Contribuţii Botanice, *XXXVIII, (1)*, **2003**
Grădina Botanică "Alexandru Borza"
Cluj-Napoca

CONTRIBUTIONS TO THE STUDY OF CLASS *VACCINIO-PICEETEA* BR.-BL. 1939 FROM THE ORIENTAL CARPATHIANS

Oana ZAMFIRESCU, Toader CHIFU
Universitatea "Al. I. Cuza" Iaşi, Facultatea de Biologie, Catedra de Biologie Vegetală
B-dul Carol I, nr. 11, **RO-700506 Iaşi**

Abstract: The pure *Picea abies forests* and mixed *Picea abies* and *Abies alba* forests, of the Class *Vaccinio-Piceetea* Br.-Bl. 1939, from the left side of the Izvoru Muntelui-Bicaz accumulation lake, were studied from the chorological, ecological, phytosociological, bioforms and floristic elements points of view. The class is represented, in the studied area, by two associations: *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 and *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939. The plant communities of the first association are dominated by *Abies alba* and *Picea abies*. In fact, these two species are co-dominant. The communities of the second association have just one dominant species, which is *Picea abies*. The characteristic species, for both associations is *Hieracium transsilvanicum*. The communities of the first association are richer in species (46) than the ones of the second association (14). The species characteristic for deciduous forests (Class *Querco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937 em Borhidi 1996) are well represented in the first association communities, which are in contact with the ones of *Leucanthemo waldsteinii-Fagetum* (Soo 1964) Tauber 1987. The analyses of bioforms and floristic elements revealed that hemicryptophytes and Eurasian species dominate both associations, respectively. Ecological index analysis showed that shadow to half-shadow species, fresh soil species, neutral soil species dominate both associations. The remaining ecological indices had different values. Thus, intermediate climate species, oceanic to sub-oceanic species, and species that occur in soils which are intermediate to rich in mineral nitrogen dominate the Association *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991, while cool to intermediate climate species, sub-oceanic species, and species that occur in soils which are rich in mineral nitrogen dominate the Association *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939. According to the cluster analysis, the relevees of the Association *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 are 42.8% similar, while those of the Association *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 are 57.1% similar. The similarity between the two groups of relevees, each group corresponding to an association, was 19.8%. These forest ecosystems, from the left side of the Izvoru Muntelui-Bicaz reservoir are dominated by mixed *Picea abies* and *Abies alba* forests and not by pure *Picea abies* ones, as believed according to the literature concerning the Oriental Carpathians.

Introduction

The present paper represents a detailed study of two coniferous forest associations of the Class *Vaccinio-Piceetea* Br.-Bl. 1939 – *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 and *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 – from the Oriental Carpathians. Both associations belong to the Order *Vaccinio-Piceetalia* Br.-Bl. 1939, Alliance *Piceion abietis* Pawl. in Pawl. et al. 1928.

The studied area, which is the left side of Izvoru Muntelui-Bicaz reservoir, is 136 km^2 and represents a part of the Stânişoara Mountains from the Oriental Carpathians [16].

Materials and Methods

For the identification, classification and characterisation of plant associations, we used phytosociological research methods according to the Central-European school [3]. Our results were compared with the syntaxonomic Romanian and foreign literature: Coldea (1991), Passorage (1992), Oberdorfer (1994), Coldea et Chifu (1994), Pott (1992, 1995), Mucina (1997), Sanda et al. (1997), etc. [7,13,14,15].

The synecological assessment of the two forest associations employed indicator values for each species as proposed by Ellenberg (1974) [8].

We used sampling areas of 1000 m^2 to carry out phytosociological relevees only in those habitats that were retained to be representative for the two associations.
Species implications in plant associations were evaluated through abundance-dominance index according to the system perfected by J. Braun-Blanquet and J. Pavillard (1928). The species constancy (K) was indicated, as well.

The bioform, floristic element and ecological spectra resulted from the analysis of the species presence.

The similarity of plant communities resulted from the cluster analysis. The similarity matrix was calculated with Jaccard's coefficient, which considers the presence or the absence of the species. For the cluster analysis, we used the unweighted pair group average linkage method (Fig. 7).

