JATE
EGYETEMI GYŰJTEMÉNY

HELYBEN
OLVASHATÓ

B 152138

CELL BIOLOGY AND DEVELOPMENT
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M.KEDVES

JATE Egyetemi Könyvtár
Szeged

...kölcsönzés határideje.
...sedelmi díjat számolunk fel
a később visszahozott könyvért!

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In memoriam

GÁBOR ANDREÁNSZKY
1895–1967

Preface

It is a great pleasure for our laboratory and I hope to all researchers of the world working in Paleobotany that the Centenary of Prof. Dr. Gábor ANDREÁNSZKY will be commemorated. Some years ago, at the meeting of the Paleontological Commission of the Hungarian Academy of Sciences, Dr. M. JÁRAI-KOMLÓDI (a member of the commission) proposed first the organization of a ceremonial meeting on this occasion. Prof. Dr. B. GÉCZY a member of the Hungarian Academy of Sciences as the president of the Commission, supported this proposal in every respect, and all members of the Commission were also for this idea. In the beginning of this year the first circular was distributed by Dr. L. HABLY, with the information that on 27–29 June 1995, there will be a conference in Eger for the Centenary of Gábor ANDREÁNSZKY organized by the following institutions:

Hungarian Geological Society,
Hungarian Natural History Museum,
Hungarian Academy of Sciences,
University of Rolando Eötvös Nominatae,
High School of Eszterházy Nominatae and by the
Mátra Museum.

A part of the contribution of our laboratory to this important meeting is this number of Plant Cell Biology and Development. It is a great pleasure for me, thanks to all the contributors of this number, that the multidisciplinary character of Paleobotany could be recognized in the matter presented herein. Its ideas were realized on other fields in several papers a long time ago by Prof. Dr. G. ANDREÁNSZKY.

Regarding my personal interests, I was student when Dr. ANDREÁNSZKY visited the Department of Botany as a member of the Commission of the Hungarian Academy of Sciences. He showed great interest in my microphotographs taken from the thin slides of fossil woods, and inspired me to do further investigations. Later, when I was a young assistant, he was the reviewer of my first self-made paper in German, which was published in Acta Biol. Szeged., 1958. After that he was one of the reviewers of my dissertation for the degree of Candidate of Biol. Sci. All his remarks and criticisms were extremely useful and valuable for me. During my palynological investigations on Hungarian Paleogene layers I tried to express my honour to this great scientist and the very humanitarian and nice man with the nomination of the following new form-species:

Monocolpopollenites andreanszkyi; Acta Bot. Acad. Sci. Hung. 11, p. 328.

Retitricolporites andreanszkyi; Studia Biol. Acad. Sci. Hung. 15, p. 81, 82.

Finally, I would like to express my sincere thanks to the following personalities and institutions for their generous financial support to the publication of this number:

to Dr. T. KECSKEMÉTI, president of the Hungarian Geological Society,
to the Foundation for Szeged,
to Dr. GY. TELEGDY, member of the Hungarian Academy of Sciences,
to the Foundation for the Science of the South Hungarian Plain,
to Prof. Dr. K. VARGA, Dean of the Faculty of Science,
to Prof. Dr. B. RÁCZ, scientifical vice-rector of the J. A. University,
to the Foundation of the Grant OTKA 1/5 T 007206.

Szeged, 28 December 1994.

M. KEDVES
head of the laboratory

THE BIOGRAPHY AND PALEOBOTANICAL ACTIVITY OF PROF. GÁBOR ANDREÁNSZKY (COMMEMORATION OF THE 100TH ANNIVERSARY OF HIS BIRTH)

L. HABLY

Gábor ANDREÁNSZKY baron was born in Alsópetény on 1st August 1895. During his childhood he studied in his family. Later his parents sent him to the nearby Piarist Grammar School in Vác where he finished his studies with excellent results in 1913. Then he attended the Pázmány Péter University and read Biology and Chemistry. During the Great War he fought on both the Italian and the Russian fronts so he could graduate only after this break of five years. He worked under Prof. János TUZSON's guidance in the Botanical Department of the University as an unpaid assistant. In 1922 he was awarded a doctorate degree in Botanical Taxonomy and also passed exams in Geology and Chemistry. He was appointed as a first assistant in 1923 and as a candidate in 1929 in the same institution. In 1938 he was an elected member of the Szent István Academy and on 30th May 1945 a corresponding member of the Hungarian Academy of Sciences (MTA). From 1947 to 1949 he was the secretary of the IVth Department of the MTA. The National Postgraduate Degree Granting Guard (TMB) qualified him candidate degree in 1952.

In 1941 he married Ilona BOÉR. In the same year he was appointed the first curator of the Botanical Department of the Hungarian National Museum and in 1943 he was promoted to be the director of the same department, and he held this position till 1st November 1945. The Pázmány Péter University awarded him the title of Exceptional Professor in 1943. As the World War II ended, he was saving and reorganizing the valuable collection of the museum's Botanical Department. On 1st November 1945 he was appointed professor of the University's Plant Morphological and Botanical Taxonomy Institute where he was the head of the department until July 1953. Then he had to leave the university because of his social background (barony), thus he was employed as a researcher of the museum where not much later he was given retirement. But this could not divert him from continuing his researches now already in the field of Paleobotany.

Prof. ANDREÁNSZKY's scientific interest directed him towards Botany from his youth. Besides his phytogeographical study trips in Hungary, he took part in important trips along the European and African coasts of the Mediterranean sea: in Sicily, in Corsica, in the French and the Italian rivieras, in Algeria, in Tunis and in Morocco. His trips to the Alps, into Transylvania and Poland were very important at that time. Mainly as a result of his North African study trips, he was convinced that the flora was constantly changing according to the effect of the climate and its certain factors.

