THE CHARACTERIZATION OF SOME STANDS FROM CRUCEA FORESTRY DISTRICT USING ECOLOGICAL INDICES OF CORMOPHYTE SPECIES

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Abstract

In this study, four types of stands from Crucea Forestry District have been analyzed, by Ellenberg ecological indices spectrum of cormophyte species that can be found here. Thus, it is intended to highlight the differences from ecological perspective among the four analyzed stands, in terms of species preferences to light, temperature, continentality, soil moisture, soil reaction and nitrogen supply.

Key words: ecological indices, vascular plants, H. Ellenberg

INTRODUCTION

The floristic spectrum found in a certain biocoenosis has grown and developed in close liaison with environmental conditions and also with its own characteristics, a much more obvious fact in the case of forests. Given the complex relationships within forest phytocoenoses at both interspecific level and especially at the relationship level between species and environmental conditions, it was found appropriate to perform an ecological analysis of cormophyte species spectrum in four sample areas accomplished in stands that grow in tougher soil conditions.

The sample areas were made in representative regions of the stands from Crucea Forestry District, Romanian National Forest Administration, Suceava Branch, near Zugreni and Crucea localities on the eastern chain of Eastern Carpathians. They are:

-S_1 in 90D forest unit, working section VII Pârâul Leşului (7SLI2BE1SY, 130 years, 0.6 consistency, districambosoil, 45^0 land slope, southwestern exposition, forest type according to the management plan – mixed Small-leaved lime forest;

- S_2 in 7A forest unit, working section VI Chiril (6NS3BI1SP, 75 years, 0.5 consistency, districambosoil prespodic soil, 45^0 land slope, southwestern exposition, forest type according to the management plan – Norway spruce forest with *Oxalis acetosella* on skeletal soils);

- S_3 in 69A forest unit, working section V Pietrosul (7NS2BI1SY, 130 years, 0.5 consistency, podzol litic soil, 50^0 land slope, northern exposition,

forest type according to the management plan – Norway spruce forest with *Vaccinium myrtillus*);

- S_4 in 89A forest unit, working section V Pietrosul (8NS1BI1ESF, 90 years, 0.6 consistency, podzol litic soil, 50^0 land slope, northwestern exposition, forest type according to the management plan – Norway spruce forest with *Vaccinium myrtillus*).

In Crucea Forestry District the altitude is between 650-1790 m.

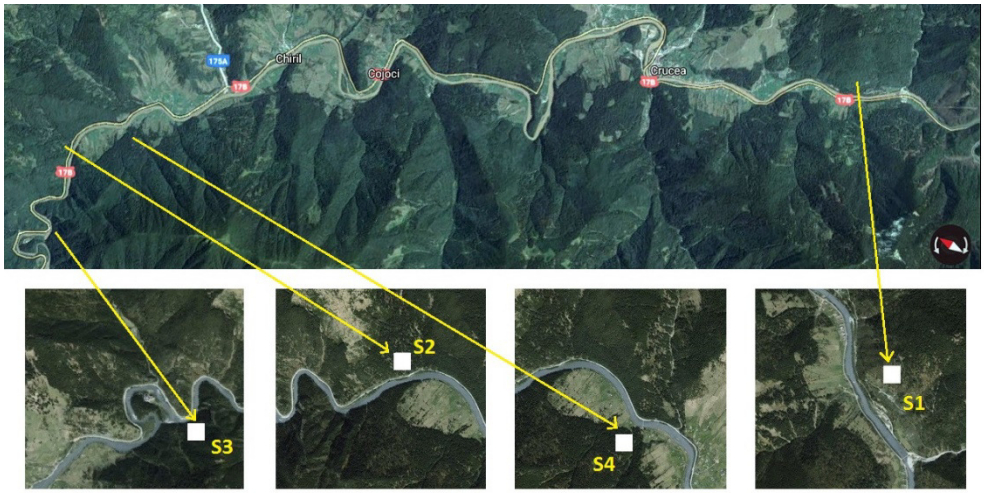


Fig. 1. The location of the four experimental areas

MATERIAL AND METHODS

In each of the four studied stands, one experimental area was materialized, of 10.000 m^2, square shape, with side of 100 m. In the experimental areas, 100 elementary areas, side of 10x10 m, were delimitated and in each of them a wooden square-shaped frame was located, in which all species of cormophyte herbaceous plants, including woody species seedlings, were identified. These data were entered into a field database in order to determine the frequency of each species.