Results and Discussions

Hieracio rotundati-Abietetum (Borhidi 1971) Coldea 1991:

The mixed forests of *Piceea abies* and *Abies alba*, included in this association, cover relatively great areas in some of the Oriental Carpathian mountains, such as the Stânişoara Mountains and especially the Obcinele Bucovinei, which contradicts some of the literature. The plant communities, of this association, occur between 875 – 975 m altitude, on less inclined slopes (15 – 30°), with soils that are brown, acid (pH = 5.8 – 6.5), moderately deep and well saturated in bases.

The forest canopy includes mainly *Abies alba* and *Picea abies*. These two species are co-dominant, and their coverage is between 60 – 80%. Among grasses, the Carpathian species *Hieracium transsilvanicum* has a good presence, which is characteristic for most *Picea abies* forests. This fact endorsed its designation as a characteristic species. Superior coenotaxa, like *Vaccinio-Piceetea* and *Piceion abietis* are also well represented, justifying the coenotaxonomical classification (Table 1). Class *Querco-Fagetea* characteristic species appear frequently. This fact correlates with the analysed forest altitudinal position, which is between mixed coniferous and deciduous forests, downward and pure *Picea abies* forests, upward.

Table. 1: Ass. *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991

Relevee No.	**1**	**2**	**3**	**4**	**5**	**K**
Altitude (m)	875	882	960	975	960	
Trees coverage (%)	75	60	80	70	90	
Shrubs coverage (%)	5	0	10	5	5	
Grasses coverage (%)	20	25	5	20	5	
Exposure	SE	SE	N	NE	SE	
Slope (degrees)	15	30	40	35	30	
Area (m^2)	1000	1000	1000	1000	1000	
Species no.	36	36	35	28	21	
Characteristic species						
Hieracium transsilvanicum	+	+	+	+	-	IV
Piceion abietis						
Picea abies	3	3	3	3	3	V
Abies alba	2	1	2	2	1	V
Gymnocarpium dryopteris	+	+	-	+	+	IV
Leucanthemum waldsteinii	-	+	+	+	-	III
Dryopteris dilatata	+	-	+	+	-	III
Vaccinio-Piceetalia						
Oxalis acetosella	1	1	+	+	+	V

Relevee No.	**1**	**2**	**3**	**4**	**5**	**K**
Vaccinio-Piceetea						
Orthilia secunda	+	+	+	-	+	IV
Symphyto-Fagion						
Acer pseudoplatanus	+	+	+	+	+	V
Fagus sylvatica	+	+	+	-	+	IV
Symphytum cordatum	+	+	+	-	-	III
Moehringia trinervia	+	-	-	+	+	III
Hepatica transsilvanica	+	+	-	-	+	III
Luzula luzuloides	-	+	+	-	-	II
Fagetalia						
Euphorbia amygdaloides	+	+	+	+	+	V
Salvia glutinosa	+	+	+	+	+	V
Daphne mezereum	+	+	+	-	-	III
Epilobium montanum	-	+	+	+	-	III
Mycelis muralis	+	+	+	-	-	III
Mercurialis perennis	+	+	-	-	-	II
Dentaria bulbifera	+	-	-	-	-	I
Viburnum opulus	+	+	+	+	+	V
Polystichum aculeatum	+	+	+	-	-	III
Querco-Fagetea						
Corylus avellana	+	+	+	+	+	V
Campanula rapunculoides	-	+	+	+	+	IV
Dryopteris filix-mas	+	+	+	+	-	IV
Athyrium filix-femina	+	-	-	+	+	III
Glechoma hirsuta	+	+	+	-	-	III
Gallium schultesii	+	-	-	-	-	I
Companion Species						
Dryopteris carthusiana	+	+	-	+	+	IV
Veronica officinalis	+	+	+	+	-	IV
Ajuga reptans	+	-	+	+	+	IV
Senecio ovatus	+	+	+	+	-	IV
Campanula persicifolia	-	+	+	+	+	IV
Sambucus nigra	+	+	+	-	-	III
Viburnum lantana	-	+	+	+	-	III
Frangula alnus	+	+	-	-	+	III
Rubus idaeus	+	-	+	+	-	III
Lamium maculatum	+	-	+	+	-	III
Circaea alpina	+	+	-	-	+	III
Lonicera xylosteum	+	-	+	+	-	III
Prunella vulgaris	+	-	-	+	+	III
Turritis glabra	-	+	+	+	-	III
Fragaria vesca	-	+	+	-	-	II
Arabis hirsuta	-	+	+	-	-	II
Polypodium vulgare	-	+	+	-	-	II

Rel. 1, 2 – Hangu, 22-07-1998, Rel. 3 – Buhalnița, 28-07-1998, Rel. 4 – Buhalnița, 30-07-2002, Rel. 5 – Dealul Frasinului, 30-07-2002

The bioform analysis (Fig. 1) shows the clear dominance of hemicryptophytes (50%), followed by phanerophytes (26.09%) and then by other categories.