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In his work on vegetation history he assigned a great importance to climate as a factor strongly affecting the migration of plants.

In 1949 he gave lectures on Paleontology to students of Geology, and from that time investigation of the Tertiary flora was the centre of his scientific interest. His scholar and self-forgetful personality attracted followers around him, so very soon a Paleobotanical School was formed, with nearly twenty students. In 1954 he published a handbook titled "Paleobotany", in which he gave a review of plants of the geohistorical past on the basis of their taxonomical order, and in the second part he characterized the florae and vegetation of geohistorical periods.

He payed special attention to the acquintance of native paleoflora – hardly discovered at that time – by issuing his first examination results, thoughts and observations. It follows from this that his book is not only a handbook but also a work including new knowledge and even more fruitful new ideas, which show the vocation of a researcher actively dealing with the subject. This work can be recommended for a useful reading to date with its readable style and inspiring questions.

Thereupon his many papers on Paleobotany appeared one after the another, in which he revealed undiscovered sites of the native Tertiary flora. In spite of spending already his retired years, he produced the main work of his life at that time, which made him an acknowledged man all over the world. He carried out his assembling work under bad circumstances such as travelling by train, going on foot with a rucksack on his back escorted by one of his colleagues, friends or disciples. His best helper in uncovering and gathering the native Tertiary flora was Ferenc LEGÁNYI who collected the sites mainly near Eger with a possessed spirit.

In the beginning and later on, during his paleobotanical activity Prof. ANDREÁNSZKY was working with Tertiary and essentially Sarmatian florae. His greatest work originated from this subject and beares the title "Die Flora der Sarmatischen Stufe in Ungarn" of which several publications appeared later. In this monography Prof. ANDREÁNSZKY elaborates all the known Hungarian sites which were considered as Sarmatian. This work has a great importance because this area was almost unknown before (except for Erdőbénye and Tállya).

Prof. ANDREÁNSZKY made a good use of his phytogeographical and ecological knowledge in the reconstruction of the Sarmatian flora and vegetation as well as the climate. It was an entirely new method at that time that he spent a lot of time on ecological and climatological conclusions besides descriptive botany. On this occasion he was dealing with drought-resistance and the presence of xerophilous species in young Tertiary florae. His researches of Neogene are inspired for discussions with his opinions about these problems even today.

He got into touch with native Paleogene while dealing with the collection (collected by Ferenc LEGÁNYI) of the Dobó István Museum in Eger. He examined two very rich findspots of well preserved leaf-remnants: the older Oligocene from Eger-Kiseged and the younger one from Wind Brickyard (Eger). Meanwhile he obtained a little quantity of matter from Oligocene sites of Budapest, so he could compare the florae of two regions with each other. Although geologists had very different opinions about the age of the problematical formations, Prof. ANDREÁNSZKY dated them to the same age on the basis of their vegetation. His statement was verified later by stratigraphical and paleobotanical investigations. It is an incontestable fact even today that both florae fossilized in the Tard Clay Formation. Prof. ANDREÁNSZKY could not complete his Oligocene researches as much as the Sarmatian ones, however, he published several papers and a small monography on the flora of the Wind Brickyard (Eger). As a matter of fact, these could be regarded as the first scientific elaborations of native Oligocene vegetations. His conclusions proved to be correct about the endemic species and isolated vegetations of native Tertiary Paleoflora despite many debates and disprovals.

We could not neglect his collection-establishing efforts besides his scientific and educational activities. The doubling of the paleobotanical collection of the Hungarian Natural History Museum is connected with ANDREÁNSZKY's name. Native Paleoflora is represented and documented most completely there. At the same time we are obliged to him for country collections because he elaborated them and determined mostly and marked out standard species and published them in many cases.

He formed comprehensive connections with several European paleobotanists by means of his competent knowledge of languages and admissions.

Up to the present day Prof. ANDREÁNSZKY was the most prominent character of Hungarian Paleobotany. The irradiation of his self-forgetful, kind and clear personality has influenced many of his former disciples and his spiritual followers through his works and his friend's recordings. He wrote his own name into the book of immortals by his scientific work throughout his life.

