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COMPARATIVE STUDY OF SOME MOUNTAIN HABITAT TYPES IN RETEZATUL MIC MOUNTAINS (ROMANIA) BASED ON CORMOPHYTES' ECOLOGY

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Abstract: During the botanical investigations carried on in the summer of the year 2002 in the Retezatul Mic Mountains, as part of the Retezat National Park's flora and fauna inventory programme, 225 species of cormophytes were identified in the 12 investigated habitat types on magma and calcareous substratum. In many aspects, it can be remarked a clear differentiation between similar habitats situated on the two investigated geological substrata, namely magma and calcareous. This is valid not only for the plant communities' structure regarding the response to the soil reaction and humidity, but also for the life-forms spectres, diversity and the specific composition. On limestone the vegetation presents a more basiphilous and xerophilous character compared with the plant communities on eruptive substratum, as well as a higher diversity, illustrated both by higher number of species and values of the diversity indices, and the chamaephytes reach a higher percentage. From these points of view, the rocky vegetation, followed by the subalpine meadows present the most "calcareous" character.

Introduction

During the summer of the year 2002 the authors of this paper carried out a survey on the cormophytes communities from Retezatul Mic Mountains. These investigations were part of the flora and fauna inventory programme co-ordinated by the Retezat National Park's Administration in Deva.

The present study aims to illustrate the reactions of cormophyte communities to the ecological conditions offered by the different major habitat types in the investigated mountain area, a special attention being given to the substratum type.

Retezatul Mic Mountains, part of the Retezat National Park, is situated southwards Retezatul Mare, from which it is separated by the Lăpuşnicul Mare Valley. Its altitude ranges from 950 m at Gura Butei up to 2081 m - Piule Peak. From geological point of view it is divided in two areas. The northern part, comprising Drăgşanu and Scorota ridges as far as Scocu Drăgşan, and a small area around Buta Chalet is geologically similar to Retezatul Mare. The substratum is formed of magma and metamorphic rocks, especially of granodiorite with massive texture and granitoid gnaise, covered in part by cristaline schist, traversed by a system of lamprofire veins [8]. The granodiorite presents characteristics between those of the acid granite and the more basiphilous diorite. The southern part includes Piule-Pleşa Ridge, Scorota, Albele, Piatra Iorgovanului, Stănuleţii Mari, eastwards to Paltina Valley and southwards to Jiul de Vest Valley, where the substratum is formed mainly of Mesozoic limestone.

Data regarding the flora and vegetation of this massif can be found in several papers beginning with the end of the XIXth century. In 1898 F. Pax [11] published at Leipzig the first data on the calciphilous flora from Retezat Mountains in a paper on the plants' distribution in Carpathian Mountains. More specific studies were carried out in this massif by Jávorka (1911), Borza (1934), Nyárády (1929, 1958), Csűrös et al. (1962, 1957) and Boşcaiu (1971, 1977). Data regarding the presence of some species or infraspecific taxons in the area can be found also in the "Flora R.P.R." [13].

Material and Methods

The data used for the ecological analysis presented in this paper were gathered in the summer of the year 2002, using the vegetation transects method in all the areas of the massif. We used a map divided into 0.25 km^2 survey squares, their co-ordinates being established in the field using a GPS. In survey squares presenting several habitat or plant community types, vegetation transects were carried out in each of these, being avoided the ecotones. The 30 m transect formed the centre line of a 20 m x 30 m rectangular plot used to survey the tree cover, its density and composition. Along the length of the transect five 1 m x 1m quadrates were placed at 5 m intervals, in each quadrate being investigated the plant species less than 1 m tall and estimated their cover. The cover of tall shrub species (between 1 m and 3 m) was estimated from three 3.1 m radius circular plots located at 5, 15, and 25 m on the transect (fig. 1). Cover was estimated by percentage, not by cover classes.

