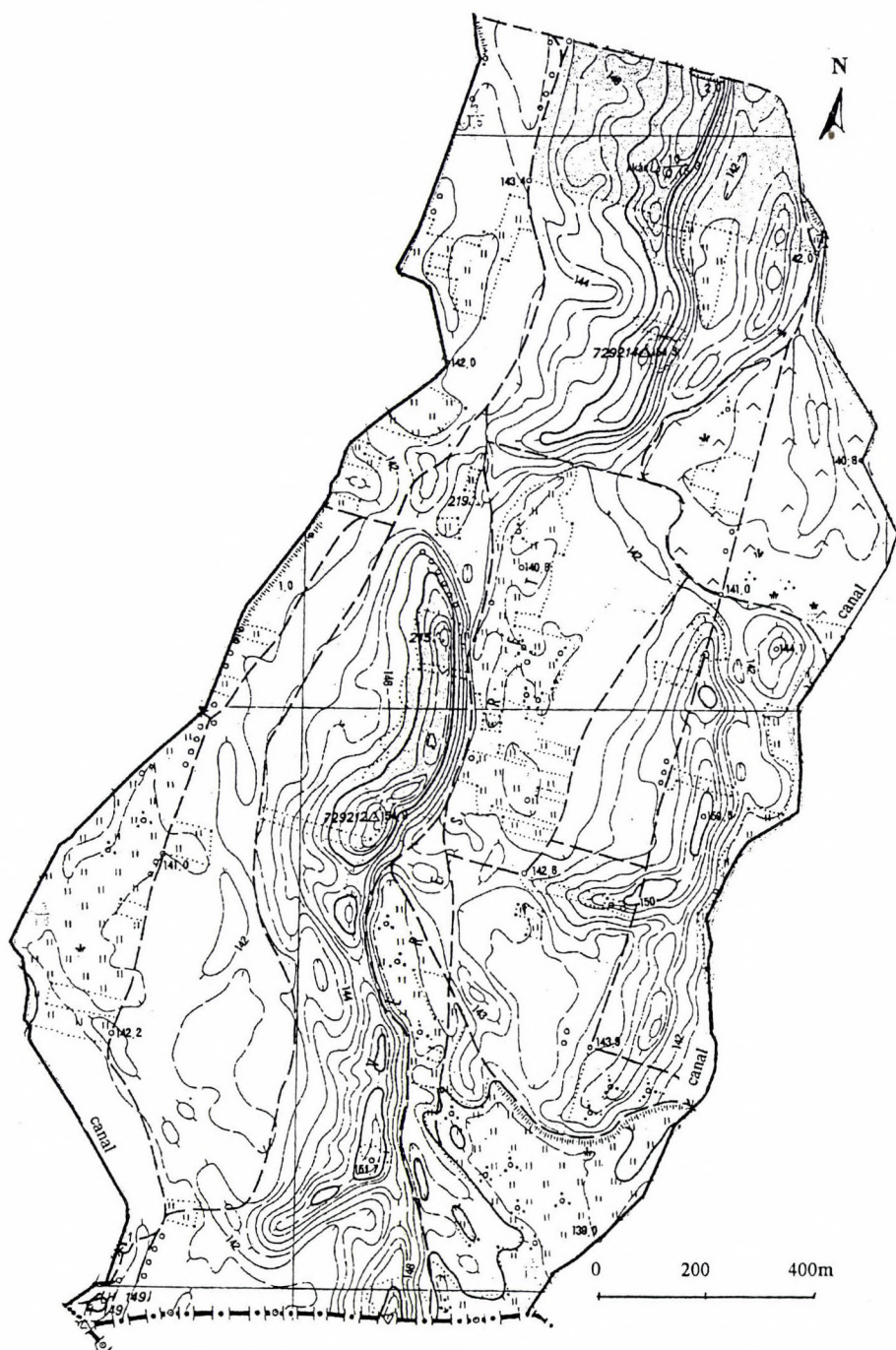


Fig. 1. The relief map of the area

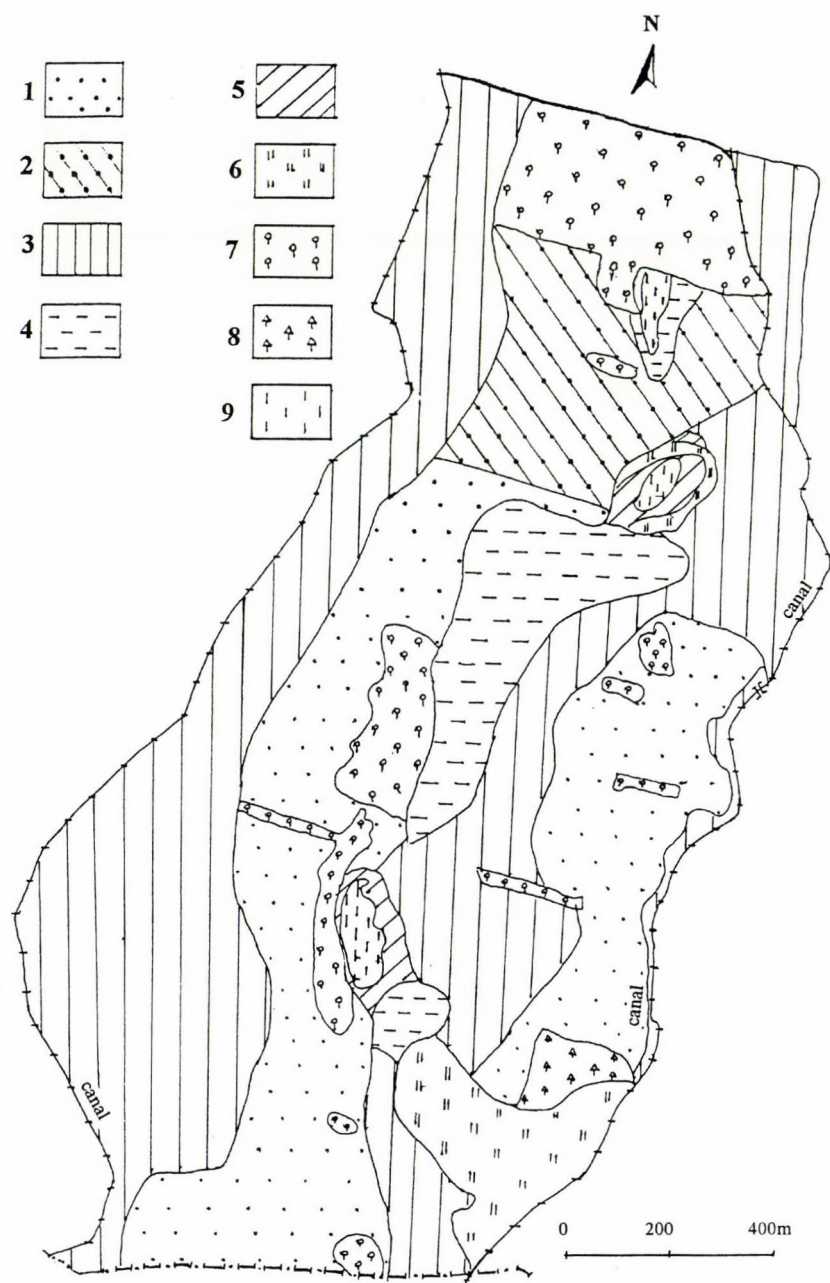


Fig. 2. Vegetation map. 1. Sandy grasslands: *Brometum tectorum*, *Festuco-Corynephorum*. 2. *Festuco-Corynephorum* ploughed in 1992, now false acacia plantation. 3. *Agrostetum albae*. 4. *Caricetum acutiformis-ripariae*. 5. *Caricetum appropinquatae* and *Carici-Menyanthetum*. 6. *Cirsio cani-Festucetum pratensis*. 7. *Bromo sterili-Robinetum*. 8. *Populus alba* plantation. 9. *Salicetum cinereae*. ----- drainage canals. -.-.-.-.- frontier

Table 1
Distribution of social behaviour types (SBT, Borhidi 1993) in the communities studied

	C	S	G	NP	DT	W	A	RC	AC
<i>Corynephorum</i>	4	6	15	25	27	13		6	4
<i>Brometum</i>	4	12	4	15	38	15		4	8
<i>Agrostetum</i>	13	2	16	4	49	11		5	
<i>Caricetum acutiformis</i>	21	8	28		35	4		4	
<i>Cirsio-Festucetum</i>	11	6	41		36	5		1	
<i>Salicetum cinereae</i>	15	9	38		34	2	2		
<i>Scirpo-Phragmitetum</i>	33	10	33		24				
<i>Caricetum approp. and Menyanthetum</i>	24	12	36	2	26				

Table 2
Festuco vaginatae-Corynephorum

A	B	C	D	E	Species names	1	2	3	4	5	6	7	8	9	10	11	12
covers in %																	
GY	RC	-2	G	Cp	<i>Agropyron repens</i>	0	15	0	2	0	0	0	4	0	0	2.1	II
E	C	5	H	Cp	<i>Agrostis stolonifera</i>	0	2	0	0	0	0	0	0	0	0	0.2	I
TZ	DT	2	G	Em	<i>Allium scorodoprasum</i>	0	0	0	0	2	0	0	0	0	0	0.2	I
A	AC	-3	Th	Adv	<i>Ambrosia elatior</i>	0	2	2	2	0	0	0	0	0	0	0.6	II
K	NP	3	Th	Ke	<i>Anthemis ruthenica</i>	12	10	8	4	2	6	2	4	4	6	5.8	V
GY	W	1	Th	Eua	<i>Apera spica-venti</i>	0	0	0	0	2	0	0	0	0	0	0.2	I
TP	NP	3	Th	Eua	<i>Arenaria serpyllifolia</i>	0	0	0	0	2	0	0	0	0	0	0.2	I
GY	W	1	Th	Eua	<i>Berteroa incana</i>	2	0	0	0	0	0	0	0	0	0	0.2	I
TP	DT	2	Th	Eua	<i>Bromus tectorum</i>	20	0	10	8	6	0	0	2	2	0	4.8	III
E	G	4	G	Cp	<i>Carex stenophylla</i>	0	0	4	0	0	0	0	0	0	0	0.4	I
TZ	DT	2	TH	Eu	<i>Centaurea micranthos</i>	0	0	0	2	0	0	6	4	0	4	1.6	II
GY	G	4	Th	Kp	<i>Cerastium glomeratum</i>	5	4	6	4	0	0	0	0	0	0	1.9	II
GY	DT	2	H	Eua	<i>Chondrilla juncea</i>	2	0	0	0	0	0	0	2	4	0	0.8	II
GY	AC	-3	Th	Kp	<i>Conyza canadensis</i>	6	6	3	2	2	0	0	4	0	2	2.5	IV
K	S	6	H	Em	<i>Corynephorus canescens</i>	45	65	65	55	65	50	55	55	45	35	53.5	V
GY	W	1	Th	Eua	<i>Crepis rheoadifolia</i>	0	0	0	0	2	0	0	0	0	0	0.2	I
TZ	RC	-2	G	Kp	<i>Cynodon dactylon</i>	0	0	0	4	10	30	8	20	2	4	7.8	IV
K	G	4	H	Ke	<i>Dianthus pontederiae</i>	0	2	0	0	0	0	0	0	0	0	0.2	I
GY	DT	2	G	Adv	<i>Equisetum arvense</i>	2	2	0	0	0	0	0	0	0	0	0.4	I
K	S	6	G	Eua	<i>Equisetum ramosissimum</i>	2	2	0	0	0	2	4	10	6	6	3.2	IV
TP	NP	3	H	Eua	<i>Erophila verna</i>	3	0	0	0	0	0	0	0	0	0	0.3	I
KV	C	5	H	Ke	<i>Festuca vaginata</i>	0	0	4	0	4	0	0	0	0	0	0.8	I

Table 2 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7	8	9	10	11	12
						covers in %											
K	DT	2	H	Eu	<i>Hieracium pilosella</i>	0	0	0	0	14	0	0	0	0	0	1.4	I
GY	W	1	Th	Eua	<i>Holosteum umbellatum</i>	0	2	0	2	0	0	0	0	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Hypericum perforatum</i>	0	0	2	0	0	0	0	0	0	0	0.2	I
K	G	4	H	Eu	<i>Hypochoeris radicata</i>	0	0	2	4	2	0	0	0	0	0	0.8	II
K	S	6	TH	Eu	<i>Jasione montana</i>	0	2	0	0	4	0	0	0	0	0	0.6	I
TP	NP	3	Th	Eua	<i>Kochia laniflora</i>	2	0	0	0	0	0	0	0	0	0	0.2	I
TZ	DT	2	H	Eua	<i>Leontodon autumnalis</i>	4	0	0	4	0	0	0	0	0	0	0.8	I
TZ	DT	2	H	Eu	<i>Luzula campestris</i>	2	0	0	4	0	0	0	0	0	0	0.6	I
TP	NP	3	Th	Eua	<i>Myosotis stricta</i>	2	4	0	0	0	0	0	0	0	0	0.6	I
GY	W	1	TH	Eu	<i>Oenothera biennis</i>	0	0	0	2	0	0	0	0	0	0	0.2	I
V	G	3	H	Ke	<i>Onosma arenarium</i>	0	0	2	0	0	0	0	0	0	0	0.2	I
TZ	NP	3	Th	Eua	<i>Plantago arenaria</i>	0	0	2	0	0	0	0	0	0	0	0.2	I
GY	RC	-2	Th	Kp	<i>Poa annua</i>	4	2	2	2	2	0	0	0	0	0	1.2	III
TZ	NP	3	H	Eua	<i>Poa bulbosa</i>	0	0	0	0	10	6	0	0	2	0	1.8	II
E	DT	2	H	Cp	<i>Poa angustifolia</i>	4	6	6	6	0	0	0	0	0	0	2.2	II
TP	NP	3	Th	Ke	<i>Polygonum arenarium</i>	10	5	15	0	10	0	0	0	0	0	4.0	II
TZ	DT	2	H	Eua	<i>Potentilla argentea</i>	4	0	0	0	0	0	4	2	2	2	1.4	III
TZ	DT	2	H	Cp	<i>Rumex acetosa</i>	0	0	0	0	0	2	0	0	10	0	1.2	I
K	NP	3	H	Kp	<i>Rumex acetosella</i>	6	4	0	0	2	6	4	4	4	4	3.4	IV
GY	W	1	Th	Eua	<i>Scleranthus annuus</i>	0	0	18	8	0	0	0	10	15	0	5.1	II
K	G	4	H	Eua	<i>Silene otites</i>	2	0	0	0	0	0	0	0	0	0	0.2	I
TP	NP	3	Th	Em	<i>Spergula pentandra</i>	6	2	15	2	2	0	0	0	0	0	2.7	III
TZ	DT	2	TH	Eua	<i>Tragopogon orientalis</i>	0	2	0	0	0	0	0	0	0	0	0.2	I
TP	NP	3	Th	Eua	<i>Veronica dillenii</i>	2	6	2	2	4	0	0	0	0	0	1.6	III
TZ	DT	2	H	Cp	<i>Vicia cracca</i>	0	0	2	0	0	0	0	0	0	0	0.2	I
TP	NP	3	Th	Em	<i>Vicia lathyroides</i>	4	2	2	4	0	0	0	0	0	0	1.2	II

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–10: surveys, 11: average cover, 12: frequency

from permanent closing. Small patches of *Brometum tectorum* community alternate with *Festuco vaginatae-Corynephorum* community (Table 2). The last mentioned community grows in large extension and shows variations on facies level. In some patches *Corynephorus canescens* tussocks are replaced by such perennials as *Rumex acetosella*, *Carex stenophylla* and *Cynodon dactylon*, in other patches weeds dominate e.g. *Conyza canadensis* and *Scleranthus annuus*. The surveys in Table 2 represent the less disturbed patches. Lately, this com-

Table 3
Brometum tectorum

A	B	C	D	E	Species names	1	2	3	4	5	6	7	8	9	10	11	12
						covers in %											
A	AC	-3	Th	Adv	<i>Ambrosia elatior</i>	0	0	4	0	0	0	0	0	0	0	0.4	I
GY	DT	2	H	Eu	<i>Anchusa officinalis</i>	2	0	0	0	0	2	0	0	0	0	0.4	I
K	NP	3	Th	Ke	<i>Anthemis ruthenica</i>	0	0	1	0	0	0	0	4	20	4	2.9	II
GY	W	1	Th	Eua	<i>Apera spica-venti</i>	0	0	0	0	0	0	0	0	1	0	0.1	I
K	C	5	H	Cp	<i>Bromus inermis</i>	6	2	1	0	0	0	0	0	0	0	0.9	II
TP	DT	2	Th	Eua	<i>Bromus tectorum</i>	6	28	2	4	6	60	35	35	35	35	17.6	V
GY	W	1	Th	Eua	<i>Camelina microcarpa</i>	0	0	0	0	0	0	0	3	0	0	0.3	I
TZ	DT	2	H	Eu	<i>Centaurea micranthos</i>	2	2	0	2	0	0	0	0	2	0	0.8	II
TZ	DT	2	H	Kp	<i>Cerastium fontanum</i>	0	0	0	0	2	0	0	0	0	0	0.2	I
GY	DT	2	H	Eua	<i>Chondrilla juncea</i>	2	0	6	0	0	0	0	0	0	0	0.8	I
GY	AC	-3	Th	Kp	<i>Conyza canadensis</i>	25	2	29	8	2	0	0	6	8	4	8.4	IV
K	S	6	H	Em	<i>Corynephorus canescens</i>	0	0	0	4	2	0	0	0	0	0	0.6	I
GY	W	1	Th	Eua	<i>Crepis rheadifolia</i>	0	0	0	0	0	0	0	1	0	0	0.1	I
TZ	RC	-2	G	Kp	<i>Cynodon dactylon</i>	0	8	6	6	6	15	8	35	10	10	10.4	V
K	S	6	G	Eua	<i>Equisetum ramoissimum</i>	4	4	8	8	15	2	6	8	8	6	6.9	V
GY	NP	3	TH	Eua	<i>Erysimum diffusum</i>	2	0	0	0	2	0	0	0	0	0	0.4	I
K	DT	2	H	Eu	<i>Hieracium pilosella</i>	0	0	0	2	0	0	0	0	0	0	0.2	I
TZ	DT	2	H	Eua	<i>Hypericum perforatum</i>	0	0	1	0	0	0	0	0	0	0	0.1	I
K	G	4	H	Eu	<i>Hypochoeris radicata</i>	2	0	2	0	0	0	0	0	0	0	0.4	I
K	S	6	TH	Eu	<i>Jasione montana</i>	2	4	4	2	0	0	2	0	0	0	1.4	III
K	DT	2	H	Eu	<i>Leontodon hispidus</i>	0	0	0	1	0	0	0	0	0	0	0.1	I
TZ	DT	2	G	Subm	<i>Muscari comosum</i>	0	0	4	0	0	0	1	0	0	0	0.5	I
GY	W	1	Th	Eu	<i>Oenothera biennis</i>	0	0	0	0	0	0	2	0	0	0	0.2	I
TZ	NP	3	H	Eua	<i>Poa bulbosa</i>	20	18	14	15	0	0	0	0	0	0	6.7	II
TZ	DT	2	H	Eua	<i>Potentilla argentea</i>	0	0	4	1	4	0	2	0	0	0	1.1	II
K	NP	3	H	Kp	<i>Rumex acetosella</i>	55	4	55	45	70	4	6	4	6	12	26.1	V

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–10: surveys, 11: average cover, 12: frequency

Table 4
Agrostetum albae

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Em	<i>Achillea collina</i>	6	6	8	2	0	4.4	IV
E	C	5	H	Cp	<i>Agrostis stolonifera</i>	6	6	4	14	20	10	V
K	G	4	H	Eua	<i>Astragalus glycyphyllos</i>	6	4	0	0	0	1.2	I
TP	NP	3	Th	Eua	<i>Bromus squarrosus</i>	0	0	0	0	1	0.2	I
E	C	5	H	Eu	<i>Carex distans</i>	6	0	18	8	10	8.4	IV
GY	DT	2	G	Eu	<i>Carex hirta</i>	2	2	0	4	2	2.0	IV
K	DT	2	H	Eua	<i>Carex vulpina</i>	0	0	0	4	2	1.2	II
TZ	DT	2	Th	Eua	<i>Carlina vulgaris</i>	1	0	0	0	0	0.2	I
TZ	DT	2	H	Eu	<i>Centaurea pannonica</i>	0	0	2	0	0	0.4	I
TZ	DT	2	H	Kp	<i>Cerastium fontanum</i>	0	1	0	0	0	0.2	I
GY	W	1	H	Eua	<i>Cichorium intybus</i>	0	8	2	0	0	2.0	II
K	G	4	H	Eua	<i>Cirsium canum</i>	0	0	0	2	0	0.4	I
GY	RC	-2	H	Kp	<i>Convolvulus arvensis</i>	2	0	0	0	0	0.4	I
TP	NP	3	Th	Em	<i>Crepis capillaris</i>	0	0	0	0	2	0.4	I
GY	W	1	Th	Eua	<i>Crepis tectorum</i>	4	0	0	0	0	0.8	I
TZ	RC	-2	G	Kp	<i>Cynodon dactylon</i>	0	4	4	0	0	1.6	II
K	C	5	H	Em	<i>Cynosurus cristatus</i>	0	10	0	0	4	2.8	II
TZ	DT	2	TH	Eua	<i>Daucus carota</i>	2	2	2	0	0	1.2	III
K	C	5	H	Cp	<i>Deschampsia caespitosa</i>	4	0	4	0	0	1.6	II
K	S	6	G	Eua	<i>Equisetum ramosissimum</i>	2	4	2	4	4	3.2	II
E	C	5	H	Eua	<i>Festuca pratensis</i>	8	14	2	15	6	9.0	V
E	C	5	H	Eua	<i>Festuca pseudovina</i>	12	6	6	0	6	6.0	IV
KV	C	5	H	Ke	<i>Festuca vaginata</i>	2	0	0	0	0	0.4	I
K	G	4	H	M	<i>Galium mollugo</i>	0	0	0	0	2	0.4	I
K	G	4	H	Cp	<i>Galium palustre</i>	0	0	0	1	0	0.2	I
K	DT	2	H	Eua	<i>Glechoma hederacea</i>	0	4	2	2	0	1.6	III
K	G	4	H	Eu	<i>Hieracium caespitosum</i>	6	0	0	0	0	1.2	I
K	DT	2	H	Eu	<i>Hieracium pilosella</i>	14	0	2	0	0	3.2	II
GY	DT	2	H	Eua	<i>Inula britannica</i>	0	2	8	0	0	2.0	II
TZ	DT	2	H	Kp	<i>Juncus effusus</i>	0	0	2	4	0	1.2	II
K	DT	2	H	Eu	<i>Leontodon hispidus</i>	2	2	2	0	0	1.2	III
GY	DT	2	H	Kp	<i>Lolium perenne</i>	4	6	4	8	12	6.8	V

Table 4 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Eua	<i>Lotus corniculatus</i>	6	0	18	8	10	8.4	V
TZ	DT	2	H	Eu	<i>Luzula campestris</i>	4	2	2	0	0	1.6	III
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	4	0	0	0	2	1.2	II
GY	W	1	H	Eu	<i>Marrubium peregrinum</i>	1	0	0	0	0	0.2	I
TZ	DT	2	H	Adv	<i>Medicago falcata</i>	2	6	6	6	8	5.6	V
TZ	W	1	Th	Eua	<i>Odontites vernus</i>	0	0	0	2	0	0.4	I
TZ	G	4	H	Eua	<i>Ononis arvensis</i>	0	0	6	0	0	1.2	I
TZ	DT	2	H	Eua	<i>Pastinaca sativa</i>	0	3	0	2	0	1.0	II
TZ	DT	2	H	Kp	<i>Plantago lanceolata</i>	4	4	4	6	6	4.8	V
TZ	DT	2	H	Eu	<i>Poa compressa</i>	4	2	0	0	0	1.2	II
K	G	4	G	Cp	<i>Poa pratensis</i>	0	0	0	0	4	0.8	I
GY	W	1	H	Kp	<i>Potentilla anserina</i>	0	2	4	4	4	2.8	IV
TZ	DT	2	H	Eua	<i>Potentilla argentea</i>	6	0	0	0	0	1.2	I
GY	DT	2	H	Kp	<i>Potentilla reptans</i>	0	0	0	6	0	1.2	I
TZ	DT	2	H	Cp	<i>Prunella vulgaris</i>	4	4	6	2	2	3.6	V
TZ	G	4	H	Eua	<i>Ranunculus acris</i>	0	1	0	0	2	0.6	II
TZ	DT	2	H	Eua	<i>Ranunculus repens</i>	0	2	0	0	0	0.4	I
K	NP	3	H	Kp	<i>Rumex acetosella</i>	1	4	2	4	4	3.0	V
TZ	W	1	Th	Adv	<i>Stenactis strigosa</i>	0	0	2	0	0	0.4	I
GY	RC	-2	H	Kp	<i>Taraxacum officinale</i>	2	6	4	2	1	3.0	V
TZ	DT	2	H	Eua	<i>Trifolium pratense</i>	2	10	8	6	6	6.4	V
TZ	DT	2	H	Eua	<i>Trifolium repens</i>	0	0	0	20	8	5.6	II
TZ	G	4	Th	Eu	<i>Verbascum austriacum</i>	0	2	0	0	0	0.4	I
K	DT	2	H	Eua	<i>Veronica anagalloides</i>	2	0	0	0	0	0.4	I

(A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency)

munity is already very rare in Nyírség (see Papp and Dudás 1990, Nagy *et al.* 1990, Précsényi *et al.* 1990), although this association is an endemic one (Simon 1992). The composition of the flora list reflects the relative stability of the community despite the relatively high proportion of native weed species (13%). Stress tolerants altogether come to 21%, disturbance tolerant (S+G) plants of natural habitats to 27% and natural pioneers to 25% (Table 1). The naturalness value for the community is 2.36.

Table 5
Caricetum acutiformis ripariae

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
GY	RC	-2	G	Cp	<i>Agropyron repens</i>	4	0	0	0	0	0.8	I
TZ	DT	2	G	Em	<i>Allium scorodoprasum</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eua	<i>Angelica sylvestris</i>	0	0	0	4	6	2.0	II
V	C	5	H	Eua	<i>Calamagrostis canescens</i>	2	0	0	4	0	1.2	II
K	G	4	H	Cp	<i>Caltha palustris</i>	0	0	0	0	14	2.8	I
K	DT	2	H	Eua	<i>Calystegia sepium</i>	0	6	0	0	8	2.8	II
E	C	5	HH	Eua	<i>Carex acutiformis</i>	40	35	35	20	30	32.0	V
V	S	6	HH	Cp	<i>Carex pseudocyperus</i>	0	0	0	4	0	0.8	I
E	C	5	HH	Eua	<i>Carex riparia</i>	0	5	10	12	0	5.4	III
K	C	5	HH	Cp	<i>Carex vesicaria</i>	2	0	0	0	4	1.2	II
K	DT	2	H	Eua	<i>Carex vulpina</i>	0	0	0	0	6	1.2	I
GY	RC	-2	G	Eua	<i>Cirsium arvense</i>	0	2	4	0	0	1.2	II
K	G	4	H	Eua	<i>Cirsium canum</i>	0	0	0	4	16	4.0	II
K	G	4	H	Em	<i>Cirsium rivulare</i>	0	0	2	0	0	0.4	I
V	S	8	H	Eua	<i>Dianthus superbus</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eua	<i>Epilobium parviflorum</i>	0	0	2	0	0	0.4	I
GY	DT	2	G	Adv	<i>Equisetum arvense</i>	0	18	0	0	8	5.2	II
K	S	6	G	Cp	<i>Equisetum palustre</i>	0	0	25	6	0	6.2	II
K	C	5	G	Cp	<i>Eriophorum angustifolium</i>	2	6	0	0	0	1.6	II
TZ	DT	2	H	Eua	<i>Eupatorium cannabinum</i>	0	0	0	4	6	2.0	II
E	C	5	H	Eua	<i>Festuca pratensis</i>	0	0	2	0	0	0.4	I
K	G	4	H	Cp	<i>Galium palustre</i>	4	0	2	0	0	1.2	II
K	S	6	H	Eua	<i>Galium uliginosum</i>	6	2	0	6	0	2.8	III
K	C	5	HH	Eu	<i>Glyceria fluitans</i>	0	0	0	2	0	0.4	I
K	C	5	H	Eua	<i>Gratiola officinalis</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eu	<i>Holcus lanatus</i>	0	0	0	2	0	0.4	I
TZ	DT	2	H	Eua	<i>Hypericum perforatum</i>	0	0	0	4	4	1.6	II
GY	DT	2	H	Eua	<i>Inula britannica</i>	2	0	0	0	0	0.4	I
TZ	DT	2	H	Eu	<i>Juncus conglomeratus</i>	14	0	12	18	0	8.8	III
TZ	DT	2	H	Kp	<i>Juncus effusus</i>	10	0	8	8	4	6.0	IV

Table 5 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Eua	<i>Lathyrus pratensis</i>	2	0	0	4	0	1.2	II
K	DT	2	HH	Eua	<i>Lycopus europaeus</i>	0	6	6	2	6	4.0	IV
K	DT	2	Ch	Eu	<i>Lysimachia nummularia</i>	0	0	4	8	16	5.6	III
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	6	8	6	8	12	8.0	V
K	G	4	H	Eua	<i>Lythrum salicaria</i>	0	6	2	6	1	3.8	IV
K	G	4	H	Eua	<i>Lythrum virgatum</i>	0	0	2	0	0	0.4	I
K	G	4	H	Eua	<i>Mentha aquatica</i>	0	2	0	4	6	2.4	III
K	G	4	H	Eua	<i>Myosotis palustris</i>	0	0	4	0	0	0.8	I
GY	DT	2	Ch	Eua	<i>Myosoton aquaticum</i>	0	0	6	0	0	1.6	I
TZ	DT	2	H	Eua	<i>Pastinaca sativa</i>	0	0	2	0	0	0.4	I
K	G	4	H	Eua	<i>Peucedanum palustre</i>	0	4	0	0	0	0.8	I
E	C	5	H	Kp	<i>Phragmites australis</i>	0	4	0	0	0	0.8	I
K	DT	2	H	Cp	<i>Poa trivialis</i>	0	0	8	0	0	1.6	I
GY	DT	2	Th	Eua	<i>Polygonum persicaria</i>	4	0	0	0	0	0.8	I
GY	W	1	H	Kp	<i>Potentilla anserina</i>	0	0	0	4	0	0.8	I
TZ	DT	2	H	Eua	<i>Ranunculus repens</i>	0	0	4	4	4	2.4	III
E	C	5	M	Eua	<i>Salix cinerea</i>	10	0	0	2	0	2.4	II
K	G	4	H	Cp	<i>Scutellaria galericulata</i>	0	0	0	0	2	0.4	I
K	DT	2	H	Eua	<i>Senecio jacobaea</i>	0	0	2	0	0	0.4	I
K	G	4	HH	Eua	<i>Sium latifolium</i>	0	0	2	2	0	0.8	II
K	C	5	HH	Eua	<i>Sparganium erectum</i>	6	0	0	6	0	2.4	II
K	G	4	H	Eu	<i>Symphytum officinale</i>	0	0	4	0	0	0.8	I
GY	W	1	Th	Kp	<i>Verbena officinalis</i>	2	0	0	0	0	0.4	I

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency

Brometum tectorum community (Table 3) is poorer in species. Altogether 26 species were found in the 10 surveys. Among them 18 species are perennial and only 8 are therophyte, which illustrates that the grass communities overlap each other there. The naturalness value is 2.12. The ratios reflecting the social behaviour type composition are in Table 1. Stress and disturbance tolerant species give more than 50%. As in other open pioneer communities, the natural pioneers and the weeds appears in larger quantity (altogether 30%).

Table 6
Cirsio cani-Festucetum pratensis

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Em	<i>Achillea collina</i>	0	0	0	4	4	1.6	II
K	G	4	H	Eua	<i>Achillea setacea</i>	4	2	2	0	0	1.6	III
E	C	5	H	Cp	<i>Agrostis stolonifera</i>	8	4	10	6	6	6.8	V
K	G	4	G	Em	<i>Allium sphaerocephalon</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eua	<i>Angelica sylvestris</i>	4	14	10	6	6	8.0	V
V	C	5	H	Eua	<i>Calamagrostis canescens</i>	0	0	0	2	6	1.6	II
K	G	4	H	Cp	<i>Caltha palustris</i>	0	0	0	4	6	2.0	II
K	G	4	H	Cp	<i>Cardamine pratensis</i>	4	0	2	0	0	1.2	II
E	C	5	HH	Eua	<i>Carex acutiformis</i>	0	0	0	14	8	4.4	II
GY	DT	2	G	Em	<i>Carex hirta</i>	0	4	6	6	4	4.0	IV
K	DT	2	H	Eu	<i>Carex leporina</i>	0	6	0	4	0	2.0	II
K	DT	2	H	Eua	<i>Carex pairae</i>	4	12	4	0	0	4.0	III
E	C	5	HH	Eua	<i>Carex riparia</i>	0	0	0	8	8	3.2	II
K	DT	2	H	Eua	<i>Carex vulpina</i>	4	0	0	6	2	2.4	III
TZ	G	4	H	Eua	<i>Centaurea jacea</i>	25	18	0	0	0	8.6	II
GY	RC	-2	G	Eua	<i>Cirsium arvense</i>	0	0	0	0	4	0.8	I
K	G	4	H	Eua	<i>Cirsium canum</i>	20	30	0	4	4	11.6	IV
K	G	4	H	Em	<i>Cirsium rivulare</i>	35	0	0	22	35	18.4	III
K	G	4	Th	Eua	<i>Cnidium dubium</i>	0	0	2	0	0	0.4	I
V	S	6	G	Eua	<i>Dactylorhiza incarnata</i>	0	4	0	0	0	0.8	I
TZ	DT	2	TH	Eua	<i>Daucus carota</i>	4	2	0	0	0	1.2	II
K	DT	2	H	Eua	<i>Epilobium hirsutum</i>	2	0	0	0	2	0.8	II
K	G	4	H	Eua	<i>Epilobium montanum</i>	0	2	0	0	0	0.4	I
K	G	4	HH	Cp	<i>Equisetum fluviatile</i>	0	0	0	4	4	1.6	II
K	S	6	G	Cp	<i>Equisetum palustre</i>	10	24	4	0	0	7.6	III
K	C	5	G	Cp	<i>Eriophorum angustifolium</i>	0	0	2	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Eupatorium cannabinum</i>	6	0	0	0	0	1.2	I
K	G	4	H	Eu	<i>Euphorbia lucida</i>	0	4	0	0	0	0.8	I
E	C	5	H	Eua	<i>Festuca pratensis</i>	20	16	6	8	6	11.2	V
E	C	5	H	Eua	<i>Festuca rupicola</i>	8	8	0	0	0	3.2	II
K	G	4	H	Eua	<i>Filipendula ulmaria</i>	0	4	0	0	0	0.8	I
K	S	6	H	Eua	<i>Galium uliginosum</i>	4	10	6	0	0	4.0	III

Table 6 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
K	G	4	H	Cp	<i>Geranium palustre</i>	0	0	0	4	6	2.0	II
K	C	5	H	Eua	<i>Gratiola officinalis</i>	0	2	0	0	0	0.4	I
K	G	4	H	Eu	<i>Holcus lanatus</i>	4	0	2	1	0	1.4	III
TZ	DT	2	H	Eua	<i>Hypericum perforatum</i>	4	0	0	0	0	0.8	I
K	G	4	H	Eu	<i>Hypochoeris radicata</i>	0	0	0	2	0	0.4	I
K	G	4	H	Eua	<i>Juncus atratus</i>	0	4	0	2	0	1.2	II
TZ	DT	2	H	Eu	<i>Juncus conglomeratus</i>	0	0	0	6	0	1.2	I
TZ	DT	2	H	Kp	<i>Juncus effusus</i>	6	0	0	6	2	2.8	III
E	C	5	G	Cp	<i>Juncus gerardii</i>	4	4	0	0	0	1.6	II
K	G	4	H	Cp	<i>Koeleria cristata</i>	4	0	0	0	0	0.8	I
TZ	DT	2	H	Eua	<i>Lathyrus pratensis</i>	0	4	2	0	0	1.2	II
K	DT	2	H	Eu	<i>Leontodon hispidus</i>	2	0	0	2	0	0.8	II
K	G	4	Th	Eu	<i>Linum catharticum</i>	0	2	0	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Lotus corniculatus</i>	2	0	0	0	0	0.4	I
TZ	G	4	H	Eua	<i>Lychnis flos-cuculi</i>	15	6	6	2	2	6.2	V
K	DT	2	HH	Eua	<i>Lycopus exaltatus</i>	0	0	0	0	2	0.4	I
K	DT	2	Ch	Eu	<i>Lysimachia nummularia</i>	0	0	0	6	2	1.6	II
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	0	0	0	4	6	2.0	II
K	G	4	H	Eua	<i>Lythrum salicaria</i>	0	0	0	2	2	0.8	II
K	G	4	H	Eua	<i>Lythrum virgatum</i>	0	0	0	2	6	1.6	II
GY	W	1	H	Eu	<i>Marrubium peregrinum</i>	0	0	0	2	0	0.4	I
TP	G	4	Th	Eua	<i>Medicago minima</i>	2	4	0	0	0	1.2	II
K	G	4	H	Eu	<i>Mentha aquatica</i>	0	0	0	2	4	1.2	II
K	DT	2	H	Cp	<i>Mentha arvensis</i>	0	6	4	0	0	2.0	II
K	DT	2	H	Eua	<i>Mentha longifolia</i>	0	4	2	0	4	2.0	III
GY	DT	2	Ch	Eua	<i>Myosoton aquaticum</i>	0	0	0	0	1	0.2	I
V	G	4	G	Km	<i>Orchis laxiflora</i>	2	0	0	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Pastinaca sativa</i>	0	0	4	2	0	1.2	II
TZ	DT	2	H	Kp	<i>Plantago lanceolata</i>	4	2	0	0	0	1.2	II
K	G	4	G	Cp	<i>Poa pratensis</i>	6	6	6	4	2	4.8	V
K	DT	2	H	Cp	<i>Poa trivialis</i>	0	0	0	4	4	1.6	II
GY	DT	2	Th	Eua	<i>Polygonum persicaria</i>	0	4	4	0	0	1.6	II
GY	W	1	H	Kp	<i>Potentilla anserina</i>	2	4	2	0	2	2.0	IV
GY	DT	2	H	Kp	<i>Potentilla reptans</i>	4	4	0	0	4	2.4	III
TZ	G	4	H	Eua	<i>Ranunculus acris</i>	4	6	4	4	2	4.0	V

Table 6 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Eua	<i>Ranunculus repens</i>	4	2	6	6	4	4.4	V
K	S	6	Th	Eua	<i>Rhinanthus borbassii</i>	0	0	4	0	0	0.8	I
K	G	4	Th	Eu	<i>Rhinanthus minor</i>	8	8	0	1	0	3.4	III
K	G	4	HH	Eua	<i>Rorippa amphibia</i>	2	6	0	4	0	2.4	III
TZ	DT	2	H	Cp	<i>Rumex acetosa</i>	0	0	2	0	0	0.4	I
K	DT	2	H	Eua	<i>Sanguisorba officinalis</i>	0	0	0	2	0	0.4	I
E	G	4	G	Cp	<i>Scirpus sylvaticus</i>	0	0	0	1	0	0.2	I
K	G	4	H	Cp	<i>Scutellaria galericulata</i>	0	4	2	0	0	1.2	II
K	G	4	H	Eu	<i>Scutellaria hastifolia</i>	2	0	0	0	0	0.4	I
TZ	W	1	Th	Adv	<i>Stenactis strigosa</i>	0	0	0	2	0	0.4	I
K	G	4	H	Eua	<i>Succisa pratensis</i>	0	2	0	0	0	0.4	I
K	G	4	H	EM	<i>Thalictrum lucidum</i>	0	0	4	0	0	0.8	I
K	G	4	H	Eua	<i>Thesium arvense</i>	2	0	0	0	0	0.4	I
GY	DT	2	Th	Eua	<i>Trifolium arvense</i>	1	0	0	0	0	0.2	I
TZ	DT	2	H	Eua	<i>Trifolium pratense</i>	0	0	2	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Trifolium repens</i>	0	4	0	2	0	1.2	II
GY	W	1	Th	Kp	<i>Verbena officinalis</i>	0	0	0	1	0	0.2	I
K	S	6	H	Eua	<i>Viola stagnina</i>	0	0	2	0	0	0.4	I

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency

Table 7
Calamagrosti-Salicetum cinereae

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
E	C	5	H	Cp	<i>Agrostis stolonifera</i>	0	4	0	0	0	0.8	I
K	G	4	HH	Cp	<i>Alisma plantago-aquatica</i>	0	0	1	0	0	0.2	I
K	G	4	H	Eua	<i>Angelica sylvestris</i>	0	0	2	2	0	0.8	II
K	G	4	H	Eua	<i>Athyrium filix-femina</i>	0	0	2	0	0	0.4	I
V	C	5	H	Eua	<i>Calamagrostis canescens</i>	0	0	4	0	0	0.8	I
K	G	4	H	Cp	<i>Caltha palustris</i>	4	4	4	6	4	4.4	V
K	DT	2	H	Eua	<i>Calystegia sepium</i>	0	0	4	6	2	2.4	III
E	C	5	HH	Eua	<i>Carex acutiformis</i>	4	6	0	6	4	4.0	IV
KV	C	5	HH	Eua	<i>Carex appropinquata</i>	0	0	1	0	0	0.2	I
K	DT	2	H	Eua	<i>Carex leporina</i>	0	0	0	2	0	0.4	I

Table 7 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
K	DT	2	H	Eua	<i>Carex pairae</i>	4	0	0	0	0	0.8	I
E	C	5	HH	Eua	<i>Carex riparia</i>	0	0	4	2	4	2.0	III
K	C	5	HH	Cp	<i>Carex vesicaria</i>	0	0	1	0	0	0.2	I
TZ	DT	2	H	Kp	<i>Cerastium fontanum</i>	0	0	2	0	0	0.4	I
K	G	4	H	Eua	<i>Cirsium canum</i>	0	0	2	0	0	0.4	I
K	G	4	H	Em	<i>Cirsium rivulare</i>	0	0	0	4	2	1.2	II
K	G	4	M	Eu	<i>Crataegus monogyna</i>	0	2	0	0	0	0.4	I
V	S	6	H	Cp	<i>Dryopteris carthusiana</i>	0	4	0	2	0	1.2	II
A	A	-1	Th	Adv	<i>Echinocystis lobata</i>	0	4	2	0	0	1.2	II
K	G	4	H	Eua	<i>Epilobium parviflorum</i>	4	0	1	0	1	1.2	III
GY	DT	2	G	Adv	<i>Equisetum arvense</i>	0	6	2	0	0	1.6	II
K	G	4	HH	Cp	<i>Equisetum fluviatile</i>	0	0	2	4	2	1.6	III
K	S	6	G	Cp	<i>Equisetum palustre</i>	0	0	0	2	0	0.4	I
TZ	DT	2	H	Eua	<i>Eupatorium cannabinum</i>	0	0	2	1	1	0.4	III
K	G	4	M	Eua	<i>Frangula alnus</i>	2	4	0	6	4	3.2	IV
GY	W	1	Th	Cp	<i>Galium aparine</i>	0	0	2	2	2	1.2	III
K	G	4	H	Cp	<i>Galium palustre</i>	0	0	1	0	0	0.2	I
K	S	6	H	Eua	<i>Galium uliginosum</i>	16	0	0	1	1	3.6	III
K	G	4	H	Eu	<i>Geranium palustre</i>	0	0	2	0	0	0.4	I
K	G	4	H	Eua	<i>Hypericum maculatum</i>	0	0	2	2	0	0.8	II
TZ	DT	2	H	Kp	<i>Juncus effusus</i>	2	0	0	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Lathyrus pratensis</i>	0	2	1	1	0	0.8	III
V	S	6	G	Eua	<i>Listera ovata</i>	0	0	0	1	0	0.2	I
TZ	G	4	H	Eua	<i>Lychnis flos-cuculi</i>	2	0	0	2	0	0.8	II
K	DT	2	HH	Eua	<i>Lycopus europaeus</i>	6	4	1	2	1	2.8	V
K	DT	2	Ch	Eu	<i>Lysimachia nummularia</i>	25	14	4	4	3	10.0	V
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	4	4	0	2	0	2.0	III
K	G	4	H	Eu	<i>Mentha aquatica</i>	0	0	4	2	4	2.0	III
K	DT	2	H	Cp	<i>Mentha arvensis</i>	4	0	0	0	0	0.8	I
KV	S	6	H	Cp	<i>Menyanthes trifoliata</i>	0	0	2	0	4	1.2	II
K	G	4	H	Eua	<i>Myosotis palustris</i>	4	0	0	2	0	1.2	II
GY	DT	2	Ch	Eua	<i>Myosoton aquaticum</i>	0	0	4	2	0	1.2	II
K	G	4	H	Eua	<i>Peucedanum palustre</i>	12	0	4	2	0	3.6	III
E	C	5	H	Kp	<i>Phragmites australis</i>	0	6	0	0	0	1.2	I
K	G	4	H	Cp	<i>Poa palustris</i>	0	0	4	0	2	1.2	II
K	DT	2	H	Cp	<i>Poa trivialis</i>	8	4	4	2	0	3.6	IV
K	DT	2	H	Eua	<i>Potentilla erecta</i>	0	0	1	0	0	0.2	I

Table 7 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
TZ	DT	2	H	Cp	<i>Prunella vulgaris</i>	2	0	0	0	0	0.4	I
E	C	5	MM	Eu	<i>Quercus robur</i>	2	0	0	0	0	0.4	I
TZ	DT	2	H	Eua	<i>Ranunculus repens</i>	2	0	0	0	0	0.4	I
K	G	4	HH	Eua	<i>Rorippa amphibia</i>	0	0	2	2	2	1.2	III
E	C	5	MM	Eua	<i>Salix alba</i>	0	0	10	0	0	2.0	I
E	C	5	M	Eua	<i>Salix cinerea</i>	90	80	60	85	90	81.0	V
K	G	4	MM	Eua	<i>Salix fragilis</i>	0	0	6	0	0	1.2	I
GY	DT	2	M	Eu	<i>Sambucus nigra</i>	2	0	0	0	0	0.4	I
E	G	4	G	Cp	<i>Scirpus sylvaticus</i>	0	0	2	0	0	0.4	I
K	DT	2	H	Eua	<i>Senecio jacobaea</i>	0	2	0	0	0	0.4	I
K	G	4	HH	Cp	<i>Sium erectum</i>	0	0	4	0	2	1.2	II
TZ	DT	2	Th	Eua	<i>Solanum dulcamara</i>	4	8	4	6	4	5.2	V
K	DT	2	H	Cp	<i>Stachys palustris</i>	0	0	0	2	0	0.4	I
K	G	4	H	Eu	<i>Symphytum officinale</i>	0	0	2	0	2	0.8	II
K	S	6	G	Kp	<i>Thelypteris palustris</i>	55	45	20	30	25	30.0	V
TZ	DT	2	H	Kp	<i>Urtica dioica</i>	6	0	1	4	0	2.2	III
K	G	4	H	Eua	<i>Valeriana officinalis</i>	0	0	4	0	1	1.0	II
K	G	4	M	Cp	<i>Viburnum opulus</i>	4	0	0	6	0	2.0	II

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency

Table 8
Scirpo-Phragmitetum

A	B	C	D	E	species names	1	2	3	4	5	6	7
						covers in %						
K	G	4	HH	Cp	<i>Alisma plantago-aquatica</i>	6	2	0	0	2	2.0	III
V	C	5	H	Eua	<i>Calamagrostis canescens</i>	0	0	25	2	6	6.6	III
K	DT	2	H	Eua	<i>Calystegia sepium</i>	2	0	0	2	2	1.2	III
E	C	5	HH	Eua	<i>Carex acutiformis</i>	0	0	4	2	0	1.2	II
KV	C	5	HH	Eua	<i>Carex appropinquata</i>	0	0	12	0	6	3.6	II
E	C	5	HH	Em	<i>Carex elata</i>	8	2	4	0	0	2.8	II
V	S	6	HH	Cp	<i>Carex pseudocyperus</i>	0	6	0	2	6	2.8	III
K	G	4	HH	Cp	<i>Equisetum fluviatile</i>	0	0	4	4	0	1.6	II
K	G	4	H	Cp	<i>Galium palustre</i>	2	0	4	2	6	2.8	IV
K	C	5	HH	Eu	<i>Glyceria fluitans</i>	6	10	0	4	0	4.0	III

