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DIPLOIDY INDICES IN THE PLANT ASSOCIATIONS FROM NATURA 2000 SITE: SIGHIŞOARA-TÂRNAVA MARE

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REZUMAT:
Habitatele identificate în situl Natura 2000, Sighişoara-Târnava-Mare se remarcă printr-o mare bogăţie floristică, importante pentru conservarea diversităţii plantelor şi animalelor, unele dintre ele fiind recunoscute ca habitate cheie pentru menţinerea biodiversităţii la nivel european. În urma studiului efectuat, au fost identificate 43 de asociaţii vegetale, grupate în 30 alianţe, 1 subalianţă, 18 ordine şi 13 clase. Am redat distribuţia diploizilor şi poliploizilor, în vederea estimării indicilor de diploidie, calculaţi după formula lui Pignatti, bazaţi pe stabilirea raportului dintre suma prezenţei speciilor diploide şi a celor poliploide. Din totalul celor 897 taxoni vegetali, identificaţi în situl Sighişoara-Târnava Mare, 51,32% sunt diploizi, 46,29% sunt poliploizi, 2,40% sunt diplo-poliploizi, iar pentru 2,01% nu am dispus de informaţii cariologice. Valoarea raportului dintre speciile diploide şi cele poliploide calculat pentru ansamblul florei vasculare este de **1,11**. Cele mai ridicate frecvenţe ale poliploizilor au fost întâlnite în cazul biotopurilor destabilizate, iar cele mai reduse frecvenţe în cazul asociaţiilor aflate în stadiu de climax. În ansamblul lor, indicii de diploidie ai asociaţiilor din teritoriul cercetat corespund cu valorile indicilor similare din Europa centrală. Valorile acestor indici rămân similare cu cele ale asociaţiilor identificate în alte zone ale Transilvaniei: Defileul Mureşului, Valea Gurghiului dar şi cele din zonele umede din nord-vestul României.
Keywords: indici de diploidie, situl Sighişoara-Târnava-Mare, asociaţii vegetale

INTRODUCTION

Sighişoara-Târnava Mare (Fig. 1) is located in the geographical center of the country, in Southern Transilvania and contains 27 cities and towns that belong to three counties: Braşov, Mureş and Sibiu (Table 1). This site has a surface of 97000 hectares, making it the largest site in the continental region (of Romania).