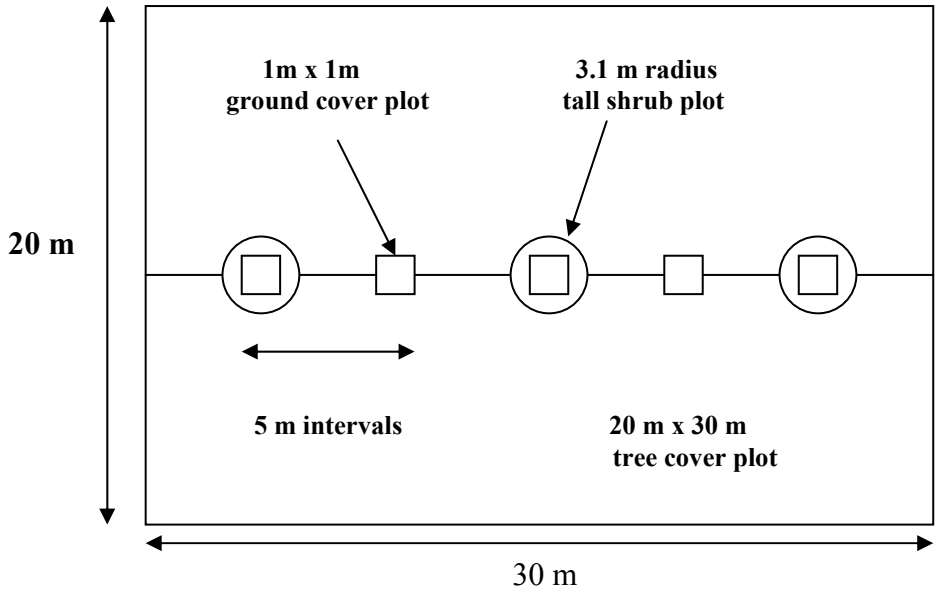

Fig. 1: Design of the vegetation transects used in the present study

The vegetation transects were grouped in 12 habitat types, coded as follows: subalpine meadow on limestone – SML, subalpine meadow on magma and metamorphic substratum – SMM, subalpine shrubs on calcareous substratum – SSL, subalpine shrubs on magma and metamorphic substratum – SSM, mountain meadow on magma and metamorphic substratum – MMM, vegetation of limestone rocks – RL, bank vegetation on granodiorite – BM, upper limit spruce forest on eruptive and metamorphic substratum – LFM, upper limit spruce forest on calcareous substratum - LFL, spruce forest on magma and metamorphic rocks – SFM, mixed forest on eruptive and metamorphic substratum – MFM, mixed forest on limestone – MFL.

This represents a simplified and sinthetic classification compared with the accepted European one, and is based on ecological rather than taxonomic (characteristic species) criteria, namely on altitude, geological substratum and the dominant plant life forms.

To calculate the Menhinick, Shannon-Wiener and Lloyd-Gheraldi (equitability) diversity indices as well as the Ivan-Doniță similarity index [6] we used only the quantitative data from the 1m x 1m ground cover plots, while for the ecological spectres were used all the qualitative data from the 88 transects. For the life form diagrams were used the categories of the Raunkiaer system [6], and the H, T, R values according to [12].

Results and Discussion

In the summer of the year 2002 we identified in the Retezatul Mic Mountains, in the 88 vegetation transects, 225 cormophyte species. The ecological preferences, for humidity (H), temperature (T), and soil reaction (R) of the plants from the investigated habitats, are synthesised in table 1. Among these habitats, only the extremes, in case of each ecological factor, were illustrated in diagrams.