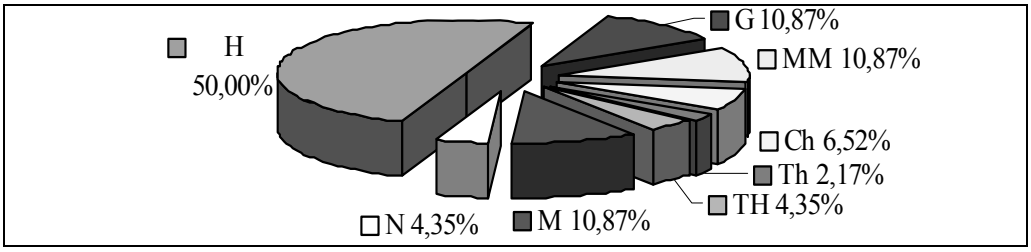

Fig. 1: Bioforms spectrum of Ass. *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 (H – hemicryptophytes; G – geophytes; MM – megaphanerophytes; Ch – chamaephytes; Th – annual therophytes; TH – biennial therophytes; M – mesophanerophytes; N – nanophanerophytes)

The floristic element analysis (Fig. 2) reveals the dominance of the Eurasian species (26.09%) followed by the circumpolar ones (23.91%), which is most likely in coniferous forests.

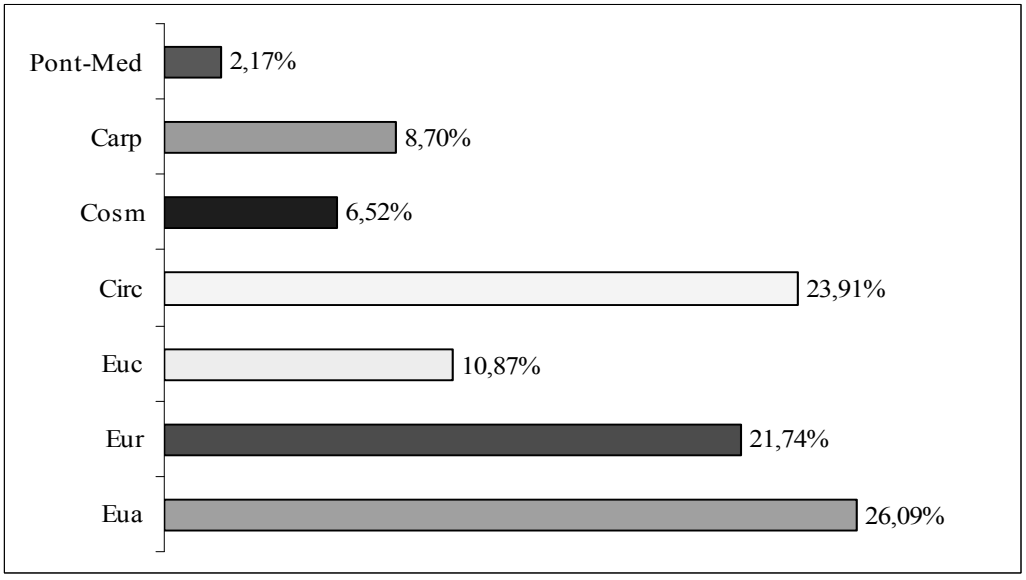

Fig. 2: Floristic elements spectrum of Ass. *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 (Pont-Med – Pontic- Mediterranean; Carp – Carpathian; Cosm – world-wide; Circ – Circumpolar; Euc – Central-European; Eur – European; Eua – Eurasian)

The ecological index analysis (Fig. 3) shows the following dominant categories: shadow to half-shadow species (33.33%), intermediate climate (i.e. concentrated in the sub-mountain belt) species (76.19%), oceanic to sub-oceanic species (42.11%), fresh soil species (43.33%), neutral soil species (37.50%), and species that occur in soils which are intermediate to rich in mineral nitrogen.