The nomenclature adopted for the cormophyte species identified in the field is that from the study *Flora ilustrată a României – Pteridophyta et Spermatophyta* (Ciocârlan, 2000), a study universally accepted by the Romanian specialists.

In order to note the ecological characteristics of the species, the system elaborated by H. Ellenberg was adopted (Ellenberg, 1974), based on six ecological indices (L - light, T - temperature, K - continentality, F - soil moisture, R - soil reaction, N – nitrogen supply). The indices L, T, K , R and N have values between 1-9 and F index between 1-12, each species having a value of that index which corresponds to its requirements. The species with

a very high amplitude from ecological point of view for a certain index are called amfitolerante species, fact illustrated by the *x* symbol that attends that index.

According to the floristic spectrum identified in each sample area, to the frequency of each species and to the value of ecological indices specific to them, the weighted average of each index for the four studied stands was calculated. There are species for which the ecological indices have not been established, according to the above mentioned study. They appear in the tables but without indices. The indices of the amfitolerante species (those marked with *x*) have not been counted.

RESULTS AND DISCUSSIONS

After covering the field, the cormophyte species were identified, being listed in the table below, in alphabetical order, for each sample area.

Table 1

Ecological indices and their weighted average of the four sample areas

S_1 – Pârâul Leşului													
Frequency (K)	Species (number of species = 46)	Ecological indices											
		L	L_P	T	T_P	K	K_P	F	F_P	R	R_P	N	N_P
4	*Abies alba*	3	0,12	5	0,20	4	0,16	x		x		x	
79	*Acer pseudoplatanus*	4	3,16	x		4	3,16	6	4,74	x		7	5,53
21	*Aconitum toxicum*												
2	*Aegopodium podagraria*	5	0,10	x		3	0,06	6	0,12	7	0,14	8	0,16
1	*Ajura reptans*	6	0,06	x		2	0,02	6	0,06	x		6	0,06
4	*Alliaria petiolata*	5	0,20	6	0,24	3	0,12	5	0,2	7	0,28	9	0,36
1	*Asarum europaeum*	3	0,03	5	0,05	5	0,05	6	0,06	8	0,08	6	0,06
2	*Campanula persicifolia*	5	0,10	5	0,10	4	0,08	4	0,08	8	0,16	3	0,06
5	*Chaerophyllum hirsutum*	6	0,30	3	0,15	4	0,2	8	0,4	x		7	0,35
6	*Clematis alpina*	4	0,24	3	0,18	7	0,42	5	0,3	3	0,18	?	
4	*Cruciata glabra*	7	0,28	6	0,24	4	0,16	5	0,2	6	0,24	6	0,24
8	*Daphne mezereum*	4	0,32	x		4	0,32	5	0,4	7	0,56	5	0,4
35	*Dryopteris filix-mas*	3	1,05	x		3	1,05	5	1,75	5	1,75	6	2,1
17	*Euphorbia amygdaloides*	4	0,68	5	0,85	2	0,34	5	0,85	7	1,19	6	1,02
15	*Fagus sylvatica*	3	0,45	5	0,75	2	0,3	5	0,75	x		x	
21	*Fragaria vesca*	7	1,47	x		5	1,05	5	1,05	x		6	1,26
68	*Galium odoratum*	2	1,36	5	3,40	2	1,36	5	3,4	x		5	3,4
24	*Gentiana asclepiadea*	7	1,68	x		4	0,96	6	1,44	7	1,68	x	
2	*Geranium phaeum*												
23	*Hieracium murorum*	4	0,92	x		3	0,69	5	1,15	5	1,15	x	
22	*Lamium galeobdolon*												
10	*Lathyrus vernus*	4	0,40	x		4	0,4	4	0,4	7	0,7	x	
3	*Lonicera nigra*	3	0,09	3	0,09	4	0,12	5	0,15	R5		x	
81	*Luzula luzuloides*	4	3,24	x		4	3,24	x		3	2,43	4	3,24
28	*Maianthemum bifolium*	3	0,84	x		6	1,68	x		3	0,84	3	0,84
12	*Mercurialis perennis*	2	0,24	5	0,60	3	0,36	x		7	0,84	7	0,84