Table 8 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
K	S	6	HH	Eu	<i>Hottonia palustris</i>	4	0	4	0	6	2.8	III
V	G	4	G	Eu	<i>Iris pseudacorus</i>	4	2	0	2	0	1.6	III
K	DT	2	HH	Eua	<i>Lycopus exaltatus</i>	0	0	6	0	0	1.2	I
K	DT	2	HH	Eua	<i>Lycopus europaeus</i>	0	0	18	0	2	4.0	II
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	0	0	20	0	4	4.8	II
K	G	4	H	Eua	<i>Lythrum virgatum</i>	0	0	4	4	0	1.6	II
K	G	4	H	Eu	<i>Mentha aquatica</i>	0	0	8	2	4	2.8	III
KV	S	6	H	Cp	<i>Menyanthes trifoliata</i>	0	2	10	4	0	3.2	III
K	C	5	HH	Eua	<i>Oenanthe aquatica</i>	4	0	0	6	0	2.0	II
K	G	4	H	Eua	<i>Peucedanum palustre</i>	0	2	15	8	2	5.4	IV
E	C	5	H	Kp	<i>Phragmites australis</i>	30	22	30	20	35	27.4	V
K	DT	2	H	Cp	<i>Poa trivialis</i>	0	0	4	0	4	1.6	II
K	DT	2	HH	Cp	<i>Polygonum amphibium</i>	8	2	0	0	0	2.0	II
K	G	4	HH	Eua	<i>Rorippa amphibia</i>	12	4	0	8	6	6.0	IV
TZ	G	4	H	Em	<i>Rumex hydrolapathum</i>	4	0	0	2	4	2.0	III
E	C	5	M	Eua	<i>Salix cinerea</i>	0	0	4	0	0	0.8	I
TZ	DT	2	Th	Eua	<i>Solanum dulcamara</i>	2	4	0	2	0	1.6	III
K	C	5	HH	Eua	<i>Sparganium erectum</i>	10	4	0	6	2	4.4	IV
K	G	4	H	Eua	<i>Symphytum officinale</i>	6	4	0	2	6	3.6	IV
E	C	5	HH	Kp	<i>Typha angustifolia</i>	15	10	0	10	2	7.4	IV

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency

Table 9
Carici-Menyanthetum and *Caricetum cinereae* communities

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
E	C	5	H	Cp	<i>Agrostis stolonifera</i>	4	2	0	6	0	2.4	III
K	G	4	HH	Cp	<i>Alisma plantago-aquatica</i>	2	2	2	10	14	6	V
TZ	DT	2	H	Cp	<i>Alopecurus aequalis</i>	4	2	4	0	0	2	III
V	C	5	H	Eua	<i>Calamagrostis canescens</i>	12	4	20	0	0	7.2	III
U	C	9	H	Cp	<i>Calamagrostis stricta</i>	4	0	0	0	0	0.8	I
K	G	4	H	Cp	<i>Caltha palustris</i>	6	4	8	0	0	3.6	III
K	DT	2	H	Eua	<i>Calystegia sepium</i>	1	2	0	0	0	0.6	II
K	G	4	H	Cp	<i>Cardamine pratensis</i>	2	1	2	0	0	1.0	III

Table 9 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
KV	C	5	HH	Eua	<i>Carex appropinquata</i>	35	40	20	50	30	35.0	V
E	C	5	HH	Em	<i>Carex elata</i>	6	2	4	0	0	2.4	III
K	DT	2	H	Eua	<i>Carex leporina</i>	2	0	0	0	0	0.4	I
V	S	6	HH	Cp	<i>Carex pseudocyperus</i>	4	4	0	6	0	2.8	III
K	C	5	HH	Cp	<i>Carex vesicaria</i>	2	2	0	0	0	0.8	II
K	DT	2	H	Eua	<i>Carex vulpina</i>	2	0	0	0	0	0.4	I
K	G	4	H	Em	<i>Cirsium rivulare</i>	2	4	2	0	0	1.6	III
K	C	5	G	Kp	<i>Eleocharis palustris</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eua	<i>Epilobium montanum</i>	1	1	0	0	0	0.4	II
K	G	4	H	Cp	<i>Epilobium palustre</i>	1	0	0	2	0	0.6	II
K	G	4	HH	Cp	<i>Equisetum fluviatile</i>	8	6	4	0	0	3.6	III
K	S	6	G	Cp	<i>Equisetum palustre</i>	2	0	2	0	0	0.8	II
K	G	4	H	Eu	<i>Euphorbia lucida</i>	4	0	0	0	0	0.8	I
K	G	4	H	Cp	<i>Galium palustre</i>	2	4	0	0	0	12	II
K	S	6	H	Eua	<i>Galium uliginosum</i>	4	0	2	4	2	2.4	IV
K	C	5	HH	Eua	<i>Glyceria fluitans</i>	1	0	0	0	0	0.2	I
K	S	6	HH	Eu	<i>Hottonia palustris</i>	6	0	0	10	15	6.2	III
TZ	DT	2	H	Eu	<i>Juncus conglomeratus</i>	0	0	0	4	0	0.8	I
TZ	DT	2	H	Kp	<i>Juncus effusus</i>	0	0	0	6	0	1.2	I
K	DT	2	HH	Eua	<i>Lycopus europaeus</i>	4	2	2	4	4	3.2	V
K	DT	2	Ch	Eu	<i>Lysimachia nummularia</i>	4	6	2	2	0	2.8	IV
K	DT	2	H	Eua	<i>Lysimachia vulgaris</i>	2	4	4	15	20	9.0	V
K	G	4	H	Eua	<i>Lythrum salicaria</i>	1	0	2	4	0	1.4	III
K	G	4	H	Eua	<i>Lythrum virgatum</i>	1	0	0	0	0	0.2	I
K	G	4	H	Eu	<i>Mentha aquatica</i>	4	2	2	0	0	1.6	III
K	DT	2	H	Cp	<i>Mentha arvensis</i>	0	0	0	2	4	1.2	II
KV	S	6	H	Cp	<i>Menyanthes trifoliata</i>	18	20	30	0	0	13.6	III
K	G	4	H	Eua	<i>Myosotis palustris</i>	2	0	0	0	2	0.8	II
K	C	5	HH	Eua	<i>Oenanthe aquatica</i>	4	0	2	0	0	12	II
K	G	4	H	Eua	<i>Peucedanum palustre</i>	4	6	4	15	20	9.8	V
E	C	5	H	Kp	<i>Phragmites australis</i>	2	0	1	12	0	3.0	III
K	DT	2	HH	Cp	<i>Polygonum amphibium</i>	1	0	1	0	0	0.4	II
GY	DT	2	Th	Cp	<i>Polygonum lapathifolium</i>	0	0	0	4	0	0.8	I
K	S	6	HH	Eua	<i>Ranunculus lingua</i>	0	0	0	0	2	0.4	I
TZ	DT	2	H	Eua	<i>Ranunculus repens</i>	5	4	2	0	0	22	III
GY	NP	3	Th	Cp	<i>Ranunculus sceleratus</i>	4	2	2	0	0	1.6	III

Table 9 cont.

A	B	C	D	E	Species names	1	2	3	4	5	6	7
						covers in %						
K	G	4	HH	Eua	<i>Rorippa amphibia</i>	4	1	4	0	0	1.8	III
E	C	5	M	Eua	<i>Salix cinerea</i>	6	0	0	4	6	3.2	III
K	C	5	M	Eua	<i>Salix rosmarinifolia</i>	2	0	0	0	0	0.4	I
K	G	4	H	Cp	<i>Scutellaria galericulata</i>	1	0	0	0	0	0.2	II
K	G	4	HH	Eua	<i>Sium latifolium</i>	2	0	0	0	0	0.4	I
K	C	5	HH	Eua	<i>Sparganium erectum</i>	2	0	0	4	6	2.4	III
K	DT	2	H	Cp	<i>Stachys palustris</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eu	<i>Symphytum officinale</i>	6	0	2	0	0	1.6	II
K	S	6	G	Kp	<i>Thelypteris palustris</i>	2	0	0	14	0	3.2	II
K	G	4	H	Eua	<i>Teucrium scordium</i>	1	0	0	0	0	0.2	I
E	C	5	HH	Cp	<i>Typha latifolia</i>	1	0	0	0	0	0.2	I
TZ	DT	2	H	Kp	<i>Urtica dioica</i>	2	0	0	0	0	0.4	I
K	G	4	H	Eua	<i>Valeriana officinalis</i>	1	0	0	0	2	0.6	I
K	G	4	H	Cp	<i>Veronica scutellata</i>	2	0	0	0	0	0.4	I

A: NCV, B: SBT, C: VAL, D: life forms, E: flora element, 1–5: surveys, 6: average cover, 7: frequency

Community preferred by cows on the area is the *Agrostetum albae* (Table 4). Its mesophilous character and the large number of legumes ensure good production for animals. In deeper position, the main companions are *Festuca pratensis*, *Carex distans*, *Ranunculus* species and *Taraxacum officinale*. On drier surfaces *Festuca pseudovina*, *Hieracium* and *Leontodon* species dominate besides *Agrostis alba*. Almost 50% of the species are disturbance tolerant, and generalists represent still a remarkable group (Table 1). The naturalness value for the community is 2.53.

Agrostetum albae community connects to the littoral zones of the drainage canals with *Caricetum acutiformis-ripariae* community and to *Festucetum pseudovinae* community towards the dunes. *Festucetum pseudovinae* occurs only in narrow stripes in the transitive zones.

Caricetum acutiformis-ripariae community (Tables 1, 5) being extended is rich in species. The species often mix with the species of *Cirsio cani-Festucetum pratensis* and encircle *Carex elata* tussocks of 1–1.5 m height in deeper spots. In the hollows *Hottonia palustris* blossoms if water is sufficient in springs. The habitat completely dries out by summers. The species number in 5 surveys is 53, among them only 2 are ruderal competitor, thus the naturalness value of the community is high, 3.34.

Cirsio cani-Festucetum pratensis community (Table 6) lies on the border and accompanies the two willow-fen complexes. Its species richness is remarkable (85 species in 5 surveys). Most of the species are natural disturbance tolerants and generalists (Table 1). The species often mix with those of *Carici-Menyanthetum* and *Caricetum appropinquatae* communities.

Wetlands having shrunk tend to occur as vegetation complexes on two plots on the area. The different communities cannot evolve their typical features as their habitats become smaller and smaller, so they combine. These complexes preserve the most endangered and rare species, therefore they deserve more attention. The core of these complexes is *Calamagrosti-Salicetum cinereae* community (Tables 1, 7). It has patches with homogeneous mass of mosses and/or *Thelypteris palustris* in the underground. Elsewhere, especially on the edges, its herb layer is very rich. Competitors and specialists occur in larger number besides the generalists and disturbance tolerant species. The naturalness value is 3.54. *Scirpo-Phragmitetum* stands accompany the *Salix* shrubs. Nowadays these stands are also dry in summers. *Calamagrostis canescens* forms tussocks interwoven by reed in them. The 30 species occurring in the 5 surveys are all so-called good species considering their social behaviours (Tables 1, 8). The naturalness value is the highest on the area (4.07). This community connects to the tussocks and hollows of *Caricetum appropinquatae* and *Carici-Menyanthetum* communities (Tables 1, 9). Their values can be also expressed with their very high naturalness value

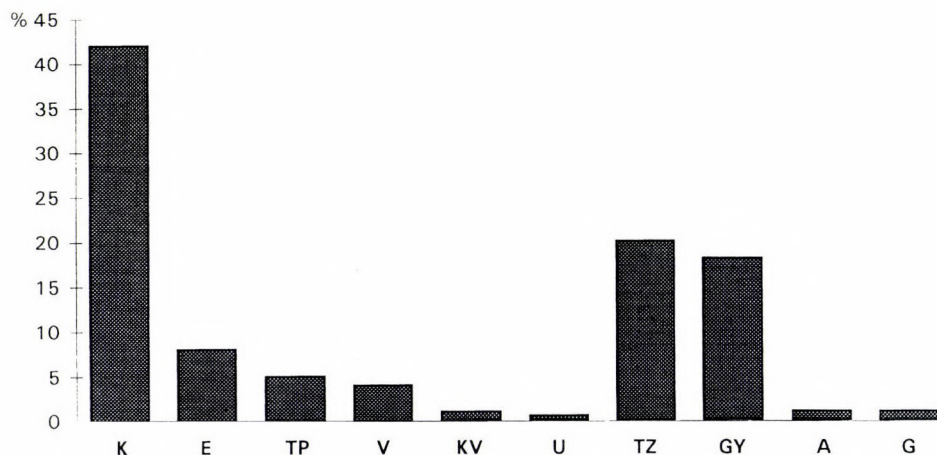


Fig. 3. Distribution of nature conservation rank (NCR, Simon 1988) in the flora list

(4.02). The stands are without weeds, the 12% of the species are specialists and somehow unique ones.

The vegetation complexes presented above consist of relic communities. Their habitats unfortunately are dry for some years in summers. Most of the species have tolerated the extra water scarcity till this time, but where the limit is.

FLORA

The vascular flora list (see Appendix 2) contains the species have been identified since 1990. The total is 292 species. Comparing the species richness, Simon (1984) identified 166 species in Bugac Biosphere Reserve on about 100 ha studying communities developed also on sand. The spectrum of the species (Fig. 3) according to Simon (1988) shows the large ratio of the main components of natural communities (42%). The second largest category is the disturbance tolerators. 16 species belong to the categories which have natural conservation interest: *Calamagrostis stricta*, *C. canescens*, *Carex pseudocyperus*, *C. appropinquata*, *Dactylorhiza incarnata*, *Dianthus superbus*, *Dryopteris carthusiana*, *Festuca vaginata*, *Iris pseudacorus*, *Listera ovata*, *Menyanthes trifoliata*, *Onosma arenarium*, *Ophioglossum vulgatum*, *Orchis laxiflora* subsp. *elegans*, *O. laxiflora* subsp. *palustris*, *Ranunculus flammula*. This richness is noteworthy, considering the relatively small size of the area. Altogether 80% of the species belong to natural communities. The number of weeds a little bit exceeds the average calculated to the whole vascular flora of Hungary (Simon 1988).

CONCLUSION

Despite some human activities, the vegetation of the studied area still represents a lot of features of ancient nature. The diverse vegetation units, unique communities and species with their curiosity and rarity make the area worth protecting. Without protection the fate of the area is worrying.

The main source of negative tendencies is the sinking of water-table. The consequence is the pressing scarcity of water. No more than 5 years can be predicted for the survival of the relic communities and species requiring water over the whole vegetation period.

Another source of danger is the ploughing of the sandy grasses. The north dune of the area already has become the first victim. False acacia plantation has been competing with great success with the remnants of the endemic *Festuco-Corynephorum* community since 1992. While the area is not protected, similar actions can occur at any time. The authors do think that the area would provide an excellent chance for spectacular and successful active nature conservation ac-

tivities. Keeping the water-table at the sufficient level, preventing from the invasion of weeds and planting of alien tree species would make the area a prominent representative of the vegetation in Nyírség for a long time.

Finally, the paper calls the attention again for the necessity of urgent realisation of appropriate measures in the area by the Nature Conservation Authority.

REFERENCES

- Aszódi, L. (1936): Adatok a nyírségi homoki vegetáció ökológiájához és szociológiájához. (Data to the ecology and phytogeography of sandy vegetation in Nyírség). – *Acta geobot. hung.* **1**: 75–105.
- Bagi, I. (1988): The role of water management in the degradation processes of halophytic vegetation in Hungary. – *Environmental Conservation* **15**(4): 359–362.
- Borhidi, A. (1993): *Social behaviour types of the Hungarian Flora, its naturalness and relative ecological indicator values.* – JPTE, Pécs, 93 pp.
- Boros, Á. (1932): *A Nyírség flórája és növényföldrajza.* (Flora and phytogeography of Nyírség). – Budapest.
- Nagy, M., Papp, M., Tóthmérész, B. and Précsényi, I. (1990): Classification and mapping of sand grassland communities on a protected area in Eastern Hungary. – *Acta Bot. Debrecina* (Suppl.), pp. 25–35.
- Papp, L. and Dudás, M. (1989): Adatok a Közép-, a Dél-Nyírség és környékének botanikai értékeiről, I, II. (Data on botanical values of Middle and South Nyírség, I, II). – *Calandrella*, Debrecen, **2**(2): 5–25, **3**(2): 13–33.
- Papp, L. and Dudás, M. (1990): Adatok a Közép-, a Dél-Nyírség és környékének botanikai értékeiről III. (Data on botanical values of Middle and South Nyírség, III). – *Calandrella*, Debrecen, **4**(1): 5–33.
- Précsényi, I., Papp, M. and Nagy, M. (1990): Comparative analysis of Potentillo-Festucetum pseudovinae and Festuco vaginatae-Corynephoretum communities. – *Acta Bot. Debrecina* (Suppl.), pp. 57–67.
- Priszter, Sz. (1985): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve. VII. Mutatók.* (Synopsis systematico-geobotanica florum vegetationisque Hungariae. VII). – Akadémiai Kiadó, Budapest, 683 pp.
- Simon, T. (1984): A bugaci bioszféra rezervátum edényes flórájának természetvédelmi értékelése. (Nature conservation value analysis on the vascular flora of Bugac Reserve). – *Abstracta Botanica* **8**: 95–100.
- Simon, T. (1988): A hazai edényes flora természetvédelmi értékbesorolása. (Nature conservation ranks of the Hungarian vascular flora). – *Abstracta Botanica* **12**: 1–23.
- Simon, T. (1992): *A magyarországi edényes flóra határozója.* (Handbook of Hungarian vascular flora). – Tankönyvkiadó, Budapest, 892 pp.
- Soó, R. (1934): Nyírségkutatásunk florisztikai eredményei. (Floristic results of the study of Nyírség). – *Bot. Közlem.* **31**: 218–252.
- Soó, R. (1937a): A Nyírség erdői és erdőtípusai. (The forests and forest types of Nyírség). – *Erdészeti Kísérletek* **39**: 337–380.
- Soó, R. (1937b): Pótlékok nyírségi flórakutatásunk eredményeihez. (Further data to the flora of Nyírség). – *Bot. Közlem.* **34**: 33–44.
- Soó, R. (1938): Vízi, mocsári és réti növényzövetkezetek a Nyírségben. (Water, marshy and meadow associations in Nyírség). – *Bot. Közlem.* **35**: 249–273.

- Soó, R. (1939): Homokpusztai és sziki növényyszövetkezetek a Nyírségben. (Sandy and alcalic grasslands in Nyírség). – *Bot. Közlem.* **36**: 307–312.
- Soó, R. (1964–1980): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve. I–VI.* (Synopsis systematico-geobotanica florum vegetationisque Hungariae). – Akadémiai Kiadó, Budapest, I (1964): 519 pp., II (1966): 655 pp., III (1968): 506 pp., IV (1970): 614 pp., V (1973): 724 pp., VI (1980): 557 pp.

Appendix 1

List of abbreviations of tables and figures respecting to nature conservation aspects

Nature conservation rank, NCR (Simon 1988)

Natural species: U – unique (endemic, sub-endemic, relicts), KV – strictly protected species, V – protected species, E – predominating species in natural communities, K – main components, also native to the area, TP – natural pioneers, TZ – native species that tolerate disturbance. Species associated with human impact: A – adventitious weeds, G – cultivated plants, GY – cosmopolitan weeds.

Social behaviour types, SBT (Borhidi 1993)

I. C – competitors, II. ST – stress tolerants: S – specialists, G – generalists, III. R – ruderals: NP – natural pioneers, DT – disturbance tolerant plants of natural habitats, W – native weed species, A – adventitious weeds, RC – ruderal competitors of the natural flora, AC – alien competitors, aggressive invaders.

Appendix 2

Enumeration

Achillea collina J. Beck
Achillea setacea W. et K.
Agropyron repens (L.) P. B.
Agrostis stolonifera L.
Agrostis tenuis Sibth.
Alisma plantago-aquatica L.
Allium scorodoprasum L.
Allium sphaerocephalum L.
Alopecurus aequalis Sobol.
Alopecurus geniculatus L.
Alopecurus pratensis L.
Ambrosia elatior L.
Anchusa officinalis L.
Angelica silvestris L.
Anthemis ruthenica M. B.
Anthoxanthum odoratum L.
Apera spica-venti (L.) P. B.
Arabidopsis thaliana (L.) Heynh.
Arenaria serpyllifolia L.

Aristolochia clematitis L.
Arrhenatherum elatius (L.) Presl
Asclepias syriaca L.
Astragalus glycyphyllos L.
Athyrium filix-femina (L.) Roth
Atriplex tatarica L.
Batrachium trichophyllum (Chaix) Bosch
Berteroia incana (L.) DC.
Bolboschoenus maritimus (L.) Palla
Bromus inermis Leyss.
Bromus mollis L.
Bromus squarrosus L.
Bromus sterilis L.
Bromus tectorum L.
Buglossoides arvensis Johnston
Butomus umbellatus L.
Calamagrostis canescens (Weber) Roth
Calamagrostis epigeios (L.) Roth
Calamagrostis stricta (Timm.) P. B.

- Caltha palustris* L.
Calystegia sepium (L.) R. Br.
Camelina microcarpa Andr. ex DC.
Cardamine pratensis L.
Cardaria draba (L.) Devs.
Carex acutiformis Ehrh.
Carex appropinquata Schuhmach.
Carex distans L.
Carex elata All.
Carex hirta L.
Carex leporina L.
Carex pairoae F. Schultz
Carex panicea L.
Carex pseudocyperus L.
Carex riparia Curt.
Carex rostrata Stok. in With.
Carex serotina Méral
Carex stenophylla Wahlbg.
Carex vesicaria L.
Carex vulpina L.
Carlina vulgaris L.
Centaurea arenaria M. B. ex Willd.
Centaurea jacea L.
Centaurea micranthos S. G. Gmel.
Centaurea pannonica (Heuff.) Simk.
Cerastium fontanum Baumg.
Cerastium glomeratum Thuill.
Cerastium semidecandrum L.
Cerasus avium (L.) Mönch
Cerinthe minor L.
Chondrilla juncea L.
Chrysopogon gryllus (Torn.) Trin.
Cichorium intybus L.
Cirsium arvense (L.) Scop.
Cirsium canum (L.) All.
Cirsium rivulare (Jacq.) All.
Clematis recta L.
Cnidium dubium (Schk.) Thell.
Convolvulus arvensis L.
Conyza canadensis (L.) Cronq.
Corynephorus canescens (L.) P. B.
Crataegus monogyna Jacq.
Crepis biennis L.
Crepis capillaris (L.) Wallr.
Crepis rhoeadifolia M. B.
Crepis tectorum L.
Cynodon dactylon (L.) Pers.
Cynoglossum hungaricum Simk.
Cynosurus cristatus L.
Dactylis glomerata L.
Dactylorhiza incarnata (L.) Soó
Daucus carota L.
Deschampsia caespitosa (L.) P. B.
Dianthus carthusianorum L.
Dianthus pontederiae Kern.
Dianthus superbus L.
Digitaria sanguinalis (L.) Scop.
Draba nemorosa L.
Dryopteris carthusiana (Will.) Fuchs
Echinocystis lobata (Michx.) T. et Gr.
Echium vulgare L.
Eleocharis palustris (L.) R. et Schult.
Epilobium hirsutum L.
Epilobium montanum L.
Epilobium palustre L.
Epilobium parviflorum Schreb.
Equisetum arvense L.
Equisetum fluviatile L. emend. Ehrh.
Equisetum palustre L.
Equisetum ramosissimum Desf.
Erigeron acris L.
Eriophorum angustifolium Honck.
Erodium cicutarium (L.) L'Hér.
Erophila verna (L.) Bess.
Erysimum diffusum Ehrh.
Eupatorium cannabinum L.
Euphorbia cyparissias L.
Euphorbia lucida W. et K.
Euphorbia palustris L.
Fallopia convolvulus (L.) Löve
Festuca heterophylla Lam.
Festuca pratensis Huds.
Festuca pseudovina Hack. ex Wiesb.
Festuca rupicola Heuff.
Festuca vaginata W. et K. ex Willd.
Filipendula ulmaria (L.) Maxim.
Fragaria vesca L.
Frangula alnus Mill.
Galium aparine L.
Galium mollugo L.
Galium palustre L.
Galium uliginosum L.
Galium verum L.
Geranium palustre Torn.
Geranium robertianum L.
Glechoma hederacea L.
Glyceria fluitans (L.) R. Br.
Gratiola officinalis L.
Gypsophila paniculata L.
Herniaria glabra L.
Hieracium caespitosum Dum.
Hieracium pilosella L.
Holcus lanatus L.
Holoschoenus romanus (L.) Fritsch
Holosteum umbellatum L.
Hottonia palustris L.
Hypericum maculatum Cr.
Hypericum perforatum L.

- Hypochoeris radicata* L.
Inula britannica L.
Iris pseudacorus L.
Jasione montana L.
Juncus atratus Krocke
Juncus conglomeratus L.
Juncus effusus L.
Juncus gerardii Lois.
Kochia laniflora (Gmel.) Borb.
Koeleria cristata (L.) Pers.
Koeleria glauca (Schkuhr) DC.
Lamium amplexicaule L.
Lathyrus pratensis L.
Leontodon autumnalis L.
Leontodon hispidus L.
Lepidium campestre (L.) R. Br.
Linaria vulgaris Mill.
Linum catharticum L.
Listera ovata (L.) R. Br.
Lolium perenne L.
Lotus corniculatus L.
Luzula campestris (L.) Lam. et DC.
Lychnis flos-cuculi L.
Lycopus europaeus L.
Lycopus exaltatus L.
Lysimachia nummularia L.
Lysimachia vulgaris L.
Lythrum salicaria L.
Lythrum virgatum L.
Marrubium peregrinum L.
Medicago falcata L.
Medicago minima (L.) Grufbg.
Medicago sativa L.
Melandrium album (Mill.) Garcke
Mentha aquatica L.
Mentha arvensis L.
Mentha longifolia (L.) Nath.
Menyanthes trifoliata L.
Morus alba L.
Muscari comosum (L.) Mill.
Myosotis palustris (L.) Nath.
Myosotis stricta Link ex R. et Sch.
Myosoton aquaticum (L.) Mönch
Odontites vernus (Bell) Dum
Oenanthe aquatica (L.) Poir. ex Lam.
Oenothera biennis L.
Ononis arvensis L.
Onosma arenarium W. et K.
Ophioglossum vulgatum L.
Orchis laxiflora subsp. *elegans* Lam.
Orchis laxiflora subsp. *palustris* Lam.
Ornithogalum umbellatum L.
Pastinaca sativa L.
Petrorrhagia prolifera (L.) Ball et Hey.
Peucedanum palustre (L.) Mönch
Phragmites communis Trin.
Plantago arenaria W. et K.
Plantago lanceolata L.
Poa annua L.
Poa bulbosa L.
Poa compressa L.
Poa nemoralis L.
Poa palustris L.
Poa pratensis L.
Poa trivialis L.
Polygala comosa Schkuhr
Polygonum amphibium L.
Polygonum arenarium W. et K.
Polygonum aviculare L.
Polygonum lapathifolium L.
Polygonum persicaria L.
Potentilla anserina L.
Potentilla arenaria Borkh.
Potentilla argentea L.
Potentilla erecta (L.) Rauschel
Potentilla recta L.
Potentilla reptans L.
Prunella vulgaris L.
Quercus robur L.
Ranunculus acris L.
Ranunculus flammula L.
Ranunculus lingua L.
Ranunculus repens L.
Ranunculus sceleratus L.
Rhinanthus borbasii (Doerfl.) Soó
Rhinanthus minor L.
Robinia pseudo-acacia L.
Rorippa amphibia (L.) Bess.
Rumex acetosa L.
Rumex acetosella L.
Rumex hydrolapathum Huds.
Salix alba L.
Salix cinerea L.
Salix fragilis L.
Salix rosmarinifolia L.
Sambucus nigra L.
Sanguisorba officinalis L.
Scirpus sylvaticus L.
Schoenoplectus lacustris (L.) Palla
Scleranthus annuus L.
Scutellaria galericulata L.
Scutellaria hastifolia L.
Senecio jacobaea L.
Silene conica L.
Silene otites (L.) Wibel
Sium erectum Huds.
Sium latifolium L.
Solanum dulcamara L.

- Solidago virga-aurea* L.
Sparganium erectum L.
Spergula pentandra L.
Stachys palustris L.
Stenactis annua subsp. *annua* (L.) Nees
Stenactis annua subsp. *strigosa* DC.
Succisa pratensis Mönch
Symphytum officinale L.
Taraxacum officinale Weber ex Wigg.
Tetragonolobus maritimus (L.) Roth
Teucrium scordium L.
Thalictrum lucidum L.
Thelypteris palustris Schott
Thesium arvense Horvatovszky
Tragopogon dubius Scop.
Tragopogon orientalis L.
Trifolium arvense L.
Trifolium campestre Schreb.
Trifolium pratense L.
Trifolium repens L.
Typha angustifolia L.
Typha latifolia L.
Urtica dioica L.
Valeriana officinalis L.
Verbascum austriacum Schott
Verbena officinalis L.
Veronica anagalloides Guss.
Veronica dillenii Cr.
Veronica scutellata L.
Veronica serpyllifolia L.
Veronica verna L.
Viburnum opulus L.
Vicia cracca L.
Vicia grandiflora Scop.
Vicia lathyroides L.
Viola arvensis Mur.
Viola elatior Fr.
Viola stagnina Kit. ex Schult.

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THE RESPONSES OF A *POTENTILLA ARENARIA* BORKH. SUBPOPULATION TO SOME SOIL FACTORS IN SANDY GRASSLAND

I. PRÉCSÉNYI and I. MÉSZÁROS

Dept. Botany, Kossuth Lajos University
H-4010 Debrecen, Egyetem tér 1, Hungary

The study has been initiated with the intention to observe the responses of a plant population to certain soil nutrients. Since the soil nutrient distribution can be regarded as niche axis the study was addressed to on what axis, when and where might be the position of a population and when and what kind of responses to the examined soil nutrients it might produce.

The investigations were carried out on a subpopulation of *Potentilla arenaria*. The P, K, Ca contents and pH value of the soil were chosen as niche axis. The response of *Potentilla* was estimated by the dry weight of above-ground plant parts.

The plant and soil samples were collected in a sandy grassland near the town Debrecen (East Hungary) on May 4, 1992 (springtime sampling) and September 29, 1993 (autumtime sampling). During the two samplings 60–60 *Potentilla* individuals were collected. After harvesting the above-ground plant parts, the soil from the upper 15 cm of the rhizosphere was lifted out in order that we could gain soil sample corresponding to the plant sample. After counting the number of shoots the dry weight was determined. The available concentration of P, K, Ca and the pH were measured in the soil samples. The soil and response axes were divided into six classes. The niche breadth was estimated by the Shannon formula using log naturalis.

The niche width on the pH axis decreased from spring till autumn, on Ca axis it did not change considerably, while on P and K axes it increased. In spring, similar niche breadth values were obtained on the P and K axis and on the pH and Ca axis, respectively. But in the case of the former two axis, the niche breadth values were smaller than in the case of the latter two ones. In autumn, the niche of *Potentilla* on the all axes were not different. On the basis of frequencies obtained in dry weight (DM) categories the spring and autumn niches were different only in the case of P and K. On axis of K/P ratio axis the niche in spring was wider than in autumn. In the case of P/K ratio axis the autumn niche of *Potentilla* was significantly larger than in spring. The paper discusses some possible causes of niche changes of *Potentilla arenaria*.

Key words: niche breadth, *Potentilla arenaria*, seasonal change of niche, soil nutrients, soil pH

INTRODUCTION

Plant ecologists have been long concerned with certain, crucial questions referring to the nutrient uptake of plants from the soil. When and in what circumstances does this process take place? How much nutrient do plants uptake from the soil? In order to reveal these problems, a large number of experiments – both *in situ* and laboratory – have been performed. On the other hand, the responses of various populations to the given soil nutrients have been hardly examined. The present study has been initiated with the intention to observe the reaction of a

(sub)population to certain soil nutrients; or more specifically, when and how does it respond? The soil nutrient distribution can be regarded as niche axes, and this notion leads the ecologist to approach the question from another aspect: on what axis, when and where the position of the (sub-)population is and when and what kind of responses to the examined soil nutrient it produces.

The investigations were carried out on a subpopulation of *Potentilla arenaria*. The P, K, Ca contents and pH value of the soil were chosen as soil axes. The response of *Potentilla* was estimated by the weight of dry matter of above-ground plant parts.

MATERIALS AND METHODS

The plant and soil samples were collected in a pasture which is situated near Debrecen ("Daru Hills" in the vicinity of village Bagamér) on May 4, 1992 (springtime sampling) and September 29, 1993 (autumntime sampling). During the first sampling individuals of *Potentilla* were in full flowering, while on the second sampling occasion the plants were well after seed shedding, in this phase of development the individuals had leaves of rosette only (*Potentilla arenaria* is a rosette bearing species). The pasture is covered by an open stand *Potentillo-Festucetum pseudovinae* community (the plant cover is 40–50%, Nagy *et al.* 1990). The soil of the area is slightly acidic and has low CaCO₃ content.

On the two sampling dates, 60–60 *Potentilla* individuals were chosen with special attention to that individuals of other species do not occur in the proximity of *Potentilla* individuals. After harvesting the above-ground parts of plants, the soil from the upper 15 cm of the rhizosphere was collected (the size of monoliths: 10 cm × 10 cm × 15 cm). In this way, one soil sample belonged to one plant sample. After counting the number of shoots in the above-ground plant sample the dry weight was determined by drying at 85 °C. Dividing the dry weight by the number of shoots the weight of one shoot was obtained, in the further evaluation and discussion of results the total dry weight of 10 shoots (DM) were used.

The soil pH was measured in KCl (1 M) suspension (1:2.5) and the available concentration of P, K, and Ca in the soil were determined by means of methods suggested in Allen (1974).

The soil axes and the response axis were divided into six classes:

Axis	Extreme values	Class breadth
P (mg/100 g soil)	0.60–6.95	1.15
K (mg/100 g soil)	2.25–8.40	1.22
Ca (mg/100 g soil)	16.00–54.0	7.5
pH	3.50–4.70	0.23
DM ⁺ (g)	0.2–0.7	0.099

⁺DM = dry weight of 10 shoots (g).

In the tables the class means are indicated.

The niche breadth was estimated by the Shannon's formula ($H' = -\sum p_i \ln p_i$); for the comparison of breadths the method of Hutcheson was used (Hutcheson 1970, Tóthmérész 1993).

RESULTS

THE SOIL AXES AND RESPONSES

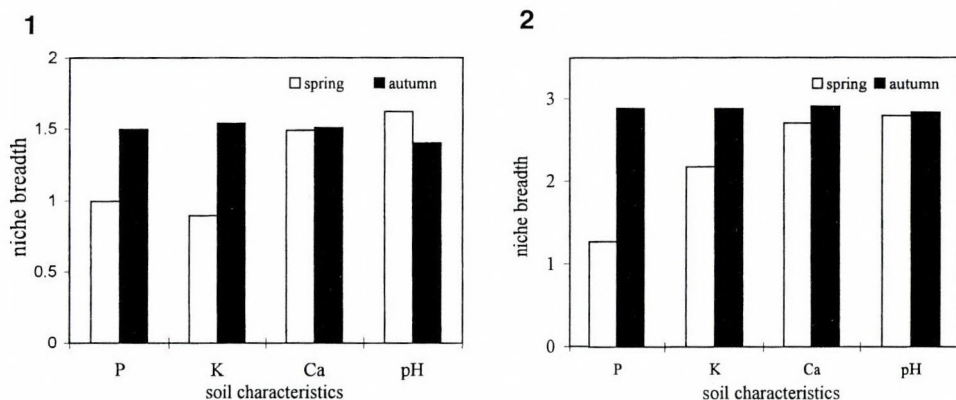
The niche on the pH axis reduced from spring till autumn (Table 1, Fig. 1), the mean value for pH was 4.198 in spring and 4.064 in autumn. On the Ca axis, the niche did not change considerably (Tables 2 and 5, Fig. 1), though the mean of Ca content also decreased from spring to autumn (from 33.95 to 30.95 mg/100 g soil). From spring till autumn the niche on P and K axes increased (Tables 3–5, Fig. 1), at the same time the means became greater (P axis: 1.7575 and 4.4; K axis: 3.551 and 5.686 mg/100 g soil).

In spring, the niche on P and K axes do not differ (Table 6, Fig. 1). There are also similar niche breadth values on the pH and Ca axes. In autumn, there were not found any deviation among the niches on the four axes (Table 6, Fig. 1).

Inside the soil characteristics (P, K, Ca, pH) we can estimate the niche breadths on the basis of frequencies in different DM categories (Tables 1–4, Fig. 2). The spring and autumn niches differ in the case of P and K (Tables 7–8), in spring the niche is narrower.

COMBINATIONS AND RATIO AXES

The combinations of P and K axes (*e.g.* P_1K_1 etc.) showed that in the autumn the most responses are produced to the combinations of P_5K_2 and P_5K_3 (Table 9; class means: $P_5 = 5.365$ and $K_2 = 4.09$; $K_3 = 5.32$), while in the spring to the combinations P_1K_1 and P_1K_2 combinations (class means: $P_1 = 1.125$; $K_1 = 2.86$ and $K_2 = 4.09$).



Figs. 1–2. Niche breadths: 1 – on axes of soil nutrients and pH; 2 – on axes of soil nutrients and pH calculated on the basis of frequencies in dry matter categories

Table 1
Distribution of responses on soil pH axis

Spring							
DM	3.615	3.855	4.095	4.335	4.575	4.815	Total
0.2495		5	1	5	1		12
0.3495	4	6	3	7	6	1	27
0.4495		2	3	4	3	1	13
0.5495		2			3		5
0.6495		1		1		1	3
0.7495							
Total	4	16	7	17	13	3	60

Autumn							
DM	3.615	3.855	4.095	4.335	4.575	4.815	Total
0.2495		2	3	2			7
0.3495	2	3	3	5			13
0.4495	2	10	7	4	1		24
0.5495		2	2	1	2		7
0.6495		3	2	1			6
0.7495			2	1			3

Table 2
Distribution of responses on soil Ca axis

Spring							
DM	19.75	27.35	34.95	42.55	50.15	57.75	Total
0.2495	2	6	3	1			12
0.3495	2	8	11	1	4	1	27
0.4495	1	3	6	2	1		13
0.5495		2	1	2			5
0.6495		1		1	1		3
0.7495							
Total	5	20	21	7	6	1	60

Autumn							
DM	19.75	27.35	34.95	42.55	50.15	57.75	Total
0.2495	1	3	2		1		7
0.3495	4	4	1	2	2		13
0.4495	9	8	3	4			24
0.5495		2	3	1	1		7
0.6495	1	1	3	1			6
0.7495		1	1	1			3
Total	15	19	13	9	4		60

Table 3
Distribution of responses on soil P axis

Spring							
DM	1.125	2.185	3.245	4.305	5.465	6.425	Total
0.2495	6	5	1				12
0.3495	16	7	4				27
0.4495	8	4	1				13
0.5495	2	3					5
0.6495	1	1		1			3
0.7495							
Total	33	20	6	1			60
Autumn							
DM	1.125	2.185	3.245	4.305	5.465	6.425	Total
0.2495		1	1	2	3		7
0.3495		1	3	2	6	1	13
0.4495		4	6		11	3	24
0.5495		1	1	2	1	2	7
0.6495		1	1	2	2		6
0.7495			1	2			3

Table 4
Distribution of responses on soil K axis

Spring							
DM	2.86	4.09	5.32	6.55	7.78	9.01	Total
0.2495	5	6	1				12
0.3495	16	8	3				27
0.4495	7	6					13
0.5495	3	2					5
0.6495		3					3
0.7495							3
Total	31	25	4				60
Autumn							
DM	2.86	4.09	5.32	6.55	7.78	9.01	Total
0.2495		1	4	1	1		7
0.3495	2	2	6	2	1		13
0.4495	1	6	10	2	3	2	24
0.5495		2	4		1		7
0.6495		2		1	3		6
0.7495					2	1	3
Total	3	13	24	6	11	3	60

Table 5
Comparison of spring and autumn niche breadths (soil nutrient categories)*

Soil nutrient	<i>t</i> -value	Degrees of freedom
P	4.8404	110
K	6.1363	112
Ca	0.1740	100
pH	2.5730	119

* If the *t*-value > 1.96, the two breadths are significantly different

Table 6
Comparison of niche breadths of soil nutrients (*t*-values)*

Soil nutrient	P	K	Ca	pH
P	—	1.0134 (112)**	4.1643 (120)	6.1794 (112)
K	0.4040 (109)	—	5.6731 (112)	8.3804 (120)
Ca	0.1330 (117)	0.3172 (100)	—	1.4469 (111)
pH	0.3274 (118)	1.2623 (116)	1.2278 (111)	—

* If the *t*-value > 1.96, the two breadths are significantly different

** In parantheses the degrees of freedom; above the main diagonal the spring values, under the main diagonal the autumn values

Table 7
Comparison of spring and autumn niche breadths on the basis of frequencies in dry matter categories (*t*-values)*

Soil nutrient	<i>t</i> -value	Degrees of freedom
P	4.1559	120
K	5.5532	118
Ca	1.3797	119
pH	0.3415	118

* If the *t*-value > 1.96, the two breadths are significantly different

Choosing the K/P ratio as an axis (Table 10), the niche in spring is wider than that in the autumn (1.6173 and 1.0161). In spring, the most responses (35% of the total cases) could be observed when the amount of potassium was approximately one and a half times or twice than the amount of phosphorus. In the autumnal period, more than 50% of the cases were found in the 0.6–1.17 category, when the K/P ratio was near to 1. The results of the combinations and K/P ratio showed quite a reliable correspondence. On the P/K ratio axis of spring (Table 10), a nar-

Table 8
Comparison of niche breadths based on frequencies in dry matter categories (*t*-values)*

Soil nutrient	P	K	Ca	pH
P	—	0.7886 (116)**	2.9138 (120)	4.0540 (111)
K	0.0390 (119)	—	3.9529 (114)	5.4866 (119)
Ca	0.1464 (120)	0.1878 (120)	—	0.6849 (109)
pH	0.3565 (118)	0.3368 (119)	0.5288 (119)	—

* If the *t*-value > 1.96, the two breadths are significantly different

** In parantheses the degree of freedom; above the main diagonal the spring values, under the main diagonal the autumn values

Table 9
Distribution of responses in combinations of P and K axes

Spring															
P ₁ *				P ₂		P ₃		P ₄	total						
K ₁	K ₂	K ₁	K ₂	K ₃	K ₂	K ₃	K ₂								
23	10	8	11	1	3	3	1								60
Autumn															
P ₂				P ₃				P ₄							
K ₂	K ₃	K ₄	K ₅	K ₁	K ₂	K ₃	K ₄	K ₅	K ₁	K ₂	K ₃	K ₄	K ₅	K ₆	
1	2	2	3	1	3	3	2	4	2	1	4	—	1	2	
P ₅										P ₆			Total		
K ₂				K ₃	K ₄	K ₅	K ₆					K ₃	K ₄	K ₅	
8				11	1	2	1					4	1	1	60

* For abbreviations P₁K₁ etc. see Tables 3 and 4 (e.g. P₁: 1.125 etc., K₁: 2.86)

Table 10
Distribution of responses on axes K/P and P/K

K/P							
Season	0.885*	1.465	2.045	2.625	3.205	3.785	Total
Spring	3	11	21	13	7	5	60
Autumn	34	17	8	1			60
P/K							
Season	0.345	0.565	0.785	1.005	1.225	1.445	Total
Spring	30	24	3	3			60
Autumn	1	16	11	16	8	8	60

* Class means

row niche (1.0120) was detected with a half of the cases in the 0.24–0.45 category. By the autumn, the niche increased (1.6215) and the observations resulted in identical percentages (26.7%) in two categories. This latter result shows a rough correspondence with the results of the combination investigations.

Considering the K/P ratio and the response axis together the niche is somewhat wider in spring, than in autumn (spring: 2.7591; autumn: 2.4870, *t*-value: 1.8577, df: 118). In the case of P/K ratio and response axis, the autumn niche was observed to be significantly larger than the same data in spring (spring: 2.3015; autumn: 3.0184, *t*-value: 5.5026, df: 112). It may be supposed that apart from the amount of nutrients, the ratio of the nutrients have an important effect on the responses.

DISCUSSION

In autumn there are responses in higher categories of K and P, the subpopulation uses these categories, while in spring the most responses occur in lower categories. This seasonal change can be explained by the fact that due to the decomposition of organic materials the soil become more saturated with P and K by the autumn, and the subpopulation uses more categories for preparing oneself to the next vegetation period. By the end of spring and the beginning of summer, however, the pool of these nutrients gets exhausted.

Responses for Ca showed that the subpopulation reacted to this factor in an approximately similar way both in spring and autumn. It is the constant Ca demand of the population living in the so Ca-deficient sandy soil that accounts for this phenomenon. This also suggests that the subpopulation has a permanent need for Ca.

An explanation for narrow and broad niche can be the following if there are data in many cells the niche space will be wide. Similar examples could be observed for the P and K axes in autumn when data were found in 69% and 64% of all cells (36 cells). The narrow niche showed exactly the opposite characteristics: data could be found in a much smaller number of cells. For this latter phenomenon, the spring values for P and K gave examples when data were found in 39 and 30 per cent of the cells (Tables 3–4). The wide niche indicates that responses scatter, and there is no distinguished category, the resource is abundant. On the other hand, narrow niche shows that responses are limited to few categories, and the populations uses exclusively these categories.

The results of the study raise the question on the “generalist-specialist” character of the populations. Presumably, this distinction is relative in the majority of the populations, since the resource supply and the ratio of resources significantly influence such a classification for any population. Still, another factor can be

added to this consideration, the phenological state of the given population, *i.e.* in a phenophase what demand the population expresses for a given resource.

*

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REFERENCES

- Allen, S. E. (ed.) (1974): *Chemical analysis of ecological materials*. – Blackwell Sci. Publ., Oxford.
- Hutcheson, K. (1970): A test for comparing diversities based on the Shannon formula. – *J. Theor. Biol.* **29**: 151–154.
- Nagy, M., Papp, M., Tóthmérész, B. and Précsényi, I. (1990): Classification and mapping of sand grassland communities on a protected area in Eastern Hungary. – *Acta Biol. Debrecina* (Suppl.) **22**: 25–34.
- Tóthmérész, B. (1993): NuCoSA 1.0: Number Cruncher for community studies and other ecological applications. – *Abstracta Botanica* **17**: 283–287.

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ZWERGBINSEN-GESELLSCHAFTEN DES FIMBRISTYLIDENION BISUMBELLATAE IN GRIECHENLAND – KENNTNISSTAND UND FORSCHUNGSBEDARF*

TH. RAUS

*Botanischer Garten und Botanisches Museum Berlin-Dahlem, Freie Universität Berlin
Königin-Luise-Str. 6–8, D-14191 Berlin, Deutschland*

Autumnal therophytic plant communities of the suballiance *Fimbristylidenion bisumbellatae* (*Nanocyperion flavescentis*, *Cyperetalia fusci*, *Isoëto-Nanojuncetea*) are expected to occur in many parts of Greece on muddy soils along river banks and lake shores. A relevé table of the *Dichostylo-Fimbristylidetum bisumbellatae* from the Pinios delta in East Thessaly is commented, the only *Nanocyperion flavescentis* material 45 years after the alliance's first record from Greece. The occurrences in Greece of many species, characteristic and diagnostic for *Isoëto-Nanojuncetea* units elsewhere in Europe, indicate the existence of a manifold regional *Isoëto-Nanojuncetea* vegetation. This vegetation class is in urgent need of intensive syntaxonomic research throughout the East Mediterranean region.

