STUDIA BOTANICA HUNGARICA
(Antea: Fragmenta Botanica)
XVIII. 1985 p. 59-63

Stratigraphical revision of some Hungarian Badenian-Sarmatian floras

By
M. KORDOS-SZAKÁLY

(Received November 30, 1984)

Abstract: The so-called "Sarmatian flora" (ANDREÁNSZKY 1959) known from NE Hungary is the richest one among the Hungarian fossil floral assemblages. Among them the impressed remains from the sites Balaton, Buják, Bánhorváti, Mikófalva, Sály, the Paris and Bertece valleys in the vicinity of Nógrádszakál and the older Badenian beds of Eger-Tihamér are considered as basic floral assemblages. The sequence and chronology of these floras are fairly uncertain, therefore, statistical evaluation (clusteranalysis, GREGOR leaf-type analysis) was chosen in order to define the proper stratigraphical position of the floras (KORDOS-SZAKÁLY 1983).

SUMMARY OF PREVIOUS RESEARCH RESULTS

ANDREÁNSZKY G. (1955, 1959) studied in details the Hungarian Miocene especially the Sarmatian floras from the paleobotanical point of view. He based the stratigraphical assignment of the layers on the work of SCHRÉTER (1959). However, recent detailed Neogene stratigraphical research based on radiometric data, as well as the chronostratigraphical revision concerning the whole Miocene Paratethys, necessitates the stratigraphical re-evaluation of the basic floras of crucial importance. As it was clear from the previous paleobotanical revision of the floras from the Bertece and Paris-stream valleys near Nógrádszakál, these sites are not Sarmatian, but belong to the Lower Badenian (KORDOS-SZAKÁLY 1983). Based on the frequency of the species acurring in common with those of the site Paris-stream (C_{sp}) and the radiometrical dates of the Middle and Upper Rhyolite Tuff, the probable sequence of eight Miocene floras were defined (Balaton, Buják, Bánhorváti, Mikófalva, Sály, Paris-stream, Bertece-valley, Eger-Tihamér), and their relative "year-distance" (Fig. 1).

CLUSTER ANALYSIS

This method is the most frequent and simplest way of numerical classification, a comparison of the Jaccard and Sørensen coefficients by object pairs. The similarity of the fossil floras was calculated by the Jaccard-formula,

$$s_{R_{jk}} = \frac{a}{a + b + c},$$

and the Sørensen-coefficient (PODANI 1980)

$$s_{PS_{jk}} = \frac{2a}{2a + b + c}$$

where a is the number of attributes shared by both of the objects.
b is the number of attributes present in one of the objects, but missing from the other.
c is the number of attributes missing in the first, but present in the other object.