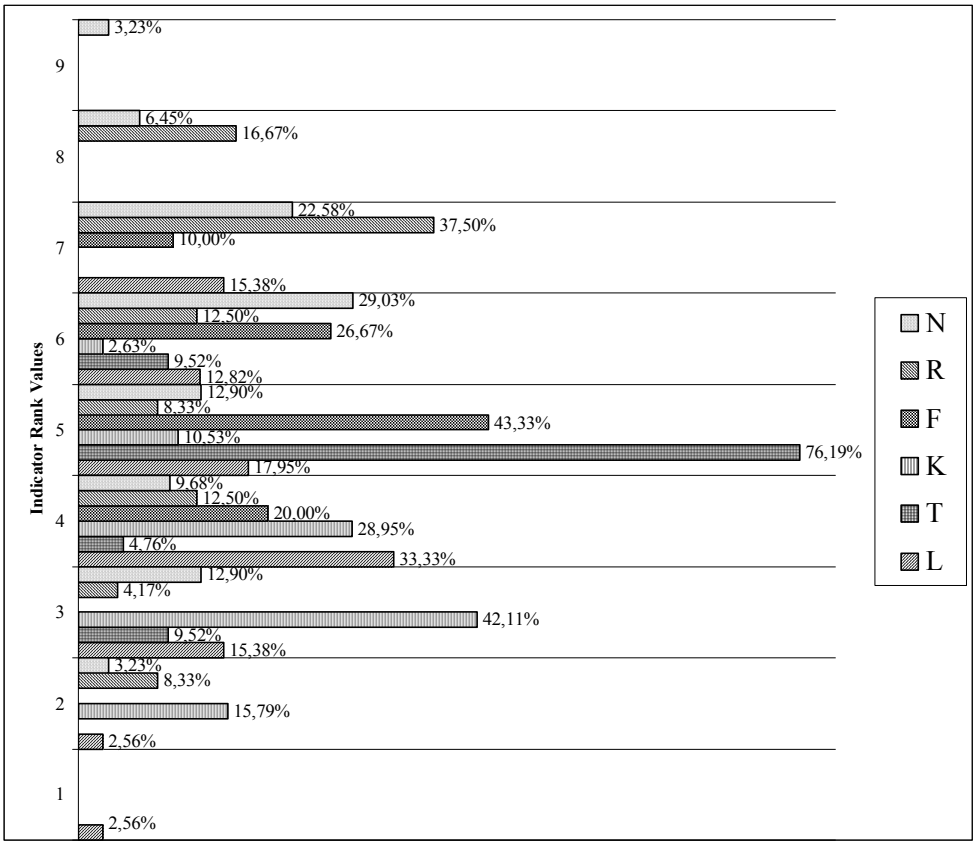

Fig. 3: Ecological index spectrum of Ass. *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 (L – light; T – temperature; K – continentality; F – soil moisture; R – soil reaction; N – soil nitrogen content)

Hieracio rotundati-Piceetum Pawl. et Br.-Bl. 1939:

Pure *Picea abies* forests of this association are wide spread on all superior mountain slopes of the Romanian Carpathians [7], although, they appear as patches in the research area (boreal zone is dominated by mixed *Picea abies* and *Abies alba* forests). These forests occur on soils that are acid, brown, highly saturated in bases, and rich in humus [7]. *Picea abies* dominates the forest canopy and its coverage is between 65 – 85% (Table 2). Because of the ground acidity, the grasses coverage is just 5%. Most of the species are acidophilous and characteristic for the order and alliance. *Picea abies* forests low limit is invaded by numerous species that are characteristic for deciduous forest.

Table 2: Ass. *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939

Relevee No.	**1**	**2**	**3**	**4**	**5**	**K**
Altitude (m)	860	875	950	960	880	
Trees coverage (%)	95	95	90	90	95	
Shrubs coverage (%)	0	2	2	0	0	
Grasses coverage (%)	5	2	3	2	2	
Exposure	NV	N	N	NV	NV	
Slope (degrees)	10	10	5	5	15	
Area (m^2)	400	400	400	500	500	
Species no.	11	14	11	8	12	
Characteristic species						
Hieracium transsilvanicum	+	+	+	+	+	V
Piceion abietis						
Abies alba	+	+	+	+	+	V