1. COMPRESSED TRIASSIC FRUCTIFICATIONS FROM INDIA, AND THEIR USEFULNESS IN GONDWANAS

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Abstract

There has been increased emphasis on the study of Triassic fructifications from India during the last two decades. *Dicroidium* bearing Triassic beds of Nidpur have yielded excellently preserved compressions of fertile organs in attached and detached forms; these fertile structures associated with their vegetative remains are represented by micro- and megasporangiate organs and exhibit a variety of morphological forms assignable to different plant groups. Systematic studies of the fructifications suggest recognition of major taxonomic groups: *Phycophyta, Bryophyta, Pteridophyta, Pteridospermophyta, Cycadophyta, Ginkgophyta* and *Coniferophyta;* considering the diversities of reproductive structures, found in various groups, strides have been made to trace the ancestral relationships. The possible affiliations of the various fertile and vegetative organs are discussed, based on their distinctive epidermal features, comparative morphology, patterns of arrangements, in situ spore-pollen morphography, seed characters and the distributions of fossils. Epidermal studies of fertile structures enhanced taxonomic resolution is useful for interpreting the systematics and phylogeny. Some enigmatic fertile forms are interpreted as "morphological intermediates" a potential link to Paleozoic relatives and during the course of evolution may have given rise to Mesozoic forms spread over Gondwanic continents. Consistent association of certain fructifications underlines their usefulness in correlation, interpretation of systematics and the time of origin of major groups. *Pteruchus* – a pollen organ is such an example, always associated with leaf – genus *Dicroidium* which is by far the most common, ubiquitous and diverse fructification throughout the realm of Triassic in Gondwana continents. These taxa co-occur nowhere except in regions that were once parts of ancient Gondwanaland. This kind of consistent association can be used to infer the morphoelement comprising the unattached organs. The seed taxon *Savitrispermum* is quite prolific and plays a significant role in the correlation of the Triassic of Gondwana. Also noteworthy is the seed cone *Nidia,* displaying a line of development in the direction of *Cycadales* and elucidates the origin of *zamoid cycads.* Other significant fructifications like *Nidpuria* and *Lelestrobus* are characterized by having *pteridophytic* structural organization but bear *gymnospermous* pollen grains. Likewise, *Bosea* also appears to be an intermediate form because of the pattern of its microsporophyll bearing pendant sporangia somewhat identical with that of *Crossotheca* but it is radically different in bearing costate pollen.

Key words: Paleobotany, Triassic, India.

Introduction

There has been increased emphasis on the study of Triassic fructifications from India during the last two decades. Of the Triassic outcrops in peninsular India, *Dicroidium* bearing Triassic beds of Nidpur have yielded exquisitely preserved compressions of fertile organs in attached and detached forms; these fertile structures, associated with their vegetative remains are represented by micro-and megasporangiate organs and exhibit a variety of morphological forms assignable to different plant groups. The possible affiliations of various fertile and vegetative organs have been attempted by SRIVASTAVA (1974, 1975, 1990) based on their distinctive epidermal features, comparative morphology, patterns of arrangements, in situ spore-pollen morphography, seed characters and the distribution of fossils. Epidermal studies of fertile structures enhanced taxonomic resolution, which is useful for interpreting the systematic resolution.

Results

Systematic studies of fructifications suggest recognition of major taxonomic groups: *Phycophyta, Bryophyta, Pteridophyta, Pteridospermophyta, Cycadophyta* and *Coniferophyta. Ginkgophyta* is represented by leaf only, no fertile organs have yet been reported.

The algal remains have shown their representation in the form of carbonized filamentous mat-like structure. In some of the filaments, the rounded swellings appeared to be oogonium containing spores which have been described as *Algacites oogonifera.* The presence of oogonia like bodies may be cited as an evidence of their algal nature. However, the oospore is not that distinct (PANT and BASU 1981).

The other non-vascular *cryptogams* are represented by genera *Hepaticites nidpurensis* which evidently has shown an attached sporogonium whereas the other species *H. riccardioides, H. metzeroides* and *H. foliata* have not shown any evidence of fruiting structure. The sporogonium of *H. nidpurensis* when compared with *Cyathodium tuberosum* have shown a similar position on the thalli and their size and oval form are also identical. Also the apical dehiscense in *H. nidpurensis* is a point of resemblance between the two sporogonia but the absence of an involucre around the sporogonium and the lack of elaters inside the sporogonium of *H. nidpurensis* differentiate the fossil genus *H. nidpurensis* from *Cyathodium tuberosum.* The sculpturing of the spore of *H. nidpurensis* have a smooth exine but of *C. tuberosum* are spinous and therefore it could be considered that *H. nidpurensis* might have evolved from the allied forms of thallose *bryophytes* as *Cyathodium.* The lack of elaters, however, of *H. nidpurensis* brings it nearer to that of *Riccia* but the shape of sporogonium of *Riccia* and its complete embedding in the thallus tissue contrast it from former. With this evidence, it could be safely inferred that *H. nidpurensis* might have been an intermediate form in the progressive evolution of thallose *bryophytes.*

The *pteridophytes* have been represented only in the form of occurrence of megaspores of *lycopsid* alliance. However, the present detached sporangium bearing cingulate spores of *lycopsid* affiliations have refuted the contention of the absence of macrofossils of *lycopsida* in the Triassic of India. The taxon is described here as *Krauselitheca* gen. nov. for sporangia bearing cingulate spores. The presence of cingulum in the spores of *Krauselitheca* gives some insight into the evolution of *pteridophytes* at the onset of Mesozoic i.e. Triassic to a fuller understanding of their phylogeny. It also reflects that the giant *lycopods* of Mid–Paleozoic started disap-

Plate 1.1.

1. *Algacites oogonifera* PANT and BASU 1981. A few filaments of alga showing walls and septa. No: 41305, 2.225x.
2. *Algacites oogonifera* PANT and BASU 1981. Highly magnified view of oogonium-like body showing tuberculate oospore and lateral opening. No: 41306, 990x.
3. *Hepaticites nidpurensis* PANT and BASU 1976. Thallus showing rhizoids and dorsally attached sporogonium. No: 40651, 66x.
4. *Hepaticites nidpurensis* PANT and BASU 1976. Compressed spores obtained after teasing the sporogonium showing a trilete mark. No: 40651, 940x.
5. *Hepaticites nidpurensis* PANT and BASU 1976. Compressed spore, showing a proximal trilete. No: 40651, 940x.
6. *Cyathodium tuberosum.* Proximal view of spore showing spinous exine. 1000x.

7,8. *Krauselitheca* gen. nov. An isolated sporangium in carbonized state immersed in glycerine. No: 10579, 10x, and the macerated sporangium showing sporangial membrane associated with spore mass showing at places liberated spores. Slide No: 10579, 50x.