Key words: *Fimbristylidenion bisumbellatae*, autumnal therophytic communities, Greece

EINLEITUNG

Zwergbinsen-Gesellschaften (*Isoëto-Nanojuncetea*) sind annuelle Pioniergesellschaften feuchter bis nasser, offener Böden. Die Klasse umfaßt zwergwüchsige, meist nur kurzlebige und häufig unbeständige Vegetationseinheiten, als deren natürliche Standorte austrocknende Schlammböden sommerlich freifallender Fluß- und See-Ufer und wechselfeuchte Böden flacher Mulden (Deflationswannen, Dünentäler etc.) anzunehmen sind. In der anthropogen überformten Kulturlandschaft sind periodisch abgelassene Fischwirtschaftsgewässer, Stauseen mit schwankendem Wasserstand, wechsellasse Fahrspuren, Sand- und Kiesgruben, Trittstellen an Viehtränken, staunasse Äcker etc. kennzeichnende Sekundärbiotope von Zwergbinsen-Gesellschaften. Entscheidende Wettbewerbsvorteile der konkurrenzschwachen, lichtbedürftigen Zwergbinsen-Arten sind ihre hohe Samenproduktion, kombiniert mit geringer Samengröße und Wasser-, Wind- und Tierverbreitung der Diasporen (vor allem Ornithochorie), die Fähigkeit zu jahrelanger Samenruhe, die rasche Samenkeimung bei günstigen Bedingungen sowie ihr kurzer Vegetationszyklus. Obwohl geeignete Wuchsplätze für Zwergbinsen-Ge-

* Prof. Dr. Olivér A. Horvát, dem Nestor der ungarischen Geobotanik, zum 90. Geburtstag gewidmet.

sellschaften je nach Witterung und Bewirtschaftung von Jahr zu Jahr wechseln und in der Landschaft oft nur „disjunkt“, das heißt kleinflächig und räumlich stark voneinander isoliert auftreten, ist die floristische Kenn- und Trennartengarnitur der Bestände europaweit erstaunlich homogen und hat deshalb schon früh die (zum Teil monographische) Aufmerksamkeit vieler Vegetationskundler geweckt. Zur Syntaxonomie, Syndynamik, Ökologie und Chorologie der Klasse liegt daher ein reichhaltiges Übersichtsschrifttum vor (Koch 1926: 21–30, Klika 1935, Moor 1936, Braun-Blanquet 1952: 80–89, Pietsch 1973a, 1973b, Oberdorfer 1992: 166–181, Grabherr und Mucina 1993: 197–212, Pott 1995: 155–163, Ellenberg 1996: 855–859, etc.). Isoëto-Nanojuncetea galten in der früheren pflanzensoziologischen Literatur als mitteleuropäisch-westmediterran (Moor 1936: 28, Fig. 2), eine pflanzengeographische Charakterisierung, die teilweise noch heute zitiert wird, aber der oben skizzierten Ökologie der Klasse zufolge gewiß eine unzutreffende synchorologische Einschränkung darstellt. Die Existenz von Zwergbinsen-Gesellschaften auch in Südosteuropa ist inzwischen vielfach belegt (Tüxen 1973, Horvat *et al.* 1974), wenn auch auf viel zu schmaler pflanzensoziologischer Tabellenbasis.

NANOCYPERION FLAVESCENTIS-VEGETATION IN THESSALIEN UND MAKEDONIEN

Die Suche nach syntaxonomisch verwertbaren, in Tabellenform publizierten pflanzensoziologischen Aufnahmen von Zwergbinsen-Gesellschaften aus Griechenland ist qualitativ und quantitativ ausgesprochen enttäuschend und reizt gerade deshalb zum erneuten Aufgreifen des Themas. Krause *et al.* (1963: 375–376) und Gradstein und Smittenberg (1977: 82–84) teilen einige zum Teil heterogene Aufnahmen von *Isoetes hixtrix*-Gesellschaften und eine Aufnahme einer *Montia arvensis*-Vergesellschaftung aus Euböa und Kreta mit und belegen damit griechische Vorkommen von frühjahrsaktiven Isoëtetalia-Einheiten auf oberflächenvernässten, am Ende der Winterregenzeit abtrocknenden Offenböden. Oberdorfer (1952: 347) hatte zwischen Juli und September 1944 in der Umgebung von Thessaloniki Gelegenheit, einige Aufnahmen *Cyperus fuscus*-reicher Zwergbinsen-Bestände zu notieren. Das ist alles, was wir bis heute über das wärmekeimende, herbstliche Nanocyperion flavescens in Griechenland wissen!

Im Zuge der vegetationskundlichen Erforschung Ostthessaliens (vgl. Raus 1979a, 1979b, 1980, 1981, 1983, 1987) fertigte ich am 26. September 1974 auf feinsandigen Flußschlammhängen im Delta des Pinios-Flusses östlich der Schlucht von Tembi (Tempe), bei 20 m ü. NN nördlich des Dorfes Omolion (Nomos und Eparchia Larisis) neun bislang unveröffentlichte Aufnahmen einer Zwergbinsen-Gesellschaft an. Seit Oberdorfer (1952), also nach 45 Jahren (!),

sind dieses die ersten Aufnahmen einer *Nanocyperion flavescens*-Vegetation nackter Schlammböden, die wieder aus Griechenland publiziert werden. Bei einem derartig geringen regionalen Kenntnisstand scheint mir eine kurze, kommentierte Mitteilung dieser Beobachtungen trotz ihrer Singularität von Wert zu sein. In der Tabelle 1 sind die makedonischen Aufnahmen Oberdorfers (*l. c.*) in Form einer vorgeschalteten Stetigkeits-Spalte mit den ostthessalischen Aufnahmen vergleichend in Beziehung gesetzt (unter Berücksichtigung folgender, von Oberdorfers Originaltabelle abweichender taxonomischer Korrekturen: „*Agrostis verticillata*“ = *Polypogon viridis*, „*Anagallis femina*“ = *Anagallis arvensis* var. *caerulea*, „*Equisetum variegatum*“ = *Equisetum ramosissimum*, „*Fimbristylis dichotoma*“ = *Fimbristylis bisumbellata*, „*Plantago coronopus*“ = *Plantago weldenii*).

Als standörtliche und soziologische Kennart der herbstlichen Zwergbinsen-Vegetation an griechischen Flußufern ist an erster Stelle *Fimbristylis bisumbellata* (Forssk.) Bubani (= *F. dichotoma* auct., non (L.) Vahl) zu nennen, die mit zahlreichen, zentrifugal-vielsprossig niederliegenden Individuen das nackte, feinsandig-schlammige Substrat besiedelt, begleitet von einigen weiteren annuellen, wärmekeimenden Cyperaceen mit der gleichen Wuchsform (*Cyperus fuscus*, *C. flavescens*, *C. michelianus*) sowie dem annuellen Pioniergras *Crypsis alopecuroides*, welches ebenfalls vegetationsarme Feuchtböden kennzeichnet. Oberdorfer traf bei Thessaloniki als klassentypische Arten darüberhinaus *Blackstonia perfoliata*, *Juncus bufonius*, *Samolus valerandi* und *Lythrum hyssopifolia* an, die in den Beständen am Ufer des Pinios und seiner Altwässer nicht angetroffen wurden. Diese Beobachtung entzieht sich jedoch einer Interpretation, solange nicht mehr griechisches Aufnahmемaterial aus verschiedenen (trockenen oder feuchten) Jahren für eine kritische Beurteilung zur Verfügung steht.

Die Unbeständigkeit der Artenzusammensetzung von Isoëto-Nanojuncetea-Beständen von Jahr zu Jahr und ihre wechselnde, durch den jährlich und örtlich individuellen Verlauf des Wasserhaushaltes bedingte Verzahnung mit Littorelletea- und Bidentetea-Einheiten ist ein konstituierendes Kennzeichen der gesamten Isoëto-Nanojuncetea (vgl. Hejny 1960). Kontaktarten benachbarter Flutrasen (Potentillo-Polygonetalia), Röhrichte (Phragmitetea) und Ufer-Pioniergehölze (Salicetea purpureae) keimen auf den entblößten Schlammböden parallel zur Entfaltung der annuellen Zwergbinsen-Vegetation oder dringen vegetativ in diese ein; bei fallendem Wasserstand und fortschreitender Austrocknung der Standorte bilden sich rasch Verschränkungen mit Bidentetea tripartitae-Gesellschaften. Speziell am Unterlauf und im Mündungsbereich von Flüssen tritt ein merklicher Anteil von Begleitern annueller Ruderal- und Segetal- („Hackfrucht“-)Gesellschaften der Stellarietea mediae als Konkurrenten um die vegetationsarmen, gut wasserversorgten Keimflächen hinzu, zumal, wenn der diasporentransportierende Fluß in seinem Ober- und Mittellauf lange Strecken landwirtschaftlicher Nutzfläche durchfließt und seine Ufer bei intensivem Viehtrieb als Tränke genutzt

werden (Zoochorie der Samen vieler Pflanzenarten durch Schlammtransport der Huftiere!). Die Gruppierung der Begleitarten nach soziologischen Gruppen (und deren syntaxonomische Bezeichnung) in Tabelle 1 hat rein informellen Charakter und ist nicht als nomenklatorische Fixierung zu verstehen. Für eine brauchbare Gliederung der Isoëto-Nanojuncetea und mit diesen ökologisch verschränkter

Tabelle 1

Aufnahme 1–9: *Dichostylido-Fimbristylidetum bisumbellatae* im Pinios-Delta Ostthessaliens (Griechenland; nähere Ortsangaben vgl. Text). In Spalte 1 zum Vergleich die Stetigkeitswerte der makedonischen "*Fimbristylis dichotoma-Cyperus fuscus*-Ass." (Oberdorfer 1952; Pflanzennamen zum Teil taxonomisch korrigiert, vgl. Text)

Nr. der Aufnahme		1	2	3	4	5	6	7	8	9
Fläche (m ²)		4	4	4	4	8	4	4	7	4
Deckung (%)		90	60	80	60	45	90	80	60	45
Artenzahl		25	27	26	17	17	14	13	14	5
Ass. <i>Dichostylido-Fimbristylidetum bisumbellatae</i>										
Suball. <i>Fimbristylidenion bisumbellatae</i>		[Oberdorfer 1952]								
<i>Fimbristylis bisumbellata</i>	V	3.3	3.2	2.2	2.2	2.2	2.2	2.2	1.1	2.1
<i>Crypsis alopecuroides</i>		2.2	1.1	2.1	2.2	+	2.2	1.1	+	.
<i>Cyperus michelianus</i>		+	1.1	2.1	1.1	.	.	.	.	.
All. <i>Nanocyperion flavescens</i>										
Ord. <i>Cyperetalia fusci</i>										
Cl. Isoëto-Nanojuncetea										
<i>Cyperus fuscus</i>	V	2.2	2.2	3.2	2.2	2.2	2.2	2.2	2.1	2.1
<i>Cyperus flavescens</i>		1.1	1.1	1.1	+	+	2.1	1.1	1.1	1.1
<i>Centaureum pulchellum</i>	V	.	+	.	.	.	.	.	.	.
<i>Blackstonia perfoliata</i>	V									
<i>Juncus bufonius</i>	IV									
<i>Samolus valerandi</i>	IV									
<i>Lythrum hyssopifolia</i>	III									
Begleiter, Kontaktarten:										
Bidentetea tripartitae-Gruppe										
<i>Persicaria maculosa</i>		+	1.1	.	+	.	+	1.1	+	.
<i>Veronica beccabunga</i>		1.2	2.2	2.1	+	.	1.1	.	.	.
<i>Pulicaria vulgaris</i>	I	+	+	+	.	.	+	.	.	.
<i>Eragrostis pilosa</i>		.	+	.	1.2	.	1.2	.	.	.
<i>Persicaria lapathifolia</i>		+	.	+	1.1	.	.	.	.	.
<i>Echinochloa crus-galli</i>		+	.	+	.	.	.	.	.	.
<i>Bidens tripartita</i>		+	.	.	.	.	.	.	.	.
<i>Digitaria ischaemum</i>		.	+	.	.	.	.	.	.	.

Tabelle I Fortsetz.

Nr. der Aufnahme		1	2	3	4	5	6	7	8	9
Potentillo-Polygonetalia-Gruppe										
<i>Paspalum paspalodes</i>		2.2	1.2	2.2	2.2	2.2	4.4	3.3	2.3	2.2
<i>Plantago major</i> subsp. <i>intermedia</i>		1.1	1.1	1.1	+	+	.	+	.	.
<i>Scirpoides holoschoenus</i>	II	.	1.1	+	.	+	.	+	1.1	.
<i>Rorippa sylvestris</i>		1.1	2.2	1.1	2.1	.	.	.	.	.
<i>Epilobium tetragonum</i>		1.1	+	+	+	.	.	.	.	.
<i>Verbena officinalis</i>	II	+	.	1.1	.	+	+	.	.	.
<i>Juncus inflexus</i>		.	.	1.1	.	+	.	.	+	.
<i>Juncus articulatus</i>	V	+	+	.	.	.	.	.	.	.
<i>Polypogon viridis</i>	IV	.	+	+	.	.	.	.	.	.
<i>Polypogon monspeliensis</i>	III									
<i>Equisetum ramosissimum</i>	II									
<i>Teucrium scordium</i> subsp. <i>scordioides</i>	II									
<i>Mentha longifolia</i>	I									
Stellarietea mediae-Gruppe										
<i>Cyperus rotundus</i>		1.1	+	2.1	.	+	2.1	+	+	.
<i>Eragrostis minor</i>		2.2	1.1	1.1	1.1	+	+	.	+	.
<i>Amaranthus albus</i>		+	+	.	.	.	.	+	+	.
<i>Cynodon dactylon</i>		.	.	.	.	.	.	2.3	2.3	+
<i>Chenopodium ambrosioides</i>		+	.	+	.	+	.	.	.	.
<i>Chenopodium botrys</i>		+	+	.	.	.	.	.	.	.
<i>Solanum nigrum</i>		+	.	+	.	.	.	.	.	.
<i>Portulaca oleracea</i>		.	+	.	.	+	.	.	.	.
<i>Chenopodium album</i>		.	.	+	+	.	.	.	.	.
<i>Amaranthus retroflexus</i>		.	.	.	.	+	.	.	+	.
<i>Polygonum arenarium</i>		.	+	.	.	.	.	.	.	.
<i>Conyza canadensis</i>		.	.	+	.	.	.	.	.	.
<i>Polygonum aviculare</i>		.	.	.	.	.	+	.	.	.
<i>Anagallis arvensis</i> var. <i>coerulea</i>	III									
<i>Kickxia commutata</i>	III									
<i>Kickxia elatine</i> subsp. <i>sieberi</i>	III									
<i>Plantago weldenii</i>	I									
Phragmitetea-Gruppe										
<i>Lycopus europaeus</i> Klg.		.	+	1.2	1.1	+	.	.	+	.
<i>Mentha aquatica</i> Klg.		+	+	1.1	+	.	.	.	.	.
<i>Lythrum salicaria</i> Klg.		.	.	.	.	1.1	.	+	.	.
Salicetea purpureae-Gruppe										
<i>Salix purpurea</i> Klg.		1.1	1.2	2.1	.	+	2.2	+	.	.

Tabelle 2

In Griechenland vorkommende Kenn- und Trennarten der Isoëto-Nanojuncetea und ihrer Ordnungen und Verbände (floristische Quellen vgl. Text)

TRACHEOPHYTA

Anagallis arvensis subsp. *parviflora*
Anagallis minima (= *Centunculus minimus*)
Blackstonia acuminata
Blackstonia perfoliata
Carex viridula (= *Carex serotina*)
Centaureum pulchellum
Cicendia filiformis
Crassula alata (= *Tillaea alata*)
Crassula tillaea (= *Tillaea muscosa*)
Crassula vaillantii (= *Bulliarda vaillantii*)
Crypsis alopecuroides (= *Heleochloa alopecuroides*)
Crypsis schoenoides (= *Heleochloa schoenoides*)
Cyperus flavescens (= *Pycnus flavescens*)
Cyperus fuscus
Cyperus glaber (= *Pycnus glaber*)
Cyperus globosus (= *Pycnus globosus*)
Cyperus hamulosus (= *Dichostylis hamulosa*)
Cyperus michelianus (= *Dichostylis michelianus*)
Damasonium alisma (= *Damasonium polyspermum*)
Elatine alsinastrum
Elatine macropoda
Fimbristylis bisumbellata (= *Fimbristylis dichotoma*)
Fimbristylis ferruginea (= *Fimbristylis sieberiana*)
Gnaphalium luteo-album
Gnaphalium uliginosum
Gypsophila muralis
Illecebrum verticillatum
Isoetes duriei
Isoetes histrix
Isolepis cernua (= *Scirpus savii*)
Isolepis setacea (= *Scirpus setaceus*)
Juncus bufonius
Juncus capitatus
Juncus hybridus (= *Juncus fasciculatus*)
Juncus minutulus
Juncus pygmaeus
Juncus sphaerocarpus
Juncus tenageia

Limosella aquatica
Lindernia dubia
Lindernia procumbens (= *Lindernia pyxidaria*)
Ludwigia palustris
Lythrum borysthenticum (= *Peplis hispidula*)
Lythrum hyssopifolia
Lythrum portula (= *Peplis portula*)
Lythrum thymifolia
Lythrum tribracteatum
Marsilea quadrifolia
Mentha pulegium
Montia arvensis (= *Montia fontana* subsp. *chondrosperma*)
Myosurus minimus
Myosurus sessilis (= *Myosurus heldreichii*)
Pilularia minuta
Radiola linoides
Ranunculus lateriflorus
Sagina apetala
Samolus valerandi
Schoenoplectus supinus (= *Scirpus supinus*)
Solenopsis laurentia (= *Laurentia gasparrinii*)
Solenopsis minuta (= *Laurentia minuta*)
Stellaria alsine
Trifolium ornithopodioides
Veronica acinifolia
Veronica anagalloides
Veronica oetaea

BRYOPHYTA

Anthoceros agrestis (= *Anthoceros crispulus*)
Anthoceros punctatus
Archidium alternifolium
Blasia pusilla
Dicranella rufescens (= *Anisothecium rufescens*)
Dicranella schreberiana (= *Anisothecium schreberianum*)
Drepanocladus kneiffii
Fossombronia foveolata (= *Fossombronia dumortieri*)
Fossombronia pusilla
Fossombronia wondraczekii
Jungermannia gracillima (= *Solenostoma crenulatum*)

<i>Phaeoceros bulbiculosus</i> (= <i>Anthoceros dichotomus</i>)	<i>Pseudephemerum nitidum</i> (= <i>Pleuridium nitidum</i>)
<i>Phaeoceros laevis</i> (= <i>Anthoceros laevis</i>)	<i>Riccia bifurca</i>
<i>Phascum cuspidatum</i> (= <i>Phascum acaulon</i>)	<i>Riccia canaliculata</i>
<i>Philonotis fontana</i>	<i>Riccia ciliata</i>
<i>Physcomitrium pyriforme</i>	<i>Riccia crystallina</i>
<i>Pleuridium subulatum</i> (= <i>Pleuridium alternifolium</i>)	<i>Riccia glauca</i>
<i>Pohlia annotina</i>	<i>Riccia michelii</i>
<i>Pottia truncata</i> (= <i>Pottia truncatula</i>)	<i>Riccia sorocarpa</i>

Vegetationsklassen stehen in Griechenland und darüberhinaus im größten Teil des Mittelmeergebietes bisher in keiner Weise ausreichende Grundlagen zur Verfügung. Die verdienstvolle, speziell auf die mitteleuropäischen Verhältnisse abzielende Studie von Pietsch (1973a) ist diesbezüglich mehr als Beginn denn als Ergebnis syntaxonomischer Synthesearbeit zu sehen. Im gleichen Sinne kann auch die hier (vgl. Tabelle 2) für die ostthessalischen Zwergbinsen-Bestände vertretene, auf den Klassifizierungsvorschlägen von Horvatic (1954) und Pietsch (1973a) fußende syntaxonomische Einordnung nur ein an umfangreicherem Material zu prüfender Diskussionsvorschlag sein (Autorzitate bis zur Verbandsebene nach Pott 1995):

Klasse: Isoëto-Nanojuncetea Braun-Blanquet et R. Tüxen 1943 ex Westhoff *et al.* 1946

Ordnung: Cyperetalia fusci Pietsch 1963 [Nanocyperetalia Klika 1935, *nomen nudum*]

Verband: Nanocyperion flavescens W. Koch 1926 ex Libbert 1932

Unterverband: Fimbristylidenion bisumbellatae [„Fimbristylon dichotomae“] Horvatic 1954, *nom. corr.* (= Fimbristylido bisumbellatae-Cyperenion [„Fimbristylidi dichotomae-Cyperion (Br.-Bl. 1952) Pietsch 1961“] Pietsch 1973, *nom. corr. et syn. superfl.*).

Ass.: *Dichostylido-Fimbristylidetum bisumbellatae* [„Dichostyleto-Fimbristyletum dichotomae“] Horvatic 1954, *nom. corr.* (= *Cypero-Fimbristylidetum bisumbellatae* [„Cypero-Fimbristyletum dichotomae“] Horvatic ex Horvat, Glavac und Ellenberg 1974, *nom. corr. et syn. superfl.*).

Locus classicus des *Dichostylido-Fimbristylidetum bisumbellatae* ist das Neretva-Delta in Süd-Dalmatien (Horvatic 1954: 448, siehe auch Horvat *et al.* 1974: 155, Abb. 109). Zwei weitere Assoziationen von der Balkanhalbinsel mit *Fimbristylis bisumbellata* als namengebender Kennart sind mit Tabellenmaterial validiert worden, zum einen die „*Cyperus flavescens-Fimbristylis dichotoma*-Ass.“ Slavnic 1951 (= *Cypero flavescens-Fimbristylidetum bisumbellatae* Slavnic 1951, *nom. corr. hoc loco*; vgl. Barkman *et al.* 1986: Art. 41b, Art. 43

und App. 57), zum anderen die „*Fimbristylis dichotoma*-*Cyperus fuscus*-Ass.“ Oberdorfer 1952 (= *Fimbristylido bisumbellatae-Cyperetum fusci* Oberdorfer 1952, *nom. corr. hoc loco*; vgl. Barkman *et al.* 1986: Art. 41b, Art. 43 und App. 57). Es ist keineswegs geklärt, ob es sich dabei um drei eigenständige Assoziationen oder um drei Aufnahmekollektive ein und derselben überregional verbreiteten, dreifach beschriebenen und benannten Assoziation handelt. Im zweiten Fall wäre das von Horvatic aufgestellte *Dichostylido-Fimbristylidetum bisumbellatae* in die Synonymie zu verweisen. Auch das „*Dichostylidi-Heleochloetum alopecuroidis*“ (Timár 1950) Pietsch 1973 (Pietsch 1973a: 424; *recte: Dichostylido-Heleochloetum alopecuroidis*, vgl. Barkman *et al.* 1986: App. 57) muß vermutlich in diese Prioritätsüberlegungen miteinbezogen werden.

Fimbristylis-reiche Zwergbinsen-Gesellschaften werden zirkummediterran in voneinander durchaus abweichende syntaxonomische Zusammenhänge gestellt. Horvatic (1954: 449) hält sie auf der Balkanhalbinsel für floristisch so eigenständig, daß er einen eigenen Verband „*Fimbristylion dichotomae*“ (= *Fimbristylidion bisumbellatae* Horvatic 1954, *nom. corr. hoc loco*; vgl. Barkman *et al.* 1986: Art. 43 und App. 57) für gerechtfertigt hält. Pietsch (1973a: 423) reiht sie dem *Nanocyperion flavescens* ein, und zwar als südosteuropäischen Unterverband unter dem Namen „*Fimbristylidi dichotomae-Cyperion*“ (= *Fimbristylido bisumbellatae-Cyperenion nom. corr. hoc loco*; vgl. Barkman *et al.* 1986: Art. 41b, Art. 43 und App. 57), einem überflüssigen Synonym für das nomenklatorisch prioritäre *Fimbristylidenion bisumbellatae* Horvatic 1954, *nom. corr.*, vom selben Autor (Pietsch 1973b: 282) an anderer Stelle und wiederum auf Verbandsebene mit dem für „am zweckmäßigsten“ erachteten (und deshalb nach Barkman *et al.* 1986: Art. 29 unzulässigen) Namen *Heleochloo-Cyperion* belegt. Eine *Fimbristylis bisumbellata*-reiche Flußschlamm-Gesellschaft der Iberischen Halbinsel wird von Braun-Blanquet (1967: 29) als „*Fimbristylido-Heleochloetum*“ (= *Fimbristylido-Heleochloetum nom. corr.*; vgl. Barkman *et al.* 1986: Art. 41b und App. 57) dem *Heleochloion* (= *Heleochloo-Cyperion*, *syn. superfl.*; Pietsch 1973a: 423) zugerechnet, einem mediterran verbreiteten *Isoëto-Nanojuncetea*-Verband, der an anderer Stelle (Braun-Blanquet und Bolós 1957: 91–93) mit der (identischen?) Assoziation „*Heleochloeto-Fimbristyletum*“ (= *Heleochloo-Fimbristylidetum, nom. corr.*; vgl. Barkman *et al.* 1986: Art. 41b und App. 57) als mediterrane „*Chenopodietea*“-Einheit innerhalb der *Paspalo-Heleochloetalia* geführt wird, einer Ordnung, die im Mittelmeergebiet quasi vikariierend den ökologischen Platz der mitteleuropäischen *Bidentetalia tripartitae* einnehmen soll. Hier besteht nach wie vor ein großer Klärungsbedarf, gestützt auf noch zu erhebendes umfangreiches Aufnahmемaterial aus dem gesamten Mittelmeerraum.

WEITERER FORSCHUNGSBEDARF IN GRIECHENLAND

Die synchorologische Vorstellung (Moor, *l. c.*), die Isoëto-Nanojuncetea seien in Südosteuropa nur noch „verarmt“ ausgebildet und stünden dort an ihrer östlichen Arealgrenze, kann zwar als überholt gelten, bedarf aber selbstverständlich noch einer Substantiierung durch brauchbar erhobenes pflanzensoziologisches Material. Hier kann die neuere regionale floristische Literatur wichtige Hinweise geben. Gustavsson (1978: 23) macht beispielsweise auf flache Schmelzwasserpfannen im mittell griechischen Hochgebirge aufmerksam, die nach dem Abtrocknen im Sommer eine kurzlebige Annuellen-Vegetation tragen, in der unter anderem *Limosella aquatica*, *Lythrum thymifolia* und *Myosurus minimus* tonangebend sind. Ganz ähnliche Gesellschaften entwickeln sich offenbar in vernäßten Dolinen kreischer Hochgebirge (Egli 1993: 163, 166). Fast auf Meeresspiegelniveau fanden Snogerup *et al.* (1980: 146) auf den Nördlichen Sporaden frühjahrsvernäßte flache Hohlformen im Gelände („vernal pools“), die einer Massenvegetation von *Pilularia minuta*, vergesellschaftet mit *Lythrum borysthenticum*, Entwicklungsmöglichkeiten boten. Der europäischen Erstfund von *Fimbristylis ferruginea* stammt aus einem Bachtal in Südost-Kreta, in dem sich „eine reiche Cyperaceenflora angesiedelt hatte“ (Merxmüller und Podlech 1976: 683). Ich selbst beobachtete flächige Massenbestände von *Cyperus michelianus* subsp. *michelianus* und *Cyperus michelianus* subsp. *pygmaeus* auf dem abgetrockneten Schlamm des Kerkini-Sees in Makedonien und des Amvrakischen Sees in Ätolien sowie auf Schlammhängen der Ströme Strimon und Evros in Nordostgriechenland (Raus 1991: 573–575). Auch die Reisanbaugebiete der griechischen Flußdelten beherbergen offenbar eine recht differenzierte, aber nahezu unerforschte Isoëto-Nanocyperion-Vegetation mit *Ammannia*-Arten als Kenn taxa (Lavrentiades 1973, Raus 1996). Die Notizen zu Isoëtion-Gesellschaften von Krause *et al.* (1963) und Gradstein und Smittenberg (1977) wurden bereits einleitend erwähnt. Nach meinen eigenen (flüchtigen) Geländebeobachtungen sind Isoëtion- und Cicion-Gesellschaften mit *Anagallis arvensis* subsp. *parviflora*, *Cicendia filiformis*, *Radiola linoides*, *Solenopsis laurentia* etc. im Lagunengebiet bei Strofilia in der nordwestlichen Peloponnes außerordentlich reich entwickelt (siehe hierzu auch Georgiadis *et al.* 1990).

In der Tabelle 2 sind in Griechenland vorkommende Gefäßpflanzen (nach Greuter *et al.* 1984, 1986, 1989, Tutin *et al.* 1968–1980, 1993, Raus unpubl.) und Moose (nach Preston 1981, 1984a, 1984b, Düll 1995) alphabetisch aufgelistet, die im übrigen Europa übereinstimmend als Kenn- und Trennarten der Isoëto-Nanojuncetea und ihrer Ordnungen und Verbände eingestuft werden (vgl. Rivas-Goday und Borja Carbonell 1961: 165–167, Pietsch und Müller-Stoll 1968, Pietsch 1973a, 1973b, Oberdorfer 1990, Borhidi 1996: 47, etc.). Ergänzend und ohne Anspruch auf floristische Vollständigkeit seien weitere Arten der griechi-

schen Flora erwähnt, die ihren soziologischen Schwerpunkt in Bidentetea tripartitae-, Littorelletea-, Polygono arenastri-Poëtea annuae-, Helianthemetalia guttati- oder auch Trifolio-Hordeetalia-(Trifolion resupinati)-Gesellschaften, etc. haben, aber auf Isoëto-Nanojuncetea-Standorte übergreifen, wie z.B. *Centaurium maritimum*, *Corrigiola litoralis*, *Digitaria ischaemum*, *Eleocharis acicularis*, *Heliotropium supinum*, *Hordeum geniculatum*, *Lotus angustissimus*, *Lotus conimbriensis*, *Myosotis sicula*, *Plantago major* subsp. *intermedia*, *Polypogon maritimus*, *Polypogon monspeliensis*, *Polypogon subspatheus*, *Polypogon viridis*, *Potentilla supina*, *Trifolium filiforme*, *Verbena supina* sowie terrestrische Formen von *Callitriche*- und *Ranunculus* sect. *Batrachium*-Arten. Diese floristische Ausstattung des Landes gibt hinreichend Hinweise auf eine reiche Entfaltung der Isoëto-Nanojuncetea in Griechenland und unterstreicht den aktuellen überregionalen Forschungsbedarf zur syntaxonomisch-chorologischen Aufklärung der Isoëto-Nanojuncetea im östlichen Mittelmeerraum.

LITERATUR

- Barkman, J. J., Moravec, J. und Rauschert, S. (1986): Code of phytosociological nomenclature. (Code der pflanzensoziologischen Nomenklatur. Code de nomenclature phytosociologique.) – *Vegetatio* **67**: 145–195.
- Borhidi, A. (1996): *An annotated checklist of the Hungarian plant communities, I. The non-forest vegetation.* – In: Borhidi, A. (ed.): Critical revision of the Hungarian plant communities. Janus Pannonius University, Pécs, pp. 43–94.
- Braun-Blanquet, J. (1967): Vegetationsskizzen aus dem Baskenland mit Ausblicken auf das weitere Ibero-Atlantikum. II. – *Vegetatio* **14**: 1–126.
- Braun-Blanquet, J. und Bolós, O. de (1957): Les groupements végétaux du bassin de l'Ebre. – *Anales Estac. Exp. Aula Dei* **5**.
- Braun-Blanquet, J., Roussine, N. und Nègre, R. (1951): *Les groupements végétaux de la France méditerranéenne.* – CNRS, Montpellier, 297 pp.
- Düll, R. (1995): Übersicht der Moose Griechenlands. – *Bryol. Beitr.* **10**: 1–125.
- Egli, B. (1993): *Ökologie der Dolinen im Gebirge Kretas (Griechenland).* – Diss., Univ. Zürich, 275 pp.
- Ellenberg, H. (1996): *Vegetation Mitteleuropas mit den Alpen in ökologischer, dynamischer und historischer Sicht.* 5. Aufl. – Ulmer, Stuttgart, 1096 pp.
- Georgiadis, Th., Economidou, E. und Christodoulakis, D. (1990): Flora and vegetation of the Strofilia coastal area (NW Peloponnisos – Greece). – *Phyton* (Horn) **30**: 15–36.
- Grabherr, G. und Mucina, L. (eds) (1993): *Die Pflanzengesellschaften Österreichs. Teil II. Natürliche waldfreie Vegetation.* – Fischer Verlag, Jena etc., 523 pp.
- Gradstein, S. R. und Smittenberg, J. H. (1977): The hydrophilous vegetation of Western Crete. – *Vegetatio* **34**: 65–86.
- Greuter, W., Burdet, H. M. und Long, G. (eds) (1984, 1986, 1989): *Med-Checklist.* 1, 3, 4. – Genève und Berlin.
- Gustavsson, L.-Å. (1978): Floristic reports from the high mountains of Sterea Ellas, Greece 1. – *Bot. Not.* **131**: 7–25.

- Hejny, S. (1960): *Ökologische Charakteristik der Wasser- und Sumpfpflanzen in den slowakischen Tiefebene (Donau- und Theißgebiet)*. – Slovenská Akadémia Vied, Bratislava, 487 pp.
- Horvat, I., Glavac, V. und Ellenberg, H. (1974): *Vegetation Südosteuropas*. – Fischer Verlag, Jena etc., 768 pp.
- Horvatic, S. (1954): *Fimbristylion dichotomae* – ein neuer Verband der Isoëtetalia. – *Vegetatio* **5–6**: 448–453.
- Klika, J. (1935): Die Pflanzengesellschaften des entblößten Teichbodens in Mitteleuropa. – *Beih. Bot. Centralbl.* **53B**: 286–310.
- Koch, W. (1926): Die Vegetationseinheiten der Linthebene unter Berücksichtigung der Verhältnisse in der Nordostschweiz. Systematisch-kritische Studie. – *Jahrb. St. Gallischen Naturwiss. Ges.* **61**(II): 1–144.
- Krause, W., Ludwig, W. und Seidel, F. (1963): Zur Kenntnis der Flora und Vegetation auf Serpentinstandorten des Balkans. 6. Vegetationsstudien in der Umgebung von Mantoudi (Euböa). – *Bot. Jahrb. Syst.* **82**: 337–403.
- Lavrentiades, G. (1973): *I chloris ke i vlastisis ton orizonon tou Kalochoriou*. – *Prakt. Inst. Okeanol. Alievt. Erevnon* **11**: 145–165.
- Merxmüller, H. und Podlech, D. (1976): *Fimbristylis ferruginea* in Kreta. – *Mitt. Bot. Staatssamml. München* **12**: 683–684.
- Moor, M. (1936): Zur Soziologie der Isoëtetalia. – *Beitr. Geobot. Landesaufn. Schweiz* **20**: 1–148.
- Oberdorfer, E. (1952): Beitrag zur Kenntnis der nordägäischen Küstenvegetation. – *Vegetatio* **3**: 329–349.
- Oberdorfer, E. (1990): *Pflanzensoziologische Exkursionsflora*. 6. Aufl. – Ulmer, Stuttgart, 1050 pp.
- Oberdorfer, E. (1992) (ed.): *Süddeutsche Pflanzengesellschaften. I: Fels- und Mauergesellschaften, alpine Fluren, Wasser-, Verlandungs- und Moorgesellschaften*. 3. Aufl. – Fischer Verlag, Jena, 314 pp.
- Pietsch, W. (1973a): Beitrag zur Gliederung der europäischen Zwergbinsengesellschaften (Isoëto-Nanojuncetea Br. Bl. et Tx. 1943). – *Vegetatio* **28**: 401–438.
- Pietsch, W. (1973b): Zur Soziologie und Ökologie der Zwergbinsen-Gesellschaften Ungarns (Klasse Isoëto-Nanojuncetea Br.-Bl. et Tx. 1943). – *Acta Bot. Acad. Sci. Hung.* **19**: 269–288.
- Pietsch, W. und Müller-Stoll, W. R. (1968): Die Zwergbinsen-Gesellschaft der nackten Teichböden im östlichen Mitteleuropa, *Eleocharito-Caricetum bohemicae*. – *Mitt. Flor.-Soz. Arbeitsgem.* **13**: 14–47.
- Pott, R. (1995): *Die Pflanzengesellschaften Deutschlands*. 2. Aufl. – Ulmer, Stuttgart, 622 pp.
- Preston, C. D. (1981): A check-list of Greek liverworts. – *J. Bryol.* **11**: 537–553.
- Preston, C. D. (1984a): A check-list of Greek mosses. – *J. Bryol.* **13**: 43–95.
- Preston, C. D. (1984b): A check-list of Greek liverworts: Addendum. – *J. Bryol.* **13**: 97–100.
- Raus, Th. (1979a): Die Vegetation Ostthessaliens (Griechenland). I. Vegetationszonen und Höhenstufen. – *Bot. Jahrb. Syst.* **100**: 564–601.
- Raus, Th. (1979b): Die Vegetation Ostthessaliens (Griechenland). II. Quercetea ilicis und Cistomierietea – *Bot. Jahrb. Syst.* **101**: 17–82.
- Raus, Th. (1980): Die Vegetation Ostthessaliens (Griechenland). III. Querco-Fagetea und azonale Gehölzgesellschaften. – *Bot. Jahrb. Syst.* **101**: 313–361.
- Raus, Th. (1981): *Human interference with zonal vegetation in the Thessalian coastal section of the Aegean*. – In: Frey, W. und Uerpmann, H.-P. (eds): Beiträge zur Umweltgeschichte des Vorderen Orients. Beih. Tübinger Atl. Vord. Orients, Reihe A, 8, pp. 40–50.
- Raus, Th. (1983): Wechselnasse Wiesen in Griechenland. – *Tuexenia* **3**: 259–270.
- Raus, Th. (1987): Gipfelvegetation des Ossa-Gebirges im Vergleich zum Olymp (Thessalien, Griechenland). – *Münstersche Geogr. Arbeiten* **27**: 199–206.
- Raus, Th. (1991): Notes on rare vascular wetland plants of Greece. – *Bot. Chron.* **10**: 567–578.
- Raus, Th. (1996): *Ammannia* (Lythraceae) in Greece and the Balkans. – *Lagascalia* **18**: 715–720.

- Rivas-Goday, S. und Borja Carbonell, J. (1961): Estudio de vegetación y flórula del Macizo de Gúdar y Jabalambre. – *Ann. Inst. Bot. Cavanilles* **19**: 3–550.
- Slavnic, Z. (1951): Prodrome des groupements végétaux nitrophiles de la Voivodine (Yougoslavie). – *Naucni Sborn. Matice Srpske, Ser. Priir. Nauka* **1**: 84–169.
- Snogerup, S., Bothmer, R. von und Gustavsson, M. (1980): Floristic report from the island of Psathura (Greece). – *Bot. Not.* **133**: 145–148.
- Timár, L. (1950): A Tisza-meder növényzete Szolnok és Szeged között. – *Ann. Biol. Univ. Debrecen* **1**: 72–145.
- Tutin, T. G., Burges, N. A., Chater, A. O., Edmondson, J. R., Heywood, V. H., Moore, D. M., Valentine, D. H., Walters, S. M. und Webb, D. A. (eds) (1993): *Flora Europaea*. Vol. 1. Ed. 2. – Cambridge University Press, Cambridge.
- Tutin, T. G., Burges, N. A., Heywood, V. H., Moore, D. M., Valentine, D. H., Walters, S. M. und Webb, D. A. (eds) (1968–1980): *Flora Europaea*. Vol. 2 (1968), Vol. 3 (1972), Vol. 4 (1976), Vol. 5 (1980). – Cambridge University Press, Cambridge.
- Tüxen, R. und Zevaco, C. (1973): *Bibliographia Phytosociologica Syntaxonomica. Lief. 19: Isoëto-Nanojuncetea*. – J. Cramer, Lehre, 90 pp.

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POLLEN VIABILITY AND FRUIT SET IN APPLE CULTIVARS*

T. SZABÓ¹, Á. FARKAS², ZS. OROSZ-KOVÁCS², T. BUBÁN¹,
E. NAGY-TÓTH³, R. ZORN², E. GÖRÖG¹, E. FEJES¹ and M. SZÉKELY¹

¹Research Station for Fruitgrowing, H-4244 Újfehértó, Pf. 38, Hungary

²Dept. Botany, Janus Pannonius University, H-7624 Pécs, Ifjúság útja 6, Hungary

³Dept. Botany, Berzsenyi Dániel Teachers' Training College
H-9761 Szombathely, Pf. 17, Hungary

Pollen viability and rate of fruit set in trees of ten apple cultivars have been investigated in years 1994 and 1996. Isatin staining was used for testing viability of pollen. The intensity of the isatin staining is proportional to the amount of proline in pollen grains. Proline is known as one of the most important amino acids concerning the physiological activity of pollen. Pollen viability proved to be excellent, good, or middling, depending on years and cultivars, excepting cvs Gloster and Lysgolden in year 1994. This year during the bloom period of both late flowering cultivars, however, there was unusually high (sometimes 27–28 °C) air temperature in the orchard. Cultivars like Red Rome van Well, Idared, Burgundy and Smoothee can be qualified as ecostable ones. It is an instructive experience, that pollen grains of the triploid cv Jonagold (without any fertilizing potential) can be stained by isatin fairly well, too. Cross pollination among apple cultivars investigated provided a reliable fruit set. One of the exceptions was the cv Jonagold, being a triploid one. It must not be used as a pollinator. On the other hand, we recorded a rather weak fruit set (or nothing) in its trees during the bloom period of high air temperature (1994). Furthermore, there is no possibility of fertilization between cvs Lysgolden and Smoothee belonging to the same group of varieties.

Key words: apple, fruit trees, pollen viability, fruit set

INTRODUCTION

Compatibility and viability of the pollen of apple cultivars are essential conditions in pollination. It is well-known that apple flowers are entomogamous and autosterile, and pollination is ensured if pollen viability and compatibility relations are appropriate, and the insect attraction of flowers is also sufficient. In this study pollen viability was determined by an isatin staining reaction. Along with pollen studies pollination experiments were carried out with isolated flowers. Research was carried out in two years, at the Research Station for Fruitgrowing, Újfehértó.

The total amino acid content of apple pollen is very high (20.07%). The pollen of all fruit species can be characterized by the highest quantity of asparagin acid, glutamin acid and proline (Kocsis-Molnár *et al.* 1996). Apple pollen was found

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to contain proline as the most abundant amino acid. It may attain 2.2% fresh weight of pollen. The amount of proline is not only determined by the properties of the given variety but also by environmental conditions. Pollen of over-aged uncared for trees of the Golden Pearmain variety were reported to contain less proline than the pollen from properly managed trees of the same variety. It was also observed that proline content increased generally with increasing fertility (Tupy 1963).

The other important amino acid in connection with pollen fertility is histidine. Its amount is higher in poorly germinating pollen grains than in the fertile ones. Its relationship to the fertility of pollen is the reverse of that of proline. The proline/histidine ratio (PHQ) can be considered as a general criterion of apple pollen fertility (Tupy 1963).

High proline content may indicate a high degree of pollen viability at other species, as well. According to Pálfi and Köves (1984) weakly fertile or sterile pollen of corn contains less than 1.0% proline, while the proline content of fertile pollen is 1.5–2.5% of the dry matter.

Proline plays an important role in the initiation of pollen germination and tube elongation. Part of the proline pool is used for protein synthesis during germination and outgrowth of the tube (Zhang *et al.* 1982). Proline can also be used for cell-wall synthesis in the fast growing tip of the pollen tube (Zhang and Croes 1983). It was observed by Pálfi and Köves (1984) that exogenous proline stimulates the growth of the pollen tubes considerably. Besides storing energy, proline has a key-role in amino acid and protein synthesis in the pollen grain (Pálfi and Gulyás 1985).

Proline can function as osmoprotectant and cryoprotectant when accumulated in the cytoplasm of cells. The most important advantage of proline is its high degree of water solubility. Proline is the only amino acid being solute and chemically active even at an extremely low water content of the pollen grain. At the same time proline increases the water-binding capacity and draught-resistance of pollen significantly by its strong hydrophilicity (Pálfi *et al.* 1974).

Besides the isatin test, which determines pollen viability on the basis of proline content, there is a number of other reliable histochemical methods for testing pollen viability. The effectiveness of the fluorescein diacetate (FDA) procedure was confirmed by Huang and Johnson (1996) in determining the viability of blueberry pollen.

The quality of pollen influences the frequency of bee visitation of flowers. In the Rosaceae family the pollen itself frequently has a special odour connected to lipids and localised in the pollenkitt.

MATERIAL AND METHODS

Compatibility studies were carried out and pollen samples were collected from trees of various apple cultivars on rootstocks M.26 and MM.106, resp., at the Research Station for Fruitgrowing, Újfehértó in 1994 and 1996.

The studied apple cultivars were the following:

- | | |
|--------------------|---------------------------|
| 1. Summerred/M.26 | 6. Red Rome Van Well/M.26 |
| 2. Smoothee/MM.106 | 7. Idared/MM.106 |
| 3. Ozark Gold/M.26 | 8. Jonagold/M.26 |
| 4. G. 243/M.26 | 9. Gloster/M.26 |
| 5. Burgundy/M.26 | 10. Lysgolden/MM.106 |

Staining of pollen grains was carried out by the quick staining method of Pálfi and Gulyás (1985). Staining by the reagent isatin shows the degree of pollen viability in each pollen grain based on their proline concentration. Staining was evaluated by light microscope. The ratio of differently coloured pollen grains was expressed in percentages.

Based on the percentage of dark staining pollen grains, which are sure to develop a pollen tube, the following classification of cultivars is suggested:

Percentage of dark staining pollen grains (%)	Classification
91–100	excellent
71–90	good
51–70	medium
31–50	weak
30	bad

RESULTS

The pollen viability of apple cultivars – studied in two years – showed quite significant differences. The reasons of this variation are probably the yearly changing environmental factors (mainly air temperature and water supply) that have an impact on the amount of proline and on its staining, too (Figs 1 and 2, Table 1). On the basis of the isatin reaction the studied cultivars in 1996 could be classified as being of medium or good pollen viability, whereas in 1994 the pollen of two cultivars (Gloster and Lysgolden) belonged to the weak category.

It was an important observation that pollen grains of the triploid cv Jonagold (without any fertilizing potential) can be stained by isatin to a medium degree. This conveys the suggestion that pollen viability of apple cultivars might be better evaluated by the ratio of proline and histidine (Tupy 1963). According to others, proline can be found in the greatest amount in apple pollen and this amino acid (1.46%) is responsible for pollen fertility (Gulyás and Pálfi 1986, 1989). The question can be settled only by pollen tube growth experiments.

Table 1
Viability of pollen of apple cultivars tested by proline staining (Újfehértó, 1994 and 1996)

Cultivars	1994	1996
Lysgolden	weak	medium
G. 243*	good	good
Red Rome Van Well	good	good
Gloster	weak	medium
Idared	good	good
Burgundy	good	good
Smoothee	good	good
Jonagold**	medium	medium
Ozark Gold	good	good
Summerred	excellent	good

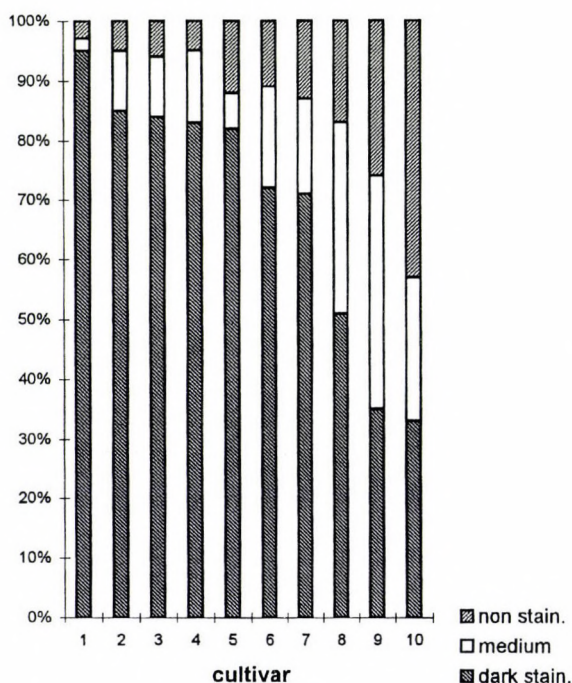


Fig. 1. Pollen viability of apple cultivars on the basis of the isatin staining reaction (Újfehértó, 1994). Cultivars: 1. Summerred M-26, 2. Smoothee MM-106, 3. Ozark Gold M-26, 4. G. 243 M-26, 5. Burgundy M-26, 6. Red Rome Van Well M-26, 7. Idared MM-106, 8. Jonagold M-26, 9. Gloster M-26, 10. Lysgolden MM-106

On the basis of pollen viability Summerred, Smoothee, Ozark Gold, G.243, Burgundy, Red Rome Van Well and Idared can be considered as ecologically stable cultivars (Figs 1 and 2, Table 1). These are consistently, always good pollen donors.