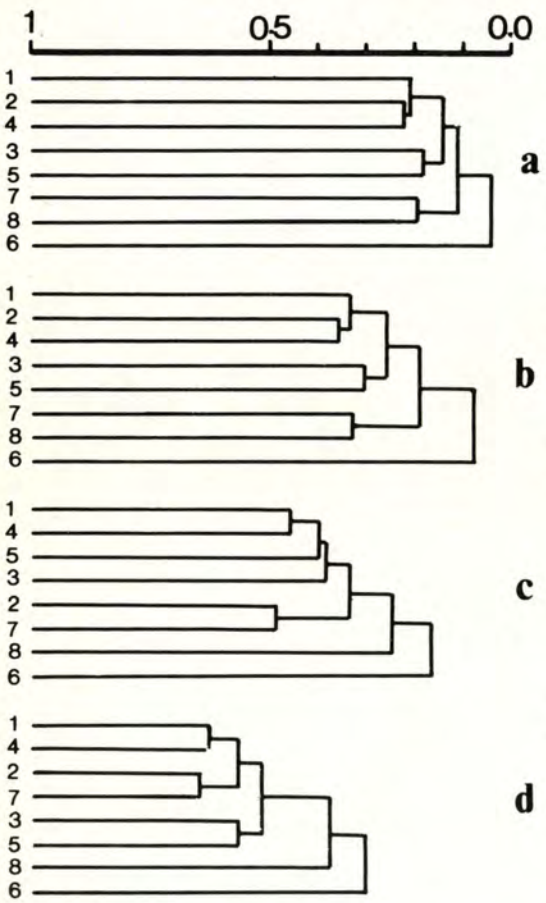


Fig. 1. Dendrograms of the eight Hungarian Miocene flora a = Jaccard's index for species, b = Sørensen's index for species, c = Jaccard's index for genera, d = Sørensen's index for genera; 1= Buják, 2= Mikófalva, 3= Bánhorváti, 4= Sály, 5= Balaton, 6= Eger-Tihamér, 7= Páris-valley, 8= Bertece-valley

Both coefficients were computed for the species and the genera of the eight paleofloras examined. The results are shown in the from of a dendrogram on Fig. 2. The vertical axis here is the eight objects classified, while the horizontal axis is the degree of similarity.

When evaluating the dendrogram, it seemed that the comparison of the species provided a more fruitful basis for comparison then that of the genera, because these are evidently more species than genera. Based on the species the following groups can be separated: Bánhorváti-Balaton, Sály-Mikófalva, Paris-Bertece, while the floras of Buják and Eger-Tihamér seem independent. However, cluster analysis is suitable for the definition of the groups only and not chronology; therefore the above groups were ranged according to the sequence determined earlier (KORDOS-SZAKÁLY 1983) Fig. 1).

GREGOR-LEAF-TYPE ANALYSIS

A rapid stratigraphical method valid for Central Europe was published by GREGOR in 1982. By the help of this method, the genera composing the flora, assigned into leaf-types selected on the basis of ecological and evolutionary principles, considered by different significance level can be assigned to flora types. The latter ones are suitable for characterizing a geohistorical period and for correlating with climate types as well as the Neogene Mammal zones defined by MEIN (MN-zones). A detailed description of this method can be found in the relevant paper of GREGOR (1982). The advantage of the method lies in, that it excludes any subjectivity. Several genera are lumped into the leaf-type groups. The number of imprints leaf depending mainly on local factors are blunted by categories 1 to 4 (1 = specimen number over 109, 2= specimen number between 11-100, 3= specimen number between 2-10, 4= 1 specimen). GREGOR separated the following leaf-type groups, putting the "-oid" ending after the genus name characteristic of the type group:

a. cinnamomoid	b. lauroid	c. diospyroid	d. taxodicoid
e. myricoid	f. juglandoid	g. aceroid	h. leguminosoid
i. quercoid	k. tilioid	l. populoid	m. carpinoid
n. cornoid	o. rosoid	p. salicoid	q. hydrophytoid
r. typhoid	s. smilacoid	t. gingkoid	u. comptonioid
v. viscoid	w. pinoid	x. palmoid	

The leaf-type group assignment of the eight examined Hungarian floras are shown in Table 1.

Table 1. Gregor's leaf-type index in the examined localities

Locality \ leaf types	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x
Eger-Tihamér	3	-	-	4	2	4	4	3	4	-	3	2	3	4	-	3	3	-	-	-	-	4	-
Buják	4	3	4	-	4	3	3	3	3	3	3	2	4	3	4	-	-	4	-	-	-	4	-
Mikófalva	3	3	3	4	-	3	3	3	2	3	2	2	-	3	4	-	-	-	4	-	-	-	4
Bánhorváti	3	2	2	-	4	2	1	3	1	1	3	1	3	2	1	-	3	4	-	-	-	-	-
Sály	3	3	4	2	3	2	2	3	2	3	2	1	-	2	4	-	-	3	4	-	-	-	-
Balaton	4	3	-	3	-	2	1	3	1	2	2	1	3	1	4	-	3	4	2	-	-	3	-
Nógrádszakál-Páris	-	3	3	-	-	2	1	4	2	3	1	1	-	3	2	-	-	-	3	2	-	-	3
Nógrádszakál-Bertece	4	3	-	-	-	4	2	4	2	3	2	2	-	1	4	-	-	-	-	2	-	-	-