9–11. Spores retrieved from the sporangium showing cingulum and distinct trilete mark.

Plate 1.2.

1. *Bosea indica* SRIVASTAVA 1975. A branched fructification, showing lateral arrangement of microsporophylls and longitudinally ribbed surface of axis. Holotype No: 85164, 6x.
2. *Bosea indica* SRIVASTAVA 1975. A piece of sporangium wall associated with a few spores. Slide No: 35154–I, 500x.
3. *Rugatheca nidpurensis* PANT and BASU 1977. Compressed sporangia showing striations on the surface. Slide No: 40331. 35x.
4. *Grambastisporites nidpurensis* PANT and BASU 1979. External feature of dry megaspore. Slide No: 41911, 154x.
5. *Srivastavaesporites triassicus* PANT and BASU 1979. Dry megaspore showing sinuous laesurae and well defined arcuate ridges. Slide No: 41021, 84x.
6. *Nidhitriletes spinosa* PANT and BASU 1979. Dry lageniculate megaspores with surface and marginal spines. Distal view. Slide No: 41052, 58x.
7. *Trikonia emerginata* PANT and BASU 1979. A dry trianguloid megaspore showing notches at angles and rounded outline of the inner sac. Slide No: 41040, 100x.

Plate 1.3.

1. *Pteruchus indicus* PANT and BASU 1973. The sporangial head having sporangia. No: 40079, 9x.
2. *Pteruchus gopadensis* PANT and BASU 1979. Central axis showing spirally inserted lateral stalks. No: 40552, 13x.
3. *Bosea indica* SRIVASTAVA 1975. A macerated pendant sporangium with its membranous wall through which spores are visible. Slide No: 35154–8, 100x.
4. *Bosea indica* SRIVASTAVA 1975. A restored branched microsporophyll.
5. *Rugatheca nidpurensis* PANT and BASU 1977. Oval cuticle of an individual sac from a synangium, filled with masses of striate pollen grains of *Rugapites spherica* associated with pieces of outer cuticle. Slide No: 40332, 100x.
6. Pollen grains from inside macerated synangia showing ectexine enclosing endexine. Slide No: 40333, 800x.
7. A pollen grain with an open triradiate slit. Slide No: 40334, 1000x.
8. Endexine of a pollen grain to show triradiate and anastomosing granules giving a reticulate appearance. Slide No: 40334, 1000x.
9. A loose tetrad of pollen grains. Slide No: 40333, 500x.