Gloster and Lysgolden usually blossom late. In this relatively late period, air temperature often increases suddenly. In 1994 at the blossoming of these two cultivars air temperatures reached 27–28 °C. According to fruit set studies carried out with seven apple cultivars by Davary-Nejad *et al.* (1993), after pollination with the pollen of cv Gloster, seeds of full value developed out of a great number (4.2–8.2, average 6) of ovules within a flower. Nevertheless, artificial pollination experiments with samples containing a small amount of viable pollen may give a good result, because a great quantity of pollen can reach the surface of the stigma. However, in nature it is not certain that the stigma will get enough pollen, if the quality of pollen is not satisfactory. For this reason, in the case of planting two cultivars only (a pollen donor and a cultivar to be pollinated), establishing experimental parcels with free pollination is essential.

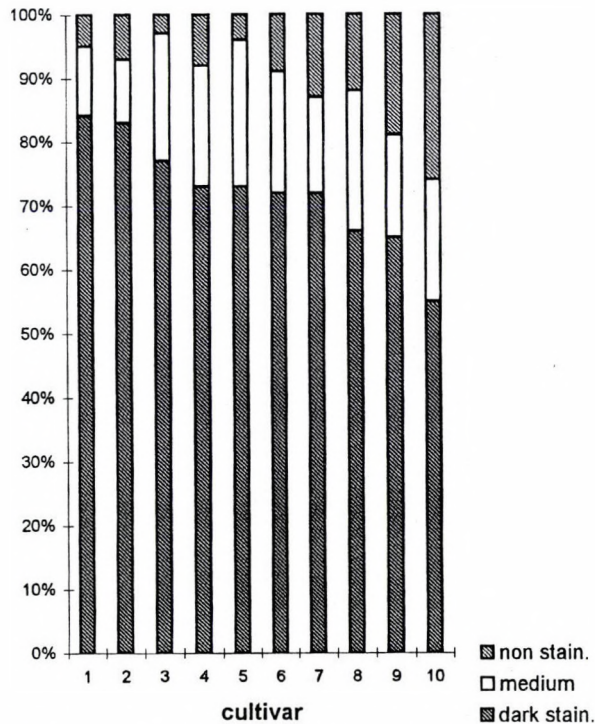


Fig. 2. Pollen viability of apple cultivars on the basis of the isatin staining reaction (Újfehértó, 1996). Cultivars: 1. Summerred M-26, 2. Smoothee MM-106, 3. Ozark Gold M-26, 4. G. 243 M-26, 5. Burgundy M-26, 6. Red Rome Van Well M-26, 7. Idared MM-106, 8. Jonagold M-26, 9. Gloster M-26, 10. Lysgolden MM-106

Table 2
Fruit set after cross-pollination of apple cultivars (%) (Újfehértó, 9 June, 1994)

	Sum- merred	Bur- gundy	G. 243	Ozark Gold	Gloster	Idared	Smoo- thee	Lys- golden	Red Rome Van Well
Summerred	–	41.7	31	42.8	33.3	41.4	65.6	52.8	43.2
Burgundy	15.9	–	22.5	36.4	22.9	23.1	23.5	23.1	23.4
G. 243	100	88.0	–	74.2	78.1	70.0	82.3	57.1	77.8
Ozark Gold	30.8	41.9	50	–	37.1	31.4	32.5	26.2	31.1
Gloster	15.4	57.7	19.4	31.6	–	32	38.9	33.3	51.7
Idared	26.2	48.4	15.6	45	53.3	–	61.7	20	36
Smoothee	13.7	53.8	6.4	31.6	21.6	30.8	–	–	29
Lysgolden	25	4.3	28.6	21.7	10.4	20.0	–	–	5.9
Red Rome Van Well	15.4	11.1	9.5	30.3	22.2	14.6	27.3	13	–
Jonagold	0	8.7	0	33.3	2	14.3	–	–	17.9

The percentage of non-staining pollen grains – containing no proline at all, i.e. not viable – was not too high in the case of the studied cultivars. Pollen grains taking an intermediate colour, light blue, are not sure to develop a pollen tube, so these cannot be counted among the viable ones, either. The dark-staining pollen grains are the undoubtedly fertile ones. Except for two, all the samples from 1994 contained more than 50% of surely viable pollen grains.

Table 3
Fruit set after cross-pollination of apple cultivars (%) (Újfehértó, 11 June, 1996)

	Sum- merred	Bur- gundy	G. 243	Ozark Gold	Gloster	Idared	Smoothee	Lys- golden	Red Rome Van Well
Summerred	–	30	30.8	23.5	22.2	21.3	32.4	31.8	33.3
Burgundy	16.9	–	13.8	19.3	9.8	10.3	22.6	30.6	32.7
G.243	23.1	47.5	–	46.5	70.6	30.9	47	39.5	27.6
Ozark Gold	25	25.5	10.7	–	23.5	16.4	20.9	27.8	20.4
Gloster	28.6	16.7	36.8	18.2	–	20	15.8	27.8	50
Idared	34.4	37.5	34.4	38.1	45.8	–	36.4	34.5	39.4
Smoothee	38.1	42.8	52.2	23.1	31.8	31.2	–	–	36.8
Lysgolden	10.0	21.4	38.5	30	40	26.3	–	–	28.6
Red Rome Van Well	26.9	19.3	10.5	37.5	28	27.3	21.7	17.4	–
Jonagold	11.8	25	38.9	44.4	39.1	42.1	–	–	46.1

Table 4
Fruit set in trees of apple cultivars 1994, Újfehértó (Fruit pieces/100 flower clusters)

Cultivars: male, female	1.	2.	3.	4.	6.	7.	8.	9.	10.	Aver- age
1. Summerred M-26	—	167	112	167	100	133	262	190	160	161
2. Burgundy M-26	100	—	112	160	122	120	120	133	137	125
3. G.243 M-26	440	420	—	367	400	350	467	300	233	372
4. Ozark Gold M-26	171	217	257	—	217	157	186	143	175	190
5. Jonagold M-26	0	40	0	111	8	71	—	—	83	45
6. Gloster M-26	50	214	58	71	—	100	140	75	167	109
7. Idared MM-106	110	214	64	180	267	—	242	75	150	163
8. Smoothee M-26	64	216	27	150	100	117	—	—	100	111
9. Lysgolden M-26	75	20	120	100	45	67	—	—	33	66
10. Red Rome Van Well M-26	86	60	50	167	113	75	150	75	—	97
Average	122	174	89	164	152	132	224	142	138	

Note: final fruit set, before harvest

Primary fruit set and final fruit set in trees of the studied apple cultivars are presented in Tables 2–3 and 4, 5, respectively. It can be stated that the studied apple cultivars fertilize each other satisfactorily. The difference between data of the two years (1994 and 1996) can be explained by environmental differences.

Table 5
Fruit set in trees of apple cultivars 1996, Újfehértó (Fruit pieces/100 flower clusters)

Cultivars: male, female	1.	2.	3.	4.	6.	7.	8.	9.	10.	Aver- age
1. Summerred M-26	—	150	150	120	100	100	137	144	160	133
2. Burgundy M-26	91	—	80	110	54	54	122	167	170	105
3. G.243 M-26	100	237	—	250	343	189	267	214	145	218
4. Ozark Gold M-26	127	150	67	—	133	100	100	155	111	118
5. Jonagold M-26	100	50	140	67	—	75	60	100	160	94
6. Gloster M-26	40	100	140	160	150	133	—	—	150	125
7. Idared MM-106	143	150	183	160	167	—	160	150	171	160
8. Smoothee M-26	160	200	200	100	140	167	—	—	233	171
9. Lysgolden M-26	50	150	167	100	143	125	—	—	200	133
10. Red Rome Van Well M-26	140	100	50	200	175	150	100	100	—	136
Average	106	143	131	141	156	121	135	147	167	

Note: final fruit set, before harvest

Jonagold is a unique exception. This cultivar – being a triploid one – cannot be planted as a pollen donor at all, and in 1994, when the temperature was high during blossoming, in some cases there was only a weak fruit-set or no fruit-set at all on these trees. Fertilization cannot be expected between Jonagold and Smoothee or Lysgolden, two cultivars belonging to the same cultivar group. Comparing eight different pollen donor cultivars, others similarly found only a few: 1.2–4.2, in average 3 well-developed seeds in the fruits of Red Jonagold (Davary-Nejad *et al.* 1993).

Among the cultivars studied by us, cvs Summerred, Burgundy and Idared blossom early, whereas the cvs Ozark Gold and Red Rome Van Well blossom late. According to our experiences, cultivars belonging to two different groups of blossoming period cannot fertilize each other in each year, although their pollen is viable (Szabó 1995).

The pollen production of potential pollen donor cultivars is occasionally very small or strikingly big, *e.g.* Grimes Golden 1,850 + 170, and Stark Delicious 10,090 + 440, the average of several apple cultivars being 6,400 pollen grains/anther (Benedek *et al.* 1989). Cultivated apple cultivars are fertilized well by *Malus* species with different blossoming times, *e.g.* *M. floribunda*, *M. spectabilis*, *M. halliana* and others (Nyéki *et al.* 1982), although the pollen tube developing ability of *Malus* species varies to a great extent (Soltész *et al.* 1982).

It is an interesting experience that certain qualitative features of apple fruits, *e.g.* the colour of the peel or the firmness of the flesh, can be modified by pollination with pollen of *Malus* species. In the American apple growing states *Malus* species are frequently planted as pollen donors in the orchards.

The degree of staining by the isatin reagent and fertilization often do not correlate, because air temperature influences the function of the stigma to a great extent. At air temperatures of 20–27 °C and at 60% relative humidity it was observed (Scheid-Nagy-Tóth 1991, Szabó-Mühlenkampff 1994, Orosz-Kovács *et al.* 1994) that nectar secretion suddenly decreases, then stops. Stigma secretion, according to our observations, is clearly detectable at the maxima of nectar production. In other words, stigma secretion is likely to be synchronized with nectar secretion, and it also can be expected to decrease under unfavourable conditions. It seems possible that the pollen does not get enough secretory product, either, to pollen tube development on the surface of the stigma. Pollen viability and fertilization are often not synchronous because of the above reasons.

Pollen viability is a precondition of fertilization, but the pollen also has to be carried on the stigma. In pollen transport several factors interact, which also must be studied in order to advance in pollination and fertilization biology.

REFERENCES

- Benedek, P., Soltész, M., Nyéki, J. and Szabó, Z. (1989): Almafajták virágainak rovarmegporzást befolyásoló tulajdonságai. (Variety features affecting pollination in apple flowers). – *Kertgazdaság* **21**(6): 42–64.
- Davary-Nejad, G. H., Szabó, Z. and Nyéki, J. (1993): Relationship between fertility and seed content in apple varieties. – *Acta Agron. Hung.* **42**(3–4): 365–375.
- Gulyás, S. and Pálfi, G. (1986): Proline type pollens and their vitality in the Rosaceae and the species of other families. – *Acta Biol. Szeged.* **32**: 9–18.
- Gulyás, S. and Pálfi, G. (1989): A zárwatermő fajok felosztása a pollenszemek prolin értékei alapján. (Division of Angiospermae species on the basis of the proline values of their pollen). – *Bot. Közlem.* **76**(3–4): 241–251.
- Huang, Y. and Johnson, Ch. E. (1996): A convenient and reliable method to evaluate blueberry pollen viability. – *Hort. Science* **31**(7): 12–35.
- Kocsis-Molnár, G., Nyéki, J., Schmidt, J. and Szabó, Z. (1996): Néhány gyümölcsfaj pollenjeinek aminosavtartalma. (Pollen amino acids content of some fruit species). – *Lippay János tudományos ülésszak előadásainak és posztereinek összefoglalói*, Budapest, pp. 234–235.
- Nyéki, J., Soltész, M., Tóth, M., Gyúró, F. and Terpó, A. (1982): Possibilities of pollinating single variety apple orchards with *Malus* species. – *Acta Agron. Acad. Sci. Hung.* **31**: 252–256.
- Orosz-Kovács, Zs., Nagy-Tóth, E. and Mühlenkamp, E. (1994): *The effect of microclimatic factors on the attractivity of apple cultivars*. – Abstracts, XXIst Congress of the Hungarian Biological Society, Pécs, p. 45.
- Pálfi, G. and Gulyás, S. (1985): Adatok a pollenek vitalitás vizsgálatának a kiegészítéséről. (Data about the extensions of pollen vitality studies). – *Növénytermelés* **34**(5): 351–357.
- Pálfi, G. and Köves, E. (1984): Determination of vitality of pollen on the basis of its amino acid content. – *Biochem. Physiol. Pflanzen* **179**: 237–240.
- Pálfi, G., Köves, E. and Bitó, M. (1974): The role of amino acids during waterstress in species accumulating proline. – *Phyton* **32**: 121–127.
- Scheid-Nagy-Tóth, E. (1991): *Almafajták nektárium szerkezete és nektártermelése*. (Structure of nectary and nectar production in apple cultivars). – Doct. dissert., Pécs, pp. 1–160.
- Soltész, M., Tóth, M., Gyúró, F., Terpó, A. and Nyéki, J. (1982): Pollination biological characteristics of various *Malus* taxa. – *Acta Bot. Acad. Sci. Hung.* **28**(3–4): 391–402.
- Szabó, T. (1995): Fontosabb almafajták. (Apple cultivars of importance). – In: Inántszy, F. (ed.): *Az integrált almatermesztés kézikönyve*. (Manual of the integrated apple production), Újfehértó, pp. 25–45.
- Szabó-Mühlenkamp, E. (1994): *Spur típusú almafajták nektárium szerkezete és nektártermelése*. (Structure of nectary and nectar production in Spur types apple cultivars). – Doct. dissert., Pécs, pp. 1–159.
- Szalai, Z. (1996): Pollenattraktivitás vizsgálata mézelő méhekkel három termesztett és egy díszalmafajta esetében. (Testing the attractiveness of pollen of three cultivated and one ornamental apple). – *Lippay János tudományos ülésszak előadásainak és posztereinek összefoglalói*, Budapest, pp. 238–239.
- Tóth, M., Dula, P., Tóth, F., Soltész, M. and Nyéki, J. (1985): Effect of *Malus* pollinators on the quality of apple. – *Acta Agronom. Acad. Sci. Hung.* **34**: 72–76.
- Tupy, J. (1963): Free amino acids in apple pollen from the point of view of its fertility. – *Biol. Plantarum* **5**: 154–160.

- Zhang, H. Q. and Croes, A. F. (1983): Proline metabolism in pollen: degradation of proline during germination and early tube growth. – *Planta* **159**: 46–49.
- Zhang, H. Q., Croes, A. F. and Linskens, H. F. (1982): Protein synthesis in germinating pollen of *Petunia*: role of proline. – *Planta* **154**: 199–202.

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SURVIVAL CHANCES OF LOESS GRASSLAND FRAGMENTS IN THE HORTOBÁGY, HUNGARY: A CASE STUDY ON THE COMMUNITY TRANSFORMATION EFFECT OF A COLLAPSED WAYSIDE INN

A. TÓTH¹ and K. TÖRÖK²

¹*GATE Mezőgazdasági Főiskolai Kar, H-5400 Mezőtúr, Petőfi tér 1, Hungary*

²*Institute of Ecology and Botany, Hungarian Academy of Sciences, H-2163 Vácraátót, Hungary*

The relic loess grassland fragments represent high natural value owing to their species richness and diversified structure. Fragmented occurrence threatens communities with degradation and elimination. The study focused on the survival chances of a loess grassland patch under the intensive perturbation of adobe deposition, as a result of ruined wayside inn. Permanent plots were investigated twice with a 15 years delay, by the methods of traditional plant sociology. Results were analysed by means of ecological indicator values of species and by multivariate methods. Both types of data analysis indicated intensive increase in weed dominance with a less remarkable species replacement. The authors conclude that the investigated loess grassland fragment still maintains its major species composition characteristic to this vegetation type. A new set of investigation in the coming years would help in estimating the rehabilitation capacity of the community.

Nomenclature: Simon (1992).

Key words: adobe, ecological indication, multivariate methods, plant sociology

INTRODUCTION

The impoverishment of vegetation is a worldwide, accelerating process, that is proved by more and more scientific evidence (Marrs *et al.* 1988, Moles and Breen 1991, Bagi 1988, Martin and Turner 1977, Juhász-Nagy 1993). Impoverishment can be characterised by the replacement of species that are specialists, native to restricted areas with narrow tolerance, by adaptive, tolerant invaders. This process results in the homogenisation of vegetation within climatic boundaries and in the loss of biodiversity (Fekete 1996).

In most cases the reason of degradation is a result of human activity, like in the case of species rich, lowland loess grasslands, which were mainly turned to arable land. Surviving grassland patches are endangered by human disturbance, as garbage disposal, irregular perturbation, fragmentation etc. These influences result in the impoverishment of the grassland, which, after a limit, risks survival. The study of resilience (limit of survival) against certain environmental variables is a major task of theoretical and applied scientific research (Westman and

O'Leary 1986). Such types of studies contribute to understand conditions of species composition stability in communities (Lepš *et al.* 1982, Rejmánek 1979, Smedes and Hurd 1981).

Prior to human agriculture, loess steppe grasslands (*Salvio-Festucetum rupicola*) occupied large areas of the Great Hungarian Plain. Its territory has been gradually decreased, at present, only fragments of this community type have survived (Zólyomi and Fekete 1994). Three geographical variants of the community have been distinguished (Zólyomi and Jankó 1962, Zólyomi 1969), one in the Danube region, another east of the river Tisza, the third variant was described from the foot of the North Hungarian Central Range. The variant, common in the Tisza region was subjected to detailed analysis within the Hortobágy area. Map of the loess grassland fragments was prepared, coenological character and the process of degradation and species loss was described in the frame of this research (Tóth 1988).

The aim of the present study was to investigate disturbance tolerance of loess grasslands. The grassland patch around the Sas Inn seemed to be a good opportunity for this study. The grassland fragment was in a species rich condition when the building was abandoned in the 1970s, in 1983 it collapsed (Fig. 1). The ma-



Fig. 1. The surrounding of the collapsed Sas Inn taken from the air in 1996.
Note the spread adobe material over the area

terial of the adobe bricks was spread around the former building by precipitation resulting in an intensive change of soil properties. The influence of this change on vegetation composition was sampled in two periods.

SAMPLING AREA AND METHODS

The site was selected in June 1980, when the inn was already abandoned but still erect. The loess grassland fragment beside the building was in good condition, with a large population of *Phlomis tuberosa* and several other protected species, a real rarity, *Salvia betonicifolia* (Zólyomi and Jankó 1962, Tóth and Török 1996). It was presumed that the change in land-use will have an impact on this vegetation patch. Two transects of 15 and 10 permanent plots (1 m^2) were selected around the building (Fig. 2).

Sampling was performed according to the Braun-Blanquet plant sociological methodology (cover-abundance values). Special attention was paid for plot identification during re-sampling in 1995.

DATA ANALYSES

The two vegetation data sets (1980, 1995) of permanent plots were investigated by means of traditional phytosociological methods on the basis of coenoelements. The objective of this study was to

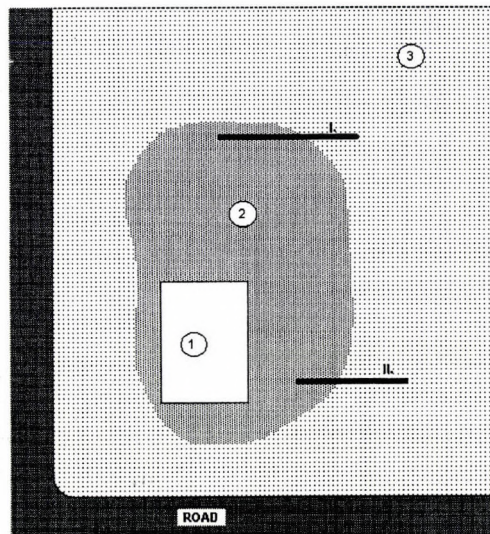


Fig. 2. Map of the Sas Inn. (1 – Original location of the building, 2 – Area of adobe spread after the collapse of the building, 3 – Loess grassland fragment, I – Location of the transect of ten 1 m^2 adjacent plots, II – Location of the transect of 15 plots)

follow the disappearance, invasion or dominance change of species, typical to certain vegetation types.

The multivariate methods of the SYN-TAX 5.1 program package was applied (Podani 1993). Species cover-abundance was expressed according to the ordinal scale from 0 to 9 (van der Maarel 1979) in the data set.

The different indicator values of species were applied to reveal the character, type and reason of vegetation change, these are the following: natural conservation ranks (Simon 1992), social behaviour types (Borhidi 1993), life history strategies (Ujvárosi 1971), nitrogen demand (Borhidi 1993, 1995).

RESULTS

Species replacement was detected between the 2 sampling periods: 16% of total species number (22 species) was found to be present only during one sampling. Regarding the social character distribution of the two species lists (see Table 1) it

Table 1
Unified table of 25 permanent plots (*Salvia nemorosa*-*Festucetum rupicolae*) Sas Inn, July 1980 and July 1995

	1980		1995	
	A-D	K	A-D	K
I. Local character species of the association				
<i>Euphorbia pannonica</i>	+2	I	—	—
<i>Salvia betonicifolia</i>	?	—	—	—
II. Species of the pioneer loess community (<i>Agropyro-Kochietum</i>)				
<i>Agropyron pectinatum</i>	1-5	II	1-5	I
<i>Kochia prostrata</i>	1-3	I	—	—
III. Steppe species (<i>Festucion rupicolae</i>)				
<i>Festuca rupicola</i>	+5	V	+5	V
<i>Thymus pannonicus</i>	+4	IV	+2	II
<i>Thymus glabrescens</i>	+4	III	+2	I
<i>Medicago falcata</i>	+2	I	+1	I
<i>Artemisia pontica</i>	+2	I	—	—
<i>Stipa capillata</i>	+2	I	—	—
IV. Species of dry grasslands (<i>Festucetalia</i>)				
<i>Salvia nemorosa</i>	+4	V	+3	IV
<i>Carex praecox</i>	+3	III	+3	III
<i>Lotus corniculatus</i>	+3	III	+2	II
<i>Scabiosa ochrolenca</i>	+3	III	+2	II
<i>Filipendula vulgaris</i>	+3	III	+1	I
<i>Potentilla arenaria</i>	+2	III	+1	I
<i>Salvia austriaca</i>	+2	II	+3	I

Table 1 cont.

	1980		1995	
	A-D	K	A-D	K
<i>Euphorbia virgata</i>	+1	I	+1	I
<i>Tragopogon dubius</i>	+1	I	+1	I
<i>Veronica prostrata</i>	+1	I	+1	I
V. Species of the forest steppe (<i>Festucetalia-Quercetalia pubescentis petraeae</i>), partly relics of forests				
<i>Phlomis tuberosa</i>	1-5	IV	+3	I
<i>Coronilla varia</i>	+4	III	+2	II
<i>Fragaria viridis</i>	+3	III	+2	II
<i>Thalictrum minus</i>	+3	II	-	-
<i>Asparagus officinalis</i>	+2	I	-	-
<i>Aster linosyris</i>	+1	I	-	-
<i>Aster sedifolius</i> subsp. <i>sedifolius</i>	+1	I	+1	I
<i>Inula germanica</i>	+1	I	+	I
<i>Lavatera thuringiaca</i>	+1	I	+	I
<i>Verbascum austriacum</i>	+	I	-	-
<i>Verbascum phoeniceum</i>	+	I	-	-
VI. Common dry grassland species (<i>Festuco-Brometea</i>)				
<i>Poa angustifolia</i>	+5	V	+5	IV
<i>Achillea collina</i>	+4	IV	+4	III
<i>Galium verum</i>	+5	IV	+3	III
<i>Agrimonia eupatoria</i>	+3	IV	+1	I
<i>Agropyron repens</i>	+4	IV	+4	IV
<i>Bromus mollis</i>	+2	III	+5	IV
<i>Euphorbia cyparissias</i>	+1	II	+2	II
<i>Eryngium campestre</i>	+1	I	+3	II
<i>Falcaria vulgaris</i>	+1	I	+1	I
<i>Leontodon hispidus</i>	+1	I	+	I
<i>Medicago lupulina</i>	+1	I	+1	I
<i>Potentilla argentea</i>	+2	I	+	I
<i>Trifolium arvense</i>	+1	I	+	I
<i>Ajuga genevensis</i>	+2	I	+1	+
<i>Bromus inermis</i>	+3	I	+4	III
<i>Acinos arvensis</i>	+2	I	+2	II
<i>Cynodon dactylon</i>	+1	I	+3	III
<i>Dactylis glomerata</i>	+1	I	+3	II
<i>Hypericum perforatum</i>	+2	I	+	I
<i>Poa bulbosa</i>	+1	I	+2	I

Table 1 cont.

	1980		1995	
	A-D	K	A-D	K
<i>Poa compressa</i>	+2	I	+3	II
<i>Bromus tectorum</i>	+1	I	+2	II
<i>Carex stenophylla</i>	+1	I	+1	I
<i>Echium vulgare</i>	+	I	+1	I
<i>Erodium cicutarium</i>	+	I	+3	II
<i>Nonea pulla</i>	+	I	-	-
<i>Senecio jacobaea</i>	+	I	-	-
<i>Verbascum phlomoides</i>	+	I	+1	I
<i>Viola kitaibeliana</i>	+	I	+1	I
VII. Species common with saline grasslands (Festucion pseudovinae)				
<i>Festuca pseudovina</i>	+4	IV	+4	IV
<i>Achillea setacea</i>	+3	III	+2	III
<i>Gypsophila muralis</i>	+2	II	+1	II
<i>Artemisia santonicum</i>	+2	II	+2	II
<i>Limonium gmelini</i>	+2	II	+2	II
<i>Melandrium viscosum</i>	+	I	+	I
<i>Podospermum canum</i>	+	I	+1	I
VIII. Species of marshlands (Agrostion Molinio-Arrhenatheretea)				
<i>Alopecurus pratensis</i>	+3	IV	+3	IV
<i>Arrhenatherum elatius</i>	+2	II	+2	II
<i>Daucus carota</i>	+2	II	+2	II
<i>Knautia arvensis</i>	+1	II	+2	II
<i>Potentilla reptans</i>	+2	II	+2	II
<i>Trifolium repens</i>	+2	II	+1	II
<i>Centaurea pannonica</i>	+2	II	+2	II
<i>Dipsacus laciniatus</i>	+1	I	+	I
<i>Inula britannica</i>	+3	I	+1	I
<i>Lythrum virgatum</i>	+1	I	+1	I
<i>Taraxacum officinale</i>	+1	I	+3	II
IX. Species of ruderal vegetation (Onopordion Ruderato-Scalinetea)				
<i>Convolvulus arvensis</i>	+3	III	+4	IV
<i>Plantago lanceolata</i>	+3	III	+3	III
<i>Capsella bursa-pastoris</i>	+3	III	+3	III
<i>Carduus acanthoides</i>	+2	III	+3	III
<i>Carduus nutans</i>	+1	II	+2	II
<i>Cichorium intybus</i>	+3	II	+3	II

Table 1 cont.

	1980		1995	
	A-D	K	A-D	K
<i>Meladrium album</i>	+2	II	+3	II
<i>Plantago media</i>	+2	II	+4	III
<i>Polygonum aviculare</i>	+1	II	+3	III
<i>Veronica arvensis</i>	+1	II	+2	III
<i>Adonis aestivalis</i>	+	I	+1	II
<i>Allium scorodoprasum</i>	+	I	+1	I
<i>Anagallis arvensis</i>	+	I	+1	I
<i>Arctium lappa</i>	+	I	+3	III
<i>Ballota nigra</i>	+	I	+3	III
<i>Bromus sterilis</i>	+	I	+3	III
<i>Centaurea solstitialis</i>	+	I	+2	II
<i>Cirsium arvense</i>	+	I	+2	II
<i>Conium maculatum</i>	+	I	+3	II
<i>Consolida orientalis</i>	+	I	+1	I
<i>Consolida regalis</i>	+	I	+2	II
<i>Crepis setosa</i>	+	I	+1	I
<i>Datura stramonium</i>	+	I	+2	II
<i>Descurainia sophia</i>	+	I	+3	II
<i>Erysinum repandum</i>	+	I	+2	I
<i>Galium aparine</i>	-	I	+3	III
<i>Hordeum murinum</i>	+1	I	+3	II
<i>Hyoscyamus niger</i>	-	-	+	I
<i>Lactuca serriola</i>	+1	I	+2	II
<i>Lamium purpureum</i>	+1	I	+2	II
<i>Lappula squarrosa</i>	+	I	+1	I
<i>Lathyrus tuberosus</i>	+1	I	+2	I
<i>Lepidium perfoliatum</i>	+1	I	+3	II
<i>Lepidium ruderae</i>	+1	I	+3	II
<i>Linaria vulgaris</i>	+	I	+	I
<i>Lolium perenne</i>	+1	I	+3	II
<i>Marrubium peregrinum</i>	+1	I	+2	II
<i>Matricaria maritima</i> subsp. <i>inodora</i>	+1	I	+3	II
<i>Melilotus officinalis</i>	-	-	+3	II
<i>Nigella arvensis</i>	-	-	+	I
<i>Onopordon acanthium</i>	+	I	+3	II
<i>Papaver dubium</i>	-	-	+	I

Table 1 cont.

	1980		1995	
	A-D	K	A-D	K
<i>Papaver rhoeas</i>	-	-	+	I
<i>Poa annua</i>	+	I	+3	I
<i>Rapistrum perenne</i>	-	-	+	I
<i>Sonchus asper</i>	-	-	+	I
<i>Torilis arvensis</i>	+	I	+3	II
<i>Verbascum blattaria</i>	+	I	+1	I
<i>Veronica hederifolia</i>	+	I	+2	II
<i>Veronica triphyllos</i>	+	I	+2	II
<i>Vicia angustifolia</i>	-	-	+1	I
<i>Vicia tetrasperma</i>	+	I	+1	I
<i>Viola arvensis</i>	+	I	+1	I
<i>Xanthium spinosum</i>	-	-	+3	II
<i>Xanthium strumarium</i>	-	-	+2	I
X. Woody species				
<i>Rosa gallica</i>	+	I	-	-
<i>Rubus caesius</i>	+	I	+	I

A-D: abundance-dominance, K: constancy values

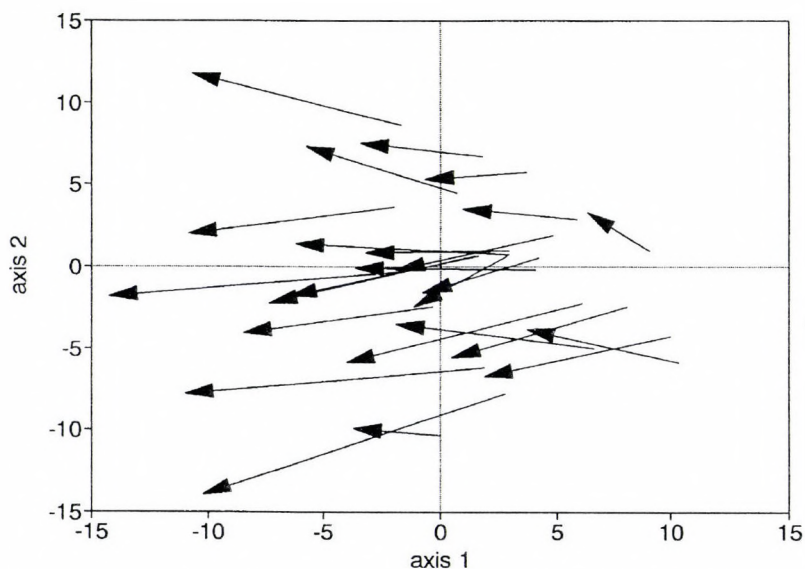


Fig. 3. Results of the Principal Co-ordinate Analysis (PCoA). Trajectories show the replacement of particular plots in the ordination space from 1980 to 1995

can be stated, that only steppe, forest-steppe and dry grassland species disappeared (12), the new species are all members of ruderal communities (10). The changes in dominance and constancy are considered to be more important, than species replacement. This change can be characterised by an intensive propagation of weeds and a decrease in loess grassland species cover.

Multivariate methodology, a more sophisticated approach for the analysis of this vegetation change was applied to the data set. Several classification and ordination methods were used, in each case the results showed that the vegetation in the two periods is somewhat different, but the plots do not produce distinct groups. Only the results of the Principal Co-ordinate Analysis (PCoA, Euclidean distance) is demonstrated here by means of trajectories (Whisenant and Wagstaff 1991, Virágh 1986). Arrows show the replacement of a particular plot in the ordination space from 1980 to 1995 (Fig. 4). The direction of arrows is strikingly similar for each plot along the first axis (the largest variance), that can be attributed to the effect of an intensive, homogeneous environmental perturbation on vegetation.

The distribution of nature conservation categories in the two sampling periods is very different (Fig. 5). The first 4 categories include components of natural communities, while the second group contains species typical in disturbed sites.

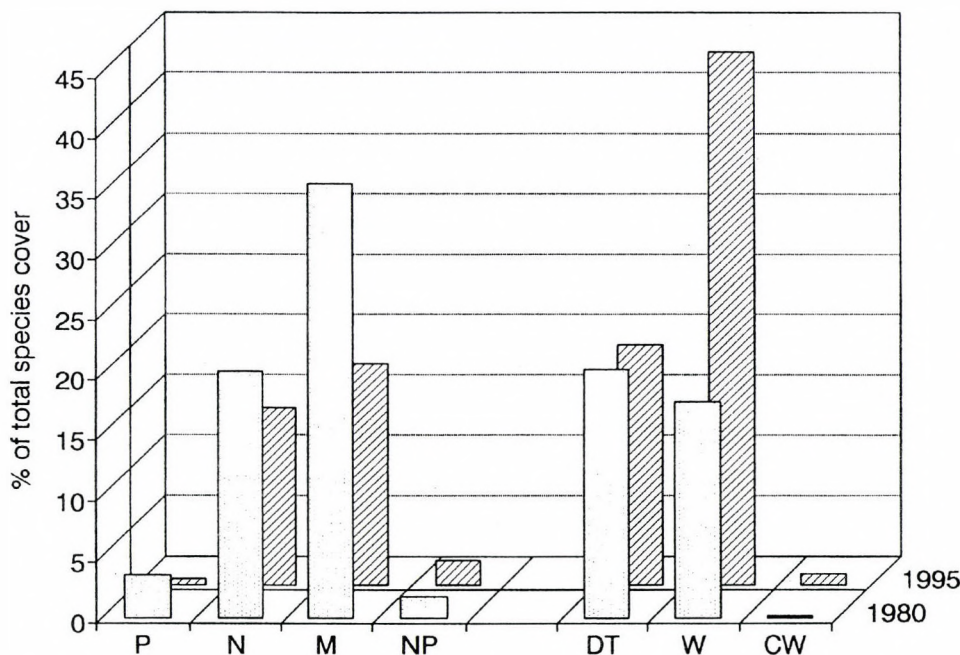


Fig. 4. Distribution of natural conservation ranks in the two sampling periods. (P – protected sp., N – natural predominants, M – main components of communities, NP – natural pioneers, DT – disturbance tolerants, W – weeds, CW – cosmopolitant weeds)

The largest differences can be observed in the decrease of importance of community natural predominants and main components (N and M) and in the increase of weed dominance (W – *Onopordum acanthium*). A similar result was obtained by the analysis of social behaviour categories (Fig. 6), where the decrease of stress tolerants (S – *Phlomis tuberosa*, G – *Thalictrum minus*) was counteracted by the increase of weeds and ruderal competitors (W – *Arctium lappa*, RC – *Agropyron repens*).

Life history strategies show important changes during the 15 years as well (Fig. 7). Annuals with a longer life cycle (T1, T2, T4) increased by 18% of total cover. Ephemeral species (T3) are not characteristic to this type of vegetation. All perennial species decreased in dominance by 1995, with the exception of species with stolon-like roots (G3 – *Cirsium arvense*, *Convolvulus arvensis*).

The distribution of nitrogen need categories of species (Fig. 8) shows an increase of dominance in nitrophilous species, and at the same time, a decrease in oligotrophic species (1–3 values, e.g. *Thymus* spp., *Achillea collina*).

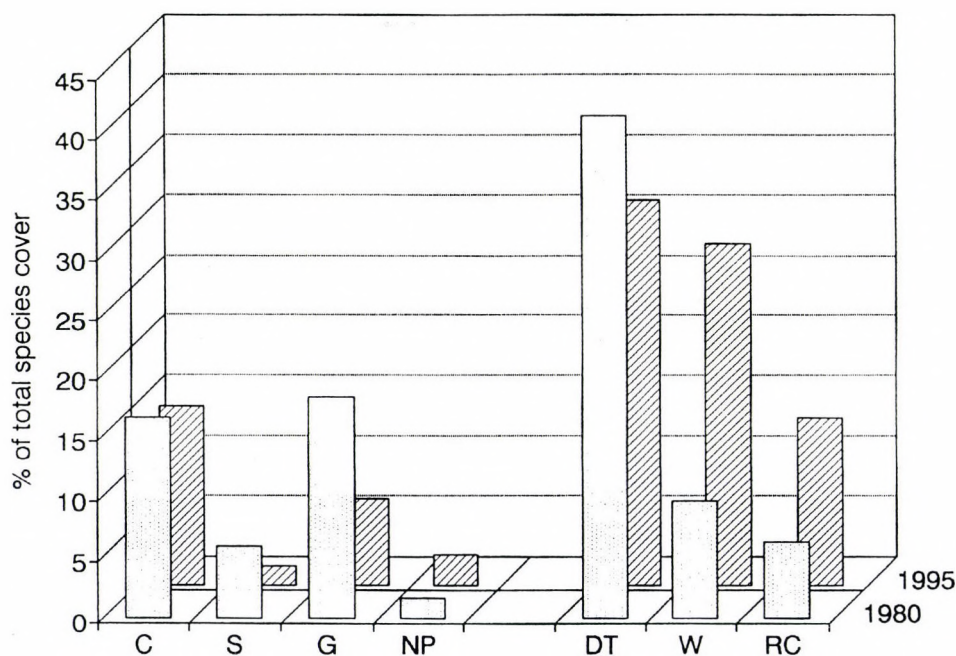


Fig. 5. Distribution of social behaviour types in the two sampling periods. (C – competitors, S – specialists, G – generalists, NP – natural pioneers, DT – disturbance tolerants, W – weeds, RC – ruderal competitors)

CONCLUSIONS

The vegetation composition around the collapsed Sas Inn has changed significantly during the 15 years of the study. Data analysis proved that the site became dominated by weeds, which threatens the natural composition of the loess grassland patch. Vegetation changes are attributed to changes in dominance relations, not to species replacement. This means, that most weeds were present already in 1980 with a restricted cover, and only a small number of loess grassland species disappeared until 1995. The population burst of weeds is the result of an intensive, homogeneous environmental change, that is proved by the one-way trajectories of the Principal Co-ordinate Analysis (Fig. 4).

In comparison with similar re-sampling studies on different vegetation types, this data set resulted in an unusual homogeneity of trajectory direction (Török *et al.* 1994, Török and Kósa 1993). Most probably the environmental variable, that

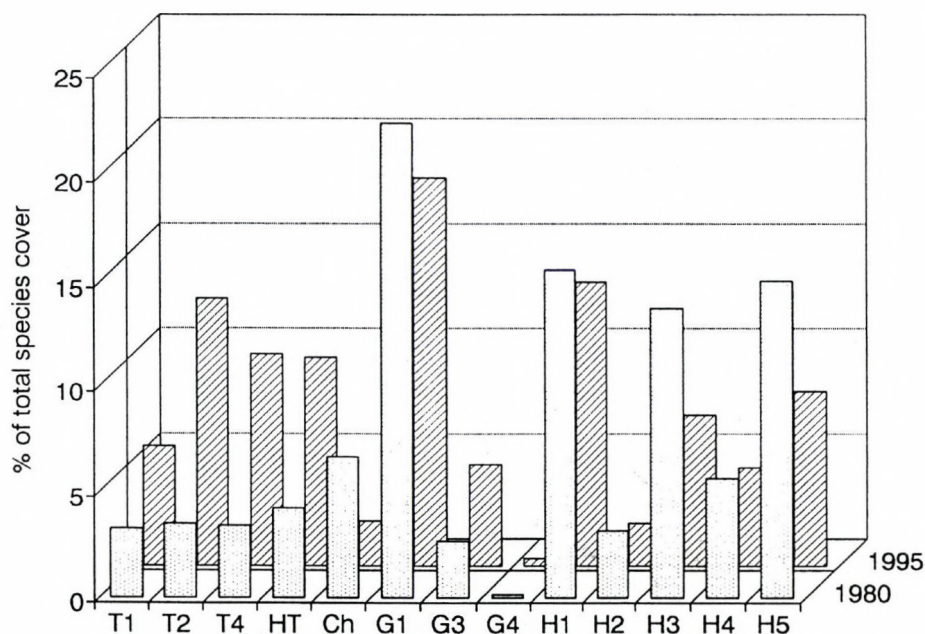


Fig. 6. Distribution of life history strategies in the two sampling periods. (T1 – overwintering early spring annuals, T2 – overwintering early summer annuals, T4 – late summer annuals, HT – biennials, Ch – perennials with above-ground overwintering organs. Perennials overwintering underground: G1 – perennials with stolon, G3 – perennials with stolon-like roots, G4 – bulbous species. Perennials overwintering at soil surface layer: H1 – fibrous root system, H2 – sarmentose sp., H3 – sp. with sprouting root system, H4 – sp. with non-sprouting root system, H5 – sp. with inclined rhizome)

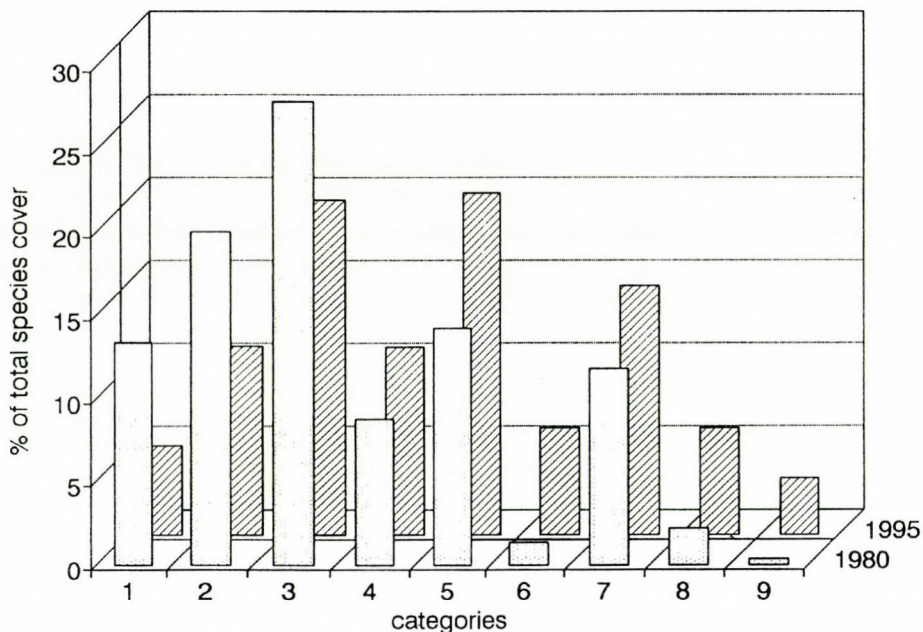


Fig. 7. Distribution of nitrogen need categories in the two sampling periods. (1 – extremely nutrient poor, 2 – nutrient poor, 3 – moderately oligotrophic, 4 – submesotrophic, 5 – mesotrophic, 6 – moderately nutrient rich, 7 – nutrient rich, 8 – manured, 9 – overmanured)

caused this type of vegetation change, is related to soil composition. Air photographs demonstrate that the adobe material of the ruined inn became spread by precipitation over the area (Fig. 1), that was beneficial for the life of weeds but disadvantageous for stress tolerants and competitors (Figs 5 and 6), which are not adapted to sudden changes of the environment. Site selection proved to be well suited for the study of clear cause-effect relation of a single environmental change, which is not the case in many ecological investigations, when complex influences and relations make the interpretation of results difficult.

The grassland patch must have suffered from human influence during the operation of the inn, like animal husbandry by the inn keeper, constant visitor traffic, nevertheless the grassland fragment has kept its basic species composition. This level of disturbance remained within the limits that maintains diversity in natural communities and thus supports intermediate disturbance hypothesis (Scheuring and Bartha 1996, Sousa 1984). The effect of adobe deposition exceeds this level.

The questions raise: which level of species loss can still guarantee the recovery of the loess grassland community; is the state recorded in 1995 reversible; and how much time is needed for recovery. To answer these questions, it is indis-

pensable to make further investigations. The results of this monitoring can help in estimating resilience and in making future predictions for the sustainability of loess grassland fragments.

*

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REFERENCES

- Bagi, I. (1988): The role of water management in the degradation process of halophilic vegetation in Hungary. – *Environmental Conservation* **15**: 359–362.
- Borhidi, A. (1993): *Social behaviour types of the Hungarian flora, its naturalness and relative ecological indicator values*. – KTM and JPTE, Pécs.
- Borhidi, A. (1995): Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungaria Flora. – *Acta bot. hung.* **39**: 97–181.
- Fekete, G. (1996): A hazai biodiverzitás: feltárás, megértés, megőrzés. [National biodiversity: discovery, understanding, conservation]. – *Természet Világa* **127**(II. Különszám): 16–19.
- Juhász-Nagy, P. (1993): *Az eltűnő sokféleség*. (Disappearing diversity). – Scientia, Budapest.
- Lepš, J., Osbornová-Kosinová, J. and Rejmánek, M. (1982): Community stability, complexity and species life history strategies. – *Vegetatio* **50**: 53–63.
- Marrs, R. H., Bravington, M. and Rawes, M. (1988): Long-term vegetation change in the *Juncus squarrosus* grassland at Moor House, northern England. – *Vegetatio* **76**: 179–187.
- Martin, S. C. and Turner, R. M. (1977): Vegetation change in the Sonoran desert region, Arizona and Sonora. – *Arizona Academy of Science* **12**: 59–69.
- Moles, R. and Breen, J. (1991): Surveillance of recent vegetation change in the Burren, County Clare, Republic of Ireland. – *Global Ecology and Biogeography Letters* **1**: 151–156.
- Podani, J. (1993): *SYN-TAX-pc, Computer Programs for Multivariate Data Analysis in Ecology and Systematics*. Version 5.1. User's Guide. – Scientia, Budapest.
- Rejmánek, M. (1979): *Stability and complexity in biotic communities: Theoretical and empirical approach*. – In: Ruzicka, M. (ed.): 5th Internat. Probl. Ecol. Land. Res. Bratislava, pp. 65–72.
- Scheuring, I. and Bartha, S. (1996): A szünbiológiai sokféleséget fenntartó mechanizmusokról. [Mechanisms maintaining synbiological diversity]. – *Természet Világa* **127**(II. Különszám): 20–23.
- Simon, T. (1992): *A magyarországi edényes flóra határozója*. [Identification guide to the Hungarian vascular flora]. – Tankönyvkiadó, Budapest.
- Smedes, G. W. and Hurd, L. E. (1981): An empirical test of community stability: resistance of a fouling community to a biological patch-forming disturbance. – *Ecology* **62**: 1561–1572.
- Sousa, W. P. (1984): The role of disturbance in natural communities. – *Ann. Rev. Ecol. Syst.* **15**: 353–391.
- Tóth, A. (1988): *Degradálódó hortobágyi löszgyepek reliktum foltjainak synökológiai viszonyai*. (Synecological character of degrading loess grassland relic fragments in the Hortobágy). – In: Tóth, A. (ed.): Scientific research in the Hortobágy National Park, 1976–1985. Hortobágyi Nemzeti Park, Budapest, pp. 11–84.