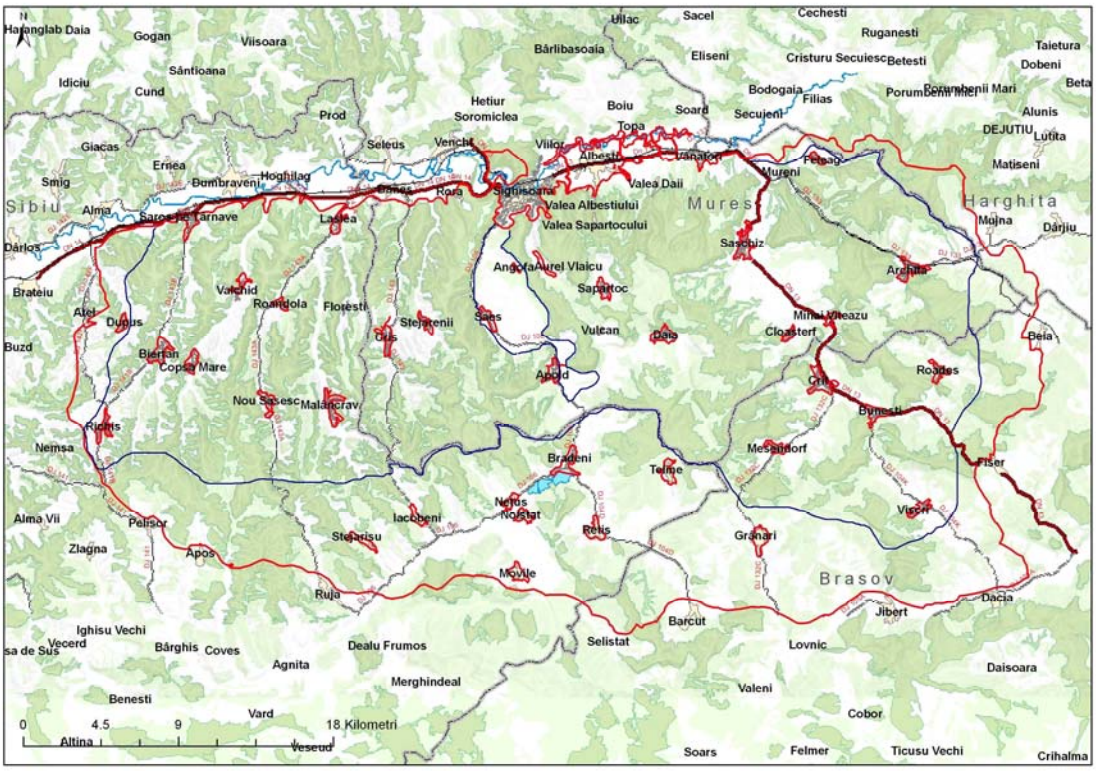

Fig. 1 – Map of the site Sighişoara-Târnava Mare

Tab. 1. Sighişoara-Târnava Mare site localities were conducted botanical research

Județul	communes	Sate aparținătoare
Braşov	**Buneşti**	Criț Meşendorf Roadeş Viscri
	Rupea (oraş)	Fişer
Mureş	**Albeşti**	Valea Albeştiului Şarpatoc
	Apold	Daia Şaeş Vulcan
	Daneş	Criş Stejăreni
	Saschiz	Cloaşterf Mihai Viteazu
	Vânători	Mureni
Sibiu	**Biertan**	Richiş Copşa Mare
	Brădeni	Retiş Țeline
	Iacobeni	Movile Netuş Noiştat Stejăriş
	Laslea	Floreşti Mălâncrav Nou Săsesc Roandola

The flora found at the Natura 2000 Sighişoara-Târnava Mare site is characteristic to the hilly regions in our country, with diversity corellated to the height of the hills, the narrow valleys, wavy land, with asymmetrical sides due to the land slides, and terrased valleys and riversides. A part of this area is Podişul Vânătorilor, a flat area with slightly unleveled terrain reaching about 550 m in height, only rarely reaching 700 m, the region actually being part of Podişul Hârtibaciului from the south. The terrain of the Podişul Hârtibaciului region is also dominated by asymmetrical, tall hills, and wide valleys, marshy at the bottom. There are two large rivers passing through the Sighişoara-Târnava Mare site: Hârtibaciu in the middle and Târnava Mare to the North.

This area is remarcable due to the large number of plant species, many of these species are protected nationally and internationally, also due to the numerous habitat types that are included in the Natura 2000. The floristic inventory includes 858 plant taxa, 839 plant species, 15 subspecies, and 4 varieties. We want to mention that the area of this research project is approximatelly 24.51% of the Romanian flora (3500 species, as presented in RPR and RSR Romanian flora). Considering the number of the plant taxa present on this land surface that is only about 0.04 % of the Romania's entire land surface, this area has aproximatelly a quarter of the plant species found in our country, which allows us to consider this Sighişoara-Târnava Mare site a site of great floristic diversity (Oroian, 2009).

Materials and Methods

For this research we used phytosocial research methods according to the Central-European School, based on the principles developed by J.Braun-Blanquet (1926) and modified by A. Borza (1934) to the special properties of the plant cover in our country. The method of naming the plant associations was done in accordance with the regulations established by the Phytosocial Code of Nomenclature (Barkman et al., 1981). While describing the plant associations we used the methods suggested by A. Borza and N. Boşcaiu (1965) and V. Cristea et al., (2004) as well as the basic knowledge of phytosiology according to J.M. Gehu and S. Rivas-Martinez (1981). Syntaxonomic identification was carried out on the basis of the most recent works on vegetation classification at European level (Grabherr et al., 1993; Mucina et al., 1993). For the detailed inventory of the plant associations floristics research was performed (ecological behaviour was analyzed by using ecological indicators U, T, R, biomorphology, floristics, karyotype, etc.). When describing the plant make-up we used hydroseries criteria, starting with the *Lemnetea* Class, and continuing with the riverside (palustrine) and marshy plant associations, followed by hydrophytic meadows, and then xerophitic meadows.

RESULTS AND DISCUSSION

As a result of this study we identified 43 plant associations, included in 30 alliances, 1 suballiance, 18 orders, and 13 classes (Oroian, 2009). The plant associations were analyzed from an ecological and corological (regarding the geographical distribution of plants), the floristical composition, as well as cytotaxonomical. We assessed the distribution of the diploid and the polyploid species, in order to estimate the indices of diploidy as calculated by the Pignatti's formula, by calculating the proportion of diploid versus the polyploid species.