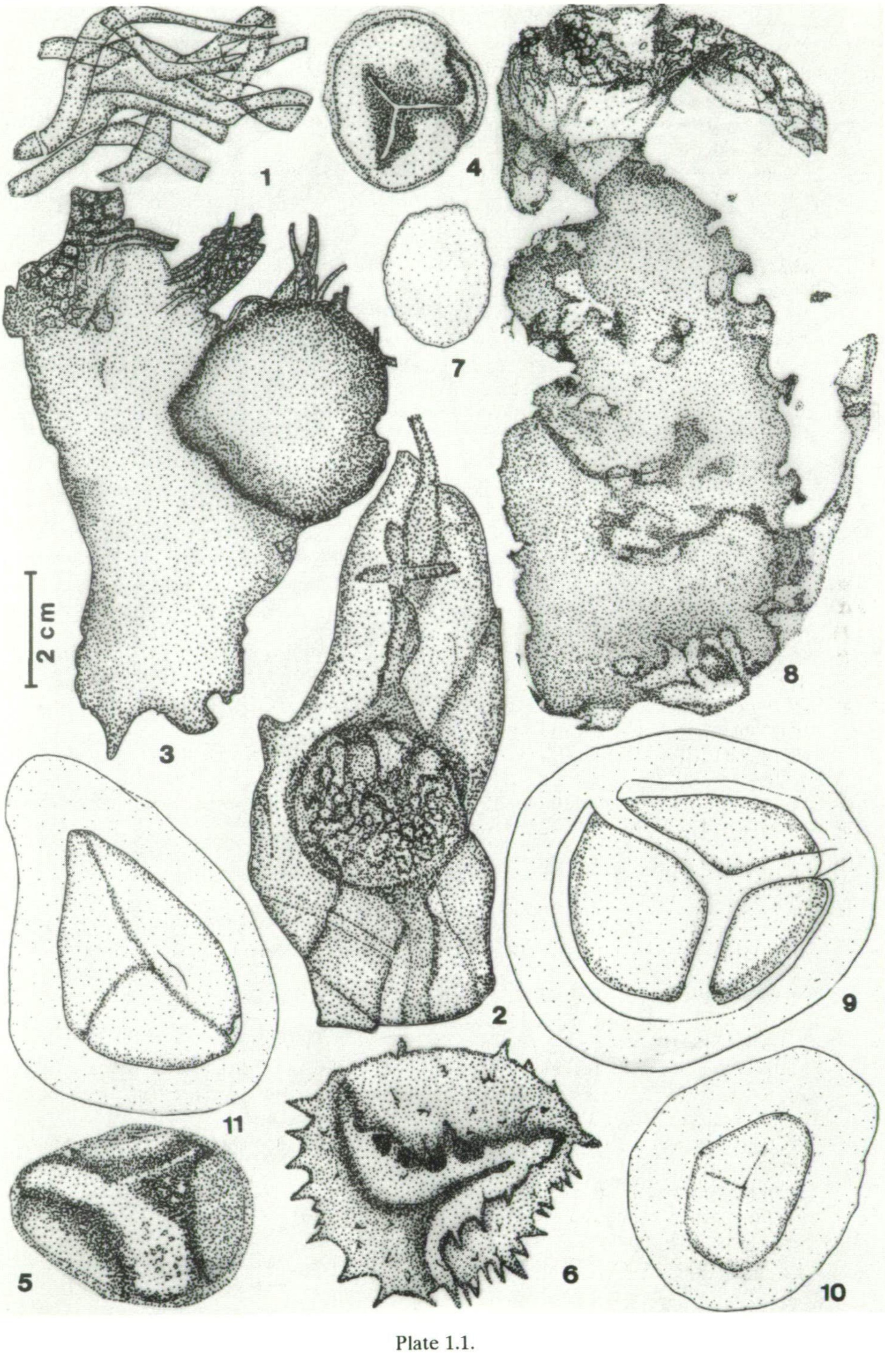

Plate 1.1.

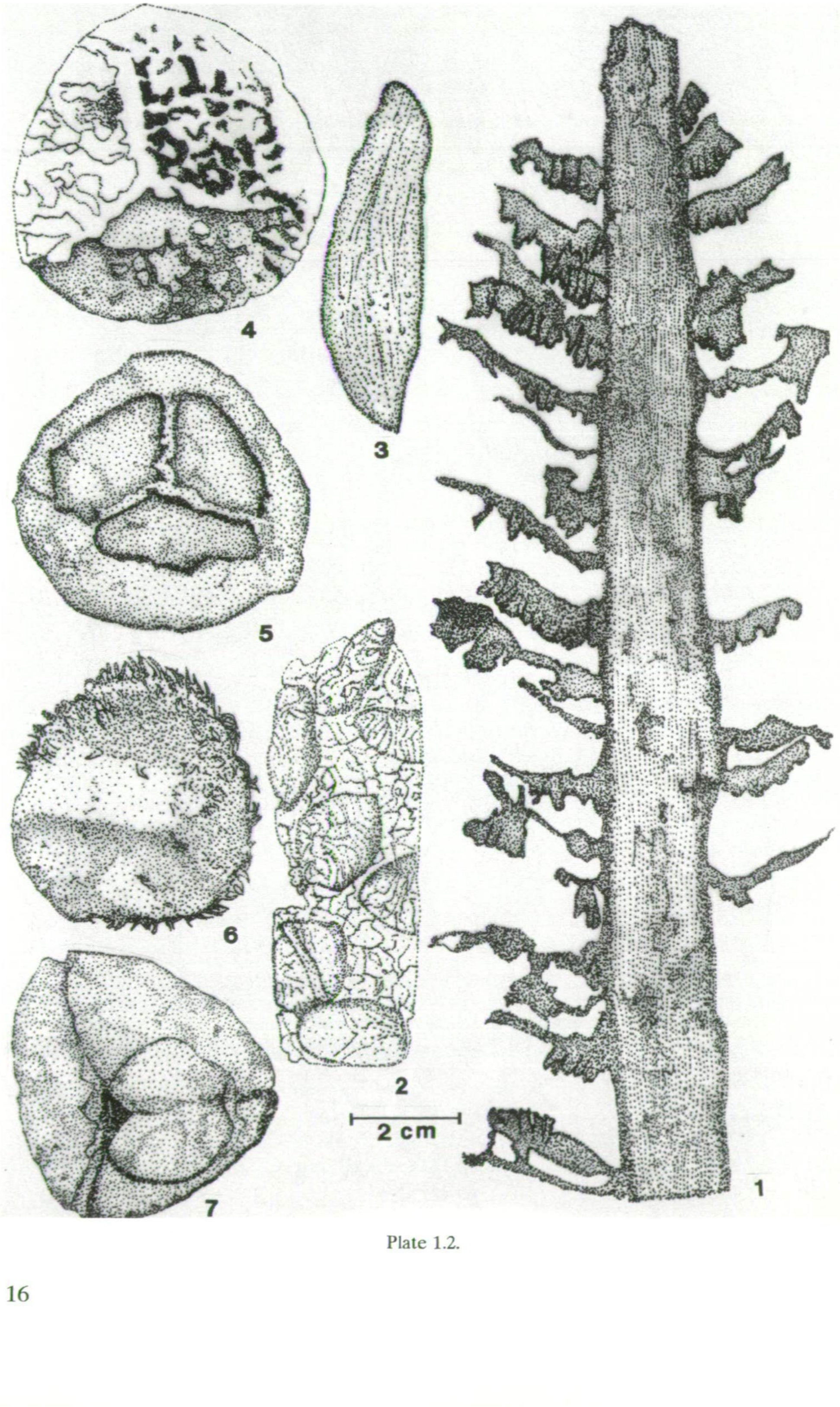

Plate 1.2.