- Tóth, A. and Török, K. (1996): *Egy erősen erodálódott, elgyomosodott hortobágyi löszgyep cönológiai karaktere.* (Coenological character of an eroded, weeded loess grassland in the Hortobágy). – In: Tóth, A. (szerk.): *Ohattól Meggyesig. Természet- és Környezetvédő Tanárok Egyesülete, Budapest*, pp. 110–115.
- Török, K. and Kósa, G. (1993): *Sustainability of a rocky grassland association over four decades.* – *Proceed. XVIIth Int. Grassland Congress, New Zealand*, pp. 337–339.
- Török, K., Horánszky, A. and Kósa, G. (1994): Long-term changes of species composition in an andesite grassland community of the Visegrád Mts., Hungary. – *Abstracta Botanica* **18**: 13–28.
- Ujvárosi, M. (1971): *A gyomnövényzet ökológiai viszonyai és összetétele a szántóföldi termőhelyeken.* [Ecological relations and composition of the weed vegetation of arable land]. – MÉM, Budapest.
- van der Maarel, E. (1979): Transformation of cover-abundance values in phytosociology and its effects on community similarity. – *Vegetatio* **39**: 97–114.
- Virágh, K. (1986): The effect of herbicides on vegetation dynamics: a multivariate study. – *Abstracta Botanica* **10**: 317–340.
- Westman, W. E. and O'Leary, J. F. (1986): Measures of resilience: the response of coastal sage scrub to fire. – *Vegetatio* **65**: 179–189.
- Whisenant, S. G. and Wagstaff, F. J. (1991): Successional trajectories of a grazed salt desert shrubland. – *Vegetatio* **94**: 133–140.
- Zólyomi, B. (1969): *Észak-alföldi hordalékkúp síkság: természetes növényzet.* [The natural vegetation of the northern part of the Great Hungarian Plain]. – In: Marosi, S. & Szilárd, J. (eds): *A tiszai Alföld.* Akadémiai Kiadó, Budapest, pp. 212–215.
- Zólyomi, B. and Fekete, G. (1994): The Pannonian loess steppe: differentiation in space and time. – *Abstracta Botanica* **18**: 29–41.
- Zólyomi, B. and Jankó, B. (1962): *Salvia nutans* L. und *S. betonicifolia* Ettl. in Ungarn. – *Acta bot. hung.* **8**: 263–277.

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THE VEGETATION OF THE BÜKK PLATEAU (NE HUNGARY) II. THE GRASSLAND COMMUNITIES OF THE LIMESTONE AND DOLOMITE ROCKS

A. VOJTKÓ

Dept. Botany, Eszterházy Károly Teacher's Training College
H-3301 Eger, Pf. 43, Hungary

Phytocoenological conditions of the rocky grasslands of the Bükk plateau area (Bükk Mts, NE Hungary) are discussed. Seven associations and subassociations are analyzed by 89 relevés. Three new associations (*Inulo ensifoliae-Seslerietum hungaricae*, *Genisto pilosae-Seslerietum hungaricae* and *Calamagrostio variae-Seslerietum variae*) and one new subassociation (*Seslerietum heuflerianae-hungaricae saxifragetosum*) are described.

Key words: rocky grasslands, phytocoenology, Bükk Mts, Hungary

INTRODUCTION

Along the edge of the limestone plateau of the Bükk Mts considerable rocky grasslands can be found. These are probably primarily treeless communities which means that in the later stages of the vegetation development these areas were not covered by forest because of edaphic reasons. That's why the species rich rocky vegetation could develop and survive there. According to the exposition and steepness of slope each grassland has different grade of cover and we can find some regularities and periods in it. Considering the bedrocks, the cliffs primarily consist of limestone and dolomite, but shale, diabase and quartzite also occur.

In this recent paper the author wishes to reveal and analyze the quite rich rocky vegetation. In order to characterize the rocky grasslands of the Bükk plateau quadrats sampled on other parts of the Bükk Mts were also used because of a better comparison. So the types of bedrocks extend the examined group of plant communities. The duality of dolomite bedrock is worth mentioning, that is the reason why on the southern parts of the Bükk Mts the sub-Mediterranean effect is the most important one and it appears in the species composition too, while on the northern edge of the plateau atlantic-montane effect can be revealed on the same bedrock. Considering limestone bedrock on the southern sides *Campanulo-Festucetum pallentis* → *Pulsatillo-Festucetum rupicolae* the process of succession (which can become stable in each intermediate stage, for example in the closing type characterized by *Stipa* spp.). On the northern sides most of the rocky grasslands can be characterized by *Sesleria* spp. Zólyomi (1936) was the first

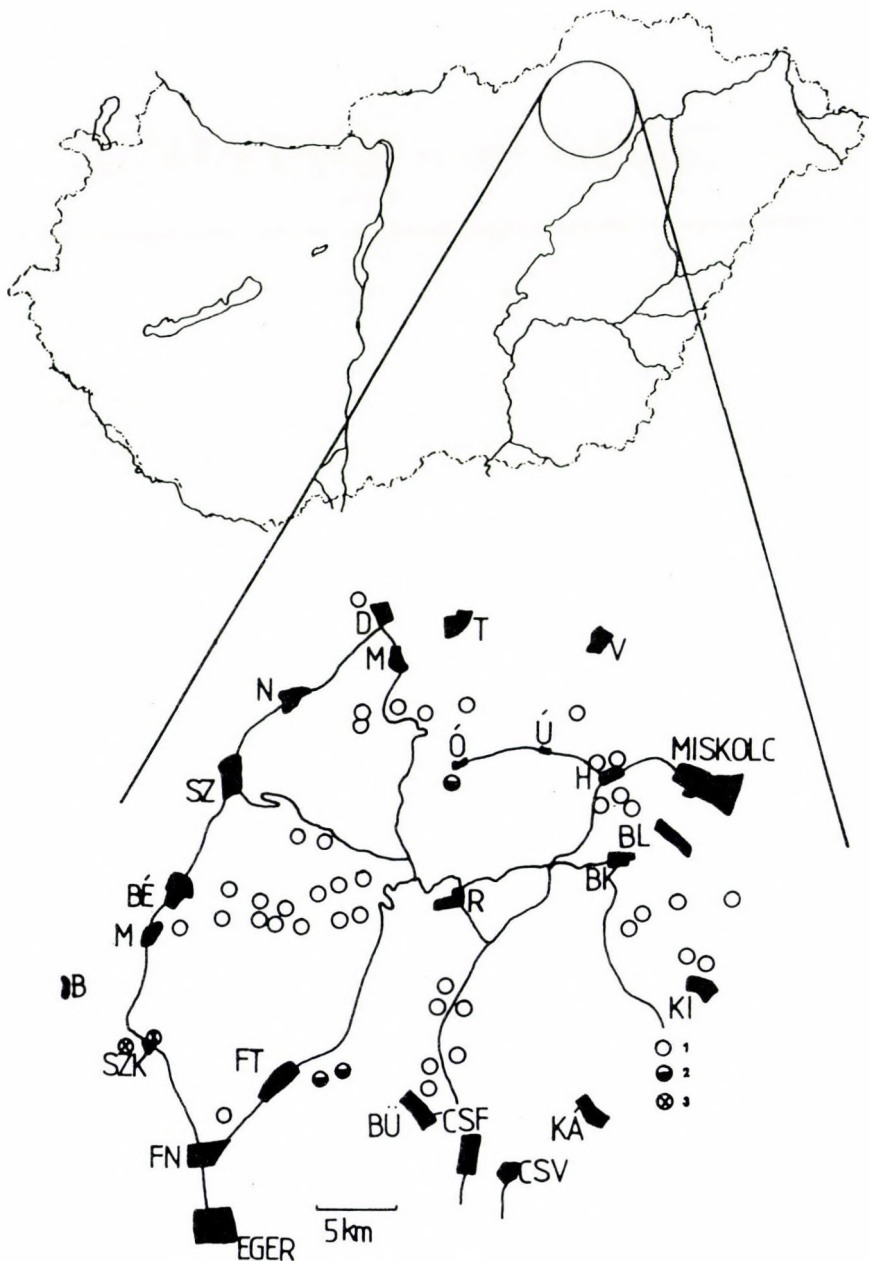


Fig. 1. Places of the coenological samples on the examined areas according to bedrocks. – 1 = Triassic limestone, 2 = dolomite, 3 = diabase. Key: D = Dédestapolcsány, N = Nagyvisnyó, SZ = Szilvásszék, BÉ = Bélapátfalva, M = Mónosbél, B = Bátor, SZK = Szarvaskő, FT = Felsőtárkány, FN = Felnémet, BÜ = Bükkszék, CSF = Cserépfalu, CSV = Cserépvárnya, KÁ = Kács, KI = Kisgyőr, R = Répáshuta, BK = Bükkszentkereszt, BL = Bükkszentlászló, H = Hámor-Lillafüred, Ú = Újmassa, Ó = Ómassa, M = Mályinka, T = Tardona, V = Varbó

who studied the unforested vegetation of the cliffs. His early reports were modified later (Zólyomi 1966), which are valid also nowadays. This paper contributes to that work characterizing some tables because the time of the end of these stands has come and we followed only the disappearance and degradation of this vegetation. The general features of the vegetation on the Bükk plateau can be found in the first part of the article series (Vojtkó 1997).

MATERIAL AND METHODS

The coenological samples were made between 1987 and 1991. The size of the sample plots was always 4 m² and the sampling was made always according to the Braun-Blanquet-Soó method.

I analysed the coenological samples always with grouping test. The exposition draws were completed from the data according to cardinal points and the slope diagrams were completed from the data of the samples. The white parts of the figures showing cover values sign the cover data of the samples in the given communities. Places of the coenological samples see in Figure 1.

RESULTS

The system of the examined communities was determined by the following literature: Zólyomi 1936, 1966, Soó 1959b, 1964–80, Kovács 1995, Borhidi 1996 and Dostál 1933, Klika 1950, Futák 1947, Oberdorfer 1957, Holub *et al.* 1967, Kolbek 1984, 1986.

FESTUCO-BROMETEA Br.-Bl. et Tx. 1943

Festucetalia valesiacae Br.-Bl. et Tx. 1943

Seslerio-Festucion pallentis Klika 1931

Campanulo-Festucetum pallentis Zólyomi 1966

Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966

bükkense Zólyomi (1936) 1966

saxifragetosum Vojtkó 1997

subcarpaticum Jakucs 1952

Inulo ensifoliae-Seslerietum hungaricae Vojtkó 1997

Genisto pilosae-Seslerietum hungaricae Vojtkó 1997

Calamagrostio variae-Seslerietum variae Vojtkó 1997

Campanulo-Festucetum pallentis Zólyomi 1966

These grasslands reach their most considerable occurrences in the mountain-sub-mountain level, the rocky forest communities can develop secondarily after a

Table 1
Campanulo-Festucetum pallentis Zólyomi 1966

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	13	14	15	16	17	20	24	48	49	56	63	64	65	71	73	84	106	107	142	145
Seslerio-Festucion species																				
<i>Sesleria hungarica</i>	-	-	-	-	-	1	+	-	+	-	-	-	-	-	-	+	+	+	+	+
<i>Asplenium ruta-muraria</i>	-	+	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	-	-
<i>Draba lasiocarpa</i>	-	-	-	-	-	+	-	+	+	+	+	-	-	+	-	-	-	-	-	-
<i>Cytisus ciliatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Thalictrum foetidum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-
Asplenio-Festucion species																				
<i>Festuca pallens</i>	+	2	+1	+	1-2	1	+	1	+1	+	2	3	1-2	+1	+1	+	1-2	+	2	3
<i>Jovibarba hirta</i> (1)	+	+	+	+	-	+	+	+	+1	+	+	+	+	-	+	+	+	-	-	+
<i>Sedum album</i> (1)	1	+1	+1	+	+1	+1	-	1	1	-	+	+1	+1	+1	+	-	-	+	-	1
<i>Lactuca perennis</i> (1)	-	+	-	-	-	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-
<i>Asplenium trichomanes</i>	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	+
<i>Ceterach javorkaeum</i> (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>Cotoneaster matrensis</i> (1)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Viola tricolor</i> (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festucetalia valesiacae species																				
<i>Melica ciliata</i>	+	+	-	-	-	+	-	1-2	+	-	+	+	+	+	+	+	-	-	-	-
<i>Campanula sibirica</i> subsp. <i>divergen.</i>	+	+	+	-	-	-	+	+	+	+	-	-	-	+	+	+1	-	+	+	+1
<i>Teucrium montanum</i>	+	+	-	+	-	+	1	-	+	-	-	+	+	+	+	+	-	+	-	+
<i>Seseli osseum</i>	-	+	+	-	+	+	+	+	+	+	-	+1	+	-	+	+	-	-	-	-
<i>Inula ensifolia</i>	-	+	-	+	+	-	-	+1	-	-	-	+	+1	-	-	+	-	-	-	+1
<i>Silene otites</i> subsp. <i>pseudotites</i>	-	+	-	+	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-	+

Table 1 cont.

[illegible]

Table 1 cont.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	13	14	15	16	17	20	24	48	49	56	63	64	65	71	73	84	106	107	142	145
<i>Thymus glabrescens</i>	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+1
<i>Anthericum ramosum</i>	-	-	+	+	-	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-
<i>Pulsatilla grandis</i>	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Dianthus pontederiae</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sedum sexangulare</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Scabiosa ochroleuca</i>	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Botriochloa ischaemum</i>	+1	-	+1	1	+1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Geranium sanguineum</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Linaria genistifolia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Potentilla recta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Melampyrum arvense</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Veronica spicata</i>	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Artemisia campestris</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Phleum phleoides</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sedum sexangulare</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercetea pubescenti-petraeae species																				
<i>Teucrium chamaedrys</i>	-	-	-	-	-	-	-	-	-	-	-	+	+1	-	-	-	-	-	-	+
<i>Vincetoxicum hirundinaria</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+
<i>Echinops sphaerocephalon</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Polygonatum odoratum</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other species																				
<i>Euphorbia cyparissias</i>	+	+	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+
<i>Acinos arvensis</i>	-	-	-	+	-	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-
<i>Coronilla varia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+

Table 1 cont.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	13	14	15	16	17	20	24	48	49	56	63	64	65	71	73	84	106	107	142	145
<i>Arenaria serpyllifolia</i>	—	—	+	—	—	+	—	—	+	—	—	+	+	—	—	—	—	—	—	—
<i>Echium vulgare</i>	—	—	—	—	—	—	+	—	—	—	—	—	+	—	—	—	—	—	—	—
<i>Lappula myosotis</i>	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Hieracium pilosella</i>	—	+	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—
<i>Hypericum perforatum</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 1

Campanulo-Festucetum pallentis Zólyomi 1966 (cont.)

Species	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	K	A-D
	150	155	177	178	179	180	198	199	268	269	270	294	299	301	313		
Seslerio-Festucion species																	
<i>Sesleria hungarica</i>	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	II	10 +—1
<i>Asplenium ruta-muraria</i>	+	+	—	—	—	—	—	—	+	+	—	—	—	—	—	II	8 +
<i>Draba lasiocarpa</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	II	7 +
<i>Cytisus ciliatus</i>	—	—	—	—	—	—	—	—	+	+	+	—	—	—	—	I	3 +
<i>Thalictrum foetidum</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	I	2 +
Asplenio-Festucion species																	
<i>Festuca pallens</i>	+—1	+—1	2–3	2	3	2–3	+	+—1	+—1	1	1–2	1–2	+—1	1–2	—	V	34 +—3
<i>Jovibarba hirta</i> (1)	+	+—1	+	+	+	+	—	+	+	+	+	—	+	+	+	V	29 +—1
<i>Sedum album</i> (1)	—	—	+	+	—	+	—	—	—	+	+	+—1	—	—	+	IV	21 +—1
<i>Lactuca perennis</i> (1)	+	+	+	+	+—1	—	+	—	+	+	—	—	—	+	—	II	13 +—1
<i>Asplenium trichomanes</i>	+	—	—	—	—	—	—	—	—	+	—	—	—	—	—	I	6 +
<i>Ceterach javorkaeaeum</i> (1)	—	+	—	—	—	—	+	+	—	—	—	—	—	—	+	I	5 +
<i>Cotoneaster matrensis</i> (1)	—	—	+	+	—	—	—	—	+	—	—	+	—	—	—	I	5 +
<i>Viola tricolor</i> (1)	+	+	—	—	—	—	+	—	—	—	—	—	+	—	—	I	+

Table 1 cont.

[illegible]

Table 1 cont.

[illegible]

Table 1 cont.

Species	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	K	A-D
	150	155	177	178	179	180	198	199	268	269	270	294	299	301	313		
Quercetea pubescenti-petraeae species																	
<i>Teucrium chamaedrys</i>	+1	-	+	+	+	+	+1	+	-	+	-	-	-	-	-	II	11 +1
<i>Vincetoxicum hirundinaria</i>	+	-	+	+	+	-	-	-	+	-	-	-	-	-	-	II	7 +
<i>Echinops sphaerocephalon</i>	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	I	2 +
<i>Polygonatum odoratum</i>	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	I	2 +
Other species																	
<i>Euphorbia cyparissias</i>	+	+	-	+	+	+	+	+1	-	-	-	+1	-	-	+	III	15 +1
<i>Acinos arvensis</i>	+	+	-	+	-	-	+	+	+	+	-	-	-	-	-	II	11 +
<i>Coronilla varia</i>	-	+	+	+	+	-	-	-	+	+	-	-	-	-	-	II	8 +
<i>Arenaria serpyllifolia</i>	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	II	7 +
<i>Echium vulgare</i>	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	I	5 +
<i>Lappula myosotis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	3 +
<i>Hieracium pilosella</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2 +
<i>Hypericum perforatum</i>	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	I	2 +

Accidental species:

Seslerio-Festucion: *Poa badensis* 5:+1; *Calamintha thymifolia* 18:+

Asplenio-Festucion: *Poa pannonica* subsp. *scabra* 35:+; *Saxifraga paniculata* (1) 19:+; *Sedum hispanicum* 35:+; *Sempervivum marmoreum* (1) 33:+

Festucetalia valesiacae: *Asyneuma canescens* 13:+; *Bupleurum falcatum* 24:+; *Centaurea sadleriana* 31:+; *Galium glaucum* 6:+; *Lactuca viminea* 1:+; *Onosma arenarium* subsp. *tuberculatum* 1:+

Festuco-Brometea: *Arabis hirsuta* 7:+; *Aster linosyris* 17:+; *Campanula glomerata* 31:+; *Petrorhagia prolifera* 29:+

Quercetea pubescenti-petraeae: *Aconitum anthora* 21:+; *Bilderdyckia dumetorum* 1:+; *Euphorbia polychroma* 21:+

Other species: *Bromus tectorum* 32:+; *Eryngium campestre* 3:+; *Poa angustifolia* 32:+; *Poa compressa* 29:+; *Senecio jacobaea* 7:+; *Senecio vulgaris* 32:+

Table 1 cont.

1. Uppony	S	45°	55%	300 m	08.08.91	Vojtkó
2. Uppony	SSW	52°	30%	310 m	08.08.91	Vojtkó
3. Uppony	SW	33°	45%	320 m	08.08.91	Vojtkó
4. Uppony	SSW	28°	35%	320 m	08.08.91	Vojtkó
5. Uppony	WSW	40°	65%	330 m	08.08.91	Vojtkó
6. Fehér-kő	S	25°	30%	520 m	15.07.91	Vojtkó
7. Molnár-szikla	W	15°	25%	300 m	15.07.91	Vojtkó
8. Kemesnye	S	15°	30%	580 m	22.07.91	Vojtkó
9. Kemesnye	S	70°	30%	590 m	22.07.91	Vojtkó
10. Kemesnye	ESE	80°	5%	590 m	22.07.91	Vojtkó
11. Odvas-kő	S	30°	15%	550 m	23.07.91	Vojtkó
12. Buzgó-kő	SSW	50°	40%	525 m	23.07.91	Vojtkó
13. Buzgó-kő	S	60°	25%	530 m	23.07.91	Vojtkó
14. Köpüs-kő	SSE	30°	30%	650 m	23.07.91	Vojtkó
15. Magos-kő	E	50°	30%	640 m	23.07.91	Vojtkó
16. Kőszál	S	70°	30%	380 m	25.07.91	Vojtkó
17. Bél-kő	WSW	60°	20%	580 m	30.07.91	Vojtkó
18. Bél-kő	SSE	90°	3%	590 m	30.07.91	Vojtkó
19. Holló-kő	E	90°	25%	790 m	07.08.91	Vojtkó
20. Holló-kő	S	85°	40%	790 m	07.08.91	Vojtkó
21. Három-kő	S	55°	40%	880 m	03.09.91	Vojtkó
22. Tar-kő	S	85°	30%	940 m	03.09.91	Vojtkó
23. Buzgó-kő	SE	15°	55%	520 m	01.07.87	Vojtkó–Marschall
24. Buzgó-kő	S	55°	35%	530 m	01.07.87	Vojtkó–Marschall
25. Buzgó-kő	S	55°	65%	530 m	01.07.87	Vojtkó–Marschall
26. Buzgó-kő	S	50°	55%	520 m	01.07.87	Vojtkó–Marschall
27. Ódor-vár	W	40°	30%	500 m	10.07.90	Vojtkó–Marschall
28. Ódor-vár	S	50°	25%	480 m	10.07.90	Vojtkó–Marschall
29. Dédes Kis-vár	W	40°	20%	585 m	22.07.91	Vojtkó
30. Dédes Kis-vár	S	75°	10%	580 m	22.07.91	Vojtkó
31. Dédes Kis-vár	SW	60°	20%	580 m	22.07.91	Vojtkó
32. Hegyes-kő	SSW	40°	25%	785 m	10.09.91	Vojtkó
33. Füzér-kő	SE	15°	35%	400 m	02.05.90	Vojtkó
34. Imó-kő	S	70°	15%	500 m	06.09.90	Vojtkó–Suba
35. Perpác	SW	25°	30%	300 m	29.07.90	Vojtkó

wrong cutting. In their floristical composition the general species of grassland communities reach considerable share but in the more closed communities some frequent species of dry grasslands can occur (Fig. 2). There can be important endemic and relict elements in them (e.g. *Sesleria hungarica* and *Calamintha thymifolia*). These communities are linked to limestone but sometimes they appear on dolomite. The typical stand of it is very rare that means it can be divided into many subassociations and facies. This community can become easily weedy due to anthropogenic effects (or because of the strong trampling of wild animals), then *Bromus tectorum*, *Echinops sphaerocephalus*, *Erigeron canadensis* may appear in it. If more closed stage can be also noticed which can be characterized by *Stipa* species (*S. capillata*, *S. pulcherrima*, *S. joannis*) and it appears to approach closing. In Hór valley (southern part of the Bükk Mts) the stands without *Festuca pallens* can be found with the appearance of *Poa pannonica* subsp. *scabra* which is an interesting phenomenon. Its important species: *Allium flavum*, *Campanula sibirica* subsp. *divergentiformis*, *Festuca pallens*, *Jovibarba hirta*, *Melica ciliata*, *Sedum album*, *Seseli osseum*, *Teucrium montanum*. The total table of *Campanulo-Festucetum pallentis* Zólyomi 1966 on the basis of 35 samples (see Table 1).

Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966

Zólyomi separated this type of *Sesleria* grasslands from the other on the basis of samples made in the Bükk Mts. According to the author in the northern exposition the conditions are optimal for the formation of these rocky grasslands but at the same time he mentioned the occurrence of it of eastern and western exposition (Zólyomi 1936). In his later work he divides the *Sesleria* grasslands into fur-

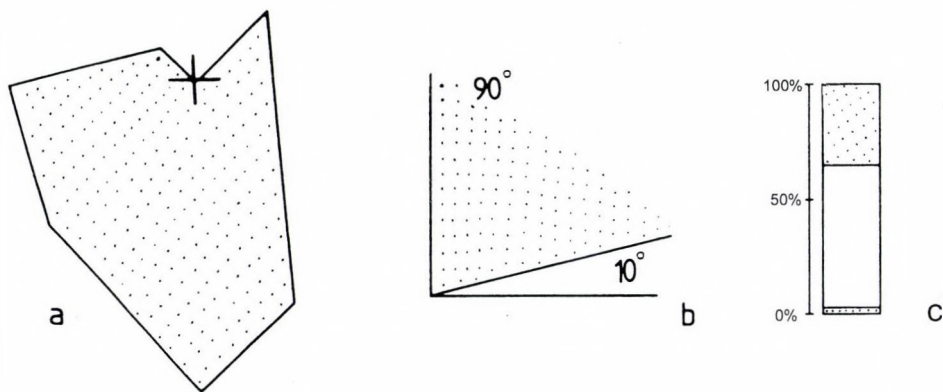


Fig. 2. Exposition (a) and declination data (b) of the *Campanulo-Festucetum pallentis* community marking the cover values of the samples (c)

ther parts which are subassociations: *bükkense* Zólyomi 1936 and *subcarpaticum* Jakucs 1952 (Zólyomi 1966). Setting out from this results on the basis of the examination of a wider range of coenological sample material we can separate newer associations and subassociations. Among others on limestone the *Inulo ensifoliae*-*Seslerietum hungaricae* and *Seslerietum heuflerianae-hungaricae saxifragetosum* and on dolomite the *Genisto pilosae*-*Seslerietum hungaricae* can be mentioned.

Seslerietum heuflerianae-hungaricae bükkense Zólyomi (1936) 1966
(syn.: *Diantho*-*Seslerietum* Soó 1962)

The habitat of the community is a rocky, craggy surface. On the slope of rock rims valuable relict species settle down for example *Dianthus plumarius* subsp. *praecox*, *Draba lasiocarpa*, *Saxifraga paniculata*, *Sesleria hungarica*. On the basis of 5 samples the differential species are: *Asplenium ruta-muraria*, *Campanula sibirica* subsp. *divergentiformis*, *Cardaminopsis arenosa*, *Dianthus plumarius* subsp. *praecox*, *Galium mollugo*. This community was known only from the hill Bél-kő (Central Bükk Mts) then another stand was found not too far from it, and it was on the hill Messzelátó-hegy (Central Bükk Mts). There are more relict communities on this habitat: *Seslerio hungaricae-Fagetum*, *Tilio-Sorbetum*, *Phyllitidi-Aceretum subcarpaticum* (Marschall *et al.* 1991). The sparse vegetation (30–60% cover) conquers the steep limestone sides (15–55°) (see Fig. 3b, Table 2).

Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966
saxifragetosum Vojtkó 1997 subass. nova

This subassociation is formed on the steep limestone walls of northern exposition. The cover of the vegetation is rarely over 50%. The fern species of shady cliffs are mixed with the elements of oak and beech forests. According to 8 samples the characteristic species are: *Campanula rotundifolia*, *Ceterach javorkaeae-num*, *Polypodium interjectum*, *Primula veris* subsp. *inflata*, *Saxifraga paniculata* (see Fig. 3c, Table 3).

Inulo ensifoliae-*Seslerietum hungaricae* Vojtkó 1997 ass. nova hoc loco

The *Sesleria* grasslands of western exposition belong to this group which was mentioned by Zólyomi. The stands form closed grasslands mainly with the cover value of 100%. It occurs more often on the light slopes (from 5°). There are more

Table 2

Seslerietum heuflerianae-hungaricae bükkense Zólyomi (1936) 1966 (syn.: *Diantho-Seslerietum* Soó 1962)

Species	1 112	2 157	3 193	4 194	5 195	K	A-D
Character species							
<i>Dianthus plumarius</i> subsp. <i>praecox</i>	+1	+	+1	1	+1	V	+1
<i>Asplenium ruta-muraria</i>	+	+	+	+	+	V	+
<i>Campanula sibirica</i> subsp. <i>divergentiformis</i>	+	+	+	+	+	V	+
<i>Galium mollugo</i>	–	+	+1	+1	+1	IV	+1
<i>Cardaminopsis arenosa</i>	+	+	+	–	+	IV	+
Seslerio-Festucion species							
<i>Sesleria hungarica</i>	2	2	2	2–3	+1	V	+3
<i>Draba lasiocarpa</i>	+	–	–	–	+	II	+
Asplenio-Festucion species							
<i>Jovibarba hirta</i> (1)	+1	+	+1	2–3	+	V	+3
<i>Festuca pallens</i> (1)	+1	+1	+	+1	+	V	+1
<i>Asplenium trichomanes</i>	+	+	+	+	+	V	+
<i>Sedum album</i> (1)	1–2	+1	+	+	–	IV	+2
<i>Cystopteris fragilis</i>	–	–	+	+	+	III	+
Festucetalia valesiacae species							
<i>Seseli osseum</i>	+	+	+	+	+	V	+
<i>Melica ciliata</i>	–	+	+	+	+	IV	+
Festuco-Brometea species							
<i>Allium flavum</i>	+	+	+	+	–	IV	+
<i>Anthericum ramosum</i>	+	–	+	–	–	II	+
Quercetea pubescenti-petraeae species							
<i>Epipactis atrorubens</i>	+	+	–	–	+	III	+
<i>Arabis turrata</i>	+1	+	–	–	–	II	+1

Accidental species:

Seslerio-Festucion: *Calamintha thymifolia* (1) 2:++; *Saxifraga paniculata* 5:++1

Festucetalia valesiacae: *Galium glaucum* 1:++;

Festuco-Brometea: *Hieracium sylvaticum* 4:++; *Origanum vulgare* 3:++; *Vincetoxicum hirundinaria* 3:++

Cephalanthero-Fagion: *Valeriana tripteris* subsp. *austriaca* 3 (+1)

Other species: *Euphorbia cyparissias* 4:++

1. Messzelátó	NNE	35°	60%	685 m	30.07.91	Vojtkó
2. Messzelátó	ESE	40°	30%	690 m	10.09.91	Vojtkó
3. Messzelátó	SE	15°	60%	690 m	20.07.88	Vojtkó–Marschall
4. Messzelátó	SE	15°	50%	685 m	20.07.88	Vojtkó–Marschall
5. Messzelátó	SE	15°	55%	675 m	20.07.88	Vojtkó–Marschall

Table 3
Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966 *saxifragetosum* Vojtkó 1997

Species	1 127	2 141	3 144	4 263	5 264	6 300	7 315	8 316	K	S	A-D
Character species											
<i>Saxifraga paniculata</i>	2	+	1	1	1-2	-	+	+	V	7	1-2
<i>Polypodium interjectum</i>	2-3	-	+	+1	+	-	-	+	IV	5	+3
<i>Primula veris</i> subsp. <i>inflata</i>	+	-	-	+	+	-	+	+	IV	5	+
Seslerio-Festucion species											
<i>Sesleria hungarica</i>	2	2	2-3	3-4	4	1-2	1-2	3	V	8	1-4
<i>Asplenium ruta-muraria</i>	-	-	+	-	-	+	+	-	II	3	+
Asplenio-Festucion species											
<i>Festuca pallens</i> (1)	-	+1	+	-	-	+	+	+	IV	5	+1
<i>Asplenium trichomanes</i>	+1	-	+	+	+	-	-	-	III	4	+1
<i>Jovibarba hirta</i> (1)	-	+	+	-	-	+	-	-	II	3	+
<i>Ceterach javorkaeum</i> (1)	1	-	-	-	-	+	-	-	II	2	+1
<i>Cystopteris fragilis</i>	-	-	-	+	+	-	-	-	II	2	+
<i>Sedum album</i> (1)	-	-	+	-	-	+	-	-	II	2	+
Festucetalia valesiacae species											
<i>Campanula rotundifolia</i>	-	-	+1	+	+1	-	-	-	II	3	+1
<i>Inula ensifolia</i>	-	+1	1	-	-	-	-	+	II	3	+1
<i>Campanula sibirica</i> subsp. <i>divergentiformis</i>	-	-	+	-	-	+	-	-	II	2	+
<i>Cytisus procumbens</i>	-	+	-	-	-	-	-	+	II	2	+
<i>Lactuca perennis</i>	+	-	-	-	-	+	-	-	II	2	+
<i>Melica ciliata</i>	+	-	-	-	-	+	-	-	II	2	+
<i>Seseli osseum</i>	-	-	+	-	-	+	-	-	II	2	+
Festuco-Brometea species											
<i>Allium flavum</i>	+	+	+	-	-	-	-	-	II	3	+
<i>Anthericum ramosum</i>	-	+	-	+	+	-	-	-	II	3	+
Quercetea pubescenti-petraeae species											
<i>Chrysanthemum corymbosum</i>	-	-	+	-	-	-	+	+	II	3	+
<i>Galium mollugo</i>	-	-	-	-	-	+	+	+	II	3	+
<i>Hieracium sylvaticum</i>	-	+	+	-	-	-	+	-	II	3	+
<i>Aconitum anthora</i>	-	-	-	+	+	-	-	-	II	2	+
<i>Turritis glabra</i>	-	-	-	-	-	-	+	+	II	2	+
Querco-Fagea species											
<i>Sedum maximum</i>	-	-	+	+	+	-	-	-	II	3	+
<i>Veronica chamaedrys</i>	-	-	+1	-	-	-	+	+	II	3	+1

Table 3 cont.

<i>Calamagrostis varia</i> (1)	–	–	+–1	–	–	–	+	+	II	3	+–1
<i>Campanula persicifolia</i>	–	–	–	–	–	–	+	+	II	2	+
<i>Geranium robertianum</i>	–	–	–	+	+	–	–	–	II	2	+

Accidental species:

Seslerio-Festucion: *Asplenium viride* 3:++; *Scabiosa columbaria* subsp. *pseudobanatica* 3:+

Asplenio-Festucion: *Viola tricolor* subsp. *polychroma* (1) 6:+

Festucetalia valesiacae: *Teucrium montanum* 2:++; *Galium glaucum* 3:++; *Iris pumila* 6:++; *Viola arvensis* 6:++;

Festuco-Brometea: *Potentilla arenaria* 6:++; *Sedum acre* 6:++; *Sanguisorba minor* 4:+

Quercetea pubescenti-petraeae: *Campanula bononiensis* 3:++; *Epipactis atrorubens* 7:++; *Fragaria vesca* 8:++; *Libanotis pyrenaica* 8:++; *Teucrium chamaedrys* 6:++; *Vincetoxicum hirundinaria* 2:+

Querco-Fagea: *Clematis alpina* (1) 3:++ (+)

Other species: *Dactylis glomerata* 7:++; *Euphorbia cyparissias* 6:+

1. Ódor-vár	N	60°	50%	450 m	01.08.91	Vojtkó
2. Holló-kő	NNE	40°	50%	785 m	07.08.91	Vojtkó
3. Holló-kő	ESE	70°	80%	790 m	07.08.91	Vojtkó
4. Uppony	N	70°	85%	330 m	08.08.91	Vojtkó
5. Uppony	NNE	65°	75%	340 m	08.08.91	Vojtkó
6. Vörös-kő	SSW	20°	45%	570 m	10.09.90	Vojtkó–Bánkuti
7. Holló-kő	NNE	50°	90%	790 m	10.09.91	Vojtkó
8. Holló-kő	N	60°	90%	780 m	10.09.91	Vojtkó

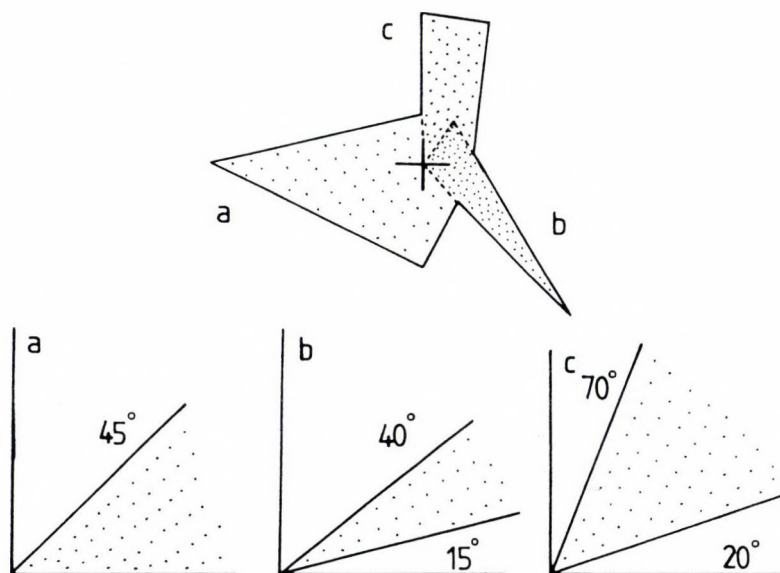


Fig. 3. Exposition diagram and declination data of the *Sesleria* grasslands on limestone. – a: *Inulensifoliae-Seslerietum hungaricae*, b: *Seslerietum heuflerianae-hungaricae bükkense*, c: *Seslerietum heuflerianae-hungaricae saxifragetosum*

Table 4

Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966 *subcarpaticum* Jakucs 1952

Species	1 21	2 35	3 36	4 305	5 326	6 327	7 328	8 329	K	S	A-D
Character species (Seslerio-Festucion species)											
<i>Sesleria heufleriana</i>	5	5	3-4	4	2-3	3-4	4	3-4	V	8	2-5
<i>Saxifraga paniculata</i>	-	+	+1	+	+1	+1	+	-	IV	6	+1
<i>Thymus praecox</i>	-	-	+	+	+	+	+1	+	IV	6	+1
<i>Spiraea media</i>	+	-	+	+	-	+1	-	+	IV	5	+1
<i>Cotoneaster matrensis</i>	-	-	-	-	-	1-2	-	+1	II	2	+2
Asplenio-Festucion species											
<i>Asplenium septentrionale</i>	-	-	+	-	-	+	+	+	III	4	+
<i>Asplenium trichomanes</i>	-	-	+	+	+	+	-	-	III	4	+
<i>Cystopteris fragilis</i>	-	-	-	-	+	+1	-	-	II	2	+1
<i>Minuartia frutescens</i>	-	-	-	-	-	+	+	-	II	2	+
<i>Poa pannonica</i> subsp. <i>scabra</i>	-	-	+	-	-	+	-	-	II	2	+
<i>Woodsia ilvensis</i>	-	-	-	-	-	+	+	-	II	2	+
Festucetalia valesiacae species											
<i>Festuca pallens</i>	1	-	+	-	1	1-2	+1	1	IV	6	+2
<i>Seseli osseum</i>	-	-	+	+	+1	+	+	+1	IV	6	+1
<i>Stachys recta</i>	+	-	-	+	-	+	-	-	II	3	+
<i>Allium flavum</i>	-	-	-	+	-	+	-	-	II	2	+
<i>Cytisus procumbens</i>	-	-	-	-	-	+1	+	-	II	2	+1
<i>Scabiosa ochroleuca</i>	+	-	-	-	-	+	-	-	II	2	+
<i>Viola arvensis</i>	+	-	-	-	-	-	+	-	II	2	+
Festuco-Brometea species											
<i>Veronica spicata</i>	+1	-	-	+	+	+	+	+1	IV	6	+1
<i>Potentilla arenaria</i>	-	-	-	-	+	+	+	+	III	4	+
<i>Jovibarba hirta</i>	-	-	-	-	+	-	+	+	II	3	+
<i>Filipendula vulgaris</i>	+	+	-	-	-	+	-	-	II	3	+
<i>Asperula cynanchica</i>	-	-	+	+	-	-	-	-	II	2	+
<i>Poa angustifolia</i>	+	-	-	-	-	+	-	-	II	2	+
Quercetea pubescenti-petraeae species											
<i>Primula veris</i>	+	+	+1	+	+	-	-	+	IV	6	+1
<i>Teucrium chamaedrys</i>	+1	+	-	-	+	-	+1	+	IV	5	+1
<i>Vincetoxicum hirundinaria</i>	+	+1	+	-	-	-	+	-	III	4	+1
<i>Rosa spinosissima</i>	-	+	-	+	-	-	+	-	II	3	+
<i>Trifolium alpestre</i>	+1	-	-	-	-	+1	+	-	II	3	+1
<i>Chrysanthemum corymbosum</i>	-	+	+	-	-	-	-	-	II	2	+

Table 4 cont.

Species	1	2	3	4	5	6	7	8	K	S	A-D
	21	35	36	305	326	327	328	329			
<i>Dictamnus albus</i>	–	+	–	–	–	+	–	–	II	2	+
<i>Geranium sanguineum</i>	+	–	+–1	–	–	–	–	–	II	2	+–1
Quercu-Fagea species											
<i>Fragaria vesca</i>	+	–	–	–	+	+–1	+	+–1	IV	5	+–1
<i>Sedum maximum</i>	+	–	–	+	–	+	+	+	IV	5	+
<i>Poa nemoralis</i>	–	–	–	–	+–1	+	–	1–2	II	3	+–2
<i>Waldsteinia geoides</i>	–	+–1	–	+	–	+	–	–	II	3	+–1
<i>Calamagrostis arundinacea</i>	–	+	–	–	–	–	+	–	II	2	+
<i>Veronica chamaedrys</i>	–	+	–	+	–	–	–	–	II	2	+
Fagetalia species											
<i>Lilium martagon</i>	–	+	–	–	–	+	–	–	II	2	+
Other species											
<i>Valeriana officinalis</i>	+	+	+	+	+	–	+	+–1	V	7	+–1
<i>Euphorbia cyparissias</i>	+	–	–	–	+	–	–	+	II	3	+
<i>Dactylis glomerata</i>	–	+	+	–	–	–	–	–	II	2	+

Accidental species:

Festucetalia valesiacae: *Bupleurum falcatum* 2:++; *Campanula rotundifolia* 3:++; *Teucrium montanum* 4:++

Festuco-Brometea: *Arenaria serpyllifolia* 1:++; *Botrychium lunaria* 3:++; *Inula ensifolia* 6:++; *Koeleria cristata* 7:++; *Plantago media* 4:++; *Thesium linophyllum* 4:++; *Trifolium campestre* 1:++; *Sanguisorba minor* 4:++; *Vicia hirsuta* 1:++

Quercetalia pubescenti-petraeae: *Aconitum anthora* 2:++; *Betonica officinalis* 2:++; *Hieracium sylvaticum* 2:++; *Inula hirta* 2:++; *Iris variegata* 6:++; *Origanum vulgare* 4:++; *Pulmonaria mollis* 2:1–2

Quercu-Fagetea és Fagetalia: *Aegopodium podagraria* 4:++; *Campanula persicifolia* 2:++; *Digitalis grandiflora* 2:++; *Euonymus verrucosus* 6:++; *Glechoma hirsuta* 2:++; *Aconitum moldavicum* 4 (+); *Melica nutans* 2:++; *Stellaria media* 1:++

Other species: *Hieracium umbellatum* 7:++; *Hypericum perforatum* 5:++; *Ranunculus acris* 1:++; *Silene multiflora* 4:++

1. Vár-hegy	NW	40°	100%	280 m	17.07.91	Vojtkó
2. Pyrker-szikla	N	40°	100%	275 m	17.07.91	Vojtkó
3. Pyrker-szikla	N	60°	80%	280 m	17.07.91	Vojtkó
4. Pyrker-szikla	ENE	50°	90%	280 m	10.06.89	Vojtkó
5. Pyrker-szikla	NW	60°	90%	285 m	03.08.91	Vojtkó
6. Vár-hegy	NNW	55°	85%	280 m	03.08.91	Vojtkó
7. Vár-hegy	N	60°	85%	285 m	03.08.91	Vojtkó
8. Vár-hegy	NNW	60°	90%	290 m	03.08.91	Vojtkó

Table 5
Inulo ensifoliae-Seslerietum hungaricae Vojtkó 1997

Species	1 21	2 23	3 26	4 45	5 57	6 60	7 61	8 62	9 69	10 72	11 82	12 83	13 108	14 118	15 126	16 265	17 266	18 272	K	S	A-D
Character species																					
<i>Inula ensifolia</i>	1	–	–	2	+1	1–2	1–2	2	+	–	–	+	+	1	2–3	+1	+1	+	V	14	+3
<i>Teucrium chamaedrys</i>	+	+	+	+	1	+	+	+	+	–	+	+	–	+	+	–	–	–	IV	13	+1
<i>Asperula cynanchica</i>	+	+	–	+	+	+1	–	+	–	–	–	+	+	+	–	+	+	–	IV	11	+1
<i>Teucrium montanum</i>	+	–	–	–	+	+	+	–	–	–	–	–	+	+	–	+	–	+	III	8	+
<i>Helianthemum ovatum</i>	–	–	–	+	+	+	+	+	–	+	–	–	+	+	–	–	+	+	III	10	+
<i>Erysimum odoratum</i> var. <i>buekkense</i>	–	–	–	–	+	+	+	–	–	+	–	+	+	–	+	+	–	+	III	9	+
Seslerio-Festucion species																					
<i>Sesleria hungarica</i>	5	5	4–5	4	5	3	5	4–5	5	5	4	3–4	4–5	2–3	3–4	2–3	3	4–5	V	18	2–5
<i>Asplenium ruta-muraria</i>	+	–	–	–	–	–	–	–	–	–	–	–	+	+	–	+	+	–	II	5	+
<i>Spiraea media</i>	–	–	–	–	–	–	+	–	+	–	–	–	+	–	–	+	+	–	II	5	+
<i>Draba lasiocarpa</i>	+	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+	+	–	II	4	+
<i>Cotoneaster matrensis</i>	–	–	–	–	–	–	–	–	+	–	–	–	+1	–	+	–	–	–	I	3	+1
<i>Cerastium arvense</i> subsp. <i>calcicola</i> (1)	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	I	2	+
Asplenio-Festucion species																					
<i>Jovibarba hirta</i> (1)	–	–	–	–	–	+	+	–	–	–	–	+	+	–	–	+	–	–	II	5	+
<i>Festuca pallens</i> (1)	–	–	–	–	–	–	+	–	–	–	–	–	+	–	–	+	–	+	II	4	+
<i>Asplenium trichomanes</i>	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–	I	2	+
<i>Sedum album</i> (1)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	I	2	+

Table 5 cont.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	K	S	A-D
	21	23	26	45	57	60	61	62	69	72	82	83	108	118	126	265	266	272			
Festucetalia valesiacae species																					
<i>Seseli osseum</i>	-	-	+	-	-	-	+	-	-	-	+	-	+	+	-	+	+	-	II	7	+
<i>Lactuca perennis</i>	-	+	-	+	-	+	-	-	-	-	-	-	+1	-	-	+	-	-	II	5	+1
<i>Melica ciliata</i>	+	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	+	-	II	5	+
<i>Stachys recta</i>	-	+	-	+	-	-	-	+	-	-	-	-	+	-	-	+	-	-	II	5	+
<i>Pulsatilla grandis</i>	+	-	-	-	-	-	-	-	+	-	-	-	-	1	-	+	-	-	II	4	+1
<i>Galium glaucum</i>	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	-	-	-	II	4	+
<i>Scabiosa ochroleuca</i>	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	+	-	-	II	4	+
<i>Thymus marschallianus</i>	-	-	+	-	-	-	-	-	-	-	-	-	+	+	-	-	+	-	II	4	+
<i>Campanula sibirica</i> subsp. <i>divergentiformis</i>	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	I	3	+
<i>Iris pumila</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	I	3	+
<i>Asyneuma canescens</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	+	-	I	3	+
<i>Centaurea sadleriana</i>	-	-	+	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	I	3	+
<i>Cytisus procumbens</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	+	-	-	-	-	I	2	+1
<i>Agropyron intermedium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	+1	-	-	+	-	I	2	+1
<i>Achillea pannonica</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	I	2	+
<i>Medicago prostrata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	I	2	+
<i>Silene otites</i> subsp. <i>pseudotites</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	I	2	+
<i>Thlaspi jankae</i>	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	I	2	+
<i>Viola arvensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	I	2	+

Table 5 cont.