Table 1: Percentages of H, T, R categories in the investigated habitat types

	H							T						R					
Habitat	0	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6	0	1-1.5	2-2.5	3-3.5	4-4.5	5	0	1-1.5	2-2.5	3-3.5	4-4.5	5
SMM	21.95	0	24.39	43.90	9.75	0	0	26.82	21.95	43.90	7.31	0	0	26.82	26.82	21.95	9.75	14.63	0
SSM	17.14	2.85	22.85	42.85	14.28	0	0	17.14	17.14	45.71	20.00	0	0	17.14	31.42	28.57	17.14	5.71	0
UFM	13.33	0	26.66	46.66	13.33	0	0	13.33	6.66	53.33	26.66	0	0	33.33	20.00	26.66	6.66	6.66	0
SFM	10.34	0	20.68	44.82	24.13	0	0	13.79	6.89	44.82	34.48	0	0	13.79	20.68	27.58	31.03	6.89	0
MFM	7.69	0	3.84	61.53	23.07	3.84	0	3.84	3.84	34.61	57.69	0	0	38.46	7.69	7.69	34.61	11.53	0
MMM	13.33	0	28.88	40.00	17.77	0	0	33.33	6.66	31.11	26.66	2.22	0	40.00	13.33	15.55	15.55	15.55	0
BM	3.22	0	3.22	45.16	29.03	19.35	0	16.12	19.35	38.70	25.80	0	0	48.38	3.22	16.12	12.90	19.35	0
SML	15.00	5.00	40.00	35.00	5.00	0	0	21.66	26.66	31.66	18.33	1.66	0	28.33	8.33	16.66	10.00	31.66	5.00
SSL	12.24	4.08	22.44	46.93	14.28	0	0	18.36	22.44	40.81	18.36	0	0	30.61	14.28	28.57	16.32	8.16	2.04
RL	4.70	2.35	31.76	42.35	18.82	0	0	15.29	31.76	42.35	10.58	0	0	18.82	4.70	16.47	16.47	38.88	4.70
UFL	9.30	0	34.88	51.16	4.65	0	0	69.76	9.30	27.90	34.88	2.32	0	32.55	2.32	18.60	25.58	20.93	0
MFL	5.26	0	7.89	73.68	13.15	0	0	21.05	2.63	26.31	47.36	2.63	0	23.68	2.63	13.15	28.94	31.57	0

The greatest differences between the investigated habitats were recorded in what concerns the preferences for the soil reaction. In the habitats situated on eruptive substratum the plant community presents an acidophilous character, especially in the subalpine shrubs, where the strongly acidophilous species (R 1-1.5) represent 31.42 %, the acidophilous species (R 2-2.5) 28.57 %, while the neutro-basiphilous (R 5) plant category is not represented at all. Meantime, in this habitat the euryionic species (R 0) are poorly represented, counting only 17.14 %. Among the habitats situated on granodiorite, the spring and brook banks present the less acidophylous character, the graphic resembling more with that illustrating the preferences of plants on limestone, especially for the acid categories (R 1-1.5 and R 2-2.5), where the two lines overlap. The euryionic cormophytes reach here almost half (48.88 %) of the total number of species.

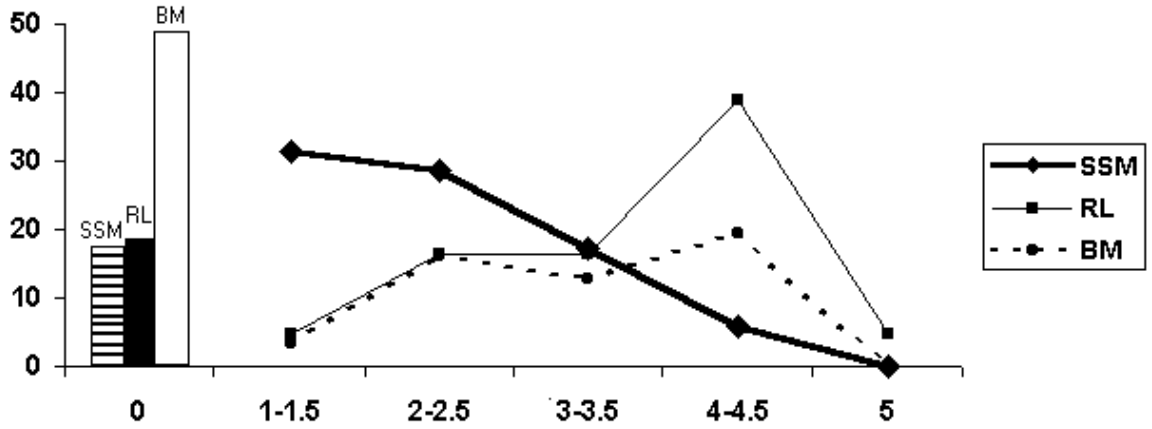

Fig. 2: The soil reaction spectre for the subalpine shrubs on magma and metamorphic substratum (SSM), the calcareous rocks (RL) and spring and brook banks on granodiorite (BM)

On calcareous substratum the most basiphilous vegetation is found in the rocky areas where the neutro-basiphilous species represent 4.70 % of the plant community, the weaker acid-neutrophilous species (R 4-4.5), the dominant category, represent 38,88%, while the intense acidophilous plants count only 4.70 % (Fig. 2). Similar values were registered in the subalpine meadows (Tab. 1).