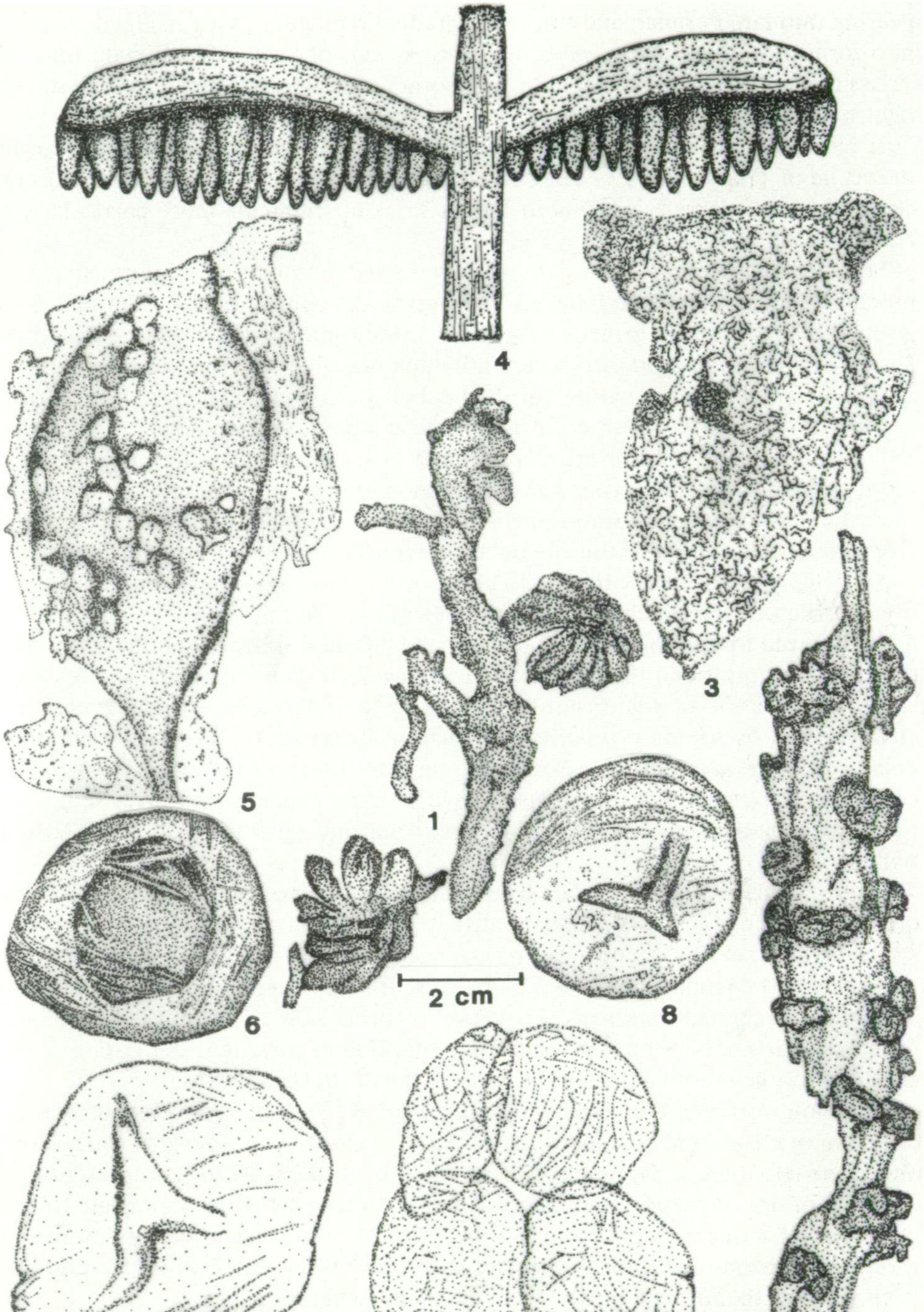

Plate 1.3.

pearing into late Permian and through a gradual reduction they remained confined into form of herbaceous *lycopods* depicting advent of favourable climate into the Triassic. The presence of cingulum is another character of spores which throws light towards the gradual evolution.

It has been obviously observed that throughout Gondwanic continents during the realm of Triassic more or less similar conditions prevailed regarding the occurrence of *pteridophytes* as we find in Indian Triassic sediments more particularly at Nidpur.

Some enigmatic fertile forms are interpreted as "morphological intermediates" a potential link to Paleozoic relatives and during the course of evolution may have given rise to Mesozoic forms spread over Gondwanic continents. Of such forms *Satsangia* and *Birbalsahniostrobus* are notable ones where we find linear microsporangia all synangiate in nature forming a bell or funnel shape structure having sporangial opening on the interior face of the campanulate/stephanate organ. Similarly in the later the entire microsporophyll is arranged in seriate order giving a shape of funnel, bearing sporangial tips conglomerating at the mouth of funnel. All these funnel–shaped microsporophylls are spirally arranged on the cone axis. But characteristically, these fertile organs bear non-striate bisaccate pollen grains depicting their affiliations with the highly evolved forms. However, their organizational structure shows identity with the *medullosan* forms. Therefore, it could be easily inferred that in the evolutionary process residual traits continued from their closely allied forms and thus the newer types evolved thereby making the relationship uncertain. Other significant fructifications like *Nidpuria* and *Lelestrobus* are characterized by having *pteridophytic* structural organization but bear *gymnospermous* pollen grains. Likewise, *Bosea* also appears to be an intermediate form because of the pattern of its microsporophyll bearing pendant sporangia somewhat identical with that of *Crossotheca* but it is radically different in bearing costate pollen.

Consistant association of certain fructifications underlines their usefulness in correlation, interpretation of systematics and time of origin of major groups. *Pteruchus* a pollen organ is such an example, always associated with leaf–genus *Dicroidium* which is by far the most common, ubiquitous and diverse fructification throughout the realm of Triassic in Gondwana continents. These taxa co–occur nowhere except in regions that were once parts of ancient Gondwanaland. This kind of consistent association can be used to infer the morpho-element comprising the unattached organs.

Also noteworthy is the seed cone *Nidia,* displaying a line of development in the direction of *cycads* and elucidates the origin of *zamoid cycads.* Besides, fairly larger and compact cones in Nidpur sediments may be best regarded as representing a complex of ancient cones and some of these forms played an important role in evolution of modern genera and can be interpreted confidently as intermediate forms. Such forms apparently correlate with other Gondwanic countries and also from some of the forms reported from northern hemisphere.