[illegible]

Table 5 cont.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	K	S	A-D
	21	23	26	45	57	60	61	62	69	72	82	83	108	118	126	265	266	272			
<i>Primula veris</i> subsp. <i>inflata</i>	-	-	-	-	-	+	+1	-	-	-	-	-	+1	-	+1	-	-	-	II	4	+1
<i>Chrysanthemum corymbosum</i>	-	-	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	II	4	+
<i>Bupleurum falcatum</i>	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	II	4	+
<i>Euphorbia polychroma</i>	-	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	II	4	+
<i>Brachypodium pinnatum</i>	-	-	-	-	-	-	-	-	-	+1	-	-	-	-	1	-	-	+	I	3	+1
<i>Iris graminea</i> subsp. <i>pseudocyperus</i>	-	-	-	-	-	-	-	-	+	1	-	-	-	-	-	-	-	+1	I	3	+1
<i>Origanum vulgare</i>	-	-	-	-	-	-	-	-	-	-	+1	-	-	-	-	+	-	-	I	2	+1
<i>Peucedanum cervaria</i>	-	-	-	-	-	-	-	-	+1	+1	-	-	-	-	-	-	-	+	I	3	+1
<i>Cytisus albus</i> (1)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	+	I	3	+
<i>Clematis recta</i>	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	-	I	3	+
<i>Epipactis atrorubens</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	I	2	+
<i>Iris variegata</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	I	2	+
<i>Lathyrus pannonicus</i> subsp. <i>collinus</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	I	2	+
<i>Piptatherum virescens</i> (2)	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	I	2	+
<i>Rosa canina</i> s.l.	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	I	2	+
Quercus-Fagea species																					
<i>Melampyrum nemorosum</i>	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	I	3	+
<i>Sedum maximum</i>	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I	2	+
<i>Veronica chamaedrys</i>	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	I	2	+
<i>Digitalis grandiflora</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	I	2	+
<i>Rhamnus cathartica</i>	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	I	2	+

Table 5 cont.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	K	S	A-D
	21	23	26	45	57	60	61	62	69	72	82	83	108	118	126	265	266	272			
Other species																					
<i>Euphorbia cyparissias</i>	+	+	+	-	+	+	+	+	-	-	-	+	+	+	-	-	-	+	IV	11	+
<i>Hypericum perforatum</i>	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	I	3	+
<i>Dactylis glomerata</i>	-	-	-	-	+1	+	-	-	-	-	-	-	-	-	-	-	-	-	I	2	+1
<i>Arrhenatherum elatius</i>	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	I	2	+

Accidental species:

Seslerio-Festucetum: *Calamintha thymifolia* (1) 13:++; *Thalictrum foetidum* (1) 13:+

Asplenio-Festucion: *Ceterach javorkaeum* (1) 14:++; *Viola tricolor* subsp. *polychroma* (1) 9:+

Festucetalia valesiacae: *Centaurea triumfettii* 13:++; *Polygala major* 15:++; *Silaum peucedanoides* 16:++1; *Veronica austriaca* 16:+

Festuco-Brometea: *Adonis vernalis* 14:++; *Koeleria cristata* 14:++; *Sedum acre* 3:++; *Thesium linophyllum* 13:++; *Trifolium campestre* 3:++; *Stipa joannis* 8:+

Quercetea pubescenti-petraeae: *Arabis turrata* 1:++; *Betonica officinalis* 10:++; *Bupleurum prealtum* 1:++; *Cotinus coggygria* 13:++; *Cytisus nigricans* 11:++; *Dictamnus albus* 15:++; *Fragaria vesca* 9:++; *Lathyrus latifolius* 15:++; *Libanotis pyrenaica* 15:++; *Pulmonaria mollis* 11:++; *Quercus pubescens* 9:++; *Rosa spinosissima* subsp. *pimpinellifolia* 9:++; *Thalictrum minus* 14:+

Querco-Fagetea: *Campanula trachelium* 5:++; *Fraxinus excelsior* 12:++; *Sorbus aria* 9:++; *Waldsteinia geoides* 15 (+);

Other species: *Achillea millefolium* 3:++; *Luzula campestris* 9:++; *Melandrium album* 2:++; *Pimpinella saxifraga* 11:++; *Valeriana officinalis* 13:++; *Vicia hirsuta* 15 (+)

Table 5 cont.

1. Fehér-kő	SW	35°	95%	520 m	15.07.91	Vojtkó
2. Molnár-szikla	W	30°	100%	300 m	15.07.91	Vojtkó
3. Szeleta-oldal	S	40°	75%	280 m	15.07.91	Vojtkó
4. Dédesi-vár	W	35°	100%	560 m	22.07.91	Vojtkó
5. Kemesnye	SW	10°	90%	600 m	22.07.91	Vojtkó
6. Kemesnye	ESE	30°	75%	580 m	22.07.91	Vojtkó
7. Odvas-kő	N	20°	100%	550 m	23.07.91	Vojtkó
8. Odvas-kő	W	30°	100%	550 m	23.07.91	Vojtkó
9. Köpüs-kő	NE	5°	100%	650 m	23.07.91	Vojtkó
10. Köpüs-kő1.	–	0°	100%	655 m	23.07.91	Vojtkó
11. Kőszál	E	45°	80%	380 m	25.07.91	Vojtkó
12. Kőszál	SE	45°	75%	375 m	25.07.91	Vojtkó
13. Bél-kő	NNW	45°	95%	600 m	30.07.91	Vojtkó
14. Kút-hegy	NNE	45°	80%	320 m	01.08.91	Vojtkó
15. Ódor-vár	N	25°	100%	500 m	01.08.91	Vojtkó
16. Fehér-kő	W	25°	90%	515 m	15.07.91	Vojtkó
17. Molnár-szikla	S	40°	45%	310 m	15.07.91	Vojtkó
18. Magos-kő	SSW	25°	100%	640 m	23.07.91	Vojtkó

Holotype: sample 5

Quercetalia elements in the species composition or their constancy is higher. The differential species are: *Asperula cynanchica*, *Erysimum odoratum* subsp. *buekkense*, *Helianthemum ovatum*, *Inula ensifolia*, *Teucrium chamaedrys*, *T. montanum* based on 18 samples (see Table 5, Holotype: sample 5).

Following the comparison with characterizing the habitats of each community, there are other differences, too. The three different communities have different expositions: *saxifragetosum* occurs mainly on the northern rocks, *Inulo-Seslerietum* occurs on the western and southern slopes and *bükkense* lives on places of east–southeast exposition (Fig. 3).

Seslerietum heuflerianae-hungaricae Zólyomi (1936) 1966
subcarpaticum Jakucs 1952

After *Sesleria* grasslands occurring on limestone bedrock some words about the community which appeared on diabase. It occurs on the cliffs of northern expositions on Vár-hegy and Keselyű-bérc (Mt Szarvas-kő, Southwest Bükk Mts) with high cover value (85–100%) (Fig. 4). It is at the stage of afforesting with many *Spiraea media* and oak forest community species. In addition to these there are

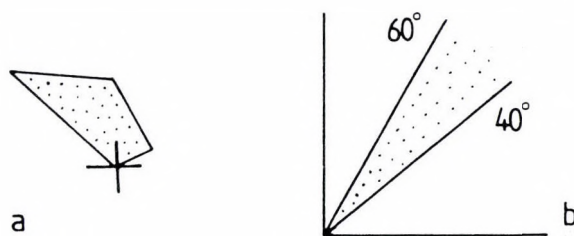


Fig. 4. The exposition diagram (a) and declination data (b) of *Seslerietum heuflerianae-hungaricae subcarpaticum* community

numerous rocky grassland species, e.g. *Asplenium septentrionale*, *A. trichomanes*, *Festuca pallens*, *Minuartia frutescens*, *Poa pannonica* subsp. *scabra*, *Saxifraga adscendens*, *S. paniculata*. The total table of the *Seslerietum heuflerianae-hungaricae* Zólyomi (1936) 1966 *subcarpaticum* Jakucs 1952 is based on 8 samples (see Table 4).

Genisto pilosae-Seslerietum hungaricae Vojtkó 1997 ass. nova hoc loco

The *Sesleria* grassland which was formed on dolomite bedrock is well differentiated from the former ones. It is particular because of the characteristics of the bedrock and considering the species this community will have further interesting features. The locally dolomite-indicator species have important rules like: *Asperula tinctoria*, *Daphne cneorum*, *Genista pilosa* and the high number of orchid species (*Cephalanthera damasonium*, *Epipactis atrorubens*, *Gymnadenia odoratissima*, *Orchis purpurea*). It is definitely the community of dolomite slopes with western exposition which are moderately steep (Fig. 5). The total table of *Genisto*

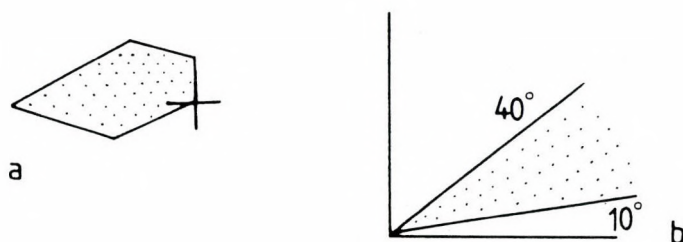


Fig. 5. The exposition diagram (a) and declination data (b) of *Genisto pilosae-Seslerietum hungaricae* community

Table 6
Genisto pilosae-Seslerietum hungaricae Vojtkó 1997

Species	1	2	3	4	5	6	7	8	9	10	K	S	A-D
	241	242	243	244	245	87	89	91	93	96			
Character species													
<i>Genista pilosa</i>	1	1	1	+	+	+	+1	+1	-	+	V	9	+1
<i>Anthericum ramosum</i>	+	+	1	+	+	+1	1	+1	+1	+	V	10	+1
<i>Asynema canescens</i>	+	+	+	+	+	+	+	+	+	-	V	9	+
<i>Anthyllis vulneraria</i>	+	+	+	+	-	+	+	+	-	+	IV	8	+
<i>Carex humilis</i>	1	-	-	-	+	+1	+1	+	+1	1-2	IV	7	+2
<i>Asperula tinctoria</i>	+	-	-	-	+	+	+	+	+	+	IV	7	+
<i>Gymnadenia conopsea</i>	+	+1	+	+	-	-	-	+	-	-	III	5	+1
Seslerio-Festucion species													
<i>Sesleria hungarica</i>	2	4	3	2	4	3-4	3-4	3-4	3	3-4	V	10	2-4
Festucetalia valesiacae species													
<i>Allium flavum</i>	+	+	+	+	+	-	-	-	+	+	IV	7	+
<i>Scabiosa ochroleuca</i>	+	+	-	+	+	-	-	-	-	-	II	4	+
<i>Teucrium montanum</i>	+	-	-	-	+	+	-	+	-	-	II	4	+
<i>Stachys recta</i>	+	-	+	-	-	-	-	-	-	+	II	3	+
<i>Cytisus procumbens</i>	-	-	-	-	-	-	-	-	+1	+1	I	2	+1
<i>Seseli osseum</i>	+	-	-	-	-	-	-	-	+	-	I	2	+
Festuco-Brometea species													
<i>Inula ensifolia</i>	+	1	2	+	1-2	+	-	1	+	-	IV	8	1-2
<i>Adonis vernalis</i>	+	+	+	+	+	+	+	-	-	-	IV	7	+
<i>Dorycnium herbaceum</i>	+	+	-	+	+	-	+	-	-	-	III	5	+
<i>Asperula cynanchica</i>	-	-	-	-	-	+	+	-	+	+	II	4	+
<i>Salvia pratensis</i>	+	+	+	-	+	-	-	-	-	-	II	4	+
<i>Cirsium pannonicum</i>	-	-	-	-	-	+1	+	+	-	-	II	3	+1
<i>Festuca rupicola</i>	-	-	-	-	-	-	-	-	+	+1	I	2	+1
<i>Briza media</i>	+	-	-	+	-	-	-	-	-	-	I	2	+
<i>Carlina vulgaris</i>	-	+	-	-	-	+	-	-	-	-	I	2	+
<i>Helianthemum ovatum</i>	-	+	-	+	-	-	-	-	-	-	I	2	+
<i>Pimpinella saxifraga</i>	-	+	+	-	-	-	-	-	-	-	I	2	+
Quercetea pubescenti-petraeae species													
<i>Teucrium chamaedrys</i>	-	1	+	1	+	+	+	+	+	-	IV	8	+1
<i>Brachypodium pinnatum</i>	+	+	+1	1	+	-	+1	+	-	-	IV	7	+1
<i>Primula veris</i> subsp. <i>inflata</i>	-	+	+	+	+	+	-	+	-	+	IV	7	+
<i>Carex montana</i>	+	+	+	1	+	+	-	-	-	-	III	6	+1
<i>Galium mollugo</i>	-	+	+	+	+	-	+	+	-	-	III	6	+

Table 6 cont.

Species	1	2	3	4	5	6	7	8	9	10	K	S	A-D
	241	242	243	244	245	87	89	91	93	96			
<i>Peucedanum cervaria</i>	1	-	+	-	+1	-	+1	+	-	-	III	5	+1
<i>Chrysanthemum corymbosum</i>	-	+	+	-	+	+	+	-	-	-	III	5	+
<i>Hieracium sylvaticum</i>	-	+	+	+	+	-	+	-	-	-	III	5	+
<i>Bupleurum falcatum</i>	-	+	+	+	+	-	+	-	-	-	III	5	+
<i>Inula hirta</i>	-	-	-	+	-	+	+	+	-	-	II	4	+
<i>Orchis purpurea</i>	+	+	+	-	+	-	-	-	-	-	II	4	+
<i>Cypripedium calceolus</i>	-	+	+	-	+	-	-	-	-	-	II	3	+
<i>Polygonatum odoratum</i>	+	-	-	-	-	-	+	-	-	+	II	3	+
<i>Anemone sylvestris</i>	-	-	+	-	-	-	-	-	-	+	I	2	+
<i>Coronilla varia</i>	-	+	-	+	-	-	-	-	-	-	I	2	+
<i>Cotinus coggygia</i>	-	-	-	+	-	-	-	+	-	-	I	2	+
<i>Digitalis grandiflora</i>	+	-	+	-	-	-	-	-	-	-	I	2	+
<i>Erysimum odoratum</i> var. <i>buekkense</i>	+	-	-	-	-	-	-	-	-	+	I	2	+
<i>Laser trilobum</i>	+	-	-	-	-	-	-	+	-	-	I	2	+
<i>Vincetoxicum hirudinaria</i>	+	-	-	-	-	-	-	-	-	+	I	2	+
Quercus-Fagea species													
<i>Melampyrum nemorosum</i>	-	-	+	+	-	+	-	-	+	-	II	4	+
<i>Viola mirabilis</i>	-	+	+	-	+	-	+	-	-	-	II	4	+
<i>Hieracium sabaudum</i>	-	+	+	+	-	-	-	-	-	-	II	3	+
Other species													
<i>Euphorbia cyparissias</i>	+	+	+	+	+	+	-	-	+	-	IV	7	+
<i>Chrysanthemum leucanthemum</i>	-	+	1	+	-	+	+	+	-	-	III	6	+1
<i>Hieracium pilosella</i>	-	-	-	-	-	-	+	-	+	+	II	4	+
<i>Linum catharticum</i>	-	+	+	+	-	+	-	-	-	-	II	4	+
<i>Centaurea pannonica</i>	-	+	-	+	-	-	-	-	-	-	I	2	+

Accidental species:

Festucetalia valesiacae: *Campanula sibirica* 1+; *Daphne cneorum* 5+; *Medicago prostrata* 7+; *Melica ciliata* 9+; *Pulsatilla grandis* 9+;

Festuco-Brometea: *Arabis hirsuta* 9+; *Acinos arvensis* 9+; *Dianthus pontederiae* 10+; *Linaria genistifolia* 6+; *Gymnadenia odoratissima* 8+; *Poa angustifolia* 10+; *Prunella grandiflora* 6+; *Sanguisorba minor* 7+; *Thesium linophyllum* 10+;

Quercetea pubescenti-petraeae: *Clematis recta* 8+; *Cytisus nigricans* 10+; *Dictamnus albus* 10+; *Epipactis atrorubens* 8+; *Geranium sanguineum* 10+;

Other species: *Leontodon autumnalis* 6+; *Polygala vulgaris* 9+; *Prunella vulgaris* 3+;

Table 6 cont.

1. Csákpilis	W	40°	80%	420 m	25.06.90	Vojtkó
2. Csákpilis	W	20°	100%	420 m	03.08.90	Vojtkó
3. Csákpilis	WSW	30°	100%	425 m	03.08.90	Vojtkó
4. Csákpilis	W	25°	100%	425 m	03.08.90	Vojtkó
5. Csákpilis	WSW	20°	100%	430 m	03.08.90	Vojtkó
6. Csákpilis	WNW	30°	90%	430 m	26.07.91	Vojtkó
7. Csákpilis	N	10°	95%	435 m	26.07.91	Vojtkó
8. Csákpilis	NW	35°	90%	435 m	26.07.91	Vojtkó
9. Vasbánya-lápa	W	30°	85%	440 m	26.07.91	Vojtkó
10. Vasbánya-lápa	NW	40°	90%	440 m	26.07.91	Vojtkó

Holotype: sample 2

pilosae-Seslerietum hungaricae Vojtkó 1997 is based on 10 samples (see Table 6, Holotype: sample 2).

The cover values of the community are presented together with other *Sesleria* grasslands. These data are worth examining together with declination and exposition diagrams (Fig. 6).

Calamagrostio variaae-Seslerietum variaae Vojtkó 1997 ass. nova hoc loco

Sesleria varia is very rare in Hungary only two occurrence were published from Hungary (Ómassa, Kőszeg, in Ujhelyi 1959, Soó 1964–80). It is not the case in the Carpathians, in the Alps, and in the western part of Europe where it is the

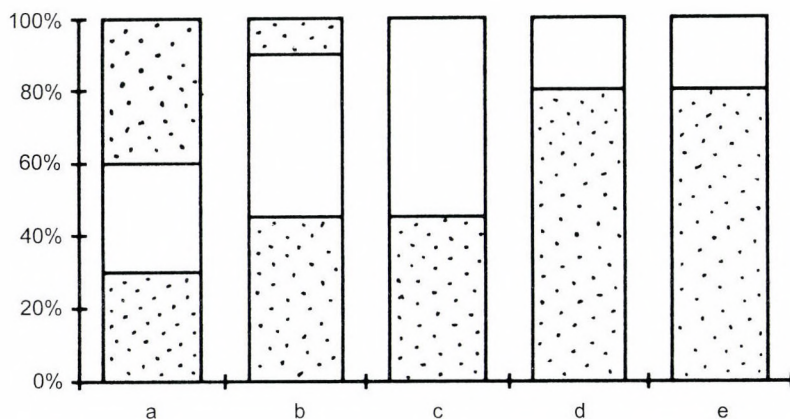


Fig. 6. The cover data of *Seslerietum* communities. – a: *Seslerietum heuflerianae-hungaricae bükkense*, b: *Seslerietum heuflerianae-hungaricae saxifragetosum*, c: *Inulo-Seslerietum*, d: *Seslerietum heuflerianae-hungaricae subcarpaticum*, e: *Genisto pilosae-Seslerietum*

Table 7
Calamagrostio variaie-Seslerietum variaie Vojtkó 1997

Species	1	2	3	4	5	K	A-D
	5	6	7	8	261		
Character species							
<i>Carex humilis</i>	+	3	1	3	+1	V	+3
<i>Sesleria varia</i>	+1	1	+	1-2	+	V	+2
<i>Genista pilosa</i>	+	+	+1	+	+	V	+1
<i>Calamagrostis varia</i>	3-4	+	2	-	4	IV	+4
<i>Ophrys insectifera</i>	+	+	-	-	-	II	+
<i>Gynnenadenia odoratissima</i>	-	-	+	-	+	II	+
<i>Rubus saxatilis</i>	-	+	-	-	+	II	+
Festucetalia valesiacae species							
<i>Inula ensifolia</i>	+1	+	+	+1	-	IV	+1
<i>Phyteuma orbiculare</i>	+	-	+	+	+	IV	+
<i>Asperula tinctoria</i>	-	+	-	-	-	I	+
<i>Campanula rotundifolia</i>	-	-	+	-	-	I	+
<i>Teucrium montanum</i>	-	-	-	-	+	I	+
<i>Helianthemum canum</i>	-	-	-	+	-	I	+
Festuco-Brometea species							
<i>Anthericum ramosum</i>	+	+1	+	+	+	V	+1
<i>Asperula cynanchica</i>	+	-	+	+	+	IV	+
Quercetea pubescenti-petraeae species							
<i>Laserpitium latifolium</i>	+1	+1	+	+	+	V	+1
<i>Polygonatum odoratum</i>	+	+1	-	+	-	III	+1
<i>Teucrium chamaedrys</i>	+1	+	-	+	-	III	+1
<i>Vincetoxicum hirundinaria</i>	+	+	-	+	-	III	+
<i>Erysimum odoratum</i>	+	-	-	+	-	II	+
<i>Epipactis atrorubens</i>	-	+	-	-	-	I	+
<i>Galium mollugo</i>	-	+	-	-	-	I	+
Querco-Fagea species							
<i>Convallaria majalis</i>	+	+	+	+	+	V	+
<i>Sorbus aria</i> s.l.	+	+	-	+	-	III	+
<i>Neottia nidus-avis</i>	+	+	-	-	-	II	+
<i>Platanthera bifolia</i>	+	-	-	-	+	II	+
<i>Campanula persicifolia</i>	-	-	+	-	-	I	+
<i>Epipactis helleborine</i>	+	-	-	-	-	I	+
<i>Melittis grandiflora</i>	+	-	-	-	-	I	+

Table 7 cont.

Species	1	2	3	4	5	K	A-D
	5	6	7	8	261		
Fagetalia species							
<i>Carex digitata</i>	+	+	—	—	—	II	+
<i>Lilium martagon</i>	+	—	+	—	—	II	+
<i>Mercurialis perennis</i>	+	+	—	—	—	II	+
<i>Cirsium erisithales</i>	—	+	—	—	—	I	+
<i>Daphne mezereum</i>	+	—	—	—	—	I	+
<i>Fagus sylvatica</i>	—	+	—	—	—	I	+
1. Jávör-hegy	NW	40°	90%	630 m	10.06.91	Vojtkó	
2. Jávör-hegy	W	55°	70%	620 m	17.06.91	Vojtkó	
3. Jávör-hegy	N	55°	80%	640 m	17.06.91	Vojtkó	
4. Jávör-hegy	NW	50°	78%	635 m	17.06.91	Vojtkó	
5. Jávör-hegy	N	50°	75%	650 m	17.06.91	Vojtkó	

Holotype: sample 1

most frequent *Sesleria* species (Deyl 1946, Schubert 1963). In accordance with the coenology of this species well elaborated works and further communities of this species have been published (Klika 1939, 1950, Braun-Blanquet 1961, Schubert 1963, Pignatti and Pignatti 1975). In Hungary the grassland on the slope of the hill Jávör-hegy is known as *Diantho-Seslerietum* (Soó 1964, Zólyomi 1966) as during the comparison of *Seslerietums* the differences of this type are prominent. It is evident to use other name. It is remarkable that this community is north-orientated and it is linked to steep slopes (40–60°). The constant species of the community are *Anthericum ramosum*, *Asperula cynanchica*, *Calamagrostis varia*, *Carex humilis*, *Convallaria majalis*, *Genista pilosa*, *Inula ensifolia*, *Laserpitium latifolium*, *Phyteuma orbiculare*, *Sesleria varia*. Among the flora elements the high rate of the atlantic elements is important. (In the characterization of the occurrence of *Ophrys insectifera* in the communities Soó refers to the strong at-

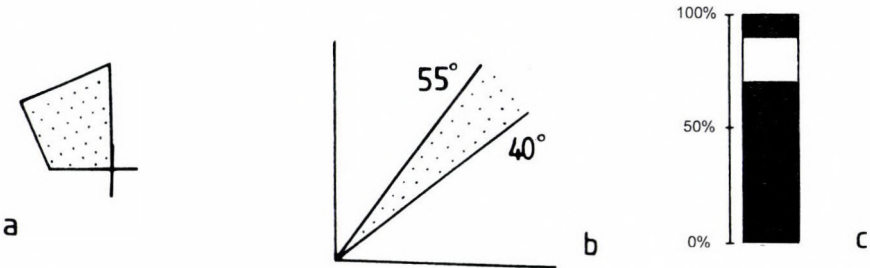


Fig. 7. The exposition diagram (a), declination data (b) and cover values (c) of the *Calamagrostio-Seslerietum varia*e community

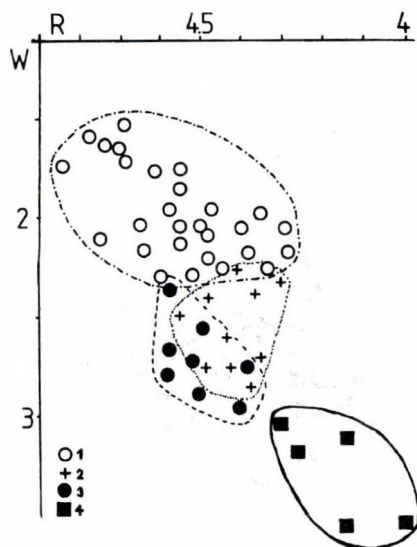


Fig. 8. The WR values of the *Sesleria* grasslands on different bedrocks. –
1: limestone, 2: dolomite (sub-Mediterranean type), 3: diabase, 4: dolomite (subalpine type)

lantic character of *Sesleria varia* grassland (Soó 1959a)). From the analyses of coenological species groups the rate of Quercetea & Querco-Fagetea and Festucetalia & Festuco-Brometea is interesting (60–40%) (Fig. 7). The total table of *Calamagrostio-Seslerietum variae* Vojtkó 1997 is based on 5 samples (see Table 7, Holotype: sample 1).

The discussion of the samples according to the TWR values of Zólyomi: I constructed the comparison of WR values on according to bedrock (limestone, dolomite, diabase), using the coenological samples of the communities with *Sesleria* species (Fig. 8).

*

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REFERENCES

- Borhidi, A. (1996): *An annotated checklist of the Hungarian plant communities, I. The non-forest vegetation*. – In: Borhidi, A. (ed.): *Critical revision of the Hungarian plant communities*. Pécs, pp. 43–94.

- Braun-Blanquet, J. (1961): *Die inneralpine Trockenvegetation*. – Stuttgart, 273 pp.
- Deyl, M. (1946): Study of the genus *Sesleria*. – *Studia Botanica Cechica* 256 pp.
- Dostál, J. (1933): Geobotanický prehľad vegetace Slovensko Krasu. – *Vestn. Král. Společen Nauk., Tr. Mat.-Prir.*, 4: 1–44.
- Futák, J. (1947): *Xerothermná vegetácia skupiny knazného stola*. – Vydal Spolok Trnave 258 pp.
- Holub, J., Hejny, S., Moravec, J. & Neuhausl, R. (1967): *Übersicht der höheren Vegetationseinheiten der Tschechoslowakei*. – Acad. Nakladatelství, Praha, 75 pp.
- Jakucs, P. (1952): Újabb adatok a Tornense flórájához. (Neue Angaben zur Flora des Tornaer Karstes.) – *Annales Biol. Univ. Hung.* 2: 235–243.
- Jakucs, P. (1955): Geobotanische Untersuchungen und die Karstaufforschung in Nordungarn. – *Acta Bot. Hung.* 2: 89–131.
- Klika, J. (1939): Die Gesellschaften des Festucion valesiacae Verbandes in Mitteleuropa. – *Studia Botanica Cechica* 2(3): 117–157.
- Klika, J. (1950): Xerothermni travinná společenstva v Českém Stredohorí. – *Rozpravy II, Trudy Ceske Akademie* 40(25): 1–47.
- Kolbek, J. (1984): *Asplenietea trichomanis* Br.-Bl. in Meier et Braun-Blanquet 1934. – *Bibliographia Syntaxonomica Cechoslovaca* 4: 4–11.
- Kolbek, J. (1986): *Festuco-Brometea* Br.-Bl. et Tx. 1943. – *Bibliographia Syntaxonomica Cechoslovaca* 11: 1–125.
- Kovács, J. A. (1995): Lágyszárú növénytársulásaink rendszertani áttekintése. – *Tilia* 1: 86–144.
- Marschall, Z., Suba, J., Orbán, S. & Vojtkó, A. (1991): Vegetációtanulmányok a Bükk hegységben: a Messzelátó-hegy, Ördög-hegy növényzete. (Vegetation studies in the Bükk mountains concerning the vegetation of the Messzelátó Hill and the Ördög Hill). – *Acta Acad. Paed. Agr.* 20: 139–159.
- Oberdorfer, E. (1957): *Süddeutsche Pflanzengesellschaften*. – Fischer Verlag, Jena, pp. 244–305.
- Pignatti, E. & Pignatti, S. (1975): Syntaxonomy of the *Sesleria* grasslands of the calcareous Alps. – *Vegetatio* 30: 5–14.
- Schubert, W. (1963): Die *Sesleria varia*-reichen Pflanzengesellschaften in Mitteldeutschland. – *Fedde's Repert., Beiträge zur Vegetationskunde* 5: 71–199.
- Soó, R. (1959a): Ophrys-Studien. – *Acta Bot. Hung.* 5: 437–471.
- Soó, R. (1959b): Systematische Übersicht der Pannonischen Pflanzengesellschaften II. – *Acta Bot. Hung.* 5: 473–500.
- Soó, R. (1964–80): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve*. I–VI. – Akadémiai Kiadó, Budapest, I (1964): 519 pp., II (1966): 655 pp., III (1968): 506 pp., IV (1970): 614 pp., V (1973): 724 pp., VI (1980): 557 pp.
- Ujhelyi, J. (1959): Species *Sesleriae* generis novae. – *Fedde's Repert.* 62(12): 59–70.
- Vojtkó, A. (1997): A Bükk-fennsík vegetációja I. A növénytársulások általános jellemzése. (The vegetation of the Bükk plateau (NE Hungary) I. General characterization of the communities). – *Bot. Közlem.*
- Zólyomi, B. (1936): A pannóniai flóratartomány és az északnyugatnak határos területek szikla-növényzetének áttekintése. (Übersicht der Felsenvegetation in der pannonischen Florenprovinz und dem Nordwestlich). – *Ann. Mus. Nat. Hung.* 30: 136–174.
- Zólyomi, B. (1966): A pannóniai flóratartomány és a környező területek sziklagyepjeinek új osztályozása. (Neue Klassifikation der Felsen-vegetation im Pannonischen raum und der Angrenzenden gebiete). – *Bot. Közlem.* 53(1): 49–54.

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GRAZING EFFECTS ON DIVERSITY OF RANGELAND VEGETATION: A CASE STUDY IN MOUTEH PLAIN, IRAN

H. ZAHEDI POUR¹ and H. EJTEHADI²

¹Dept. Botany and Plant Physiology, University of Agricultural Sciences
H-2103 Gödöllő, Páter Károly u. 1, Hungary

²Inst. Ecology and Botany, Hungarian Academy of Sciences
H-2163 Vácraót, Hungary

It is well-documented that physical disturbances such as grazing or trampling by domestic animals result in changes of diversity components. Changes of species number, species composition as well as the relative abundance and dominance of the species have been especially useful as indicator variables in monitoring programs to assess the environmental quality. This study was carried out in a rangeland area of Iran subjected to grazing by sheep and goat in order to recognize changes of its condition. Several aspects of diversity such as species richness, species diversity, evenness, diversity and related models, diversity based on the rank/abundance plots as well as methods of diversity ordering were considered in three differently grazed sites of the rangeland including ungrazed, moderately grazed and overgrazed sites. It was found that the grazing shifts the species abundance patterns of the sites. Moderately grazed site followed log normal distribution whereas species abundance patterns of the overgrazed site followed both log normal and logarithmic models.

The relative abundance of some species in a community changed consistently in response to grazing. The ungrazed site showed the highest species diversity as well as the highest evenness among the three sites, while the moderately grazed site increased the species richness and decreased the species diversity. In all cases overgrazing decreased both the species richness and the diversity of the site. Some species with high forage values became less abundant or even disappeared from the overgrazed site which is associated with invasion of several unpalatable or even piny and noxious plant species in the site.

Key words: *Artemisia herba-alba*, diversity, grazing, Iran

INTRODUCTION

A large body of observations on the effects of grazing by domestic herbivores on rangeland vegetation has accumulated over the last century, particularly in North America (e.g. reviewed by Ellison 1960, Heady 1975). Explanations for these observations and for the differences amongst communities have been given by a variety of means. These include broad comparisons of community diversity (e.g. Auclair and Goff 1971, Glenn-Lewin 1977, Peet 1978), experimental studies of the effect of individual environmental factors such as grazing and fire (Collins and Barber 1985), theoretical and experimental studies of disturbance (e.g. Peet *et al.* 1983, Huston 1979). There is a long history of these studies ranging from the classical description of the rangelands towards the more sophisticated rela-

tionship to the diversity (Huston 1979) and the stability (Noy-Meir *et al.* 1989, May 1977). In parallel, some ecological hypotheses on the effects of grazing on diversity such as intermediate disturbance hypothesis proposed by Connell (1978) that stress the highest diversity is maintained at the intermediate levels of disturbance have been developed that attempt to explain and predict these effects.

Soon after a severe disturbance, propagules of a few pioneer species arrive in the open space and if further disturbances occur frequently, gaps will not be filled in and the community will not progress. Thus, the diversity of the community as a whole will be low and as the interval between disturbances increases, the diversity will also increase because time is available for the invasion of more species. This is the situation at an intermediate frequency of disturbance. At very low frequencies of disturbance, most of the community for most of the time will reach and remain at the climax stages, with competitive exclusion having reduced diversity. Disturbance (non-equilibrium) theory suggests ways in which communities might be manipulated to desired ends with the impacts of nature conservation, agriculture, forestry, wildlife management, grazing and other intermediate disturbances. It is well-documented that under extreme environmental conditions the diversity of communities decreases (*e.g.* Fowler and Mooney 1990, Dumont *et al.* 1990, Rabatin and Stinner 1989). Overgrazing may also have such a diversity decreasing impact on the vegetation of rangelands (Bhat and Kaul 1989, Li 1993). In addition, grazing adversely affects many native plant species, particularly the perennial components, whereas introduced annuals are decidedly more common in grazed areas (Cheal 1993). On the other side, mild grazing might result in an increase of the plant species diversity, richness and evenness (Bhat and Kaul 1989, Li 1993).

As Magurran (1988) stated species diversity measures can be divided into three categories. First are the species richness indices. These indices are essentially a measure of the number of species in a defined sampling unit. Although the species richness indices give an instant comprehensive measure of communities, but an important aspect of the numerical structure of communities is completely ignored when the composition of the community is described simply in terms of the number of species present. It misses the information that some species are rare and others common. Therefore, it seems to be important to couple the richness indices with the second group of indices which are based on the proportional abundances of species that consider both abundance (or biomass) parameters and species richness.

Recently, a special method for the comparison of communities have been developed (Patil and Taillie 1979). It is well-known that different indices may in-

consistently rank a given pair of communities (Hurlbert 1971). For example, two communities with the following abundances

$$A = (33, 29, 28, 5, 5) \qquad B = (42, 30, 10, 8, 5, 5)$$

are ranked in the opposite sense by the Shannon (H) and Simpson (D) indices. There are many reasons for this mis-ordering. Patil and Taillie (1979) emphasized that such inconsistencies are inevitable whenever one attempts to reduce a multidimensional concept like a community to a single number. A more straightforward illumination of the problem is related to the different sensitivities of diversity indices. A possible solution is to use parametric families of diversity indices instead of a numerical-valued diversity index. When we use a one-parameter family $\{D_\alpha: (\alpha \text{ real})\}$ of diversity indices then the family may be portrayed graphically by plotting diversities (D) against the scale parameter. This curve is frequently mentioned as the diversity profile of the community (Patil and Taillie 1979, 1982). Using diversity profiles we can define the diversity ordering of communities in the following way:

It can be shown that diversity ordering is a partial order so that if $A > B$ and $B > C$, then $A > C$. Community A can be considered as more diverse than B only if its diversity profile is over B in the whole range of the scale parameter. If the curves intersect, it means that one of the communities is more diverse in respect to the rare species, whereas the other one is more diverse in respect to the dominant species. In this case the two communities are not comparable; this means that we can find at least two diversity indices which order the communities differently (Tóthmérész 1993a).

Thirdly, there are species abundance models which describe the distribution of the species abundances. The species abundance models range from those which represent situations where there is high evenness to those which characterize cases where the abundances of species are very unequal. The diversity of a community may therefore be described by referring to the models which provides the closest fit to the observed pattern of the species abundance. Although species abundance data will frequently be described by one or more of a family of distributions (Pielou 1975), diversity is usually examined in relation to the four main models (May 1975). These are the geometric series, where a few species are dominant with the remainder fairly uncommon, the logarithmic series and the log normal where species of intermediate abundance become more common and indicate large, mature and varied natural communities and finally McArthur's broken stick model where species are as equally abundant as ever observed in the real world.

MATERIALS AND METHODS

STUDY AREA

This research was carried out in Mouteh plain, Iran, which is located between 33°23' and 33°29' latitudes and 50°29' and 51°53' longitudes with nature reserve areas of 29,000 ha located on it. The nature reserve area was established by the Environment Protection Organization of Iran and has been protected since 1960 with the purpose of wildlife management. Mean annual precipitation of the region is 200 mm. The greatest amount of rainfall occurs in the early spring. A second precipitation peak with lower amount and shorter in duration occurs in the autumn. Soil is classified in the range of "very fine silt and clay". The maximum and minimum temperature are in July (38 °C) and in January (-6 °C), respectively. Altitude of the area is 1932 m a.s.l. Bedrock of the area are granitic, aplitic veins and dikes as well as magmatites as described on the map of the area provided by the Geological Organization of Iran. The main vegetation type is *Artemisia herba-alba*. Grazing by sheep and goat is the most characteristic exploitation of natural resources in the area.

FIELD INVESTIGATIONS

A pair of coordinate axes (abscissa and ordinate) in relation to the study area were outlined. Random sampling was chosen by using random number tables. In order to detect the number of quadrats required, a series of random samples were pooled and then placed in random order to calculate the Brillouin index (Pielou's pooled quadrat method, see Pielou 1969, 1975). The cumulative Brillouin index was plotted against the number of quadrats and the points at which the curves get plateau were determined (Fig. 1). Abundances of species were recorded at 60 random points, quadrat of 1 m² in size, at each of the ungrazed, moderately grazed and overgrazed sites.

DATA ANALYSIS

The diversities of the overgrazed, moderately grazed and ungrazed sites were obtained and compared with different methods. Several aspects of diversity including species richness, species diver-

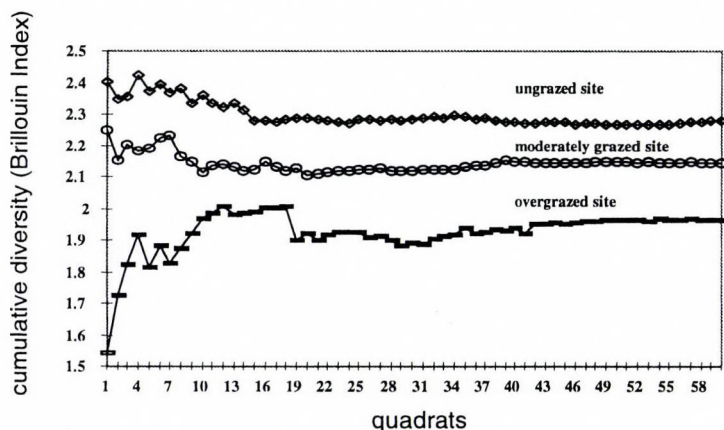


Fig. 1. Diversities of the pooled quadrats to determine the sufficient number of quadrats required in the study area. It shows that about 20 samples are sufficient for measurement of diversities in the ungrazed and moderately grazed sites whereas around 35 samples are required for the overgrazed sites

sity, equitability as well as diversity based on the models (geometric-series, logarithmic-series, log normal and broken stick model) related to the three differently grazed sites were considered using DIVER program package (Ganis 1992). A wide range of indices including those of Shannon-Wiener, Simpson, Margalef and Brillouin were considered to determine diversity of communities. Diversities of the three sites were also compared two by two Shannon's diversity indices using the *t*-test. Rank/abundance plots were made in order to get a visual inspection of the species abundance distribution. Diversities were also ordered based on the families of diversity parameter including those of Patil and Taillie, Hill and Rényi by using DIVORD 1.50 (Tóthmérész 1993a) and NuCo-SA 1.0 program packages (Tóthmérész 1993b).

RESULTS AND DISCUSSION

Table 1 gives the results of diversity indices that take species richness into account. Number of species in the ungrazed, moderately grazed and overgrazed sites are 70, 74 and 55, respectively. The species richness indices in the moderately grazed site are more than those in the overgrazed site. Both the indices and the number of species in the overgrazed site are the lowest among the three sites. Species richness, while giving a valuable insight into species diversity, can mask shifts in dominance/evenness relations. It would therefore appear important to couple an estimate of species richness with a measure of either dominance or evenness wherever possible. Table 2 gives diversity indices that take both abundances and species richness into consideration. The data clearly show that the values calculated with a variety of diversity indices as well as the evenness are higher in ungrazed site than in the two other sites. There is no significant difference, based on *t*-test, between the values of the moderately grazed site and those of the overgrazed site measured with the Shannon index (Table 3). In all cases, when the dominance is considering, since it is in a narrow range, the ungrazed site is more diverse than the two other sites. In order to get a more clear-cut notion of the species abundance distribution of the sites, fitting of different distribution models were checked. According to Table 4, that shows a summary of the goodness of fit test, the moderately grazed site follows log normal distribution, whereas overgrazed site follows both log normal and logarithmic distribution, in the other word a shift from being log normal to logarithmic model was observed in the overgrazed site. However, ungrazed site does not fit any of the models. Geometric model is clearly typical for extreme environments with high species dominance where one environmental factor, either stress or a disturbance factor such as grazing, dominates; and the log-normal distribution would refer to species-rich situation (Magurran 1988).

Considering the rank/abundance plots of the sites (Fig. 2) and the shape of the curves, it can be seen that the ungrazed site has a more flattened curve than the two others, therefore the ungrazed site is more diverse than the two other sites. The overgrazed site has a steep curve comparing to the others. It is because of

Table 1
Species richness of the three differently grazed sites in the study area

Sites	No. of Species	Species Richness	
		Margalef Index	Menhinick Index
Ungrazed	70	8.5	1.2
Moderately grazed	74	8.8	1.2
Overgrazed	55	6.8	1.0

Table 2
Values calculated based on different indices of diversity
and Pielou index of evenness for the three sites

Sites	Diversity					Evenness
	Shannon index	Brillouin index	McIntosh index	Simpson index	Q index	Pielou index
Ungrazed	2.8	2.7	0.70	0.90	34.9	0.66
Moderately grazed	2.6	2.5	0.66	0.12	21.3	0.60
Overgrazed	2.5	2.5	0.60	0.15	10.7	0.63

Table 3
T-values calculated based the results of Shannon index for the three differently grazed sites

<i>t</i> -test	Moderately grazed site	Overgrazed site
Ungrazed site	6.77	7.72
Moderately grazed site		1.65 Ns

Ns = No significant

If *t*-values < 1.96 then we cannot reject the null hypothesis that the diversities are identical

Table 4
Summarizing table of significance of fitting the models at the level of P = 5%

Sites	Four main related models of diversity			
	Geometric	Broken stick	Logarithmic	Log normal
Ungrazed	—	—	—	—
Moderately grazed	—	—	—	1
Overgrazed	—	—	2	1

*The numbers in the table indicate the significance order

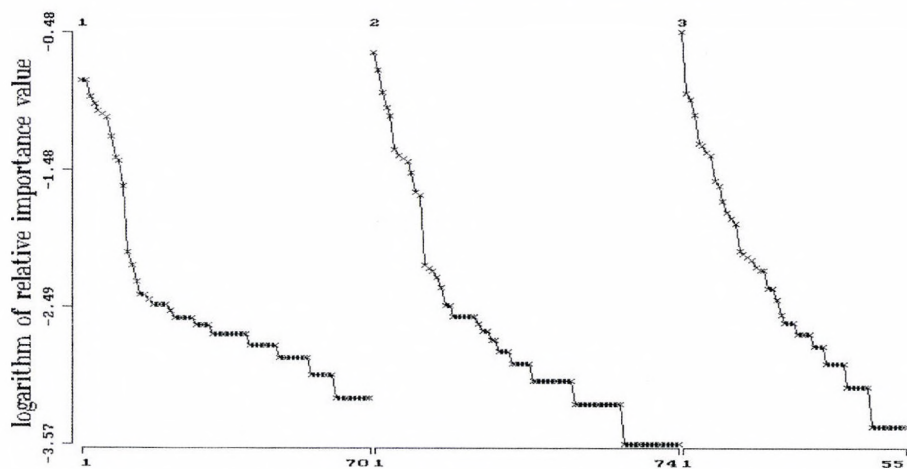


Fig. 2. Rank abundance plots of the ungrazed (1), the moderately grazed (2) and the overgrazed (3) sites

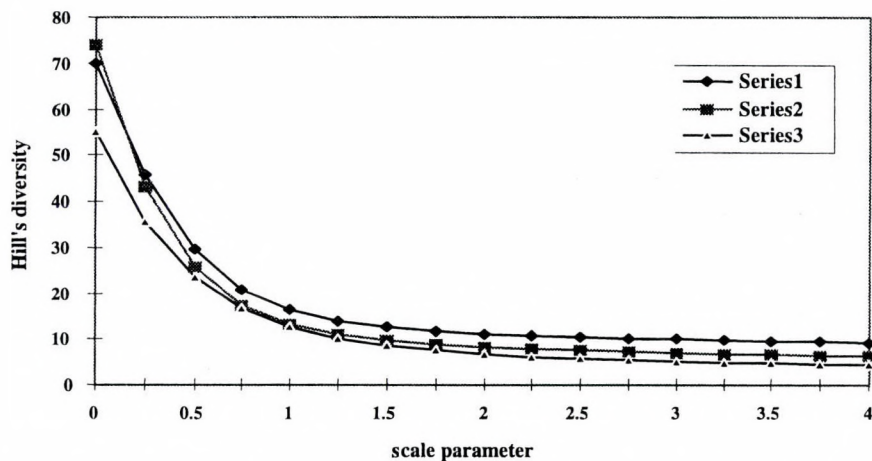


Fig. 3. Diversity ordering of the ungrazed (series 1), the moderately grazed (series 2) and the overgrazed (series 3) sites based on Hill's diversity

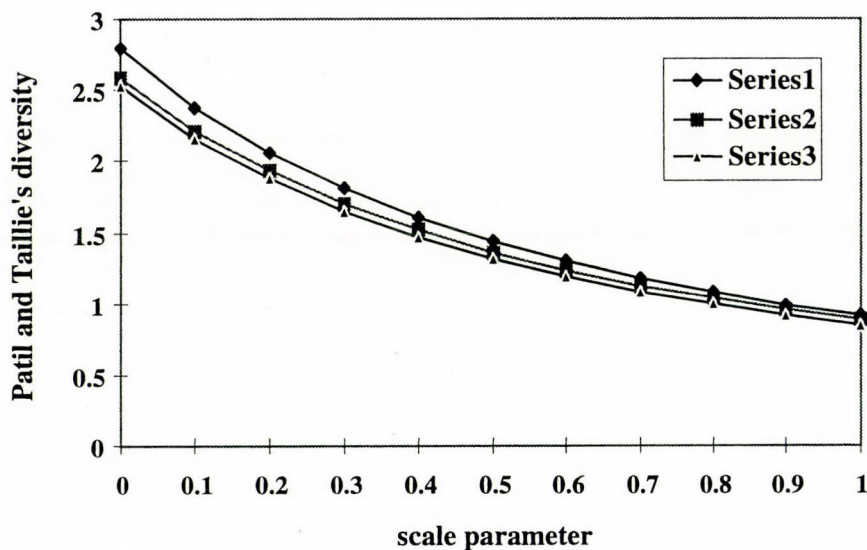


Fig. 4. Diversity ordering of the ungrazed (series 1), the moderately grazed (series 2) and the over-grazed (series 3) sites based on Patil and Taillie's diversity

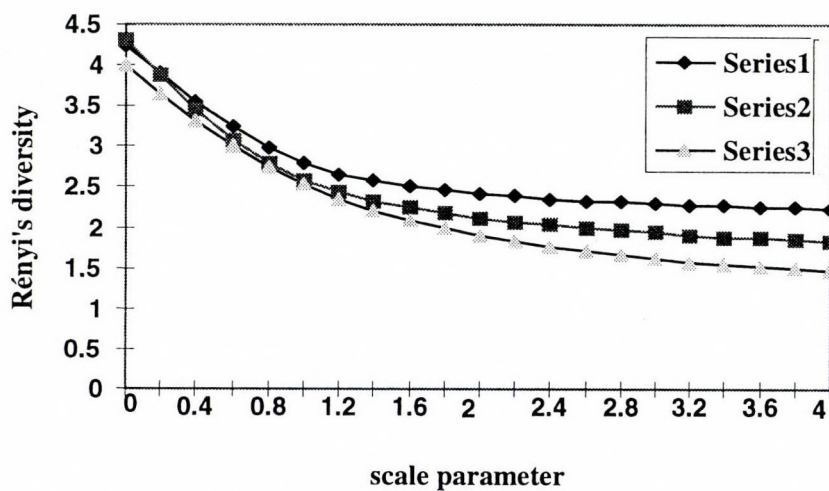


Fig. 5. Diversity ordering of the ungrazed (series 1), the moderately grazed (series 2) and the over-grazed (series 3) sites based on Rényi's diversity

high abundances of some species such as *Ceratocephalus falcatus*, *Holosteum umbellatum*, *Alyssum murale* and *Astragalus tribuloides*. Rank/abundance plots clearly show that disappearing of several species with low dominance as well as an increase of the dominance of some tolerant species caused the loss of diversity in the overgrazed site.