The general make-up of the Sighişoara-Târnava-Mare site's vegetation is determined by the past and present physical and geographical conditions, the origin of the diverse floristics elements, the modifications induced by the presence of the anthropogenic and zoogenic factors that had a strong influence on the vegetation make-up by changing natural habitats inhabited by the native flora with cultivated agricultural species. The area included in this study has a variety of habitats, spread from 375 to 700 m altitude, with well preserved forests and diverse herbaceous vegetation.

The karyotype information regarding the components of the various plant associations showed a series of legitimate that are of interest both from a phytogeographical causation stand point, as well as for phytohistorical interpretations. For the purpose of this research the chromosomal numbers of the various species was considered according to more authors (Tarnavschi, 1948; Fedorov, 1969; Löve et Löve, 1961,1974; Májovsky et al., 1987; Kuzmanov, 1993).

From the total 897 plant taxons identified in the Sighişoara-Târnava Mare site, 51.32% are diploid, 46.29% are polyploid, 2.4% are diplo-polyploid, and for 2.01% we had no karyotype information. The proportion between the diploid versus polypoid species as calculated for the vascular flora is 1.11. In the cases where we did not have that information for the Romanian native flora, as much as possible we refered to the number of chromosomes as established for a teritory as close as possible to our country. When calculating the Pignatti's diploidy index, we excluded the diplopolypoid species, as these have a variable karyological status, sometimes in the same population one can find together diploid as well as tetra- and polyploid species.

The flora in the site of our study includes the representative number of old, diploid, species. These species ensure the genetic potential for a favorable future plant evolution. The increased frequency of the polypoids is due to their increased ability of phytosocial competition. The diploid species ensure an increased resistence of the species to the ecological extremes, being the pioneer species that populated this area during the postglacial period. The highest proportion of polypoids were found in unbalanced biomes, while the lowest proportion of polypoids were located in associations that were in the ecological climax.

The numerous cytological studies show that, in general, the frequency of polypoids increases with the altitude, for this reason it is of particular importance to calculate Pigantti's diploidy index (Pignattii, 1960, 1961, 1966, 1982), starting with the proportion between the diploid species (ΣD) and the polyploid species (ΣP) from the flora of a particular region (Boşcaiu, 1971; Voik, 1975).

By comparing the diploidy indexes of the analyzed plant associations [Sig-T-M.], with the ones from the Mureş river valley between Topliţa and Deda (Oroian, 1998) [Def.], Valea Gurghiului (Sămărghiţan, 2005) [V.Gur.] and the hydrophytic areas in Northwestern Romania (Burescu, 2003) [N-V Ro], we conclude that our data have comparable values.

In the case of the plant associations of stagnant waters, with short vegetation at the edge of the ponds, depleted of nutrients, that is even more intense during the periods of periodical drying up of these ponds, the indexes remain below 1 (Table 2).

Table 2: Diploidy indexes or the plant associations from the class *ISOETO-NANOJUNCETEA* Br.-Bl. et Tx 1943

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig-T-M.	N-V Ro
Cyperetum flavescenti	**18**	94,45	4	22,22	13	72,22	**0,307**	0,798

The index values remain below 1 also in the case of the aquatic and palustrine wetland vegetation (Table 3,4).

Table 3: Diploidy indexes or the plant associations from the class *LEMNETEA* de Bolós et Masclans 1955

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.			
			No. of sp.	%	No. of sp.	%	Sig-T-M	Def.	V.Gur.	N-V Ro
Lemnetum minoris	**14**	92,85	6	42,85	7	50	**0,857**	0,749	0,85	0,562

Table 4: Diploidy indexes or the plant associations from the class *POTAMETEA* R.Tx.ex Preising 1942

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.		
			No. of sp.	%	No. of sp.	%	Sig-T-M	V. Gur.	N-V Ro
Ranunculo trichophylli-Callitrichetum cophocarpae	**25**	92	9	36	14	56	**0,642**	0,857	-
Potametum natantis	**20**	100	7	35	13	65	**0,538**	-	0,162
Potamo perfoliati-Ranunculetum circinati	**14**	92,84	3	21,42	10	71,42	**0,299**	**-**	**-**

The smallest diploidy index numbers were found in the newest associations, due to the increased phytosocial competition advantage of the polypoid species (Table 5).