The seed taxon *Savitrispermum* is quite prolific and plays a significant role in the correlation of the Triassic of Gondwana. Its parent seed fructification *Umkomasia* is known from Molteno Formation (Middle-Upper Triassic) of South Africa, a

Plate 1.4.

1. *Pteruchus nidpurensis* SRIVASTAVA 1974. Male fructification, with a group of pollen sacs arranged laterally on a fertile head. No: 35144, 9x.
2–7. Isolated pollen grains from a single sac showing morphological variation. Slide No: 35144, ca 700x.
8. *Pteruchus indicus* PANT and BASU 1973. Specimens showing spirally inserted fertile heads around central axis, some stalks are rendered invisible due to vertically telescoped sporangia. No: 40203, 12x.

Plate 1.5.

1. *Nidia ovalis* BOSE and SRIVASTAVA 1973. Restortion of megastrobilus of *Nidia ovalis*.
2. Diagrammatic representation of transverse section of megastrobilus *(Nidia ovalis)*.
3. Single megasporophyll with a seed in compressed state.
4. *Urceolaspermum gopadensis* gen. et sp. nov., a compressed seed belonging to *Cycadales*. Slide No: S/1, 10x.

Plate 1.6.

1. *Nidpuria problematica* PANT and BASU 1979. Branched fructification the longitudinal ribs are seen in some portion of axes. No: 40810, 8x.
2. *Nidistrobus harrisianus* BOSE and SRIVASTAVA 1973. A cone bearing microsporophylls, ca 1x.
3. *Nidistrobus harrisianus* BOSE and SRIVASTAVA 1973. A part of microspore bearing cone showing pad shaped sporophylls as seen from the adaxial surface. 1x.
4. *Lelestrobus pennatus* SRIVASTAVA 1984. A microstrobilus showing spirally arranged microsporophylls with its attenuated distal portion. Holotype, No: 35469, 6x.
5. A diagrammatic restoration of a microsporophyll of *Lelestrobus pennatus*.
6. A typical nonstriate, bilateral, disaccate grain showing zone of saccus attachement associated with vertically oblong-ovoid c. b. distally saccus free area recovered from *L. pennatus*. No: 6599/35469, 400x.

Plate 1.7.

1. A reconstruction of *Nidpuria problematica* PANT and BASU 1979.
2. Two winged pollen grains recovered from *N. problematica*, Slide No: 40814, 800x.
3. A large pollen grain with a striated body. Slide No: 40814, 800x.
4–5. Variously compressed four winged pollen grains. Slide No: 40814, 800x.
6. *Rugaspermum insigne* PANT and BASU 1977, a compressed seed with transverse wrinkles on surface and longitudinal ridges. Slide No: 40300, 50x.
7. *Rugaspermum insigne* PANT and BASU 1977, macerated seed showing micropylar canal and pollen chamber. Slide No: 40305, 50x.
8. A compressed seed of *Rugaspermum media* held between the folds of a scale *Equitatilepis elongatus* PANT and BASU 1977, the chalazal hole is facing the apex of the scale. Slide No: 40322, 46x.