Relevee No.	**1**	**2**	**3**	**4**	**5**	**K**
Picea abies	5	5	5	5	5	V
Leucanthemum waldsteinii	+	+	-	-	-	II
Vaccinio-Piceetalia						
Oxalis acetosella	-	+	+	+	+	IV
Sorbus aucuparia	-	+	-	+	+	III
Vaccinio-Piceetea						
Orthilia secunda	+	+	+	+	+	V
Symphyto-Fagion						
Luzula luzuloides	+	+	+	+	+	V
Acer pseudoplatanus	+	+	+	+	+	V
Querco-Fagetea						
Lonicera xylosteum	+	+	-	-	+	III
Companion species						
Veronica officinalis	+	+	+	-	+	IV
Maianthemum bifolium	+	+	+	-	+	IV
Mercurialis perennis	+	+	+	-	-	III
Viola reichenbachiana	-	+	+	-	+	III

Rel. 1 – Hangu sat, 30-07-2000, Rel. 2 – Hangu sat, 30-07-2000, Rel. 3 – Buhalnița, 20-07-2002, Rel. 4 – Buhalnița, 31-07-2002, Rel. 5 – Hangu – Valea Sasu, 31-07-2002

The bioform analysis (Fig. 4) shows the hemicryptophytes as dominant (42.86%) followed by the megaphanerophytes (28.57%). The other bioforms are also well represented, although they are less important for the regional flora.

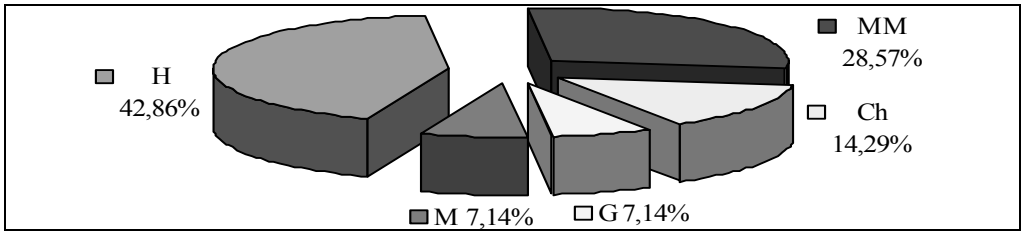

Fig. 4: Bioform spectrum of Ass. *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 (H – hemicryptophytes; MM – megaphanerophytes; Ch – chamaephytes; G – geophytes; M - mesophanerophytes)

The floristic element analysis (Fig. 5) establishes the clear dominance of the Eurasian species (28.57%) followed closely by the circumpolar and the European ones (each with 21.43%).

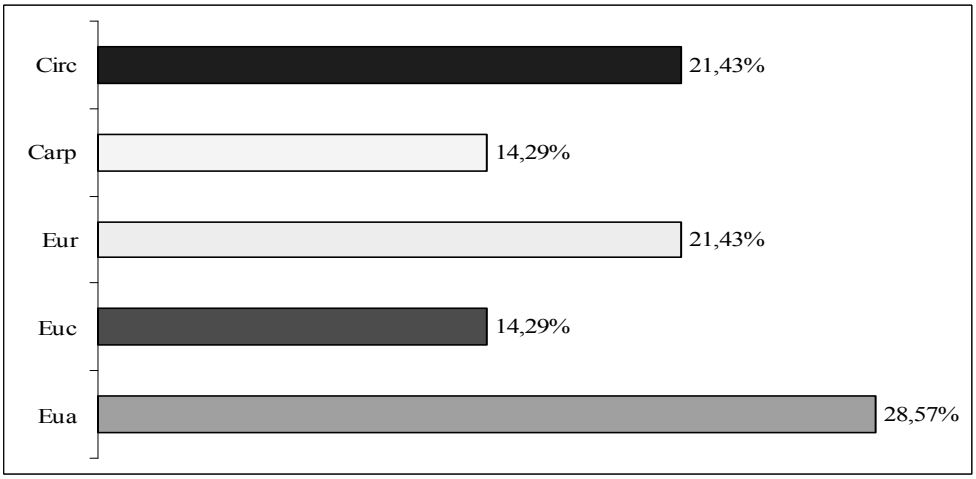

Fig. 5: Floristic element spectrum of Ass. *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 (Circ – Circumpolar; Carp – Carpathian; Eur – European; Euc – Central-European; Eua – Eurasian)

The ecological index analysis (Fig. 6) reveals the dominance of the following categories: shadow to half-shadow species (33.33%), cool to intermediate climate species (80%), sub-oceanic species (45.45%), fresh soil species (50%), neutral soil species (50%), and species that occur in soils which are rich in mineral nitrogen.