As a result of this, the leaf-type composition of the individual floras can be determined and assignment can be made to the ecological flora types determined by GREGOR on the basis of the analyses of numerous samples. GREGOR (1982) has separated the following flora types:

fgilm-flora: deciduous, with few exotic elements, juglandoiden, aceroiden, quercoiden and carpinoiden (Pliocene, MN 10 zone)

defgikm-flora: deciduous, with more exotic elements, conifers and other components like above (Pliocene, Upper Miocene, MN 9 zone)

dg-flora: a sub-unit of the previous zone, pine-maple flora (Pliocene, MN 9 zone)

defgm-flora: a part of the defgikm-flora, rich in conifers and characterized by a special Gingko-form (Upper Miocene, MN 8/9 zone)

eilmp(h)-flora: a flora characteristic for humid environment with Populus, Salix, Quercus and few exotic elements (Upper Miocene, MN 7/8 and 8 zones)

ab(h)-flora: typically deciduous flora with high number of evergreens, especially with laurel-leaf types and smaller leguminous plants (Middle and Upper Miocene, MN 4-7 zones)

abehlm-flora: a sub-unit of the previous one characterized by the Daphnogenes often occurring monotypically, with many exotic elements, smaller leguminous plants and carpinoid form (Middle Miocene, MN 5-7 zones)

abdeim-flora: a somewhat older assemblage, but not very much different from the previous one (Lower Miocene, MN 4b/5 zones)

adgi-flora: an Acer-Quercus predominated flora with great number of indeciduous elements and cinnamonides and palm trees (Upper Oligocene, Lower Miocene, MN 1-3 zones)

The characteristic leaf types and GREGOR's flora-types of the eight Hungarian floras examined are the following:

Bánhorváti	fgikm	defgikm(o)
Balaton	fgimo	defgikm(o)
Sály	fgilm	defgikm(o)
Mikófalva	bgilm	defgikm(b)
Buják	bgilm	defgikm(b)
Paris	fgilm	defgikm(u)
Bertece	gilmou	defgikm(u)
Eger-Tihamér	elmnqr	eilmp

The letter codes characteristic for the leaf types help us to determine the floras that are very similar to each other. Similarity of the Bánhorváti-Balaton-Sály, Mikófalva-Buják (completely identical!), Paris-Bertece sites and the independence of the Eger-Tihamér site could be ascertained (Fig. 1). These results are concordant with the time-distance analyses based on the common species and the kindred circles, and the flora sequence defined by cluster analysis.

Assignment of the eight Hungarian floras to the Gregor-flora types represented a more difficult task. It seems evident however, that all sites represent a transition between the fgilm and defgikm floras, except for the Eger-Tihamér assemblage, and could be classified into no other group. Considering the leaf-type codes, they are nearer the flora type fgilm. However, based on the relevant descriptions and chronological correlation they can be assigned to the defgikm flora-

type. All these features speak for the fact that the GREGOR-system, devised in the first place for the Alps cannot be directly applied to the paleoflora of the lowlands of the Carpathian Basin. At the same time, the significant chronological gap (the Pliocene and Upper Miocene in GREGOR's system equals to the Middle-Upper Miocene in Hungary) indicates that the problem lies not with the stratigraphical correlation but there exists a considerable difference between the rates of evolution of the floras the two areas. That is, a certain stage characteristic of the Alps in the Pliocene existed in Hungary as early as the Sarmatian period.

The Eger-Tihamér flora is considerably different from the others, and fairly identical with the flora type eilmp in GREGOR's system as well as its stratigraphical assignment.