2	*Mycelis muralis*	4	0,08	5	0,10	2	0,04	5	0,1	x		6	0,12
1	*Picea abies*	5	0,05	3	0,03	6	0,06	x		x		x	
14	*Poa nemoralis*	5	0,70	x		5	0,7	5	0,7	5	0,7	3	0,42
39	*Polygonatum verticillatum*	4	1,56	4	1,56	2	0,78	5	1,95	4	1,56	x	
2	*Polypodium vulgare*	5	0,10	x		3	0,06	x		2	0,04	x	
7	*Populus tremula*	6	0,42	5	0,35	5	0,35	5	0,35	x		x	
12	*Pulmonaria officinalis*	5	0,60	6	0,72	5	0,6	5	0,6	8	0,96	6	0,72
15	*Salvia glutinosa*	4	0,60	5	0,75	4	0,6	6	0,9	7	1,05	7	1,05
3	*Scrophularia nodosa*	4	0,12	5	0,15	3	0,09	6	0,18	6	0,18	7	0,21
6	*Senecio ovatus*	7	0,42	3	0,18	7	0,42	6	0,36	x		8	0,48
2	*Solidago virgaurea*	5	0,10	x		x		5	0,1	x		5	0,1
3	*Spiraea chamaedrifolia*												
10	*Stachys sylvatica*	4	0,40	x		3	0,3	7	0,7	7	0,7	7	0,7
10	*Stellaria nemorum*	4	0,40	4	0,40	4	0,4	7	0,7	5	0,5	7	0,7
1	*Tanacetum corymbosum*	7	0,07	6	0,06	5	0,05	3	0,03	8	0,08	4	0,04
7	*Tilia cordata*	4	0,28	5	0,35	4	0,28	x		x		5	0,35
1	*Urtica dioica*	x		x		x		6	0,06	x		8	0,08
28	*Veronica chamaedrys*	6	1,68	x		3	0,84	4	1,12	x		x	
28	*Veronica montana*	4	1,12	5	1,4	2	0,56	7	1,96	5	1,4	6	1,68
6	*Veronica urticifolia*	3	0,18	4	0,24	4	0,24	5	0,3	7	0,42	7	0,42
Weighted average of indices from A_1			**4,06**		**4,73**		**3,52**		**5,39**		**4,99**		**5,56**

S_2 – Chiril

Frequency (K)	Species (number of species = 14)	Ecological indices											
		L	L_P	T	T_P	K	K_P	F	F_P	R	R_P	N	N_P
1	*Betula pendula*	7	0,07	x		x		x		x		x	
4	*Dryopteris filix-mas*	3	0,12	x		3	0,12	5	0,2	5	0,20	6	0,24
2	*Fagus sylvatica*	3	0,06	5	0,10	2	0,04	5	0,1	x		x	
5	*Galium odoratum*	2	0,1	5	0,25	2	0,10	5	0,25	x		5	0,25
1	*Hieracium murorum*	4	0,04	x		3	0,03	5	0,05	5	0,05	x	
86	*Luzula luzuloides*	4	3,44	x		4	3,44	x		3	2,58	4	3,44
1	*Maianthemum bifolium*	3	0,03	x		6	0,06	x		3	0,03	3	0,03
9	*Picea abies*	5	0,45	3	0,27	6	0,54	x		x		x	
4	*Populus tremula*	6	0,24	5	0,20	5	0,20	5	0,2	x		x	
11	*Senecio ovatus*	7	0,77	3	0,33	7	0,77	6	0,66	x		8	0,88
17	*Sorbus aucuparia*	6	1,02	x		x		x		x		x	
7	*Stellaria nemorum*	4	0,28	4	0,28	4	0,28	7	0,49	5	0,35	7	0,49
85	*Vaccinium myrtillus*	5	4,25	x		5	4,25	x		2	1,70	3	2,55
23	*Vaccinium vitis-idaea*	5	1,15	x		5	1,15	4	0,92	2	0,46	2	0,46
Weighted average of indices from A_2			**4,70**		**3,76**		**4,61**		**5,04**		**2,59**		**3,76**