All the investigated habitat types present similar humidity curves, the mesophytes being dominant. The other plant categories are poorly represented, except the xero-mesophytes that record a relative high percent on limestone, which permits the infiltration of water. Thus, the subalpine meadows on calcareous substratum are the single habitat type dominated by the xero-mesophilous (H 2-2.5) plants (40,00 %), where the xeromesophytes reach the highest number, representing 5.00 %. The most hygrophilous vegetation is found on spring and brook banks, where 19.35 % of the cormophyte species are hygrophilous (H 5-5.5), 29,03 % are meso-hygrophilous H (4-4.5), while the mesophilous species count only 45,16 % (Fig. 3), and the euryhygric plants record the lowest percent. The forested and shrub habitats have in general a more hygrophilous character than the open habitats.

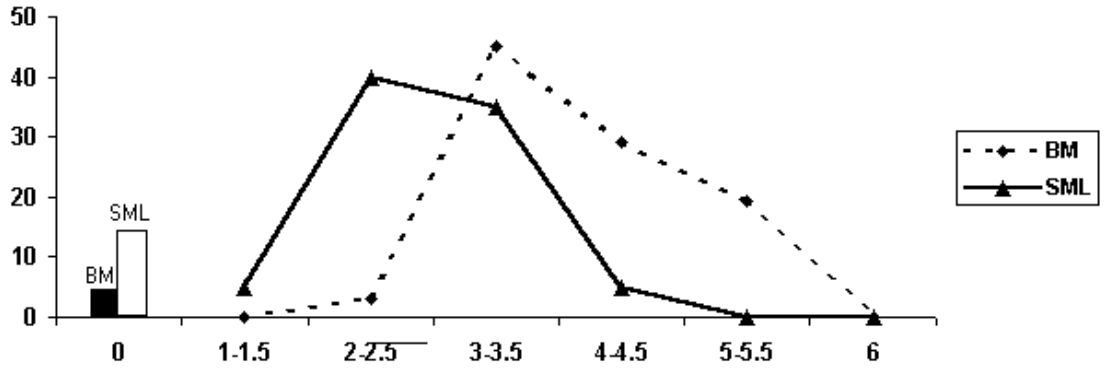

Fig. 3: The humidity spectre in the subalpine meadows on limestones (SML) and in the bank vegetation on granodiorite (BM)

In case of temperature (Fig. 4), the influence exerted by the substratum type is less obvious. The mesothermophytes (T 4-4.5) present in some habitats on limestone are represented by only one species. The main factor that influences the ratio between the temperature categories of plants in different habitats is altitude. In subalpine habitats (including the upper limit spruce forests) prevail the microthermic (T 2-2.5) species (between 27.90 % in the upper limit forests on limestone and 53.33 % in upper limit forests on granodiorite), while the cryophilous plants (T 1-1.5) also record a relative high percentage (between 6.66 % in upper limit forests on calcareous substratum and 31.76 % on limestone rocks).

In habitats from lower altitudes prevail the micro-mesothermic species (T 3-3.5), while the microthermic are less numerous. No thermophilous plant species was recorded. In the forested or shrub habitats the temperature curves show a milder climate than in the open habitats, especially at higher altitudes (Fig. 4).

The plant communities from the open habitats are dominated by the hemicryptophytes (H), which represent up to 80%, in the mountain meadows (MMM). In the subalpine meadows on limestone (SML) the relative low percent of the hemicryptophytes (65 %) is compensated by the chamaephytes (Ch) that reach 25 %. The negative correlation between the relative abundance of these two life forms can be observed also in other habitat types. Another characteristic of the chamaephytes is the affinity for the calcareous substratum. Here, in similar habitats, both open and forested, they record approximately a double percentage (25 % versus 12,19 % in subalpine meadows, 17,64 % versus 8,1 % in subalpine shrubs, 6,66 % versus 3,44 % in mixed forests).