Diversity of the sites were also compared by using diversity profiles (Patil and Taillie 1979, Tóthmérész 1993a). Figures 3, 4 and 5 show the results of diversity ordering for the three differently grazed sites performed by DIVORD 1.50 program (Tóthmérész 1993a). As the figures show the sites have well ordered based on Patil and Taillie's diversity, but in the case of Hill's and Rényi's diversities the ungrazed and moderately grazed sites are not comparable. However, it is obvious that their diversity profiles lie above the diversity profile of the overgrazed site.

The species compositions of the ungrazed and moderately grazed sites were almost identical. Only 9 species were present at the ungrazed site which were absent from the moderately grazed one and 13 species of the moderately grazed site were absent from the ungrazed one. There were 5 species in the overgrazed site which were not present at the moderately grazed one and 13 species in the overgrazed site were absent from the ungrazed site. Amongst these last ones are *Echinops* sp., *Thevenotia persica*, *Onopordon* sp., *Ceratocarpus arenarius*, *Ceratocephalus falcatus*, and *Eryngium* sp. which are piny and unpalatable species avoided by animals. These species are invaders. The others, such as *Erodium* sp., *Astragalus tribuloides*, *Boissiera squarrosa* and *Polygala amara*, probably because of their life forms which are mostly geophytic or hemycryptophytic, escape animal grazing and are frequent in the overgrazed site. On the basis of the obtained results, suggestions are made to do the necessary management practice of the pastures in order to maintain their sustainability in terms of floristical diversity.

REFERENCES

- Auclair, A. N. and Goff, F. G. (1971): Diversity relations of upland forests in the western Great Lakes area. – *Amer. Nat.* **105**: 499–528.
- Bhat, S. A. and Kaul, V. (1989): Grassland communities of Dachigam-Telbal catchment, Kashmir. – *Indian Forester* **115**: 567–577.
- Cheal, D. C. (1993): Effects of stock grazing on the plants of semi-arid woodlands and grasslands. – *Proceedings of the Royal Society of Victoria* **105**: 57–65.
- Collins, S. L. and Barber, S. C. (1985): Effects of disturbance on diversity in mixed-grass prairie. – *Vegetatio* **64**: 87–94.
- Connell, J. H. (1978): Diversity in tropical rainforests and coral reefs. – *Science* **199**: 1302–1310.

- Dumont, J. F., Lamotte, S. and Kahn, F. (1990): Wetland and upland forest ecosystems in Peruvian Amazonia: plant species diversity in the light of some geological and botanical evidence. – *Forest Ecology and Management* **33–34**: 125–139.
- Ellison, L. (1960): Influence of grazing on plant succession of rangelands. – *Botanical Reviews* **26**: 1–78.
- Fowler, C. and Mooney, P. (1990): *Shattering: food, politics, and the loss of genetic diversity*. – University of Arizona Press, Tucson, USA, 278 pp.
- Ganis, P. (1992): *Diver. A program for diversity measures in ecology*. – University of Trieste. Distributed by Scientia Publishing, Budapest, Hungary.
- Glenn-Lewin, D. C. (1977): Species diversity in North American temperate forests. – *Vegetatio* **33**: 153–162.
- Heady, H. F. (1975): *Rangeland management*. – McGraw-Hill, New York.
- Hurlbert, S. H. (1971): The non-concept of species diversity: A critique and alternative parameters. – *Ecology* **52**: 577–586.
- Huston, M. (1979): A general hypothesis of species diversity. – *Amer. Nat.* **113**: 81–101.
- Li, Y. H. (1993): Grazing dynamics of the species diversity in *Aneurolepidium chinense* steppe and *Stipa grandis* steppe. – *Acta bot. sinica* **35**: 877–884.
- Magurran, A. E. (1988): *Ecological diversity and its measurement*. – Croom Helm Ltd., London.
- May, R. M. (1975): *Patterns of species abundance and diversity*. – In: Cody, M. L. and Diamond, M. L. (eds): *Ecology and evolution of communities*. Harvard University Press, Cambridge, pp. 81–120.
- May, R. M. (1977): Thresholds and breakpoints in ecosystems with a multiplicity of stable states. – *Nature* **269**: 471–477.
- Noy-Meir, I., Gutman, M. and Kaplan, Y. (1989): Responses of Mediterranean grassland plants to grazing and protection. – *J. Ecol.* **77**: 290–310.
- Patil, G. P. and Taillie, C. (1979): *An overview of diversity*. – In: Grassle, J. F., Patil, G. P., Smith, W. and Taillie, C. (eds): *Ecological diversity in theory and practice*. International Cooperative Publishing House, Fairland, Maryland, USA.
- Patil, G. P. and Taillie, C. (1982): Diversity as a concept and its measurement. – *J. Amer. Stat. Assoc.* **77**: 548–567.
- Peet, R. K. (1978): Forest vegetation of the Colorado Front Range: patterns of species diversity. – *Vegetatio* **37**: 65–78.
- Peet, R. K., Glenn-Lewin, D. C. and Walker Wolf, J. (1983): *Prediction of man's impact in plant species diversity. A challenge for vegetation science*. – In: Holzner, W., Werger, M. J. A. and Ikusima, I. (eds): *Man's impact on vegetation*. Dr. W. Junk Publishers, The Hague.
- Pielou, E. C. (1969): *An introduction to mathematical ecology*. – Wiley, New York.
- Pielou, E. C. (1975): *Ecological diversity*. – Wiley, New York.
- Rabatin, S. C. and Stinner, B. R. (1989): The significance of vesicular-arbuscular mycorrhizal fungal-soil macroinvertebrate interactions in agroecosystems. – *Agriculture, Ecosystems and Environment* **27**: 195–204.
- Tóthmérész, B. (1993a): DIVORD 1.50: A program for diversity ordering. – *Tiscia* **27**: 33–44.
- Tóthmérész, B. (1993b): NuCoSA 1.0: Number cruncher for community studies and other ecological applications. – *Abstracta Botanica* **17**(1–2): 283–287.

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COMPARISON OF DIVERSITIES OF THREE DIFFERENTLY GRAZED SITES IN IRAN

H. ZAHEDI POUR and G. TURCSÁNYI

*Dept. Botany and Plant Physiology, University of Agricultural Sciences
H-2103 Gödöllő, Páter Károly u. 1, Hungary*

While species abundance models provide the fullest description of diversity data, they are dependent on some fairly tedious fitting test. Another approach to the measurement of diversity, which takes into account the distribution of species abundance, but not actually entails fitting a model is Q-statistic. The Q-statistic is a measure of the inter-quartile slope of the cumulative species abundance curve with no weighting towards either abundant or rare species.

In the present study the upper and the lower quartiles of the cumulative species abundance curves of the floras at three differently grazed sites in Iran were determined and the Q-statistics were calculated. On the basis of calculations it was established that the ungrazed site has higher species richness and is more diverse than the two other sites, and the moderately grazed site is also more diverse than the overgrazed site.

Key words: floristical diversity, Q-statistic, semiarid pasture, sheep grazing

INTRODUCTION

In 1975 May argued forcibly for a standardisation of methods of plotting which would facilitate a more ready comparison of different methods. Although the methods of plotting are widely used in diversity studies, inspection of a rank/abundance plot is not a safe guide to the model that provides the best description of the data. It is necessary to fit formally the model. However, many data sets can be described equally well by both the log-series and the log normal models and it may be difficult for the ecologist to decide which is more appropriate. All these methods need some goodness of fit test to compare the observed and expected frequencies in abundance classes.

An interesting approach to the measurement of diversity which takes into account the distribution of species abundance but not actually entails fitting a model is Q-statistic, proposed by Kempton and Taylor (1978). Anyway, all the other classical diversity statistics do that. The only real difference is that the Q-statistic is a measure of the inter-quartile slope of the cumulative species abundance curve (Fig. 1) and thus, it neglects the frequent and the rare species during the calculations. A more detailed description of the diversity relations is provided by those methods which provides scale-dependent diversity characterizations (Tóthmérész 1993a, 1993b, 1995).

MATERIAL AND METHODS

The investigation was carried out in the area of Mouteh plain (Iran) which is located between 33°23' and 33°29' latitudes as well as 50°29' and 51°53' longitudes with nature reserve areas of 29,000 ha located in it. The nature reserve area was founded by the Nature Protection Organisation of Iran and has been protected since 1960 with the purpose of wildlife management. Mean yearly precipitation of the region is 160 mm. The greatest amount of rainfall occurs in the early spring, and a second precipitation peak with lower total amount and shorter duration occurs in the autumn. Soil is constructed by very fine silt and clay. The maximum temperature occurred in July (38 °C), whereas the minimum occurred in January (−6 °C). Bedrocks of the area are granite with aplitic veins and dikes as well as magmatite. The prevailing plant community of the area is *Artemisietum herbae-albae*.

In each of the three sites (overgrazed, moderately grazed and ungrazed) Whittaker's nested quadrat method (Naveh and Whittaker 1979) with three replications was applied. The abundances of species were recorded in ten 1 m × 1 m quadrats (which means thirty 1 m × 1 m quadrats per each site). Tables showing the numbers of individuals, the numbers of species and the cumulative numbers of species for each site were assembled (Tables 1–3). From these tables the position of the lower and upper quartiles, *i.e.* the points at which 25% and 75% of the species lie were determined using equation (1) (Kempton and Taylor 1976, 1978). The Q-statistic index was calculated using the equation (2) (Kempton and Taylor 1976, 1978).

$$\sum_{1}^{R1-1} n_r < \frac{1}{4} S \leq \sum_{1}^{R1} n_r \quad \text{and} \quad \sum_{1}^{R2-1} n_r < \frac{3}{4} S \leq \sum_{1}^{R2} n_r \quad (1)$$

$$Q = \frac{\frac{1}{2} n_{R1} + \sum_{R1+1}^{R2-1} n_r + \frac{1}{2} n_{R2}}{\ln(R2/R1)} \quad (2)$$

where n_r = the total number of species with abundance R ; S = the total number of species in the sample; $R1$ and $R2$ are the 25% and 75% quartiles; n_{R1} = the number of individuals in the class where $R1$ falls; n_{R2} = the number of individuals in the class where $R2$ falls.

The Shannon-Wiener diversities were calculated by the program package NuCoSA (Tóthmérész 1993a).

RESULTS AND DISCUSSION

Figure 1 provides an indication of the diversity of a community, with no weighting towards either abundant or rare species. An earlier index suggested by Whittaker (1979) was based on a similar idea. Figure 1 is based on the data collected in the overgrazed area on the Mouteh plain, Iran, illustrates how the Q-statistic is calculated. The x-axis shows abundance on a logarithmic ($\log_{10}$) scale, while the cumulative number of species is given on the y-axis, and $R1$, the lower quartile, is the species abundance at the point at which the cumulative number of species is 25% of the total. Likewise $R2$, the upper quartile, marks the point at which

Table 1

Calculation of the lower and upper quartiles of the cumulative species abundance curve of an over-grazed site of Mouteh plain in Iran

Species	Number of individuals	Number of species	Cumulative number of species	Quartiles
<i>Ziziphora tenuior</i>	5	4	4	
<i>Bellevia longistyla</i>	5			
<i>Carex stenophylla</i>	5			
<i>Ajuga</i> sp.	5			
<i>Scleranthus</i> sp.	6	2	6	
<i>Caesalpinia orientalis</i>	6			
<i>Launaea acanthodes</i>	11	2	8	Lower quartile 0.25 S = 8 R1 = 11
<i>Tulipa biflora</i>	11			
<i>Torularia torulosa</i> subsp. 1	12	1	9	
<i>Torularia torulosa</i> subsp. 2	13	1	10	
<i>Ephedra strobilacea</i>	14	1	11	
<i>Acanthophyllum</i> sp.	16	1	12	
<i>Leontice minor</i>	18	1	13	
<i>Scariola orientalis</i>	20	2	15	
<i>Astragalus vanillae</i>	20			
<i>Eremopyrum boneapartis</i>	22	2	17	
<i>Astragalus glaucocanthus</i>	22			
<i>Bromus tectorum</i>	25	1	18	
<i>Valerianella dufresnia</i>	37	1	19	
<i>Stachys inflata</i>	41	1	20	
<i>Noaea mucronata</i>	44	1	21	Upper quartile 0.75 S = 21 R2 = 44
<i>Strigmostemum sulphureum</i>	69	1	22	
<i>Holosteum umbellatum</i>	73	1	23	
<i>Rumeria hybrida</i>	74	1	24	
<i>Alyssum</i> sp.	89	1	25	
<i>Alyssum murale</i>	127	1	26	
<i>Lappula microcarpa</i>	157	1	27	
<i>Artemisia herba-alba</i>	186	1	28	

Number of individuals = 1133

Number of species = 28

75% of the cumulative number of species is found. The Q-statistic is a measure of the slope between these quartiles.

Tables 1, 2 and 3 show the numbers of individuals, the numbers of species, the cumulative numbers of species as well as the 0.25 S, 0.75 S, R1 and R2 values of the overgrazed, ungrazed and moderately grazed sites, respectively. Figure 1, on the example of the overgrazed site, graphically shows how the Q-statistic was calculated.

Values of the Q-statistics for the diversities of the overgrazed (Q1), ungrazed (Q2) and moderately grazed (Q3) sites, respectively, are as follows: $Q1 = 4.32$, $Q2 = 9.74$, $Q3 = 5.05$.

The Shannon-Wiener diversities of the overgrazed, ungrazed and moderately grazed sites are 1.17, 1.21 and 1.07, respectively. The evenness of all investigated sites is 0.84.

It has been well-documented that the abundances of rare species may lead sometimes to bias in the calculation of diversity. The calculation of Q index (Kempton and Taylor 1976, 1978) does not take into consideration the lower and upper quartiles of species abundances. According to Tables 1–3, the species richness of the samples of the ungrazed site is higher (28 species) than that of the two other sites (25 in the overgrazed, and 19 in the moderately grazed sites, respectively). It was found that the diversity of the ungrazed site measured by Q-statistic, because of the high evenness of the interquartile species abundances, is also higher than that of the two other sites. The diversity of the moderately grazed site is, in spite of the lower species number, also higher than that of the overgrazed site. The explanation is, that grazing by animals in the overgrazed area provides

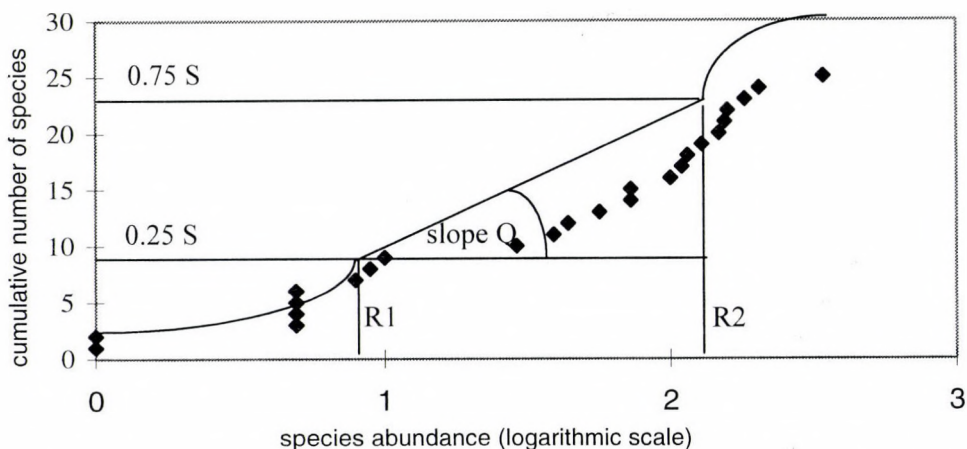


Fig. 1. Q-statistic of species abundances of an overgrazed area in the Mouteh plain in Iran, showing how the Q-statistic was calculated.

Table 2
Calculation of the lower and upper quartiles of the cumulative
species abundance curve of an ungrazed site of Mouteh plain in Iran

Species	Number of individuals	Number of species	Cumulative number of species	Quartiles
<i>Launaea acanthodes</i>	9	2	2	
<i>Bellevallia longistyla</i>	9			
<i>Hernardia persica</i>	10	1	3	
<i>Astragalus glaucocanthus</i>	12	1	4	
<i>Scorzonera</i> sp.	13	1	5	Lower quartile 0.25 S = 5 R1 = 13
<i>Bromus tectorum</i>	27	1	6	
<i>Eremopyrum boneapartis</i>	29	2	8	
<i>Torularia torulosa</i> subsp. 2	29			
<i>Torularia torulosa</i> subsp. 1	32	1	9	
<i>Noaea mucronata</i>	34	1	10	
<i>Caesalpinia orientalis</i>	37	1	11	
<i>Valerianella dufresnia</i>	39	1	12	
<i>Rumeria hybrida</i>	62	1	13	
<i>Strigmostemum sulphureum</i>	89	1	14	
<i>Holosteum umbellatum</i>	94	1	15	Upper quartile 0.75 S = 15 R1 = 94
<i>Lappula microcarpa</i>	147	1	16	
<i>Artemisia herba-alba</i>	196	1	17	
<i>Alyssum</i> sp.	237	1	18	
<i>Alyssum murale</i>	238	1	19	

Number of individuals = 1343

Number of species = 19

better conditions for the invasion of poisonous or spinous weed species (*Polygala amara*, *Peganum harmala*, *Onopordum* sp., *Echinops* sp.). A comparison of Tables 1 and 3 also shows that the omission of the upper quartiles resulted in a higher evenness in the case of the moderately grazed site than in the case of the overgrazed one. The impact of the invasion of weed species and of the increase of the dominance of some species onto the diversity of the overgrazed site is shown by its higher Shannon-Wiener index as well. Thus, in such cases the Q-statistic seems to be more indicative of the diversity connected with the degree of degradation of pastures, than the Shannon-Wiener index.

Table 3
Calculation of the lower and upper quartiles of the cumulative
species abundance curve of a moderately grazed site of Mouteh plain in Iran

Species	Number of individuals	Number of species	Cumulative number of species	Quartiles
<i>Polygala amara</i>	1	2	2	
<i>Peganum harmala</i>	1			
<i>Onopordum</i> sp.	5	4	6	
<i>Scleranthus</i> sp.	5			
<i>Stachys inflata</i>	5			
<i>Echinops</i> sp.	5			
<i>Euphorbia</i> sp.	8	1	7	Lower quartile 0.25 S = 7 R1 = 8
<i>Caesalpinia orientalis</i>	9	1	8	
<i>Thevenotia persica</i>	10	1	9	
<i>Noaea mucronata</i>	29	1	10	
<i>Eremopyrum boneapartis</i>	39	1	11	
<i>Androsace maxima</i>	44	1	12	
<i>Torularia torulosa</i> subsp. 2	56	1	13	
<i>Valerianella dufresnia</i>	72	1	14	
<i>Bromus tectorum</i>	73	1	15	
<i>Astragalus tribuloides</i>	99	1	16	
<i>Rumeria hybrida</i>	109	1	17	
<i>Torularia torulosa</i> subsp. 1	114	1	18	
<i>Stigmostemum sulphureum</i>	129	1	19	Upper quartile 0.75 S = 19 R2 = 129
<i>Artemisia herba-alba</i>	151	1	20	
<i>Ceratocephalus falcatus</i>	154	1	21	
<i>Holosteum umbellatum</i>	157	1	22	
<i>Alyssum</i> sp.	182	1	23	
<i>Lappula microcarpa</i>	204	1	24	
<i>Alyssum murale</i>	338	1	25	

Number of individuals = 1999

Number of species = 25

REFERENCES

- Kempton, R. A. and Taylor, L. R. (1976): Models and statistics for species diversity. – *Nature* **262**: 818–820.
- Kempton, R. A. and Taylor, L. R. (1978): The Q-statistic and the diversity of floras. – *Nature* **275**: 252–253.
- Kempton, R. A. and Wedderburn, R. W. M. (1978): A comparison of three measures of species diversity. – *Biometrics* **34**: 25–37.
- Magurran, A. E. (1988): *Ecological diversity and its measurement*. – Croom Helm Ltd., London.
- May, R. M. (1975): *Patterns of species abundance and diversity*. – In: Cody, M. L. and Diamond, J. M. (eds): *Ecology and evolution of communities*. Harvard University Press, Cambridge, MA, pp. 81–120.
- Naveh, Z. and Whittaker, R. H. (1979). *Measurements and relationships of plant species diversity in Mediterranean shrublands and woodlands*. – In: Grassle, J. F., Patil, G. P., Smith, W. and Taillie, C. (eds): *Ecological diversity in theory and practice*. International Co-operative Publishing House, Fairland, MD, 365 pp.
- Tóthmérész, B. (1993a): NuCoSA 1.0: Number cruncher for community studies and other applications. – *Abstracta Botanica* **17**: 283–287.
- Tóthmérész, B. (1993b): DivOrd 1.50: A program for diversity ordering. – *Tiscia* **27**: 33–44.
- Tóthmérész, B. (1995): Comparison of different methods for diversity ordering. – *Journal of Vegetation Science* **6**: 283–290.

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COMPARATIVE STUDY OF STOMATA AND SOME OTHER PROPERTIES IN THREE NEW CROATIAN WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES

D. ZIMA¹, T. BACIC¹, M. BEDE² and Z. ZAHIROVIC¹

¹Faculty of Education, University J. J. Strossmayer, L. Jägera 9, 31000 Osijek, Croatia

²"Agrygenetics" and Faculty of Agriculture, Ribarska 1, 31000 Osijek, Croatia

In this paper the number of stomata was compared with leaf surface area, length of stem and main components of yield such as length of spike, number of spikelets and number of grains per a spike, mass of grains per a spike and mass of 1000 grains in three new Croatian genotypes including their parents, the standard varieties "Zitarka" and "Hercules". The results presented indicate some positive and often significant correlations between the number of stomata and the yield. In comparison with the standard variety "Zitarka" the new genotypes have been distinguished by some improved properties, e.g. by a longer spike, a greater number of spikelets and grains per a spike and by a larger mass of grains in a spike. However, in no one genotype was recorded a higher mass of 1000 grains, which is one of the best indicators of the yield, in relation to "Zitarka". The most productive of all genotypes is the Genotype-1.

Key words: *Triticum aestivum* L., genotype, variety, stomata, stem, leaf, leaf surface area, yield

INTRODUCTION

The investigations presented in this paper are the continuation of our research on the new Croatian wheat genotypes obtained by crossing "Zitarka", a variety created in the Institute of Agriculture in Osijek, Croatia, and "Hercules", a variety created in the Institute of Agriculture in Szeged, Hungary.

Like the genotypes investigated previously (Zahirovic *et al.* 1995), these have also been selected by M. Bede in the "Agrygenetics", a Company for plant breeding and nursing in Osijek, with the same aim, of increasing the yield of "Zitarka" and to keep the resistance to drying of "Hercules". However, contrary to the earlier investigated genotypes, in the obtaining of these "Zitarka" was used as a female, and "Hercules" as a male parent.

The genotypes studied here were as follows:

Genotype-1: AG-5 139/2 – 93, Genotype-2: AG-5 139/1 – 93 and Genotype-3: AG-6 139/3 – 93.

In order to recognize the new properties of the genotypes mentioned, both varieties were also included in the study.

The research comprised a comparison of number of stomata with leaf surface area, length of stem and length of spike, number of spikelets and number of grains per a spike as well as a mass of 1000 grains.

MATERIAL AND METHODS

Ten plants of each of three genotypes and ten plants of each of two varieties were used for the research. The plant sampling was done from the experimental field of the "Agrygenetics", near Osi-jek, in the phase of heading, on May 24, 1995.

Two leaves, first (younger) and third (older), of each plant sampled were gathered for stomata and leaf surface research.

Microscopical preparations for stomata number determination were done by a modified replica method. Stomata were counted from ten microscopic fields on the top, middle and base leaf regions, on their adaxial side. The enumerated number of stomata per each microscopic field was subsequently converted into 1 mm^2 .

The determination of leaf surface area was done with a polar planimeter and the determination of length of stem and of spike with a metre scale. The yield was established by counting the number of spikelets and of grains per a spike and by measuring the mass of grains per a spike as well as by measuring the mass of 1000 grains with an analytical pair of scales.

All the mentioned parameters, except stomata number and leaf surface area, were determined with four repetitions which were made in the phase of fertility, on July 7, 1955.

The results obtained were statistically analysed with analyses of variance and "t" test using Microsoft Excel 7 and Microsoft Word 7. In "t" test the difference was significant at $p > 2.101$ (*) and coefficient of correlation was $> \pm 0.4$ (*) and $> \pm 0.6$ (**).

RESULTS

The analysis of research has revealed the following:

NUMBER OF STOMATA

The number of stomata ranged from 38.0 to 77.0 or in average from 54.0 to 58.0 per mm^2 . As far as the leaf region is concerned, the largest number was mostly recorded on the leaf base, whereas the smallest one on the leaf top. The differences among regions have often been statistically significant.

Concerning the leaf position, there has been found a significantly increased number of stomata on the first leaf compared to the third one both within the two varieties and within the three genotypes.

The results of the study as regard to a particular variety and genotype show a significantly higher number of stomata in "Hercules" than in "Zitarka" and so does in Genotype-2 in relation to Genotypes-1 and 3. Only Genotype-2 had a higher number of stomata than both varieties, whereas Genotypes-1 and 3 had nearly the same number as "Zitarka" (Fig. 1, Table 1).

LEAF SURFACE AREA

As was expected, the leaf surface area was dependent on the leaf position. On the first leaf it varied from 17.6 to 60.8 cm^2 while on the third it was from 21.02 to

Table 1

Experimental values of the "t" test for the leaf surface area, length of stem, length of spike, number of spikelets and grains per a spike, mass of grains per a spike and mass of 1000 grains

	Leaf surface area	Length of stem	Length of spike	Number of spikelets per a spike	Number of grains per a spike	Mass of grains per a spike	Mass of 1000 grains
"Hercules"/"Zitarka"	1.628	3.538*	9.143*	4.016*	8.630*	6.663*	1.847
"Hercules"/Genotype-1	1.572	2.473*	7.860*	3.095*	0.963	2.983*	3.450*
"Hercules"/Genotype-2	1.973	0.319	8.433*	4.685*	3.613*	3.809*	1.570
"Hercules"/Genotype-3	2.520*	1.621	6.926*	2.420*	2.470*	3.164*	2.047
"Zitarka"/Genotype-1	0.424	1.245	1.325	9.121*	10.035*	4.766*	4.630*
"Zitarka"/Genotype-2	0.326	4.016*	0.384	1.073	7.171*	3.047*	2.882*
"Zitarka"/Genotype-3	3.698*	5.314*	2.526*	7.398*	8.127*	4.496*	3.573*
Genotype-1/Genotype-2	0.804	2.940*	0.869	9.591*	3.380*	1.270	1.333
Genotype-1/Genotype-3	4.210*	4.326*	1.174	0.488*	1.510	0.247	1.845
Genotype-2/Genotype-3	4.005*	1.380	2.020	7.925*	1.401	1.042	0.111

56.2 cm². In average it ranged from 28.1 to 39.0 cm² and from 26.05 to 42.05 cm² respectively. In both varieties and in all genotypes examined, with the exception of Genotype-1, the first leaf had a larger leaf surface than the third leaf (Fig. 2). When both of them were compared it was noticed that the leaf surface area of "Zitarka" was larger than that of "Hercules", and of Genotype-1 larger than those of Genotypes-2 and 3. The leaf surface area of Genotype-1 was even larger than were those of both parents. However, the differences in this parameter were insignificant between both parents and between the genotypes. Only Genotype-3 had significantly the smallest leaf surface area (Table 1).

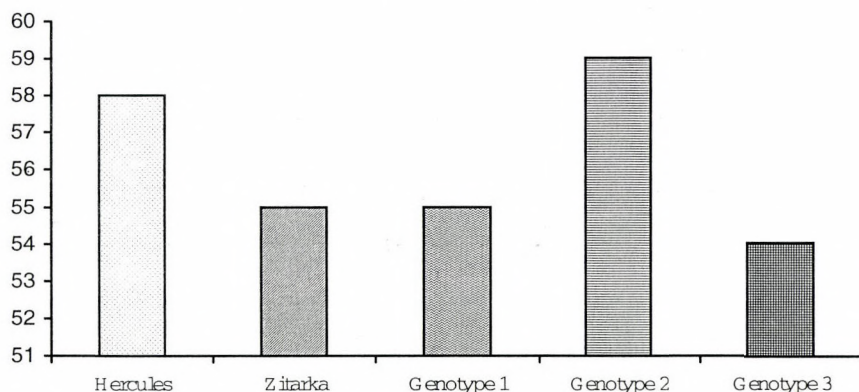


Fig. 1. The average number of stomata per mm²

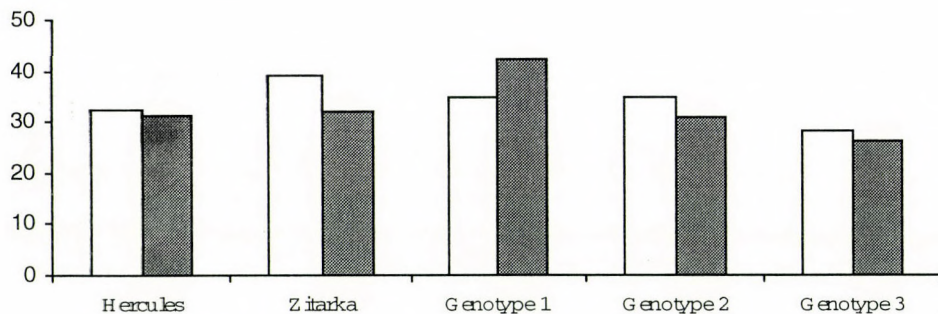


Fig. 2. The average leaf surface area in cm^2 for the first and third leaf

LENGTH OF STEM

The length of stem was within the range of 67 to 90 cm. For a particular variety and genotype it amounted from 76 to 81 cm. As is seen in Fig. 3, the significantly longer stem was measured in "Zitarka" than in "Hercules"; and in Genotype-1 than in Genotypes-2 and 3. All three genotypes had a shorter stem in comparison with the stem of "Zitarka", whereas two of them, Genotypes-2 and 3 had a shorter stem than was the stem of "Hercules". The significantly shortest stem was measured in the Genotype-3 (Table 1).

LENGTH OF SPIKE

The length of spike varied from 73 to 105 cm or in average from 87 to 102 cm. The data in Fig. 4 indicate longer spikes in "Hercules" within varieties, and in Genotype-3 within genotypes. The spikes of "Hercules" were the longest, where-

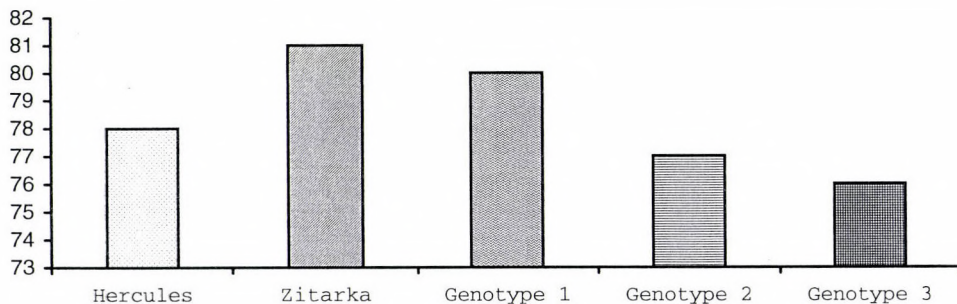


Fig. 3. The average length of stem in cm

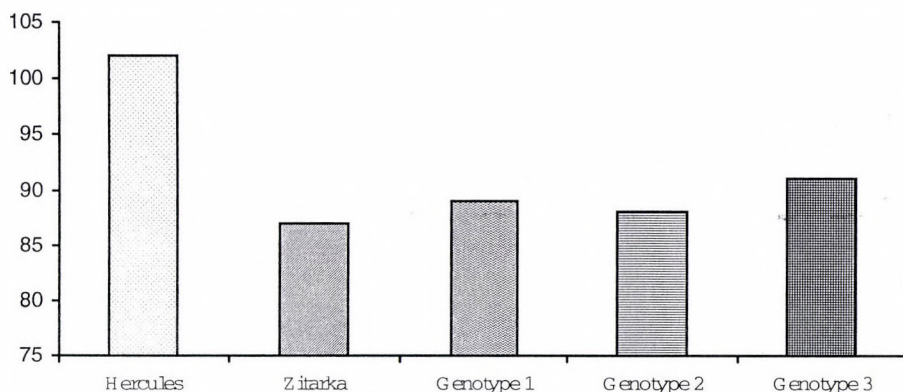


Fig. 4. The average length of spike in mm

as the spikes of "Zitarka" were the shortest. Statistically significant differences in this parameter were recorded between "Hercules" and "Zitarka", between "Hercules" and all three genotypes as well as between Genotypes-2 and 3 (Table 1).

NUMBER OF SPIKELET PER A SPIKE

The spikes consisted of 13 to 23 spikelets or in average of 33 and 51, respectively. Within varieties the spikes of "Hercules" consisted of significantly more spikelets than those of "Zitarka", while within genotypes the spikes of Genotypes-1 and 3 had more spikelets than spikes of Genotype-2 (Fig. 5). Also, a significantly greater number of spikelets was recorded in spikes of Genotypes-1 and 3 than in spikes of both parents and of Genotype-2 (Fig. 5, Table 1).

NUMBER OF GRAINS PER A SPIKE

The minimal and maximal number of grains per a spike was 27 and 77 or in average 33 and 51, respectively. The greatest number of grains per a spike was counted in "Hercules" and the smallest one in "Zitarka". Within genotypes more grains in a spike were recorded in spikes of Genotype-1 in relation to the spikes of Genotypes-2 and 3 (Fig. 6). There were significant differences between "Hercules" and "Zitarka", between "Hercules" and Genotypes-2 and 3, between "Zitarka" and Genotype-1, as well as between Genotype-1 and Genotype-2 (Table 1).

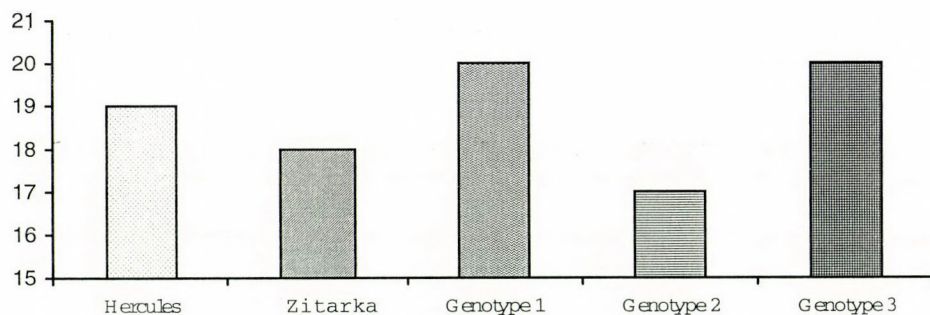


Fig. 5. The average number of spikelets per a spike

MASS OF GRAINS PER A SPIKE

The minimal and maximal mass of grains per a spike was 572 and 2860 mg, which make the average of 1364 and 1984 mg, respectively. As it is seen in Fig. 7, "Hercules" had a significantly greater average mass of grains per a spike not only in relation to "Zitarka" but also in relation to all three genotypes. All three genotypes, however, had a significantly larger mass of grains per a spike than "Zitarka" (Table 1).

MASS OF 1000 GRAINS

The mass of 1000 grains ranged from 19.782 g to 52.286 g or in average from 35.575 g to 40.989 g. The largest average mass of 1000 grains was measured in "Zitarka" and the smallest one in all three genotypes (Fig. 8). Genotypes-1 and 3

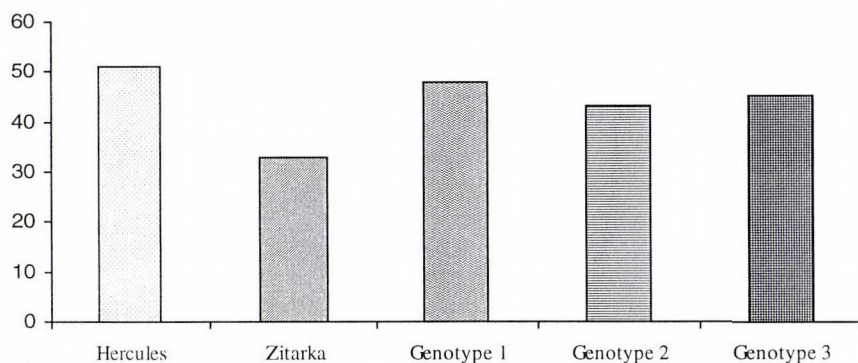


Fig. 6. The average number of grains per a spike

had a significantly smaller mass of 1000 grains than "Hercules" while Genotypes-2 and 3 exceeded "Zitarka" (Table 1).

CORRELATION BETWEEN NUMBER OF STOMATA AND OTHER QUANTITATIVE CHARACTERS WITHIN VARIETIES AND GENOTYPES

This parameter had the following values:

	Coefficient of correlation				
	"Hercules"	"Zitarka"	Genotype-1	Genotype-2	Genotype-3
Number of stomata on the first/on the third leaf	0.378	0.147	-0.314	0.357	-0.111
Number of stomata/surface area of the first leaf	-0.508*	0.831**	-0.171	0.127	0.112
Number of stomata/surface area of the third leaf	-0.610**	-0.088	0.007	-0.171	0.363
Number of stomata/length of stem	0.552*	0.251	0.755**	-0.152	0.261
Number of stomata/length of spike	0.279	-0.131	-0.412*	0.464*	0.005
Number of stomata/number of spikelets per a spike	0.293	-0.222	0.026	0.422*	0.444*
Number of stomata/number of grains per a spike	0.418*	0.409*	0.086	0.120	-0.028
Number of stomata/mass of grains per a spike	0.542*	0.318	0.679**	0.018	-0.331
Number of stomata/mass of 1000 grains	0.316	0.149	0.126	-0.113	-0.475*

DISCUSSION

As has previously been pointed out (Zahirovic *et al.* 1995) genetical breeding of the wheat (*Triticum aestivum* L.) in Croatia during the last thirty years has resulted in obtaining a relatively great number of varieties and genotypes some of which are recognized in Europe as being of the first class. The Croatian varieties and genotypes are characterized by a genetical potential for fertility of ten tons per acre. But, efforts are being made now to increase it to fifteen tons per acre.

So far the largest changes in breeding have occurred in the stem. In comparison with the older varieties which had the stem of about 140 cm long, the new ones, as is the well-known standard variety "Zitarka", are distinguished by a

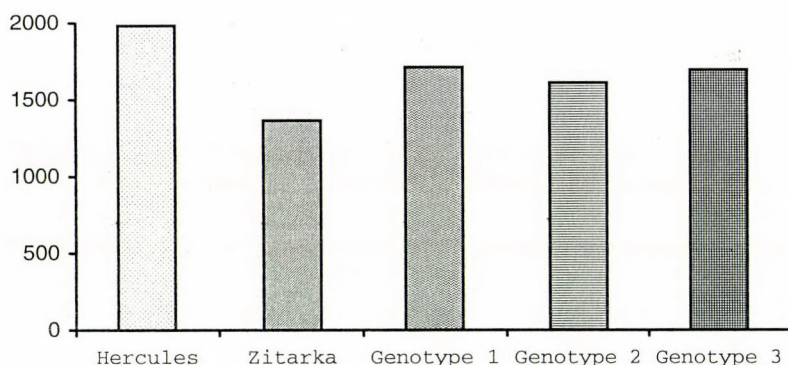


Fig. 7. The average mass of grains per a spike in mg

much shorter stem, of about 70 cm. The changes of the stem were accompanied with the increased harvest index, from 0.30 to 0.45, and this resulted in the increased yield. So far instance it is found that out of our eight new genotypes even five had a higher fertility than their parents (Bede *et al.* 1996).

It is thought that in further increasing of genetical potential an important role should be devoted to the leaves.

Since the stomata are very important for the gas exchange and indirectly for the photosynthesis, their study and comparison with other properties of the wheat plants has long been in focus. As has already been stressed too (Zahirovic *et al.* 1995) there are literature data on comparison of stomata with other wheat features. Some of the data show a lesser number of stomata (Rinjit *et al.* 1983), from 25 to 37 per mm² in average, than was the number found in our genotypes and varieties (from 54 to 58 per mm²), some suggest either the same way of stomata

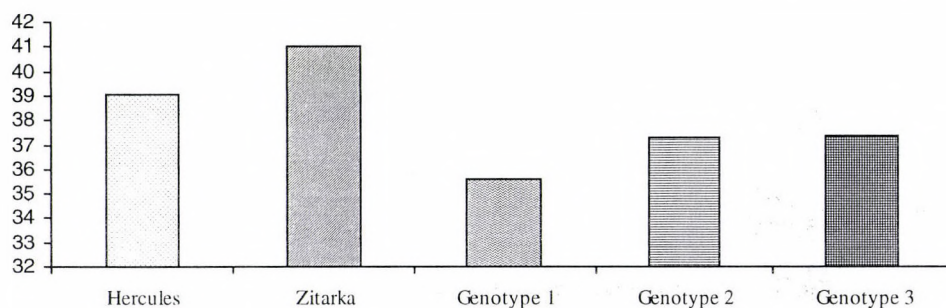


Fig. 8. The average mass of 1000 grains in g

fluctuation by to the regions, from top to the base (Teare *et al.* 1971), others show an opposite tendency to our findings (Benkova *et al.* 1968, Göbö and Kubjatko 1971), but many studies also show a greater number of stomata in the first than in the third leaf as a result of their development in different life conditions (Benkova *et al.* 1968, Miskin and Rasmusson 1970, Teare *et al.* 1971). Besides this, Janjatovic *et al.* (1972) have found, as we have, the same tendency of leaf surface area with regard to leaf position on the stem. They also stated a close occurrence on the length of stem as ours, but as far as the mass of grains per a spike is concerned they found a smaller mass (860 to 1460 g) in comparison with our findings (1.364 to 1.984 g).

The correlation data presented here indicate mostly positive and often significant correlations between the number of stomata and the yield *e.g.* between the number of stomata and the number of spikelets per a spike, between the number of stomata and the number of grains per a spike and between the number of stomata and the mass of grains per a spike.

There is, however, a trend of negative correlation between the number of stomata and the leaf surface area (the same occurrence was reported by Janjatovic *et al.* 1972), between the number of stomata and the length of spike as well as between the number of stomata and the mass of 1000 grains (Table 1).

The results presented here suggest not only positive correlations between the number of stomata and the yield but also the differences between the varieties and between genotypes examined. In relation to the standard variety "Zitarka", as one of the parents of these genotypes which was used in crossing with "Hercules" with the aim of increasing the wheat properties, it is evident that all three genotypes are distinguished by a longer spike, a greater number of spikelets and grains per a spike and by a larger mass of grains per a spike. Besides this, the Genotype-1 is characterized with a greater leaf surface. However, it should be stressed that no genotype had recorded with a higher mass of 1000 grains in relation to "Zitarka" but also in relation to "Hercules". It is obvious that the Genotype-1 can be considered as the best one.

The comparison between these genotypes and the genotypes previously examined (Zahirovic *et al.* 1995) shows that in the length of stem and in the leaf surface area of the third leaf the significant differences are noticed.

*

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REFERENCES

- Bede, M., Martincic, J. and Maric, S. (1996): *Genetska varijabilnost komponenti uroda zrna AG – kultivara ozime pšenice*. – Novi izazivi v poljodelstvu. Zbornik simpozija, pp. 145–147.
- Benkova, M., Göbbö, A. and Kubjatko, F. (1968): Zmenö poctu prieduchov pocas ontogenezy pri niektorych liniach ozimej pšenice. – *Acta fitotechnica* **17**: 15–26.
- Göbbö, A. and Kubjatko, F. (1971): *Anatomicko-morfologickadetectia intenzivnosti ozimej pšenice*. – Subor referatov zo sympozia, pp. 431–436.
- Janjatovic, V., Andelic, M. and Borojevic, S. (1972): Broj stoma i povrsina lista kod patuljastih i polupatuljastih sorti pšenice. – *Sav. polj.* **20**(4): 45–54.
- Miskin, K. F. and Rasmusson, D. C. (1970): Frequency and distribution of stomata in Barley. – *Crop Science* **10**: 575–578.
- Rinjit, K., Basra, C., Malik, P. and Dhillon, M. (1983): Frequency, size and distribution of stomata in Triticale leaves and its relation to rust infection. – *Indian J. Ecol.* **10**(2): 237–241.
- Teare, D. I., Peterson, C. J. and Law, A. G. (1971): Size and frequency of leaf stomata in cultivars of Triticum aestivum and Triticum species. – *Crop Science* **11**: 496–499.
- Zahirovic, Z., Bacic, T. and Bede, M. (1995): Study on number of stomata and its relation to some other properties in a few new Croatian wheat (Triticum aestivum L.) genotypes. – *Acta Bot. Hung.* **39**(3–4): 271–279.

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BOOK REVIEWS

Editor: K. T. KISS

BUTTERWORTH, F. M., CORKUM, L. D. and GUZMÁN-RINCÓN, J. (eds) (1995): *Biomonitoring and biomarkers as indicators of environmental change*. – Plenum Press, New York & London, 348 pp.

The 37th Conference of the International Association for Great Lakes Research on Biomonitoring and Biomarkers as Indicators of Environmental Change was held 1994 in Windsor, Ontario, Canada, and its proceedings are presented in this book as one of recent ones in Environmental Science Research Series. The purpose of Conference was giving a sum of recent developments and applications in biomonitoring and biomarker research and this book is giving the documents of it.

Monitoring the environment is essential to identify the hazards to human health or to different environmental systems and assess environmental cleanup and even to prevent further degradations of the ecosystems. This monitoring includes the detection of atmospheric pollution, the investigation of chemical pollutants with their potential accumulation in different organisms or their toxic effects and use numerous biochemical or biological test systems from applied molecular biotechnology to plant test systems. The present book gives a mirror for them from molecular tests to humans.