S_3 – Pietrosul

Frequency (K)	Species (number of species = 58)	Ecological indices											
		L	L_P	T	T_P	K	K_P	F	F_P	R	R_P	N	N_P
3	*Abies alba*	3	0,09	5	0,15	4	0,12	x		x		x	
42	*Acer pseudoplatanus*	4	1,68	x		4	1,68	6	2,52	x		7	2,94
7	*Aconitum toxicum*												
6	*Actaea spicata*	2	0,12	5	0,30	4	0,24	5	0,30	6	0,36	7	0,42
1	*Aegopodium podagraria*	5	0,05	x		3	0,03	6	0,06	7	0,07	8	0,08
1	*Chaerophyllum hirsutum*	6	0,06	3	0,03	4	0,04	8	0,08	x		7	0,07
6	*Chrysosplenium alternifolium*	4	0,24	4	0,24	x		7	0,42	7	0,42	4	0,24

5	*Clematis alpina*	4	0,20	3	0,15	7	0,35	5	0,25	3	0,15	?	
1	*Cystopteris montana*												
4	*Daphne mezereum*	4	0,16	x		4	0,16	5	0,20	7	0,28	5	0,20
69	*Dryopteris filix-mas*	3	2,07	x		3	2,07	5	3,45	5	3,45	6	4,14
1	*Epilobium montanum*	4	0,04	x		3	0,03	5	0,05	6	0,06	6	0,06
9	*Fagus sylvatica*	3	0,27	5	0,45	2	0,18	5	0,45	x		x	
5	*Fragaria vesca*	7	0,35	x		5	0,25	5	0,25	x		6	0,30
2	*Galeopsis speciosa*												
7	*Galium odoratum*	2	0,14	5	0,35	2	0,14	5	0,35	x		5	0,35
10	*Galium schultesii*	5	0,50	5	0,50	5	0,50	4	0,40	7	0,70	4	0,40
4	*Gentiana asclepiadea*	7	0,28	x		4	0,16	6	0,24	7	0,28	x	
10	*Geranium robertianum*	4	0,40	x		3	0,30	x		x		7	0,70
7	*Gymnocarpium robertianum*	5	0,35	4	0,28	5	0,35	5	0,35	8	0,56	x	
5	*Hieracium murorum*	4	0,20	x		3	0,15	5	0,25	5	0,25	x	
7	*Impatiens noli-tangere*	4	0,28	5	0,35	5	0,35	7	0,49	7	0,49	6	0,42
5	*Lamium galeobdolon*												
3	*Lathyrus vernus*	4	0,12	x		4	0,12	4	0,12	7	0,21	x	
2	*Lilium martagon*	5	0,10	x		5	0,10	4	0,08	7	0,14	5	0,10
5	*Lonicera nigra*	3	0,15	3	0,15	4	0,20	5	0,25	5	0,25	x	
17	*Luzula luzuloides*	4	0,68	x		4	0,68	x		3	0,51	4	0,68
17	*Maianthemum bifolium*	3	0,51	x		6	1,02	x		3	0,51	3	0,51
49	*Mercurialis perennis*	2	0,98	5	2,45	3	1,47	x		7	3,43	7	3,43
8	*Mycelis muralis*	4	0,32	5	0,40	2	0,16	5	0,40	x		6	0,48
26	*Oxalis aetosella*	1	0,26	x		3	0,78	6	1,56	x		7	1,82
8	*Paris quadrifolia*	3	0,24	x		x		7	0,56	6	0,48	7	0,56
39	*Petasites album*	4	1,56	x		4	1,56	6	2,34	x		x	
1	*Picea abies*	5	0,05	3	0,03	6	0,06	x		x		x	
13	*Polygonatum verticillatum*	4	0,52	4	0,52	2	0,26	5	0,65	4	0,52	x	
1	*Polypodium vulgare*	5	0,05	x		3	0,03	x		2	0,02	x	
4	*Populus tremula*	6	0,24	5	0,20	5	0,20	5	0,20	x		x	
24	*Pulmonaria officinalis*	5	1,20	6	1,44	5	1,20	5	1,20	8	1,92	6	1,44
1	*Ribes uva-crispa*	4	0,04	5	0,05	2	0,02	x		x		6	0,06
3	*Rubus idaeus*	7	0,21	x		x		5	0,15	x		8	0,24
31	*Salvia glutinosa*	4	1,24	5	1,55	4	1,24	6	1,86	7	2,17	7	2,17
2	*Sanicula europaea*	4	0,08	5	0,10	3	0,06	5	0,10	8	0,16	6	0,12
2	*Scopolia carniolica*												
6	*Scrophularia nodosa*	4	0,24	5	0,30	3	0,18	6	0,36	6	0,36	7	0,42
13	*Senecio ovatus*	7	0,91	3	0,39	7	0,91	6	0,78	x		8	1,04
2	*Solidago virgaurea*	5	0,10	x		x		5	0,10	x		5	0,10
2	*Sorbus aucuparia*	6	0,12	x		x		x		x		x	
4	*Spirea chamaedrifolia*												
8	*Stachys sylvatica*	4	0,32	x		3	0,24	7	0,56	7	0,56	7	0,56
2	*Stellaria holostea*	5	0,10	6	0,12	3	0,06	5	0,10	6	0,12	5	0,10
4	*Stellaria nemorum*	4	0,16	4	0,16	4	0,16	7	0,28	5	0,20	7	0,28
2	*Symphytum cordatum*												
8	*Tilia cordata*	4	0,32	5	0,40	4	0,32	x		x		5	0,40
1	*Ulmus glabra*	4	0,04	5	0,05	3	0,03	7	0,07	x		7	0,07
25	*Urtica dioica*	x		x		x		6	1,50	x		8	2,00
16	*Veronica chamaedrys*	6	0,96	x		3	0,48	4	0,64	x		x	