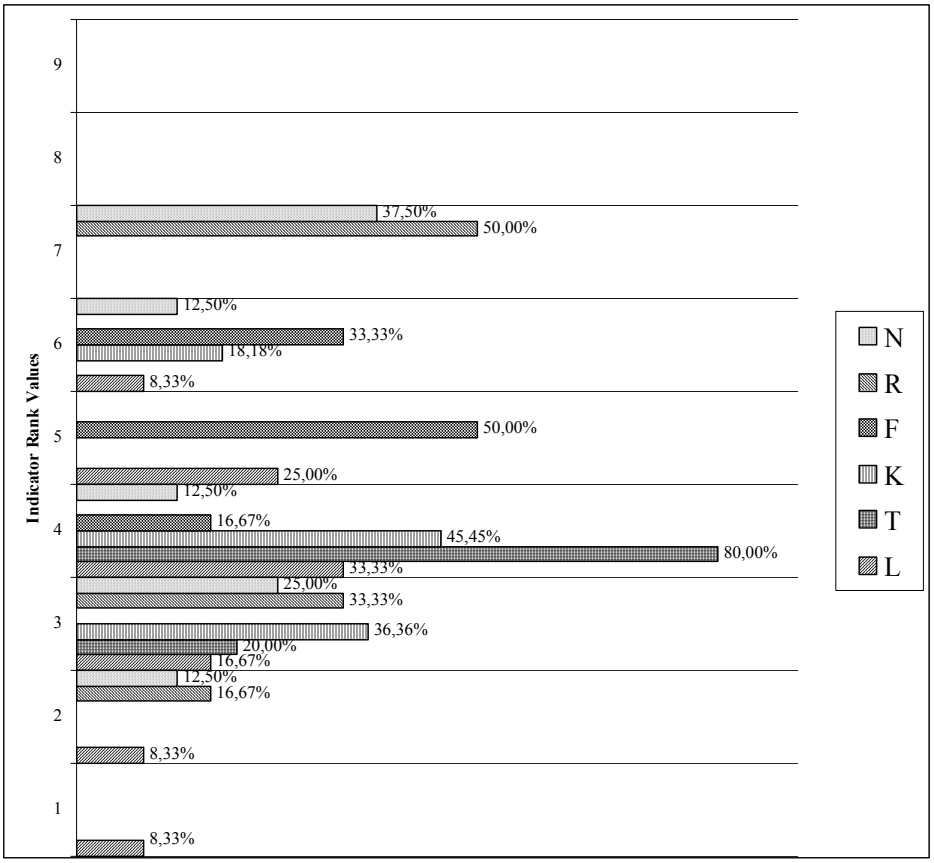

Fig. 6: Ecological index spectrum of Ass. *Hieracio rotundati- Piceetum* Pawl. et Br.-Bl. 1939 (L – light; T – temperature; K – continentality; F – soil moisture; R – soil reaction; N – soil nitrogen content)

The similarity analysis (Fig. 7) outlines the obvious resemblance of relevees corresponding to each association. Thus, *Hieracio rotundati-Abietetum* relevees are 42.8% similar, while *Hieracio rotundati-Piceetum* relevees are 57.1% similar. This difference results from the fact that the first association is richer in species than the second one. Generally speaking, the studied associations are 80.2% dissimilar, meaning that their similarity is just 19.8%.