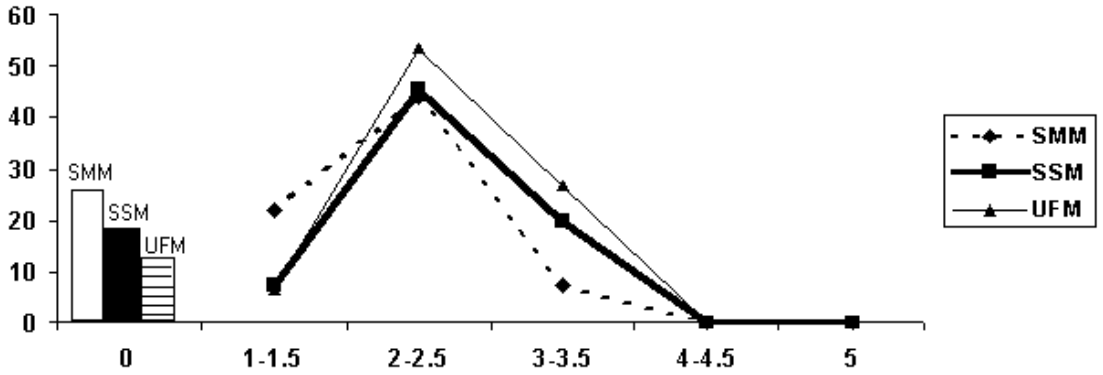

Fig. 4: The temperature curves in the subalpine meadows, in the subalpine shrubs, and in the upper limit forest vegetation on magma and metamorphic substratum

In the upper limit forest on magma and metamorphic substratum no chamaephyte was found, while on limestone they represented 16,32 %, this high percentage being due to the interference with the subalpine meadows. The phanerophytes (Ph) are poorly represented, up to 9,74 % in the subalpine meadows on granodiorites (SMM), where all the three subcategories are present (mega- MPh, meso- mPh, and nanophanerophytes NPh). The other life-form categories (geophytes - G, annual terophytes - Th, and biannual terophytes - TH) record a low percent (up to 8.33) when present.

In shrub or forested habitats hemicryptophytes are not so numerous as in the meadows or other open habitats. Their relative abundance decreases at lower altitudes, varying between 70,58% in the subalpine shrubs on magma substratum (SSM) and 55,17% in the mixed forests, where an important part is represented by the phanerophytes (29% on schist). The three phanerophyte subcategories are present in all the investigated habitats, except for the spruce forest on granodiorite (SFM), where the mesophanerophytes lack. The upper limit forests on magma and metamorphic substratum present the highest diversity of woody vegetation (Ph = 35 %), which was not considered in the estimation of the diversity. In this habitat the only herbaceous species are the hemicryptophytes.The only habitat type where all the life-form categories were encountered is the subalpine shrub on metamorphic substratum.

Table 2: The values of the diversity indices for the investigated habitat types

Diversity index **Habitat type**	Number of species	Menhinick Index	Shannon-Wiener Index	Lloyd-Gheraldi (Equitability) Index
SML - Subalpine meadows on limestone	60	6,36	4,174	0,706
SSL - Subalpine shrubs on limestone	49	6,53	4,222	0,752
RL - Vegetation on limestone rocks	85	11,47	5,922	0,923
UFL - Upper limit forest on limestone	43	4,743	4,63	0,853
MFL - Mixed forests on limestone	38	6,393	4,325	0,824
SMM - Subalpine meadows on granodiorite	41	4,239	3,754	0,701
SSM - Subalpine shrubs granodiorite	35	4,814	3,272	0,638
UFM - Upper limit forests on granodiorite	15	2,537	2,839	0,727
SFM - Spruce forests on granodiorite	29	4,926	3,606	0,75
MFM - Mixed forests on granodiorite	26	3,959	3,806	0,81
MMM - Mountain meadows on granodiorite	45	4,684	3,567	0,649
BM - Bank vegetation on granodiorite	31	3,477	3,522	0,711

Analysing the values of Menhinick and Shannon-Wiener diversity indices for the investigated habitats (Fig. 5), we can conclude that the herbaceous plant communities situated on limestone present a higher diversity than those from similar habitats situated on magma and metamorphic substratum. The same conclusion can be drawn also from the distribution of the

species' number in different habitats. Thus, on limestone 60 species were recorded in the subalpine meadows and 49 in the subalpine shrubs, while on granodiorite only 41, respectively 35 were identified. The same is valid also for the forests, the greatest difference being recorded in case of upper limit forests, with 43 species on limestone and only 15 on magma and metamorphic substratum. This fact is probably due to the high acidity of the soil, combined with unfavourable thermic conditions.