35	*Veronica montana*	4	1,40	5	1,75	2	0,70	7	2,45	5	1,75	6	2,10
9	*Veronica urticifolia*	3	0,27	4	0,36	4	0,36	5	0,45	7	0,63	7	0,63
Weighted average of indices from A_3			**3,73**		**4,77**		**3,64**		**5,27**		**5,82**		**6,30**
S_4 – Pietrosul													
Frequency (K)	Species (number of species = 31)	Ecological indices											
		L	L_P	T	T_P	K	K_P	F	F_P	R	R_P	N	N_P
16	*Abies alba*	3	0,48	5	0,8	4	0,64	x		x		x	
1	*Acer pseudoplatanus*	4	0,04	x		4	0,04	6	0,06	x		7	0,07
1	*Betula pendula*	7	0,07	x		x		x		x		x	
2	*Chrysosplenium alternifolium*	4	0,08	4	0,08	x		7	0,14	7	0,14	4	0,08
1	*Daphne mezereum*	4	0,04	x		4	0,04	5	0,05	7	0,07	5	0,05
35	*Dryopteris filix-mas*	3	1,05	x		3	1,05	5	1,75	5	1,75	6	2,1
5	*Fagus sylvatica*	3	0,15	5	0,25	2	0,1	5	0,25	x		x	
2	*Fragaria vesca*	7	0,14	x		5	0,1	5	0,1	x		6	0,12
11	*Gentiana asclepiadea*	7	0,77	x		4	0,44	6	0,66	7	0,77	x	
1	*Geranium robertianum*	4	0,04	x		3	0,03	x		x		7	0,07
45	*Hieracium murorum*	4	1,8	x		3	1,35	5	2,25	5	2,25	x	
77	*Luzula luzuloides*	4	3,08	x		4	3,08	x		3	2,31	4	3,08
50	*Maianthemum bifolium*	5	2,5	x		5	2,5	7	3,5	x		7	3,5
30	*Nardus stricta*	8	2,4	x		3	0,9	x		2	0,6	x	
23	*Oxalis acetosella*	1	0,23	x		3	0,69	6	1,38	x		7	1,61
31	*Picea abies*	5	1,55	3	0,93	6	1,86	x		x		x	
3	*Poa nemoralis*	5	0,15	x		5	0,15	5	0,15	5	0,15	3	0,09
1	*Polygonatum verticillatum*	4	0,04	4	0,04	2	0,02	5	0,05	4	0,04	x	
1	*Pteridium aquilinum*	6	0,06	5	0,05	3	0,03	6	0,06	3	0,03	3	0,03
1	*Pulmonaria officinalis*	5	0,05	6	0,06	5	0,05	5	0,05	8	0,08	6	0,06
3	*Rubus idaeus*	7	0,21	x		x		5	0,15	x		8	0,24
1	*Salix capraea*	7	0,07	x		3	0,03	6	0,06	7	0,07	x	
4	*Senecio ovatus*	7	0,28	3	0,12	7	0,28	6	0,24	x		8	0,32
60	*Sorbus aucuparia*	6	3,6	x		x		x		x		x	
1	*Spiraea chamaedrifolia*												
5	*Tussilago farfara*	8	0,4	x		3	0,15	6	0,3	8	0,4	x	
66	*Vaccinium mirtillus*	5	3,3	x		5	3,3	x		2	1,32	3	1,98
4	*Vaccinium vitis-idaea*	5	0,2	x		5	0,2	4	0,16	2	0,08	2	0,08
1	*Valeriana montana*	8	0,08	x		2	0,02	5	0,05	9	0,09	2	0,02
11	*Veronica montana*	4	0,44	5	0,55	2	0,22	7	0,77	5	0,55	6	0,66
4	*Veronica urticifolia*	3	0,12	4	0,16	4	0,16	5	0,2	7	0,28	7	0,28
Weighted average of indices from A_4			**4,72**		**4,00**		**4,05**		**5,79**		**3,67**		**4,98**