Table 5: Diploidy indexes or the plant associations from the class *PHRAGMITETEA* Tx. et Prsg. 1942

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.			
			No. of sp.	%	No. of sp.	%	Sig-T-M	Def.	V. Gur.	N-V Ro
Scirpo-Phragmitetum vulgaris	**129**	93,74	54	42,18	66	51,56	**0,818**	0,591	0,528	0,545
Typhetum latifoliae	**37**	91,89	13	35,13	21	56,75	**0,619**	0,486	0,683	0,374
Glycerietum aquaticae	**47**	89,35	14	29,78	28	59,57	**0,499**	0,406	0,38	0,483
Sparganietum erecti	**23**	86,94	5	21,73	15	65,21	**0,333**	-	-	0,333
Eleocharitetum palustris	**24**	91,66	7	29,16	15	62,5	**0,466**	**-**	-	0,431

The diploidy index is under 1 in the case of the associations from the ***Molinio-Arrhenatheretea*** class R.Tx. 1937 em R.Tx. 1970 that are also recently developed secondary succesion associations (Table 6).

Table 6: Diploidy indexes or the plant associations from the class *MOLINIO-ARRHENATHERETEA* R.Tx.1937 em.R.Tx.1970

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.			
			No. of sp.	%	No. of sp.	%	Sig-T-M	Def.	V. Gur.	N-V Ro
Angelico-Cirsietum oleracei	**19**	94,73	8	42,10	10	52,63	**0,799**	-	-	-
Scirpetum sylvatici	**50**	88	13	26	31	62	**0,419**	0,408	0,450	0,399
Ranunculeto strigulosi-Equisetetum palustris	**32**	90,62	11	34,37	18	56,25	**0,611**	-	-	0,590
Junco inflexi-Menthetum longifoliae	**21**	85,71	6	28,57	12	57,14	**0,5**	0,738	0,270	0,703
Epilobio palustri-Juncetum effusi	**83**	92,77	27	32,53	50	60,24	**0,540**	-	-	0,695
Holcetum lanati	**66**	90,9	25	37,87	35	53,03	**0,714**	-	-	-
Agrostetum stoloniferae	**202**	85,15	99	36,15	73	49	**0,737**	0,735	-	0,631
Filipendulo-Geranietum palustris	**33**	90,9	9	27,27	21	63,63	**0,428**	-	0,597	-
Agrostio- Deschampsietum caespitosae	**121**	84,3	47	38,84	55	45,46	**0,854**	-	0,513	-
Cirsio cani-Festucetum pratensis.	**124**	89,76	61	48,03	53	41,73	**1.150**	-	0,789	-
Arrhenatheretum elatioris	**212**	92,45		44,81		47,64	**0,940**	-	0,817	-
Trisetetum flavescentis	**101**	96,03	50	49,50	47	46,53	**1,063**	-	-	-
Anthoxantho-Agrostetum tenuis	**94**	86,16	39	41,48	42	44,68	**0,928**	-	-	-
Festuco rubrae-Agrostietum capillaris	**164**	87,19	78	47,56	65	39,63	**1,200**	1,082	0,962	-

The associations from the ***Festuco-Brometea*** class Br.-Bl.et R.Tx.ex Klika et Hadač 1944, that are in balance for a longer period of time, have diploidy indexes higher than 1 (Table 7).

Table 7: Diploidy indexes or the plant associations from the class *FESTUCO-BROMETEA* Br.-Bl.et R.Tx.ex Klika et Hadač 1944

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig-T-M	V. Gur.
Rhinantho rumelici-Brometum erecti	**196**	8,98	91	46,43	85	43,37	**1,070**	-
Brachypodio pinnati-Festucetum rupicolae	**195**	83.08	87	44,62	75	38,46	**1,160**	-
Danthonio-Brachypodietum pinnati	**151**	88,73	72	47,68	62	41,05	**1,161**	1,238
Polygalo majoris-Brachypodietum pinnati	**164**	85,48	86	52,55	54	32,93	**1,59**	0,898
Medicagini minimae-Festucetum valesiacae	**199**	86,93	96	48,24	77	38,69	**1,246**	1,075
Elytrigetum hispidi	**119**	84,88	55	46,22	46	38,66	**1,195**	-
Thymio pannonici-Chrysopogonetum grylli	**97**	94,84	45	46,39	47	48,45	**0,957**	-
Festuco rupicolae-Caricetum humilis	**105**	80,95	49	46,66	36	34,29	**1,360**	-
Botriochloetum ischaemi	**107**	86,92	54	50,47	39	36,45	**1,384**	-
Carici humilis-Stipetum joannis	**58**	87,93	29	50	22	37,93	**1,318**	-
Stipetum capillatae	**126**	75,4	50	39,68	45	35,71	**1,111**	-