The book deals with the role of insects at first, by assessing ecological risks in terrestrial systems with honey bees (Chapter 2), useful of aquatic insects as biomonitoring (Chapter 3) or larvae of some Chironomidae as indicators for toxicity even for genotoxicity of sediments (Chapter 4). According to these chapters honey bees could sign the cumulative effect of different environmental toxicants like insecticides, PCB's, heavy metals or some trace elements as fluoride.

On other hand the investigations on aquatic insects could solve the problems associated with sediment bioassay including relative toxicity. Using adult insects, too, while the investigations on larvae of Chironomidae might be specific to toxicity during development, e.g. morphological deformities and also to genotoxic effects e.g. by assaying polytene chromosomes.

Several further chapters also deal with genotoxicity of different environmental pollutants on different assay-systems. So, we could read about application of the single cell gel assay to environmental monitoring in different systems (Chapter 6), using lymphocyte proliferation as biomarker (Chapter 7), or chromosomal aberrations and sister chromatid exchanges (Chapter 8). Later is demonstrated on *Vicia faba*, which plant species is widely used in other test for chromosomal aberrations, too. A regional biomonitoring of environmental genotoxicity is reviewed in Chapter 9 for Southwestern Ontario.

The measurement of placental levels of heavy metals are discussed in Chapter 10, while we could read about using human and fish cell lines in Chapter 11. Some further part of book present application of so widely used test-organisms as *Drosophila* or *Tradescantia* in biotests. Even for also genotoxicity, but some different testing methods are presented, too, e.g. a less invasive method to measure cytochrome P450-1A activity.

The role of algal systems in bioassay is reviewed in Chapters 20 and 21. At first in freshwater systems when Chapter 20 is pointing to rapid bioassessment of algal periphyton. Chapter 21 is addressed to development instability as biomonitoring of environmental stress, and useful of other aquatic plants other as algae is also presented.

A further small chapter of the book is the Chapter 22, when two abstracts are presented as descriptions of monitoring systems sent as abstracts only for conference. The first discuss advanced and rapid methods for detection and identification of pathogens in lake water and some other environmental samples, while the second deals with the development of an integrated biological assessment.

Giving a summary, this book contains descriptions 18 biomonitors, and several of them had multiple endpoints involving development, biochemistry, genetics, physiology, and behavior. The presented 20 systems discussed might be divided among the three primary exposure media, as terrestrial, aquatic, and atmospheric. The present volume is also unique in that in addition to describing the background and principles. For these, will be very useful for anybody interested in environmental problems.

E. I. SIMAY

Cox, E. J. (1996): Identification of freshwater diatoms from live material. – Chapman & Hall, London, 158 pp.

I became very curious when I read first about this book. I got it now and I am a little bit disappointed. It is a very good idea to write a book about the identification of living diatoms. People have many problems, many uncertainties investigating (counting) phytoplankton or periphyton samples and they would like to identify as much species as possible in not treated material. Therefore I waited impatiently this book.

“This book represents a first attempt to provide a guide to the identification of common freshwater diatoms from living material. It covers taxa found from oligotrophic upland streams and lakes to eutrophic lowland waters and some slightly brackish habitats. However, it is not exhaustive in its species coverage and rare species have not been included. Nevertheless it should be possible to identify many of them to generic level, after which specialist diatom texts should be consulted. The key is intended to be useful to aquatic ecologists, expert and beginner, only assuming access to a calibrated light microscope equipped light good quality objectives.” (as written in the introduction)

There is a good summary of diatom morphology in the introductory chapter (for light microscopy), then the classification based on Round *et al.* 1990, a brief proposal for collection, examination of diatoms and an illustrated guide to cell shapes, measurements, chloroplast features and colony types. The author consider the chloroplast feature important in identification of living diatoms.

The main chapter of the book involve a preliminary key of 21 diatom-groups (two for centrics and 19 for pennates), then enumeration of genera included in subsequent group keys and 21 keys to species within group. This order and structure of keys doesn't follows the “traditional taxonomic order” of diatoms. We try to identify several species of each group by the keys. There are the summarised characteristics of a few hundred species included in keys with drawings about the half of them. The reduced (poor) characteristics of a group or species theoretically helps the identification of taxa, but practically can result misidentification in many cases (*e.g.* differentiation of *Stephanodiscus* and *Cyclotella* genera). Sometimes there are contradictions between descriptions and drawings. Here only one example: *Skeletonema potamos* “Very delicate cells, 3–6 μm wide, 4–10 μm deep, about 5 spines in 10 μm , solitary or forming short chains (Fig. 10b)”. First what does it mean “wide, deep”? With the help of other description we can understand it, wide = diameter, deep = height (the size of pervalvar axis). It means that the cell (the frustule) of *S. potamos* is longer than its diameter. The Fig. 10b shows a two cells chain, where the height of cell is about the half of its diameter. *S. potamos* has no spines! The spine like elements on the valve edge are the elongated external tubes of marginal fultoportulae. How can the author measure the number of “spines” in 10 μm in living material, when cells are in girdle view? *S. potamos* usually forms chains of 2–12 cells and they are rarely solitary (I am afraid the author has never seen *S. potamos*).

The last chapter of the book is a good summary for generic accounts with ecological notes on species in the keys. This is useful for algologists, ecologists, if they can identify diatoms in living material.

If author writes the book for “aquatic ecologists, expert and beginner”, she should use correct terms and should be careful, accurate in short descriptions too. It will be dangerous, if “aquatic eco-

logists, expert and beginner" will use this book for identification and by this way they will establish whatever about a water body.

I can recommend this book with doubt for "aquatic ecologists, expert and beginner". The book is interesting and I think is a good but first attempt to find the possibility to identify diatoms in living material. I think we never will able to identify them only in living material, but we have to look for all possibilities to do it. Therefore I recommend this book for algologists as a base for further research.

K. T. KISS

DAVIDIAN H. H. (1995): The *Rhododendron* species. Volume IV. *Azaleas*. – Timber Press, Portland, Oregon, 184 pp., 163 colour plates, 25 full page line drawing.

The author gained his experience with the genus in the Royal Botanical Garden in Edinburgh, which is one of the European centres of early *Rhododendron* introductions. This book is the fourth volume in a series: in the previous volumes the *Lepidotes* (Vol. I), and *Elepidotes* (Vols II and III) *Rhododendrons* have been published.

Volume IV comprises the *Azalea* Series of the *Rhododendron* species with the following Subseries: *Canadense* (6 taxa), *Luteum* (23 taxa), *Nipponicum* (1 taxon), *Obtusum* (83 taxa), *Schlippenbachii* (10 taxa).

The monograph is rigorously structured. It starts with the motivation of the adopted classification system, followed by a glossary of terms, description and presentation of leaf and flower shapes used in different diagnoses. The characterisation of the Series and a key to the subseries is also presented. The different subseries are also typified and described. The differential diagnoses of the species are presented in the form of identification keys.

Every species is described nomenclaturally (valid names and synonymies with necessary quotations) and is presented iconographically (source of basic illustration), followed by a large morphological description, the presentation of the history of the species, its distribution and the description of the natural habitat. The main introduction records are based mostly on data from the Arnold Arboretum, the Royal Botanical Garden (Edinburgh) and the Royal Botanical Gardens (Kew). The introduction of the newly discovered and/or described species in cultivation is focused on Britain (sometimes with references on continental Europe as well). From Europe Holland, Germany and Russia are mentioned in this volume, without any references on the very large *Rhododendron* collections outside this countries, as for example from Western Hungary (Jeli, Kámon, which attract yearly tourist during the *Rhododendron* flowering season from all Europe and even from USA, China, Korea or Japan, countries frequently mentioned in the book). Beside the introduction data, further interesting data regarding the recognition's, prizes and awards a taxon received during its cultivation history are also mentioned in the pages. This part is finished by a short explanation of the English meaning of the scientific species names, the hardiness categories and the flowering period of the species.

At the end of the volume some doubtful taxon names, synonyms or hybrids, a short list of little known species, an extensive index of synonymous taxon names, an Index of *Azaleas* and a General Index have been included.

For the practical gardener the synoptic presentation of the main characteristics of the described cultivated azalea species (species name, subseries, plant high, flower colour, hardiness category and flowering period) are of special interest.

The book is fascinating for various reasons. For an applied botanist for example is a wonderful sample to evaluate the history, the dynamics and the degree of domestication of a genus used in cultivation only for the enrichment of the human environment: about 1% of the taxa presented in this volume have been described in 17th century, 8% in the 18th century, 31% in the 19th century and about 60% in our century (30% even in the second part of our century !). About a half of the species described (43%) are recorded as introduced in cultivation, mostly during the last century

and 20% of the mentioned taxa have been recognised as plants of special environmental value (1% in the 19th century, about 12% in the first half, and 8% in the second half of our century).

This is a scientifically well-documented series on *Rhododendrons*, with volumes useful in every *Rhododendron* collection worldwide. The coloured plates, black and white illustrations, the typography and the editorial work meet also the highest standards of a scientific monography.

T. A. SZABÓ

LANGE-BERTALOT, H. and METZELTIN, D. (1996): Indicators of oligotrophy. 800 taxa representative of three ecologically distinct lake types. Carbonate-buffered – Oligodystrophic – Weakly buffered soft water. – In: Lange-Bertalot, H. (ed.): *Iconographia Diatomologica*, Annotated Diatom Micrographs. Vol. 2. Ecology – Diversity – Taxonomy. Koeltz Scientific Books, Königstein, 390 pp. (125 plates with 2428 figures).

The diatom flora of three ecologically different types of oligotrophic lakes was investigated. These types of lakes are becoming more and more rare in Europe and even outside it. Generally, species living in oligotrophic waters are much less known than the mostly cosmopolitan, frequent and abundant diatoms of eutrophic waters. The three studied lakes are the following:

- Julma Ölkky (Finland) is an extremely electrolyte poor and humic acid rich lake. A single sample here contained 502 taxa, includes morphotypes that at the moment have no formal taxonomic rank.
- Weinfelder-Maar (in the Eifel, West Germany) is an electrolyte rich, humic acid free and clear water lake. 216 taxa were found from several samples of the lake.
- Mittersee (Austria) is characterised with CaCO_3 or HCO_3 . It is a well-buffered relatively electrolyte rich lake.

As 213 taxa (from a total 1036) occurred in two or all three of lakes studied. The number of different taxa comes to 823 or even some more, if the uncertain species are included. This represents about 51% of the total number of c. 1600 taxa published in the "Süßwasserflora von mitteleuropa" for all of Europe. Notable is the fact that this number includes over 300 halophilic, resp., mesohaloblic species, that for ecological reasons cannot occur in the three lakes investigated.

Authors mention in the abstract: "Of the c. 800 taxa documented here, over 150 could not be identified, an astonishing 25% of the total. Our patchy knowledge of the diversity in oligotrophic waters of the relatively well-represented region of Europe is underline this. Fifty-five of these are here described as new, and further 31 are recognised as being new taxa but formally described elsewhere. Forty-six other taxa are probably new. The remaining 80 entities cannot be identified or their identification is uncertain. From the established taxa, 66 were treated as a nov. comb., nov. stat. or nov. nom. Two new genera (ex. *Navicula s.l.*) are described: *Geissleria* and *Chamaepinnularia*."

It was a good idea that the book has a bilingual introduction, summary of findings and discussion (English and German). Systematic, taxonomic part is written in alphabetical sequence, description are bilingual too (Latin and German), additional explanation in German. Morphological characterisations of taxa and descriptions of new ones are detailed and clear, the micrographs are very good and useful for identification. By this work our knowledge became much more complete concerning on taxonomy and ecology of diatoms.

I warmly recommend this excellent and rich iconography, this manual to all algologists and applied hydrobiologists working with phytoplankton and periphyton. This book is indispensable for all diatomists studying diatoms of lakes and rivers, too.

K. T. KISS

LAPPIN-SCOTT, H. M. and COSTERTON, J. W. (1995): Microbial biofilms. – Cambridge University Press, New York, 310 pp.

This is the fifth part of the Plant and Microbial Biotechnology Research series which is an excellent summary of our knowledge about the microbial biofilms.

In nature and disease, microorganisms tend to be associated with surfaces, in so-called biofilms. Though this has long been recognised the far-reaching consequences of this association have attracted attention only recently. The development of complex attached and aggregated communities is important for the survival and reproductive success of microorganism. These biofilms occur on both inert and living systems, making them important to a wide range of scientific disciplines.

The book is divided three parts after the introduction. The first provides a general discussion of the chemical, ecological and physical processes involved with the development of biofilms and their interaction with surfaces. Extensive reviews have dealt with the activities of microorganisms at surfaces, but little on the actual genetic responses of microorganisms at surfaces. One of the chapters is to consider the environmental conditions existing at gel-air and solid-water interfaces, as well as in biofilms, and to relate these conditions to possible genetic responses in the immobilised bacteria. The next part deals with biofilms on non-living surfaces. Biofilms have important engineering implications, such as mineralised bacterial biofilms in sulphide tailings and in acid mine drainage systems, microbial consortia in industrial wastewater treatment and biofilms influenced corrosion. The author offers a biogeochemical perspective of the specific biofilms formed by colonisation of the sulphide mineral surfaces by *Thiobacillus ferrooxidans* and examines the interaction between bacteria other than *T. ferrooxidans* and acid mine drainage (AMD) effluents in the natural environment and assess the potential outcome of these mineralization processes in terms of geological time scales. The final part examines the interaction with living surfaces. Biofilms have medical significance when associated with the mouth, urinary tract and urogenital tract. The aim of one of the chapters will be to review our current knowledge of the microbiology of dental plaque, with particular emphasis on properties that relate to its biofilm structure. In addition, biofilm from in plant root systems and in animals, for example in the ruminant digestive tract, and so are agriculturally important. The biofilm established on the surface of a plant root is an integral part and influential factor in the ecology of the plant and rhizosphere.

The book is well-illustrated with good quality drawings, light and electron microscopic pictures. The book will be a valuable aid in the many areas of pure and applied science and in industry where biofilms are of importance, including microbiology, applied chemistry, biotechnology, medicine, water technology. I can recommend mainly researchers dealing with the biofilms, but this book is also useful for biology student and microbiologist.

J. MAKK

LENZENWEGER, R. (1996): Desmidiaceenflora von Österreich, Teil 1. – In: Kies, L. and Schnetter, R. (eds): Bibliotheca Phycologica, Band 101. J. Cramer, Berlin–Stuttgart, 162 pp.

The first data about desmid species of Austria was published by Petsch and Schiedrmayr (1872). Later some dozen paper appeared about this interesting group, therefore it is important this book of Lenzenweger. He started to study the desmid flora of Austria more then twenty years ago and he summarises his knowledge now.

We find here the method of sampling and investigation in detail. There are important data about ecology of desmids in the fourth short chapter. In this case, ecology means first of all dependence on pH. Several species is found in oligotrophic water at low pH (2.4–4.5) others in oligotrophic-subneutral march, or near at the neutral pH (6.5–7). Altogether 8 different ecological types are enumerated.

The taxonomic chapter starts with a good illustrative compilation of all genera found in Austria, with the name and drawing of the most frequent species. Then each genera is characterised briefly, which is followed by a key of species. Keys are well-compiled and usually there are drawings in

the keys to help of determination of taxa. Author gives the morphological characteristics of all species and varieties, with a figure of them. Most part of drawings are excellent but sometimes their magnification is too small to see all morphological details. May be this is the only fault of the book.

Nine genera and altogether 163 species are discussed here (5 *Gonatozygon*, 9 *Penium*, 59 *Closterium*, 10 *Pleurotenium*, 2 *Docidium*, 3 *Tetmemorus*, 40 *Euastrum*, 16 *Micrasterias* and 20 *Actinotenium*). The places of occurrence are given for each species and a few ecological data in several cases.

Lenzenweger published a good taxonomical book which is useful for identification of desmids. Awaiting the second volume of this book, I warmly recommend it to all algologists, botanists. I think it good for basic systematic and for university education too.

K. T. KISS

LUDES, B. and COSTE, M. (1996): *Diatomées et médecine légale. Application de la recherche des diatomées au diagnostic de la submersion vitale*. – Tec. & Doc. Lavoisier, 258 pp. (11, rue Lavoisier, F 75384 Paris Cedex 08; price: 325 FF)

Authors published a unique book, missed till now for specialist. Diatoms are in the focus of interest of algologists, taxonomist and they are used widely in the practice. A special aspect is the criminology. How are diatoms useful to find the cause of death on a corpse in the water.

The first chapter is a short summary of our knowledge about diatoms (biology, ecology and classification of diatoms), with morphological characteristics of the frustule, with description of the effect of current, temperature, pH in the water, the effect of salinity, trophity and organic matter content on diatoms. There is a large and important table about the ecological characteristics of $\approx$ 400 diatom taxa. The chapter finishes with a summarised characterisation of the important freshwater genera and with the key of all genera. This key in tabular form seems to be not really useful for people with poor knowledge about diatom taxonomy.

In the chapter 2 there is a clear description of methods used in sampling and treating of diatoms from different waters and presentation of results after microscopic investigation, using different indexes (with a good example on Tables 10–11, how to use them). Authors characterise the physiopathology of drowning in chapter 3 and its different possibilities (drowning by accident or suicide or murder etc). Then you find the different techniques in detail for the extraction of diatoms from the tissues.

It is very difficult for specialist how to interpret results. It is important to study different aquatic locality nearby of drowning, to analyse the diatom flora of different water bodies during the whole year, to have a better knowledge about its seasonality too. With a large example of 40 different cases in the chapter 5, authors help us to learn and apply techniques of diagnostic in water quality and forensic medicine.

For an algologist the most valuable part of the book is the 32 plates of micrographs. There are several hundred excellent light- and scanning electron-micrographs, unfortunately with a few mistakes in determination: e.g. Plate II, Figs 1–2 seems to be *Skeletonema potamos* too, like Fig. 3. Plate III, Fig. 17 seems to be a *Stephanodiscus* sp. and not *Actinocyclus normanii*, Plate VI, Fig. 4 is a *Stephanodiscus invisitatus*, not *S. hantzschii*). On the other hand these small mistakes do not reduce the real value of the book.

We can recommend this book to algologists, applied hydrobiologists and of course specialists working in forensic medicine institute, but it is useful for all specialists working with diatoms of lakes and rivers.

K. T. KISS

NIKOLOV, H. (1996): Dictionary of Plant Names in Latin, German, English and French. – J. Cramer, Berlin–Stuttgart, 926 pp.

The present dictionary of the Bulgarian author lists more than 14,500 generic names and the same number of species plus 1600 synonyms recognized in approximately 600 families of plants, bacteria included. Nearly all genera of economic, horticultural, medicinal or industrial importance are included. Genera of tropical regions and of lower plants are particularly represented. The first part of this dictionary is an alphabetical list of scientific generic (**bold**) and family (*italics*) name with a representative species (**bold**), and if known, its German, English and French vernacular names (each followed by D, E and F, respectively, in normal type) as found in various publications or regional treatments. The vernacular name is marked with 'N' type, if it is in another language. Synonyma are in *italics* relating with arrow to their correct name in **bold**. The hybrid parent genera are listed on the line beneath the hybrid name; each parent is separated by the traditional 'x'. The second part of the dictionary lists the vernacular names in all three languages (normal type) in alphabetical order. Each name (normal type) is followed by its language abbreviation and its scientific name (*italics*). Although this collection is a result of many years and research containing the more important genera, and it is useful for translations, the pity is his several insufficiency. It proved to be ever unfortunate a fusion of phanerogam and cryptogam names in that kind of dictionary. That is the majority of the cryptogam genera and species have rarely vernacular names. In addition, it contains a lot of phanerogam names without vernacular names at all. In this way, contrasted with the aim of the dictionary, one can see only enumeration of scientific names with its Latin family names successively in the pages, similarly to the Willis dictionary (1972). On the other hand, many vernacular names are missing, especially in French. Instead of frequent repetition of the same names (D, E, F) in separate lines mainly in the second part, could be introduced further genus names or more representative species. The requirement of the completeness is coming up as usual for a dictionary, but its realisation as in our case seems to be very difficult because of the mass of names and aspects. Nevertheless, this dictionary is practicable and intended for students, translators, scientists, physicians, hobbyists and others interested in botany.

Z. KERESZTY

NOAD, T. C. and BIRNIE, A. (1992): Trees of Kenya. – General Printers Ltd. Nairobi, 308 pp.

"Let them be left" – the poet G. M. Hopkins's painful exclamation is cited on the first page of the book written by two eminent African botanists as a most timely warning to all readers and particularly to the young to prevent the greatest sin of environmental destruction in our age: mass deforestation. As a part of the rich tropical plant world, the book presents *ca* 300 of the most frequent trees and shrubs of Kenya's vascular flora. The authors wished to present an all-round scientific field guide, easy to handle also by tourists, to facilitate general orientation and a look into the rich Kenyan dendric flora for those interested. Since only the most frequently occurring wild and cultivated dendric species were selected, the usual identification keys are replaced by pictures. Handling is made easy by grouping the 58 plant families alphabetically. Short family characterizations include the principal morphological features, the distribution and the possibilities of economic and industrial utilization of the representative species as well as the genera living in the country. The species inside the families are dealt with separately also in the alphabetical order of their scientific names. The English and local denominations as well as the place of origin of the plants are also given. The more important micromorphological marks are followed by the data relating to locality and distribution; in some cases, the history of their introduction is given. The possibility of utilization in nutrition are dealt with in detail.

Though rather unusual with this type of books, the authors supported by their experience of long standing, describe in a very useful way, the methods of propagation, planting and maintenance of the plants, including the special conditions of their protection. A bibliography, also comprising the full and complete literature on the subject, a morphological vocabulary, a register with the entire

list of names; also the country's rough political map with provinces and sites are given. An extremely practical addition is the cm and inch scale on both hard covers, permitting precise measurements on the spot. In order to facilitate the identification, each species is illustrated with excellent drawings by A. Birnie. In addition, 18 full-page coloured illustrations serve the easy recognition of the particular species. The book makes excellent reading and may be recommended to all our nature-loving friends, gardeners, teachers and specialists in particular to those dedicated to the investigation and cultivation of tropical plants all over the world.

Z. KERESZTY

OLRIK, K. (1994): Phytoplankton – ecology, determining factors for the distribution of phytoplankton in freshwater and sea. – Miljøprojekt 251, Nofo Print, Elsinore, 183 pp.

Planktonic eutrophication is the most common civilised illness of the freshwater today. The last twenty years produced an enormous development in phytoplankton investigations, both theoretically and practically. The author of this book gives us an “up-to-date” summary, a modern synthesis of knowledge of ecological factors relevant to phytoplankton, based on her own investigations in Danish waters and a very rich international literature. For the first time, freshwater (except: rivers) and marine phytoplankton aspects are considered together.

The author presents the theme in the following chapters:

- Ecological theories (the niche concept, the equilibrium theory, the non-equilibrium theory, the theory of plenitude, Connell's “Intermediate Disturbance Hypothesis”).
- Resources (light energy, kinetic energy and hydraulic mixing, seasonal variations of the euphotic zone and the mixing depth, phytoplankton nutrient requirements).
- Phytoplankton physiology (light adaptation, chlorophyll concentration, growth rates, nutrient uptake, nutrient storage, N-fixation: utilisation of dissolved atmospheric N, heterotrophic nutrition, temperature, salinity, CO₂ and pH).
- Loss processes (hydraulic washout, sedimentation, form resistance, sinking rates and physiological conditions, swimming physiological stress, mortality, grazing).
- Phytoplankton adaptation strategies and successions (environmental limitations on phytoplankton, strategies, surface/volume ratio, distribution patterns, succession and competition for resources, variations and mass occurrences in Danish waters).
- List of annexes (phytoplankton organisms, the Plankton Ecology Group-model, freshwater phytoplankton groupings, phagotrophic free-living dinoflagellates).

The project presents a basis of evaluation in ecology as fundamental importance to the assessment of the water quality. This publication is useful for hydrobiologists, algologists as well in the training of persons who have no or little experience in phytoplankton research.

Publisher of this project is the Ministry of the Environment, Denmark, Danish, Environmental Protection Agency and it is also very important to know: this is the 251st published environmental project!

A. SCHMIDT

PIZZARO, H. (1995): The genus *Characiopsis* Borzi (Mischococcales, Tribophyceae). Taxonomy, biogeography and ecology. – Bibliotheca Phycologica 98. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart, 113 pp. 11 Plates.

The last general work about the Xanthophyceae and inside them about the *Characiopsis* genus was published about twenty years ago in the Pascher's Süßwasserflora von Mitteleuropas series by Ettl (1978). Pizzaro observing natural populations of *Characiopsis* species from Argentina marked difference between some and those from the literature of the rest of the world was noticed. This in-

cluded him to make a characterisation of the genus *Characiopsis* from the taxonomic, biogeographical and ecological points of view.

The taxonomy of the *Characiopsis* genus is completed on the basis of the compilation made by Ettl (1978), plus other taxa added afterwards and Pizarro's observations on different populations from a variety of environments and substrata from North-eastern Argentina. Besides 11 species and 22 varieties new for the science, 2 new records for Argentina and the Southern Hemisphere were described. Eight complexes of taxa exhibiting a close morphological similarity among them, thus being a continuum, were also established.

A study of basic characters used for taxonomic assignments was performed by means of cluster analyses, in the order to assess the variability pattern of *Characiopsis* species. The genus is characterised from both ecological and biogeographical points of view, stressing preferences of substrata and type of environment.

First the class Tribophyceae and the genus *Characiopsis* is characterised by the author. Then the studied environments and substrata are briefly described. The chapter "Systematics" starts with the key of 77 *Characiopsis* species and several varieties including the eight species complexes. We have to mention that without any experience in the taxonomy of the genus not too easy to use the key. Description of species is clear, to know the substrata where the species occurred and its geographic distribution is important. There are several excellent drawings about the taxa helping their determination.

We point out that geographical distribution of taxa is important, but not complete. The reason is our weak knowledge about the genus. Several taxa were recorded only from the former Czechoslovakia and Argentina, because there were good specialists of the *Characiopsis* species.

We hope this good work will help and encourage the algologists to examine this interesting group of algae and our knowledge increases. I recommend the book of Pizarro for algologists working with freshwater phytoplankton or periphyton. The book can be helpful for taxonomists and in university education, too.

K. T. KISS

REICHARDT, E. (1995): Die Diatomeen (Bacillariophyceae) in Ehrenbergs Material von Cayenne, Guayana Gallica (1843), Mit einem Anhang von Jahn, R.: Ehrenberg's marked species on five mica. – In: Lange-Bertalot, H. (ed.): *Iconographia Diatomologica*, Annotated Diatom Micrographs. Vol. 1. Taxonomy. Koeltz Scientific Books, Königstein, 107 pp.

It is the first volume of the series *Iconographia Diatomologica*. After a short description of material and methods, authors presents the results of the investigation of Ehrenberg's material (No. 1108) from Cayenne in French Guayana. This collection is the type-material of many important and widespread diatom species. Authors had a small quantity of material available and there was a relatively poor amount of diatoms, most of the taxa described by Ehrenberg could be identified. They are discussed in the book and documented by more than 311 light- and electron-micrographs. Lectotypes for the following species have been chosen: *Eunotia camelus*, *E. pileus*, *E. quaternaria*, *E. quinaria*, *E. tridentula*, *E. zygodon*, *Himantidium guianense*, *H. papilio*, *Pinnularia amphigomphus*, *Stauroneis anceps*, *S. gracilis*, *S. lineolata*, *S. phylloides*. In addition two new species were described (*Gomphonema archaevibrio*, *Pinnularia pseudocardinalis*) and *Stauroneis anceps* f. *gracilis* Rabh. was raised to species level. There is shorter or longer description of morphological characteristics of several taxa, with LM and/or SEM micrographs (sometimes more than 10 from one species). At the end of description we find a summary and confrontation of the diatoms mentioned by Ehrenberg from the material Cayenne and those actually found during the present investigations.

In addition micrographs of R. Jahn are published about the marked species on five original mica from the Ehrenberg-collection, with critical remarks on future work on this collection.

I warmly recommend this excellent and rich iconography to all algologists and applied hydrobiologists working with phytoplankton or mainly with periphyton. This book is indispensable for all diatomists studying diatoms of lakes and rivers.

K. T. KISS

ROGERS, A. (1995): *Peonies*. Illustrated and with an essay on landscaping by Linda ENGSTROM. – Timber Press, Portland, Oregon, 269 pp. 143 colour plates, white-and-black drawings.

Allen Rogers, the former director of the Perennial Plant Association of the United States of America and a practical peony breeder for decades was captivated by this plant almost 70 years ago. This book is a summary of his lifelong experience as a gardener and peony nursery manager. The title of different chapters reflects the pragmatic approach of the author: 1. *The peculiar charms and speciality uses of Peonies*, 2. *The modern peony and its hybridizers*, 3. *Species*, 4. *Recommended cultivars*, 5. *Culture*, 6. *Propagation*, 7. *What future holds*, 8. *Getting started commercially*. The same is true for the useful indexes regarding I. *Peonies Cultivation Worldwide*, II. *Nursery Sources*, III. *Landscaping with Peonies* etc. The recommended *Reading and sources*, as well as a complete *Index of cultivars* are also attached to the book.

Reading the volume from cover to cover (it was a pleasant task, due to its captivating and clear style and fascinating set of data) the reviewer was interested especially in the evolution of peonies under domestication. Focusing on domestication process and present state of cultivation in the genus a wonderful man made biodiversity enrichment process emerges before the eyes of the reader.

The story of peony domestication in Europe begins perhaps with the Greek legend of Paion, the student of Asclepius engaged in rivalry with his teacher risking to be killed by the master's jealousy. Paion was saved by his heavenly patient Hades who transformed him (according to the legend) in a medicinal herb named now *Paeonia officinalis*. Plinius considered this plant the most ancient of all medicinal herbs. In the middle age the peony root was also a foodstuff of the poor (but our studies did not confirm this opinion). It is present in the renaissance herbalism and present day ethnobotany as well.

The European history of cultivation (which represents of course the roots of American traditions, too) is very sketchy. For the American reader is of no interest, of course, that in Central Europe for example the culture of the peonies was favoured by Turkish invasion. Hence its Hungarian name: ba(z)sarózsza – the rose of the pasha.

The same is true for the Chinese ethnobotanical peony tradition: the reader is advised to consult the book of Foster and Chongsi (1992: *Bringing Chinese Medicine to the West*). The modern Chinese contribution to *Paeonia* evolution under domestication is somewhat larger presented.

From the point of view of peony evolution the most exciting chapter of the book is the second one, dealing with peony hybridisation. The story seems to begin in 1784, when the Chinese *lactiflora* cultivars "took Europe by storm". These double petalled *lactiflora* types (Chinese peonies) were crossed around 1800 in English and French nurseries with the autochthonous Mediterranean material and the rising diversity caused also a fashion: large fields were cultivated with the new ("French") varieties. The boom of the market spreaded in the mid-19th century to USA and lasted until the second World War, when highway transportation favoured strongly the fashion of many nontraditional flowers and reduced the demand to peonies.

The easy to cultivate and transport peony, with its perennial habit (and a life span equalling with that of the human one) was an important species of the home gardens of early American pioneers. It represents now sometimes even a respect for the ancestors. This is exemplified in the book by a documented case of tree peony brought across the prairies around 1860, transplanted several times since its 1500 mile journey, being now a living monument of American history.

Peonies were remarkably successful immigrants of the home gardens worldwide. The presentation of about 34 different, mostly American gardeners, botanists, breeders and that of the *American Peony Society (APS)*, contributing to the success story of peony domestication and evolution is a

collection of remarkable data of these processes. For more details the reader is advised to consult G. Kessenich (1976): *History of the Peonies and Their Originations* – a database of the American Peony Society.

The survey follows both practical and theoretical criteria, grouping first the species into tree peonies and herbaceous ones. In tree peonies (Sect. Moutan, Subsect Vaginatae) *P. suffruticosa* was known for a long time only in cultivation. This species was first found in the wild only in 1913. From an evolutionary point of view the radically new thesis of Hong *et al.* (1992) is worth to cite here: "... plants previously designated as *Paeonia suffruticosa* are in fact cultivars developed in China (later in Japan) over a period of centuries and were derived from various crosses between four wild species newly described" by Hong and his associates: *P. ostii* – the wild tree peony which served as a main genetic base for the cultivars, *P. jishanensis*, *P. rockii* and *P. yananensis*.

To subsection Delavayana belong species discovered in China toward the end of the 19th century (*P. delayi*, *P. lutea*, *P. potaninii*, all possible belonging to a single collective species).

In the presentation of herbaceous peonies the classification of Stern (1946: *A Study of the Genus Paeonia*) and that of Ray Cooper are followed (Cooper 1988: *Survey of the Paeony Species in the Light of Recent Literature*, republished in an abbreviated form by Rivière 1992). In Sect. Onaepia just two diploid North American species are included (*P. brownii* and *P. californica*) with no contribution to the domestication and man directed evolution of the genus. In Sect. Paeonia subsect. Foliolatae the tetraploid ($2n = 20$) "*officinalis*" complex has one of its natural gene centres in the territory of historical Hungary (*P. officinalis* subsp. *officinalis* and subsp. *banatica*). Subsp. *microcarpa* and subsp. *villosa* grow only in southwest Europe. The two endemic taxa (*P. clusii* subsp. *clusii* and subsp. *rhodia* from Crete and Rhodos) belong undoubtedly also to this complex. The most interesting member of the subsection is *P. mollis* known only in cultivation. According to Cooper there is also a Caucasian group (*P. macrophylla*, *P. molkosewitschii*, *P. wittmannia*, the questionable *P. steveniana*, *P. chameleon* etc.), a Mediterranean group (*P. mascula* ag. with subsp. *mascula* distributed from Italy to Turkey, subsp. *atlantica* in Algeria, subsp. *coriacea* in the Atlas Mts and Spain, subsp. *arietina* in E-Europe, subsp. *hellenica* cultivated in Greece, subsp. *russii* in Italy and Greece, subsp. *triternata* in Crimea and further closely related species such as *P. parnassica* in Greece, *P. broteroi* a diploid from Spain and Portugal, *P. cambesedesi* a diploid from the Balearic Islands, *P. kesrounanensis* in Syria, *P. turcica* from Anatolia etc.).

The "Asian members" of the subsection are diploids and are even less clearly delimited taxonomically as the European ones (*P. emodi* used also in hybridisations is from the Himalayas, *P. japonica* from N. Japan, *P. mairei* from central China, *P. obovata* from Siberia to Japan and the *P. lactiflora* is native from Siberia to N. China). This last species was the ancestor of the majority of garden peonies beginning with 1800. It is the most important species in *Paeonia* evolution under domestication yielding thousands of cultivars and hybrids.

In subsection Dissectifoliae there are also two "groups" of species:

- *P. peregrina* agg. (syn. *P. decora*, *P. lobata* etc. and its hybrids with *P. officinalis*) and *P. tenuifolia* agg. (incl. Caucasian subsp. *biebersteiniana*, subsp. or sp. *lithophila*, *carthalinica* and natural hybrids with *P. mascula* subsp. *triternata*),

A	
856.	1
862.	1
886.886	2
893.893.890	3
B	
05.07	2
12.16.17	3
20.22.27.28.28.28.28	7!
30.30.32.33.33.33.35.35.36.37.37.38.38.39	14!!!

41.43.46.46.49	5!
50.51.51.51.55.56.59.59	8!
66.67	2
72.75.76.78	4
81.81.85.87	4

– *P. anomala* agg. is a diploid species group with *P. anomala* var. *anomala* from Ural, Pamir and Siberia, var. *intermedia*, syn. *P. hybrida* var. *intermedia* from Altai to Kola Peninsula and several “good” species such as *P. beresowskii*, *P. sinjiangensis*, *P. veitchii* all from China, and *P. sterniana* from Tibet. These species are cultivated only in collections.

For the collection, cultivation, preservation and study of peonia species a *Species Peonies International Network* (SPIN) has been organized with enthusiasts located in temperate world, encouraging species peony cultivation in the artificial landscape.

The book of Allen Rogers is an outstanding contribution for the study of peony evolution under domestication. Looking just on years in which the different cultivars have been released the dynamics of the evolution clearly emerge.

Cultivar release in genus *Paeonia* based on a sample of herbaceous cultivars: cultivars with names beginning with letter A (Data from: Rogers 1995. A: Released in 19th century, B. Released in 20th century, C. Cultivar release year unidentified in the case of 17 samples).

Working not just with a small one letter sample, but with the full database, it would be perhaps much more evident the steady growth of the number of cultivars released during the 19th century, the tide of interest between 1920–1940 and the collapse of peony cultivation during the Second World War. A slow recovery started around 1951 and we just hope in a further growth in near future. This book is a good contribution to this trend.

T. A. SZABÓ

SIMS, P. E. (ed.) (1996): An atlas of British diatoms (illustrated by H. G. BARBER and J. R. CARTER, arranged by B. HARTLEY). – Biopress Limited, 601 pp. (Biopress Ltd. The Orchard, Clanage Road, Bristol, BS3 2JX, England)

It is a special book of drawings about diatoms of British freshwater, brackish and littoral marine species. It was an idea of Barber, one of the foremost amateur diatomist of England, to publish his drawings in an “atlas”. Barber was not only a diatomist, he was also an accomplished artist. He has brought together both these skills in this book for us to appreciate. Over a period of some forty years, he was assisted in this work by three other diatomists, R. I. Firth, J. R. Carter and B. Hartley, who were in close contact each other, exchanged material and slides, and discussed problems of taxonomy and allied matters.

At the time of Barber’ death, this drawing collection consisted of some 299 plates containing 6332 detailed illustrations (all drawn to a scale of $\times 1900$). During his work, illustrations were also circulated for comments and to check them to many diatomist. Therefore no doubt, Barber had actually seen all these forms, and that not were copied from the work of previous illustrators.

Carter assisted in the work of revision and prepared a further 600 detailed line drawings to the same scale to supplement those species which had not been included in the original work. Barber and Carter used microscopes with first-class objectives (1.3 apochromatic). It is known that Barber worked to an upper limit of resolution of 30 striae/puncta in 10 μm and Carter using very high magnification eyepieces could discern up to 50 striae in 10 μm .

This book now completed contains 6152 detailed drawings covering almost all known British diatoms (some 2000 species, except of real marine ones). There are several drawings from one species, showing their morphological variability. Most part of species are determined, but several is mentioned only by genus name.

A short introductory chapter and classification of British diatoms is followed by the long series of plates (Plates 1–290). All the plates have been prepared to the same scale, and a bar scale of 100 μ m appears at the base of each plate for comparison of size. The plates have been arranged in alphabetic order of genera. In the text of plates, a broad indication is given of the locality where each species is to be found (B – brackish, F – freshwater, M – marine, FF – freshwater fossil).

I warmly recommend this excellent and rich iconography to algologists, applied hydrobiologists working with diatoms. This book is indispensable for all diatomists studying diatoms of lakes and rivers.

K. T. KISS

VAN DEN HOEK, C., MANN, D. G. and JAHNS, H. M. (1995): *Algae, an introduction to phycology*. – Cambridge University Press, Cambridge, 623 pp.

The book gives an up-to-date, summarising and accurate introduction into phycology. It includes 32 chapters with some new electron micrographs and about 2,000 references. It is intended as a modern overview of morphology, cytology and classification of the algae. This edition is a textbook for advanced undergraduate and postgraduate students.

The authors inform us about that “This book had its origins as course notes to accompany lectures on algae, which were given to biology students in their fourth semester at the University of Groningen. The notes seemed necessary because there had been an enormous increase of knowledge about the morphology and cytology of algae. The present edition is a completely revised and updated English version of the original German textbook, published by Thieme 1978 (a second edition appeared in 1984). A thorough revision had been made necessary by the multitude of new papers that appeared, detailing the results of ultrastructural, molecular and life-history studies. The classification of the green algae (chlorophyta) has been completely revised, and many advances have also been made of other divisions. The various levels of organisation have apparently arisen many times. The taxa based on organisational level have been maintained only when there is no more satisfactory modern alternative.”

The structure and the chapters of the book are clear, the morphological, cytological characters illustrating the classes and orders. The evolutionary processes are well-understandable with the help of the numerous accurate drawings, figures and diagrams.

The book is recommended to all botanists, algologists and the medium and high level education should not lack for this excellent work, which contains the clear modern results of phycology.

H. M. SHAFIK

VERMA, D. P. S. and SHOEMAKER, R. C. (eds) (1996): *Soybean: genetics, molecular biology and biotechnology*. – CAB International, Wallingford, UK, 270 pp.

Soybean is one of the most important crop plants leading sources of food and feed protein and seed oil, while it is grown extensively. This volume, published in series *Biotechnology in Agriculture*, focuses to the recent results are available during studies of this Legume. However the eleven chapters are not grouped for the different viewpoints represented in the book, the chapters well document the different levels of the studies mentioned.

The germplasm diversity of the genus *Glycine* is discussed in Chapter 1, and a table is also presented for summarising the species of both subgenera *Glycine* and *Soya*. So, we could find the 18 species, including the cultivated *G. max* and its wild progenitor *G. soya*, in this table with their

distribution. Several other tables are also served for demonstrating the works with this plant genus genebank, and a figure, too with demonstration of a summary of genetic relationships based on cytogenetics and seed protein profiles in the subgenus *Glycine*.

Chapter 2 is dealing with molecular genetic mapping of soybean. This plants contain a rather complex genom and its chromosomal loci represented the variations yielded by breeding, too. On other hand, the further breeding also need a probably precise genetic map. This chapter is presenting it, including the molecular genetic of genome and map-based genotype analyses.

A further type of genetic investigation is discussed in Chapter 3. This is the cytoplasmic genetics, which works both chloroplast and mitochondria, and also resulted some valuable result. Some of them are the mapping of chloroplast genome or the investigation of base of cytoplasmic male sterility. Some cytoplasmic mutants are also mentioned.

The chromosomal and cytoplasmic genetics of plants are mainly based on molecular and phenotypic investigations of stable genetic elements of plants. However some other elements are also usable. This viewpoint, the potential applications of plant transposable ones for gene tagging are represented in Chapter 4. These elements can affect of gene expression and variation, and they might take action in heterologous species, too.

However there are some limitations in genetic manipulation of soybean. These limitations and potentials are pointed out in Chapter 5. This chapter is discussing the different problems and results, but criteria for evaluating new methods of genetic manipulation are also presented. These methods are the different biotechnological methods used for creating more genetic variability or even for evaluate and select the variants.

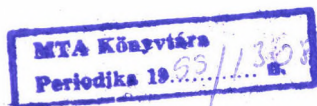
The most important methods for selection are the different *in vitro* systems worked out for different plants. The present book contains a chapter addressed to these *in vitro* methods and this chapter (Chapter 6) also present data about culture-induced variation. These systems are well usable for made breeding materials for different aims, *e.g.* resistance to herbicide or toxic metabolites of some pathogens. But the main purpose of every breeders's work will remain concentrate to the seed production of the soybeans because of its importance.

For this is very important the knowledge of the compositions of the soybean seeds. The current efforts to improve the quantity and quality of soybean seed constituents are examined in Chapter 7. This part of the book contains data about general features of seed development, too. Soybean require different time period for maturity depending on maturity group, genotype and growth conditions, while accumulate different materials. The main ones are the carbohydrates and proteins, but the soybean seed oil has also economic importance and substantial breeding efforts have been expended to alter the fatty acid composition of it. However this chapter is dealing with carbohydrates and proteins including the different types of antinutritional protease inhibiting compounds.

Connecting to the Chapter 7, Chapter 8 reviews the recent results of genetic modification of soybean oil quality. The desired oil qualities and compositions are increased oxidative stability, improved functionality and nutritional quality partial depending on polyunsaturated fraction of fatty acids, and potential usable soybean oil as industrial oil like linseed oil. This part of the book gives a summary of oil biosynthesis, the results of cloning the lipid biosynthesis genes and breeding for oil quality.

Two further parts of this volume (Chapters 9, 10) deal with the nodulation and nitrogen fixation. At first, with molecular genetic analysis of soybean nodulation mutants, which to Chapter 9 summarise the molecular approaches to the plant developmental genes, too, because nodulation is also a plant developmental process controlled different genes. So, there are different mutants and significant efforts were focused on supernodulation gene of soybean, which supernodulation is alteration in the development of a plant organ suppressing or slowing the development of ontogenally younger stages. On other hand knowledge of molecular bases of the genes have role in nodulation and other symbiotic processes might help the works with non-symbiotic plants, too.

Chapter 11 is also a "transforming" part, because we could read about soybean transformation in it, worked out mainly by the transforming *Agrobacterium*. This chapter gives an overview of transformation methods, transformations with different species of mentioned *Agrobacterium*, particle bombardment-mediated transformation or transformation using electroporation of protoplasts. However, these methods work, direct transformation of soybean has not become routine.



By the wide range of themes represented by parts of this volume and the wide literature cited after the chapters, this book might be essential to everybody interested in genetic and molecular biology of plants not only of soybean.

E. I. SIMAY

VYVERMAN, W., VYVERMAN, R., HODGSON, D. and TYLER, P. (1995): Diatoms from Tasmanian mountain lakes: a reference data-set (TASDIAT) for environmental reconstruction and a systematic and autecological study. – In: H. Lange-Bertalot (ed.): *Bibliotheca Diatomologica*. Band 33. J. Cramer, Berlin–Stuttgart, 193 pp.

This volume of the excellent book-series is focused on diatom flora of Tasmanian highland area, comprised diatom records from 76 Tasmanian mountain lakes. The aims of the book is mentioned by authors in the introduction. Diatoms are widely used in the northern hemisphere as indicators of present and past environmental conditions and have become an integral part of biomonitoring programs. Central these studies is the development of reference data-sets and the construction of inference models for specific environmental characteristics, e.g. pH, total phosphorus, salinity.

Authors think that diatom flora of these lakes can well characterise different environmental factors, because of ranging from highly acid, dystrophic lakes to ultraoligotrophic, clearwater lakes. Most of the lakeland is protected, with marked terrestrial and aquatic ecological gradients. It offers the ideal, pristine environment in which to study the relationships between the distribution of diatoms and limnological, climatic, pedagogical and geological gradients and/or discontinuities.

Description of the study area follows by materials and methods. The chapter "results" starts with the principal component analysis of chemical variables of the lakes. The autecology of species is calculated by weighted averaging regression to estimate of individual species' optima and tolerances. In the taxonomical chapter of the book 280 taxa of 35 genera are discussed. A lot of them are widely distributed in lakes and river of each continent. We can find the enumeration of recent reference of each taxon, their light- and/or electronmicrographs, its synonymy, morphology, distribution and ecology. In several cases the morphological characterisation of the taxon is very short, in other cases really detailed. The ecological characterisation of taxa are poor or seems to be similar with distribution. Sometimes species is mentioned, e.g. "occasional in mesotrophic lake" but usually, e.g. "only observed in Lake Curly". So the ecological data are not really useful and difficult to understand why authors mentioned it at every taxon. We can find misdeterminations (on Plate 2, Fig. 1 seems not to be *Cyclotella meneghiniana* by the frequency of marginal fultoportulae, or on Plate 16, Fig. 1 seems to belong to *Cyclotella stelligera* and not to *C. pseudostelligera*), but they do not reduce the value the book. It is well-illustrated, on 42 plates more than 400 LM or SEM micrographs are presented.

We can recommend this monograph showing the diatom flora of an interesting area, to algologists, applied hydrobiologists and also for basic systematic work and university education. This book is useful for all specialists working with diatoms of lakes and rivers.

K. T. KISS



Printed in Hungary
Akadémiai Nyomda, Martonvásár

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 to following components, which should be presented in the order listed:

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2. Text, acknowledgements
3. References
4. Footnotes
5. Tables
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Examples:

- Jakucs, P. (1961): Die Phytozoölogischen Verhältnisse der Flaumeichen-Buschwälder Südostmitteleuropas. – Akadémiai Kiadó, Budapest.
- Fekete, G. and Précsényi, I. (1981): Niche structure of a perennial sandy grassland. – In: Stefanovits, P., Berczik, Á., Fekete, G. and Seidl, M. (eds): Man and the Biosphere Programme. Survey of 10 Years Activity in Hungary. Budapest, 68–102.
- Borhidi, A., Muñoz, O. y Del Risco, E. (1979a): Clasificación fitocenológica 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 ecosystem within the framework of the Biosphere program.) – MTA Biol. Oszt. Közl. **16**: 11–25.

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