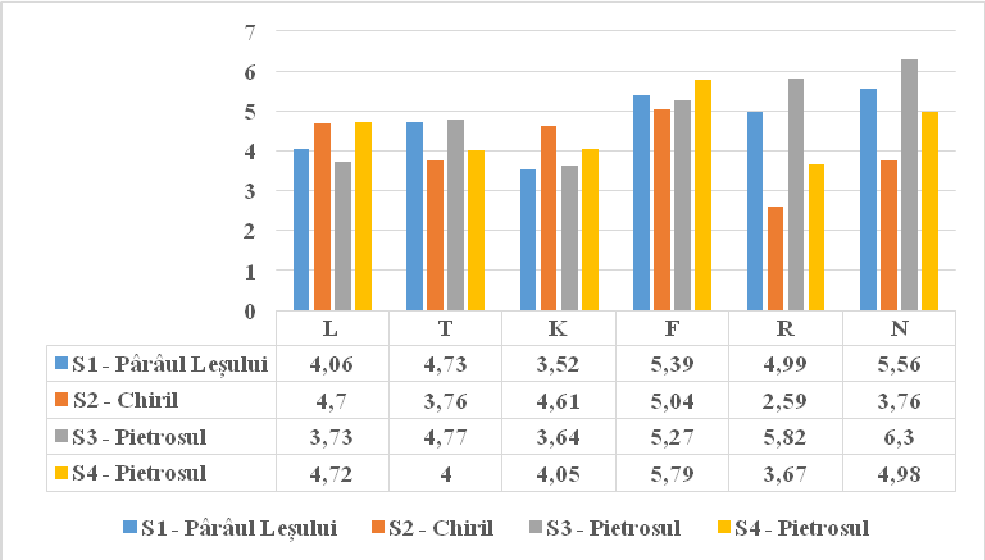
L, T, K, F, R, N – ecological indices by Ellenberg;
L_P, T_P, K_P, F_P, R_P, N_P – ecological indices weighted with the frequency of that species (L_p=L x K/100);

Figure 2 compares the weighted averages of the six ecological indices for the analyzed stands.