The anthropic associations from the ***Bidentetea*** class Tx., Lohm., et Prsg., 1950, on muddy shores, as well as the ones in the ***Artemisietea*** Lohmeyer et al.in R.Tx.1950 şi ***Secalietea*** Br.-Bl. 1951 classes, also have the diploidy indexes below 1 (Tables 8, 9,10).

Table 8: Diploidy indexes or the plant associations from the class *BIDENTETEA TRIPARTITI* Tx., Lohm., et Prsg., 1950

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.		
			No. of sp.	%	No. of sp.	%	Sig-T-M	V. Gur.	N-V Ro
Bidenti-Polygonetum hydropiperis	**15**	86,66	4	26,66	9	60	**0,444**	0,490	0,612

Table 9: Diploidy indexes or the plant associations from the class *ARTEMISIETEA* Lohmeyer et al.in R.Tx.1950

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig-T-M	V. Gur.
Conietum maculati	**37**	97,29	12	32,43	24	64,86	**0,5**	0,494

Tabel 10: Diploidy indexes or the plant associations from the class *SECALIETEA* Br.-Bl. 1951

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.
			No. of sp.	%	No. of sp.	%	Sig-T-M
Spergulo-Aperetum spica- venti	**29**	96,54	16	55,17	12	41,37	**1,333**

The assotions with *Salix alba* have the diploidy index of 1.270 due to the consistent presence of more diploids (Table 11).

Table 11: Diploidy indexes or the plant associations from the class *SALICETEA PURPUREAE* Moor 1958

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig-T-M	V. Gur.
Salicetum albae	**90**	93,33	47	52,22	37	41,11	**1,270**	0,849

The diploidy indexes for the association from the ***Alnetea glutinosae*** class Br.-Bl.et R.Tx.ex Westhoff et al.1946 as well as for the ones from the ***Rhamno-Prunetea*** class Rivas Goday et Borja Carbonell 1961, that contains shrubby associations, are values that are under 1 (Tables 12,13).

Table 12: Diploidy indexes or the plant associations from the class *ALNETEA GLUTINOSAE* Br.-Bl.et R.Tx.ex Westhoff et al.1946

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig -T-M	V. Gur.
Calamagrostio-Salicetum cinereae	**69**	92,74	30	43,47	34	49,27	**0,882**	0,812

Table 13: Diploidy indexes or the plant associations from the class *RHAMNO-PRUNETEA* Rivas Goday et Borja Carbonell 1961

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig -T-M	V. Gur.
Pruno spinosae-Crataegetum	**150**	88,67	83	55,34	50	33,33	**1,660**	1,333
Euonymo-Prunetum spinosae	**20**	95	9	45	10	50	**0,9**	**-**

The most important forests, from the ***Querco-Fagetea*** class Br.-Bl. Et Vlieger 1937 are found in the ecological climax, well balanced and their indexes of diploidy are above 1 (Table 14).

Table 14: Diploidy indexes or the plant associations from the class *QUERCO-FAGETEA* Br.-Bl. et Vlieger 1937

Association	Total no. of sp.	Know karyotype (%)	Diploids		Polyploids		D. I.	
			No. of sp.	%	No. of sp.	%	Sig -T-M	V. Gur.
Dentario bulbiferae –Quercetum petraeae	**86**	98,83	48	55,81	37	43,02	**1,297**	1,373
Corno-Quercetum pubescentis	**41**	95	24	58,53	15	36,58	**1,6**	**-**

Overall, the diplidy indexes of the analyzed plant associations are very similar with diploidy indexes found in Central Europe. These values are also similar to the diploidy indexes values found in other areas of Transylvannia (Mureş river gorge, Gurghiul river valley, as well the ones calculated for plant associations in other hydrophytic regions of Northwestern Romania).