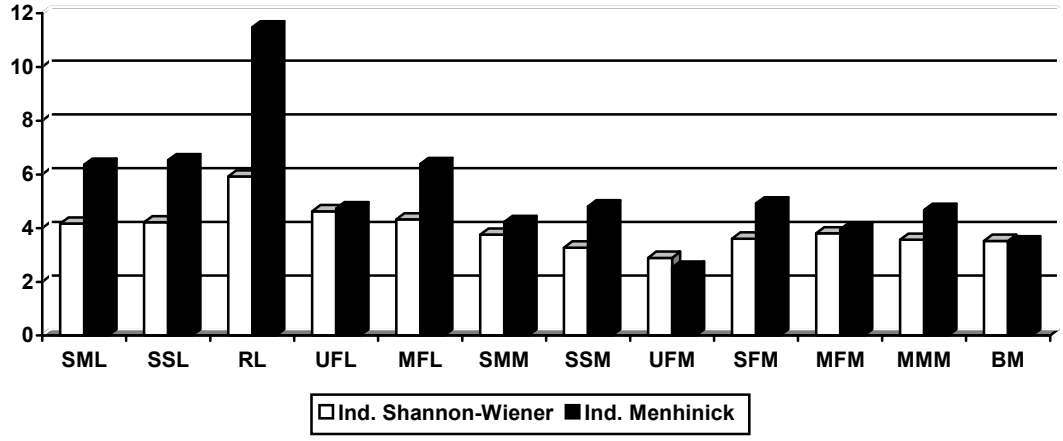

Fig. 5: The values of the Menhinick and Shannon-Wiener diversity indices calculated for the investigated habitats (the codes are explained in the text)

The highest number of species (85) was registered on the limestone rocks, where the diversity indices also recorded the highest values. The value of the Menhinick index (11,47) is much higher in this habitat type than in any other and the value of the equitability index (0,92) is close to the maximum value, due to the high number of species that present a low cover percentage. Although the number of species in the subalpine meadows on limestone (60) is higher than that from the subalpine shrubs situated on the same type of substratum (49), the Menhinick index shows a slightly lower value (6,36 against 6,53) due to the fact that the herbaceous stratum in the subalpine shrubs records a much lower cover percentage than in the meadows. Meantime, the subalpine meadows present one or more dominant species (in our sampling plots *Festuca rubra* and *Carex sempervirens* registered a mean cover of 25,02 % and 10,05 %), which cause the lowest values of the other two calculated diversity indices among the habitats on limestone.

In the habitats on magma and metamorphic substratum, the values of the Menhinick index do not exceed 5, the lowest being calculated for the upper limit forests (2,53), where the number of species encountered (15) was also the smallest. In forest at lower altitudes (spruce and mixed), the relatively small number of herbaceous species present similar and reduced cover percentages (in some sampling plots from spruce forests the herbaceous stratum was absent).

The dendrogram based on the Ivan-Doniță index, illustrating the similarity between the cormophytes communities from the investigated habitats in the Retezatul Mic (Fig. 6), reveals a high degree of resemblance between the group of herbaceous plants found in the subalpine shrubs on the two substratum types (SSM and SSL), the Ivan-Doniță index value reaching 88,21 %. This fact suggests that the few species encountered in the subalpine shrubs are tolerant to the geologic substratum, but they are not characteristic, being common also in spruce and upper limit forests on granodiorites (SFM and UFM), as the linkage of these habitat types shows. In the same group, but at a greater distance, are another two types of forests, namely the mixed forests on limestone and on magma substratum (MFL and MFL). The last forested habitat type, the upper limit forest on limestone (UFL) presents a higher similarity with the other group, formed

by the open habitats. This is due to the low density of trees in these forests, which makes them suitable for the intrusion of herbaceous species from the neighbouring subalpine meadows, fact showed also by the life-form diagram. The second group, of the open habitats, is formed by the subalpine and mountain meadows on magma and metamorphic substratum, which join at 86,74 % (SMM and MMM), and the two limestone subalpine habitats, the meadow and the rocks (SML and RL), linked at a greater distance, 71,38 %. A distinct habitat type is represented by the spring and river banks on granodiorites (BM), inhabited by many hygrophilous cormophytes that are not found in the neighbouring habitats.