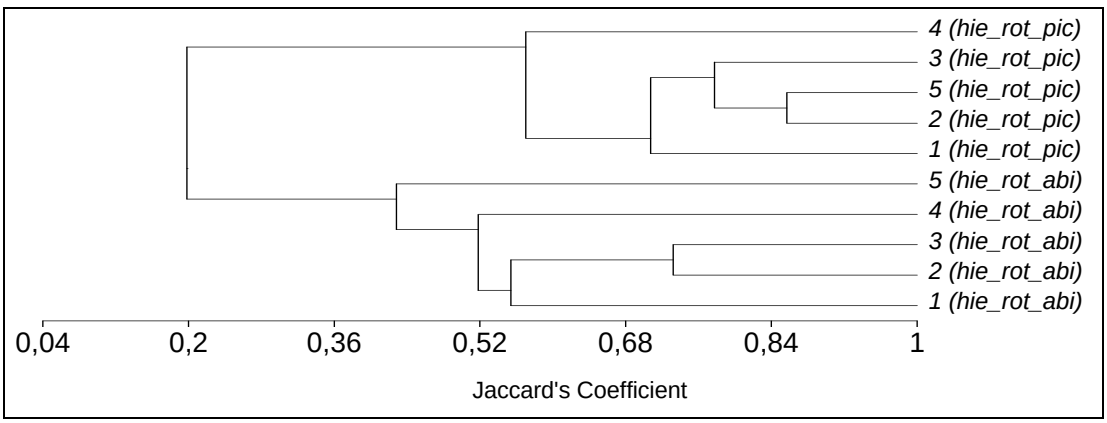

Fig. 7: Similarity cluster dendrogram of relevees (ciphers 1 – 5 – relevees numbers; *hie_rot_abi – Hieracio rotundati-Abietetum*; *hie_rot_pic – Hieracio rotundati-Piceetum*)

Conclusions

The analysis of the two associations of Class *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939 from the southwestern part of the Stânişoara Mountanis revealed the following conclusions:

1. The species characteristic to Class *Querco-Fagetea* Br.-Bl. et Vlieger in Vlieger 1937 em Borhidi 1996 are present in high numbers, especially the communities of *Hieracio rotundati-Abietetum* that occur at lower altitudes, which corresponds to the upper limit of the deciduous forests.

2. The analysis of bioforms showed the dominance of the hemicryptophytes in both studied associations – 50% in the communities of *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 and 42.86% in the communities of *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939.

3. The floristic element analysis outlined the dominance of the Eurasian species in both studied associations – 26.09% in the communities of *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 and 28.57% in the communities of *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939.

4. Ecological index analysis showed that shadow to half-shadow species, fresh soil species, neutral soil species dominate both associations. The remaining ecological indices had different values. Thus, intermediate climate species, oceanic to sub-oceanic species, and species that occur in soils which are intermediate to rich in mineral nitrogen dominate the Association *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991, while cool to intermediate climate species, sub-oceanic species, and species that occur in soils which are rich in mineral nitrogen dominate the Association *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939.

5. According to the cluster analysis, the relevees of the Association *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 are 42.8% similar, while those of the Association *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 are 57.1% similar. The similarity between the two groups of relevees, each group corresponding to an association, was 19.8%.

6. Forested ecosystems from the left side of Izvoru Muntelui-Bicaz Accumulation Lake are dominated by *Picea abies* and *Abies alba* mixed forests and not by pure *Picea abies* forests, as believed to be in the Oriental Carpathians.

BIBLIOGRAPHY

1. Borhidi, A., 1971, Die Zönologie der Fichtenwälder von Ost und Südkarpaten, *Acta Bot. Hung*., **17**: 287-319.
2. Borza, Al.; Boşcaiu, N., 1965, *Introducere în studiul covorului vegetal*, Ed. Acad. R.P. Române, Bucureşti 494 p.
3. Braun-Blanquet, J., 1964, *Pflanzensoziologie*, 3, Aufl., Springer, Wien, 865 p.
4. Burduja, C.; Gavrilescu, Gh., 1970, Studiul floristic şi fitocenologic al spaţiului din jurul lacului de acumulare Bicaz – I. Cercetări floristice asupra versantului stâng, între Dealul Gicovanu şi Piciorul Malu (Hangu), *Lucr. Staţ. de Cerc. Biol. "Stejarul"*, Piatra – Neamţ: 281-310.
5. Burduja, C.; Gavrilescu, Gh., 1976, Studiul floristic şi fitocenologic al spaţiului din jurul lacului de acumulare Bicaz – II. Cercetări floristice asupra versantului stâng, între Piciorul Malu (Hangu) şi Gura Largu (Poiana Teiului), *Lucr. Staţ. de Cerc. Biol."Stejarul"*, Piatra – Neamţ: 33-46.
6. Chifu, T.; Mititelu, D.; Dăscălescu, D., 1989, Flora şi vegetaţia judeţului Neamţ, *Mem. Sect. şt. Acad. Rom.*, **X**, (1), Bucureşti.
7. Coldea, Gh., 1991, Prodrome des associations végétales des Carpates du sud-est (Carpathes Roumaines), *Docum. phytosoc, N.S., Camerino*, **XIII**: 317-539.
8. Ellenberg, H., 1974, *Indicator values of vascular plants in Central Europe*, Verlag Erich Goltze KG, Göttingen: 7-86.
9. Géhu, J.-M., 1980, La phytosociologie d'aujord'hui. Méthodes et orientations, *Not. Soc. Ital. Fitosoc*., **16**: 1-16.
10. Géhu, J.-M.; Rivas-Martinez, S., 1981, Notions fondamentales de phytosociologie, *Ber. Intern. Sympos. Intern. Verein.* Vegetationsk.-Syntaxonomie, Rinteln (1980): 5-33.
11. Mihai, Gh., 1989, Molidişul de limită (*Cembreto-Piceetum*) din Munţii Călimani, *Stud. şi Cerc. Biol.*, Biol. Veg., **36**, (1): 28-34.