SUMMARY

The sequence and stratigraphical position of the rich Hungarian "Sarmatian floras" cannot be determined yet, due to a lack of data caused by the still insufficient geological analysis. Determination of the chronology was attempted here using objective methods based on the characteristic features of the paleofloras. A summary of the results is given in Fig. 1. With help of the three methods applied (namely time-distance analysis calculated on the basis of the jointly occurring species, cluster analysis and the GREGOR leaf- and flora-types) the following conclusions were reached:

- The oldest (Lower Badenian) flora from Eger-Tihamér is considerably different from that of the other, younger sites.
- The materials of the Bertece and Paris-valley near Nógrádszakál are closely related to each other and significantly different from the others as supported by the abundant and usable geological data.
- The connections of the Buják flora are uncertain, however the possible right dating for the assemblage is an Upper Badenian, Lower Sarmatian age.
- Among the Sarmatian floras in the strict sense, Mikófalva seems older on the basis of the examined data, while the difference between the Balaton-Bánhorváti-Sály floras lies most likely not in chronological, but facies relations.

The above data, possibly supplemented by detailed and radiometrical chronological data, might serve as a basis for reconstructing the Hungarian Middle and Upper Miocene floral and climatic evolution.

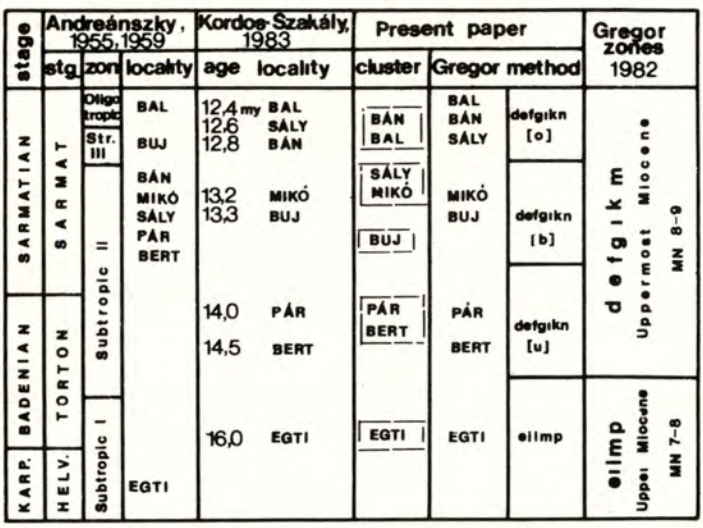


Fig. 2. Correlation of the eight localities by different methods

REFERENCES

ANDREÁNSZKY, G. (1955): Florengeschichte des ungarischen jüngeren Tertiärs und die Gliederung der Tertiärfloren. - Annales Geol. Ins., 44 (1): 231-260.

ANDREÁNSZKY, G. (1959): Die Flora der sarmatischen Stufe in Ungarn. - Akadémiai Kiadó, Budapest, 360 pp.

GREGOR, H-J. (1982): Eine Methode der ökologisch-stratigraphischen Darstellung und Einordung von Blattfloren unter spezieller Berücksichtigung der Tertiär-Ablagerungen Bayerns. - Verh. Geol. B. - A., 1982. (2): 5-19.

KORDOS-SZAKÁLY, M. (1983): New data to the Miocene flora of Nógrádszakál (Hungary). - Annls hist.-nat. Mus. natn. hung., 76: 43-63.

PODANI, J. (1980): SYN-TAX: Computer program package for cluster analysis in ecology, phytosociology and taxonomy. - Abstracta Botanica, VI.: 1-158.

SCHRÉTER, Z. (1959): Geologische übersicht. - In: Andreánszky, G. (ed.): Die Flora der sarmatischen Stufe in Ungarn.- Akadémiai Kiadó, Budapest, pp. 31-39.

Author's address: Dr. M. KORDOS-SZAKÁLY
Botanical Department of the
Hungarian Natural History Museum
Budapest, Pf: 222
H-1476
HUNGARY