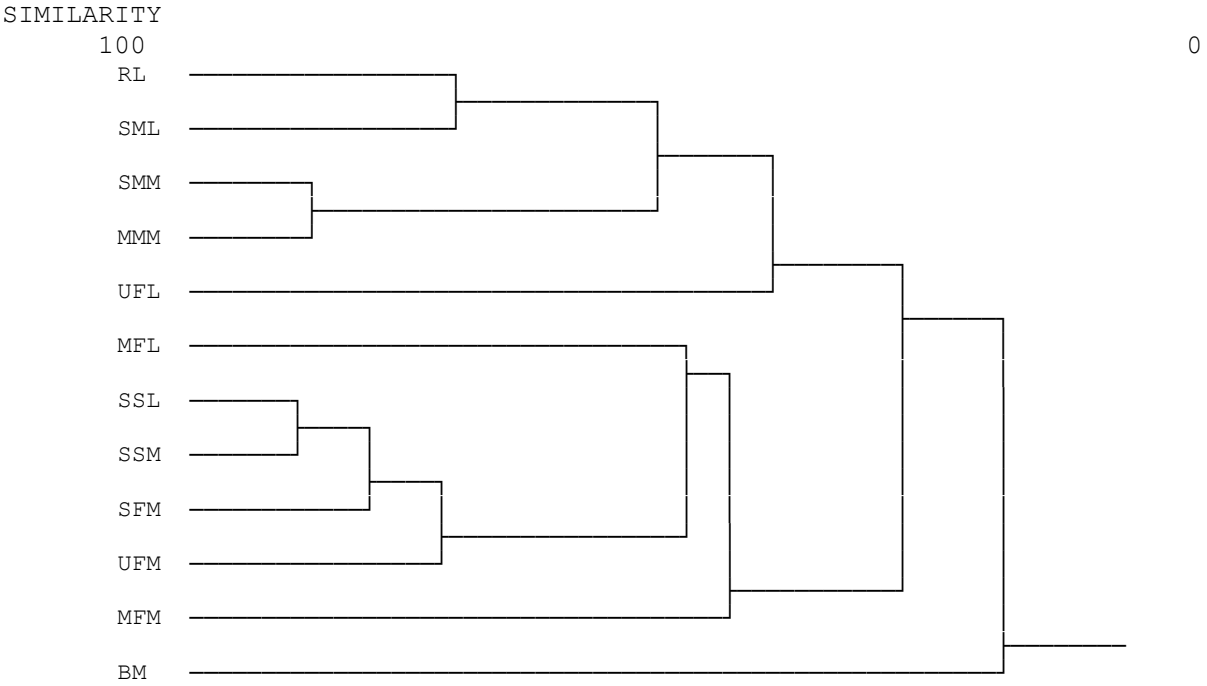

Fig. 6: The dendrogram based on the Ivan-Doniță index, at average distances, for the investigated habitat types from Retezatul Mic (the codes are explained in the text)

Conclusions

The main differences between the ecological valences of the cormophytes in the investigated habitat types were found in what concerns the soil chemical reaction. The cormophyte communities in habitats situated on magma and metamorphic substratum present an acidophilous character, which registers a maximum in the subalpine shrubs. The most basiphilous character of the vegetation was revealed in the rocky habitats on limestone. The same opposition of the two groups of habitat types can be remarked also in what concerns the species' reaction to the humidity. The plant communities on limestone present a more xerophilous character, among them the subalpine meadows represent the single habitat type dominated by xero-mesophytes, not by the mesophytes, as the rest of habitats. All the cormophytes communities are dominated by hemicryptophytes, which represent between 55 and 80 %. The relative abundance of this life-form category is negatively correlated to the relative abundance of the chamaephytes, which present an affinity for the limestone. In forested habitats the phanerophytes attain a relative high percentage, exceeding 25 %. The Menhinick index' values range from 2,53 in the upper limit forests on grandiorite (15 species) to 11,47 on limestone rocks (85 species), varying in a similar way with the number of species, except for the habitats with a poor herbaceous stratum (shrubs and some forests), where the Menhinick index indicates a higher diversity than the number of species. The highest diversity of the calcareous