REFERENCES

Barkman JJ, Moravec J, Rauschert S, Code der pflanzensoziologischen Nomenklatur, Vegetatio, vol.67, nr.3, Upssala, pp.145-195, 1981.

Borza Al, Boşcaiu N, Introducere în studiul covorului vegetal, Ed.Acad. R.P.R., Bucureşti, 1965.

Boşcaiu N, Flora şi vegetaţia munţilor Ţarcu, Godeanu şi Cernei, Ed.Acad. R.S.R., Bucureşti, 1971.

Braun-Blanquet J., Pavillard J, Vocabulaire de Sociologie Végétale, Ed.3, Impr.Lemaire-Andres, 1928.

Burescu P, Flora şi vegetaţia zonelor umede din nord-vestul României, Ed.Acad. Române, Bucureşti, 2003.

Cristea V, Gafta D, Pedrotti F, Fitosociologie, Ed. Presa Universitară Clujeană, Cluj-Napoca, 2004.

Fedorov A, Hromosomnîie cisla tvetcovîh rastenii, Nauca, Leningrad, 1969.

Géhu JM, Rivas-Martinez S, Notions fondamentales de Phytosociologie, Ber. Intern. Symposion Syntaxonomie in Rinteln, pp.1-33, 1981.

Grabherr G, Mucina L, Die Pflanzengesellschaften Österreich, Teil **II**, VEB Gustav Fischer Verlag Jena.Stuttgart.New York, 1993.

Kuzmanov B, – Khromozome numbers of Bulgarien Angiosperms: an introduction to a khromozome atlas of the Bulgarien flora, Flora Meediterranee, 3, pp.19-163, 1993.

Löve A, Löve D, Chromosome numbers of central and northwest European plant species, Opera botanica, vol.**V** a Societate botanica lundensi in suplimentum seriei „Botaniska notiser“ editata, pp.1-581, 1961.

Löve A, Löve D, Cytotaxonomical Atlas of the Slovenian Flora, Verlag von J. Cramer, Leutershausen, 1974.

Májovsky J, Murin A, Karyotaxonomicky prehl'ad flóry Slovenska, Veda vydavatel'stvo, Slovenskaj Académie Vied, Bratislava, 1987.

Mucina L, Grabherr G, Ellmauer Th, Die Pflanzengesellschaften Österreich, Teil **I**, VEB Gustav Fischer Verlag Jena.Stuttgart.New York, 1993.

Mucina L, Grabherr G, Wallnöfer S, Die Pflanzengesellschaften Österreich, Teil **III**, VEB Gustav Fischer Verlag Jena.Stuttgart.New York, 1993.

Oroian S, Flora şi Vegetaţia Defileului Mureşului între Topliţa şi Deda, Casa de Editură Mureş, 1998.

Oroian S, Flora şi vegetaţia satelor săseşti din sud-estul Transilvaniei, Ed. University Press, Tg-Mureş, 2009.

Pignatti S, Il significato delle specie poliploidi nelle associazioni vegetali, Alti Inst.Veneto di Sc., Lett. Arti, 118, pp.75-98, 1960.

Pignatti S, Die bedeutung der Polyploidie in den Pflanzengesellschaften, Mitt.ostalp.-din. pflanzensoz.Arbeitsgem., **1**, pp.57-62, 1961.

Pignatti S, Polyploidie-Verhältnisse der Anthropogenen Pflanzengesellschaften und Vegetationsserien, Anthropogene Vegetationi, pp.108-120, 1966.

Pignatti S, Flora d'Italia, vol.I-III, Edagricole Bologna, 1982.

Sămărghiţan M, Flora şi vegetaţia Văii Gurghiului, Ed. University Press, Tg-Mureş, 2005.

Tarnavschi I, Die Chromosomenzahlen der Autophyten-Flora von rumänien mit einem ausblick auf das Polyploidie-Problem, Bul.Grăd.Bot.Cluj, **XXVII**, supl.1, Cluj, pp.1-130, 1948.

Voik W, Contribuţii la studiul indicilor de diploidie ai asociaţiilor vegetale din Valea Şerbotei (Munţii Făgăraşului), Stud. şi Comunic. Muz. Brukenthal, ser. Şt.Naturale, 19, pp.121-125, 1975.