In terms of species preferences to light (L), the highest values of this index averages were obtained for S_4 and S_2, situated on lands with southwestern expositions, with a relatively low consistency for S_4 and for a stand mostly of Birch, in the case of S_2, situations that favour better lighting at ground level and the presence of sub-heliophilous species. The lowest

average of this index is hold by the stand from S_3, located on the northern slope, a fact well correlated in this case, multiple ombrophilous species being present in this place.

Regarding the average of temperature index (T), an interesting situation can be noticed, the highest averages being for S_3 (with northern exposition) and for S_1 (with southwestern exposition), a fact correlated with a relatively high frequency of some mesothermophilous species and also with the presence of amfitolerante species. The lowest average of this index is hold by S_2, due to good frequency of oligothermal species (T_3).



	L	T	K	F	R	N
S1 - Pârâul Leșului	4,06	4,73	3,52	5,39	4,99	5,56
S2 - Chiril	4,7	3,76	4,61	5,04	2,59	3,76
S3 - Pietrosul	3,73	4,77	3,64	5,27	5,82	6,3
S4 - Pietrosul	4,72	4	4,05	5,79	3,67	4,98

Fig. 2. The weighted averages of ecological indices

The average of continentality index (K) has the highest value for the stand from S_2, where the species characteristic to the areas with subcontinental climate (K_6) and to the intermediate areas between the subcontinental and the suboceanic climate (K_5) have good representation and frequency. A lower average is recorded where species share of suboceanic climate (K_4) and even of those of oceanic climate (K_2) increases.

In terms of the soil moisture index (F), the lowest value of this index average is recorded in the stand from S_2, where due to southwestern exposition and to the skeletal soil, which has a reduced edaphic volume, the mesoxerophytes (F_5) are found. The highest value of this index is hold by the stand from A_4, where multiple mesophytes (F_7) or mesophyte-mesoxerophytes (F_6) appear, which is favoured by the northwestern exposition that gives an extra moisture to the soils from this place.

An interesting situation is found in the case of the soil reaction index (R), the highest average being recorded for the Norway spruce forest from

S_3, where the high frequency of neutrophilous species (R_7) balances the presence of acidophilous species (R_3) or moderate acidophilous (R_5). The lowest average is that of the stand from S_2 due to the high frequency of three acidophilous species: *Vaccinium myrtillus, Vaccinium vitis-idaea* and *Luzula luzuloides*.

In terms of species preferences to nitrogen supply, the highest average is that of the stand from S_3, in which multiple nitrophilous species (N_7) are present, where due to extra moisture, the decomposition processes are more intense and the lowest average is obtained for the stand from S_2, where oligonitrophilous species (N_2 and N_3) are frequent, spread on soils poor in accessible nitrogen.

CONCLUSIONS

The analysis of the ecological indices spectrum often shows facts difficult to identify through direct observations on a stand. Herbaceous plant community, that grows under the shelter of a stand, develops and improves over time in close connection with local conditions, given by the soil type, geological substrate, precipitation, altitude, slope or land exposition and also according to the structure and composition of the stand, to the contribution of organic matter generated by trees, the type and thickness of the litter, the amount of water reaching the level of the litter.

Thus, the stand with the best representation of ombrophilous species is that from S_3-Pietrosul, which surprisingly also has the best representation of mesothermophilous, neutrophilous and nitrophilous species. The stand where the sample area S_2-Chiril has been made has the best representation of oligothermal species, of those which prefer a subcontinental or intermediate to suboceanic climate, of those acidophilous and oligonitrophilous.

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