rocks vegetation is illustrated also by the other two indices, the value of equitability index (0,92) being close to the maximum. In similar habitats, the diversity is higher on limestone than on magma and metamorphic substratum, regardless the calculated index. The cluster analysis, using the Ivan-Doniţă index for the herbaceous stratum, shows two groups, the open and the shrub or forested habitat types. The highest similarity was observed between the subalpine shrubs, the subalpine and mountain meadows on granodiorite, and on limestone, between the subalpine meadows and rocks. Due to the interference with the subalpine meadows, the upper limit forests on limestone are linked not directly with the other forests, but with the open habitats, although at a greater distance. A distinct habitat type is represented by the spring and river banks.

Thus, in many aspects, it can be remarked a clear differentiation between similar habitats situated on the two investigated geological substrata, namely granodiorite and limestone. This is valid not only for the plant communities' structure regarding the response to the soil reaction and humidity, but also for the diversity and the specific composition. From these points of view, the rocky vegetation, followed by the subalpine meadows presents the most "calcareous" character.

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STUDIUL COMPARATIV AL UNOR TIPURI DE HABITATE MONTANE DIN MUNŢII RETEZATUL MIC (ROMÂNIA), PE BAZA ECOLOGIEI CORMOFITELOR

(Rezumat)

În cursul investigaţiilor botanice din vara anului 2002, desfăşurate în Retezatul Mic în cadrul programului de inventariere a florei şi faunei Parcului Naţional Retezat, au fost identificate 225 specii în cele 12 tipuri de habitate investigate. Întocmirea spectrelor ecologice pentru diferitele tipuri de habitat, pe baza datelor originale, a scos în evidenţă diferenţe mai accentuate în ceea ce priveşte reacţia solului. În habitatele de pe rocile magmatice şi metamorfice vegetaţia are un caracter acidofil, acesta atingând maximul în tufărişurile subalpine. Cel mai accentuat caracter bazic al comunităţii de cormofite a fost pus în evidenţă pe stâncăriile calcaroase. Aceeaşi opoziţie între cele două grupe de habitate situate pe granodiorite şi calcare poate fi remarcată şi în ceea ce priveşte preferinţele faţă de umiditate. Comunităţile vegetale de pe substrat calcaros prezintă un caracter mai xerofil, pajiştile subalpine de aici fiind singurele în care categoria dominantă o constituie xeromezofitele, în rest cele mai abundente fiind mezofitele. În cazul temperaturii, diferenţe semnificative nu se înregistrează între habitate de pe substrate diferite, ci de la altitudini diferite. De asemenea, la aceeaşi altitudine, habitatele cu vegetaţie lemnoasă au un caracter mai termofil decât cele cu vegetaţie ierboasă, fapt evident mai ales în etajul subalpin. Toate habitatele investigate sunt dominate de hemicriptofite, a căror abundenţă este negativ corelată cu cea a camefitelor, care par a manifesta o preferinţă pentru calcare. Diversitatea habitatelor de pe calcare este mai ridicată decât cea a habitatelor similare de pe

granodiorite, valoarea maximă, ilustrată prin toți indicii calculați, se înregistrează pe stâncării. Analiza similitudinii între comunitățile de plante ierboase din habitatele investigate în Retezatul Mic, utilizând indicele Ivan-Doniță au relevat două grupe de habitate, cele cu vegetație ierboasă şi cele cu vegetație lemnoasă. Cea mai ridicată similitudine a fost calculată pentru jnepenişurile de pe cele două tipuri de substrat şi pentru pajiştile subalpine şi montane de pe granodiorite. Datorită interferenței cu pajiştile subalpine, molidişurile de limită de pe calcare nu se grupează direct cu celelalte păduri, ci cu habitatele deschise (pajişti şi stâncării). Un habitat distinct îl reprezintă cel fontinal, care are caracteristicile diferențiale cele mai pregnante comparativ cu celelalte habitate.