12. Mihăilescu, S., 2001, *Flora şi vegetaţia Masivului Piatra Craiului*, Ed. Vergiliu, Bucureşti, 400 p.
13. Mucina, L., 1997, Conspectus of Classes of European vegetation, *Folia Geobot. Phytotax.*, Praga, **32**: 117-172.
14. Oberdorfer, E., 1994, *Pflazensoziologische Exkursiflora*, **7**, Aufl., Verlag Eugen Ulmer, Stuttgart: 25-53.
15. Pott, R., 1992, 1995, *Die Pflanzengesellschaften Deuschlands*, 1 & 2 Aufl., Verlag Eugen Ulmer, Stuttgart: 451, 622.
16. Zamfirescu, Oana; Zamfirescu, Şt. R., 2003, Mapping Plant Formations from the Left Side of Izvoru Muntelui-Bicaz Accumulation Lake, *Analele Ştiinţifice ale UAIC – Iaşi*, (submitted manuscript).

CONTRIBUŢII LA STUDIUL CLASEI *VACCINIO-PICEETEA* BR.-BL. 1939 DIN CARPAŢII ORIENTALI

(Rezumat)

Lucrarea prezintă un studiu asupra pădurilor pure de molid şi a molidişo-brădetelor, aparţinând clasei *Vaccinio-Piceetea* Br.-Bl. 1939. Aceste formaţiuni forestiere sunt caracterizate din punct de vedere corologic, ecologic, cenotaxonomic, al bioformelor şi elementelor floristice. În zona cercetată, această clasă este reprezentată prin două asociaţii: *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 şi *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939. În comunităţile primei asociaţii domină speciile *Abies alba* şi *Picea abies*. De fapt, cele două specii sunt codominante. Comunităţile celei de a doua asociaţii sunt dominate doar de *Picea abies*. Specia caracteristică pentru ambele asociaţii este *Hieracium transsilvanicum*. Ca număr de specii, fitocenozele primei asociaţii conţin un număr mai mare (46 specii) faţă de cele ce intră în alcătuirea celei de a doua asociaţii (14 specii). De asemenea, se observă prezenţa în număr mai mare a speciilor caracteristice pădurilor de foioase (clasei *Querco-Fagetea*) în prima asociaţie, aceasta aflându-se la limita cu fitocenozele aparţinând asociaţiei *Leucanthemo waldsteinii-Fagetum* (Soo 1964) Tauber 1987. Analiza bioformelor şi elementelor floristice a arătat că în ambele asociaţii domină hemicriptofitele şi, respectiv, speciile eurasiatice. Analiza indicilor ecologici a arătat că ambele asociaţii sunt dominate de speciile intermediare între cele de umbră şi semiumbră, de speciile de soluri semiumede şi de speciile de soluri neutre. Ceilalţi indici ecologici au avut valori diferite pentru cele două asociaţii. Astfel, speciile de climat moderat, speciile intermediare între cele oceanice şi suboceanice şi speciile care apar pe soluri cu conţinut moderat până la bogat de azot mineral, domină asociaţia *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991, în timp ce speciile de climat răcoros până la moderat, speciile suboceanice şi cele care cresc pe soluri bogate în azot mineral sunt dominante în asociaţia *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939. Conform analizei similarităţii rezultă că releveele asociaţiei *Hieracio rotundati-Abietetum* (Borhidi 1971) Coldea 1991 sunt similare în proporţie de 42,8%, în timp ce releveele asociaţiei *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939 sunt similare în proporţie de 57,1%. Similaritatea dintre cele două grupuri de relevee, fiecare corespunzând uneia din cele două asociaţii, este de 19,8%. S-a stabilit pentru ecosistemele forestiere de pe malul stâng al lacului de acumulare Izvoru Muntelui-Bicaz predominarea molidişo-brădetelor şi nu a molidişurilor pure cum s-a specificat până acum în literatura de specialitate pentru Carpaţii Orientali.