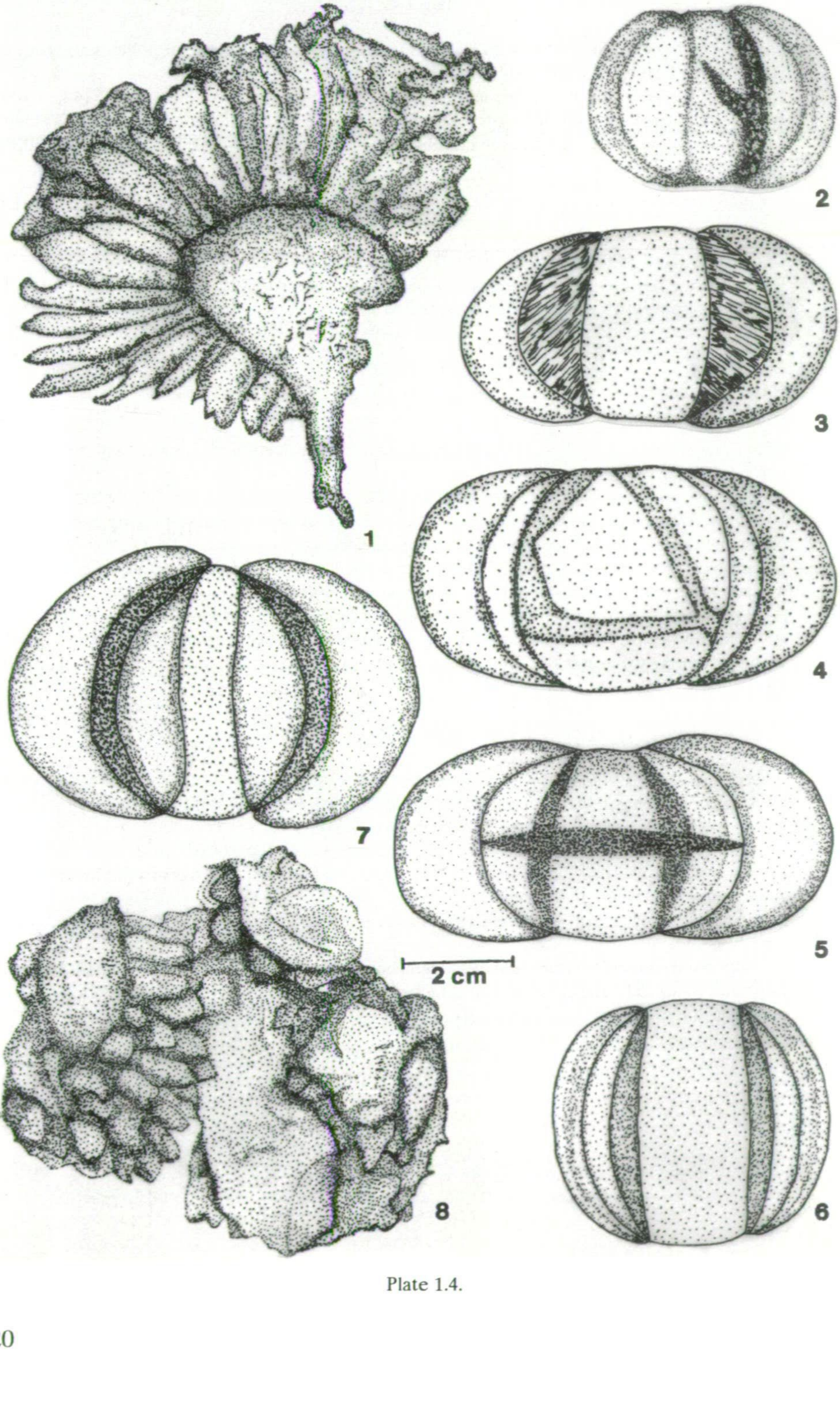

Plate 1.4.

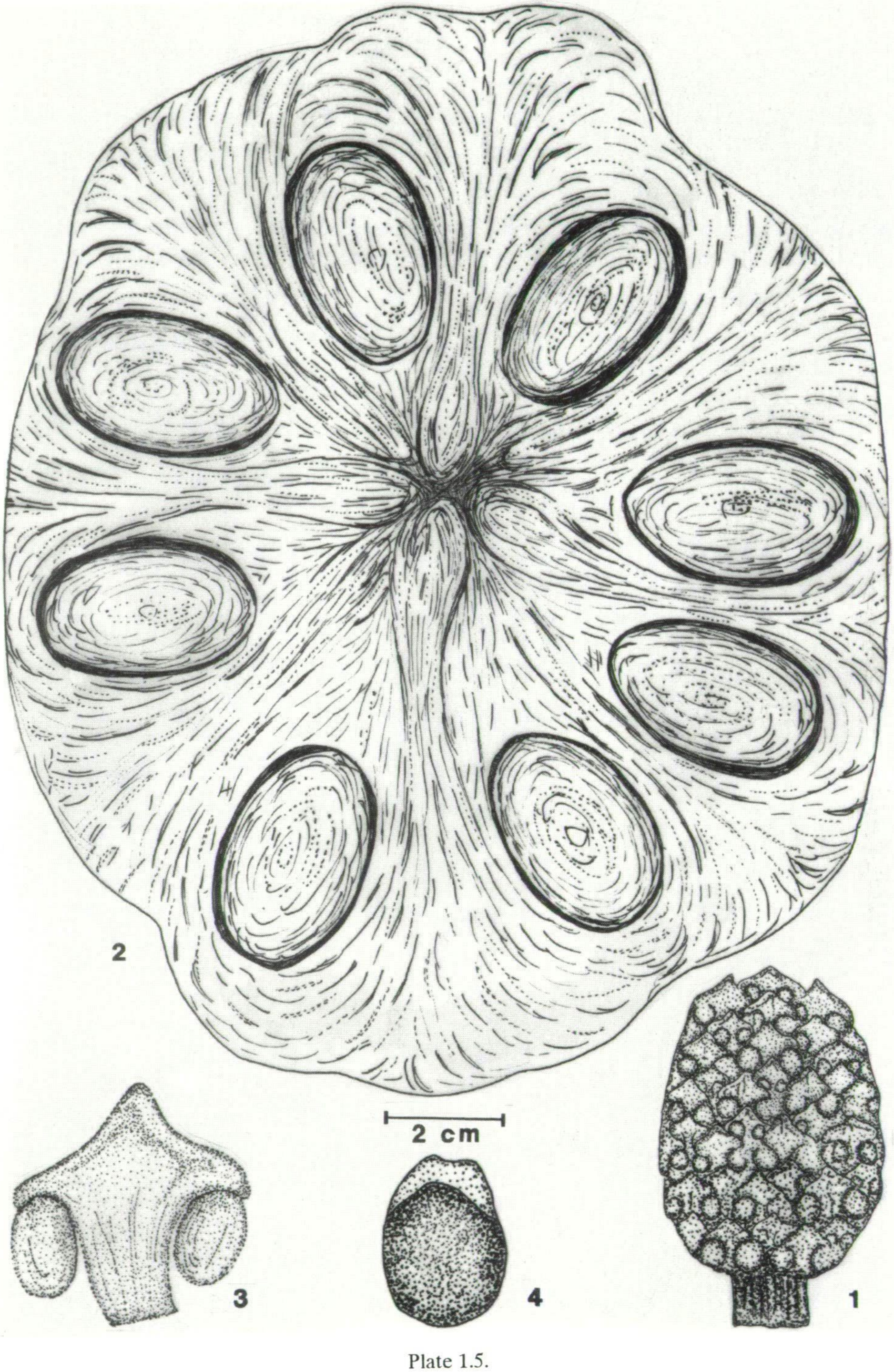

Plate 1.5.

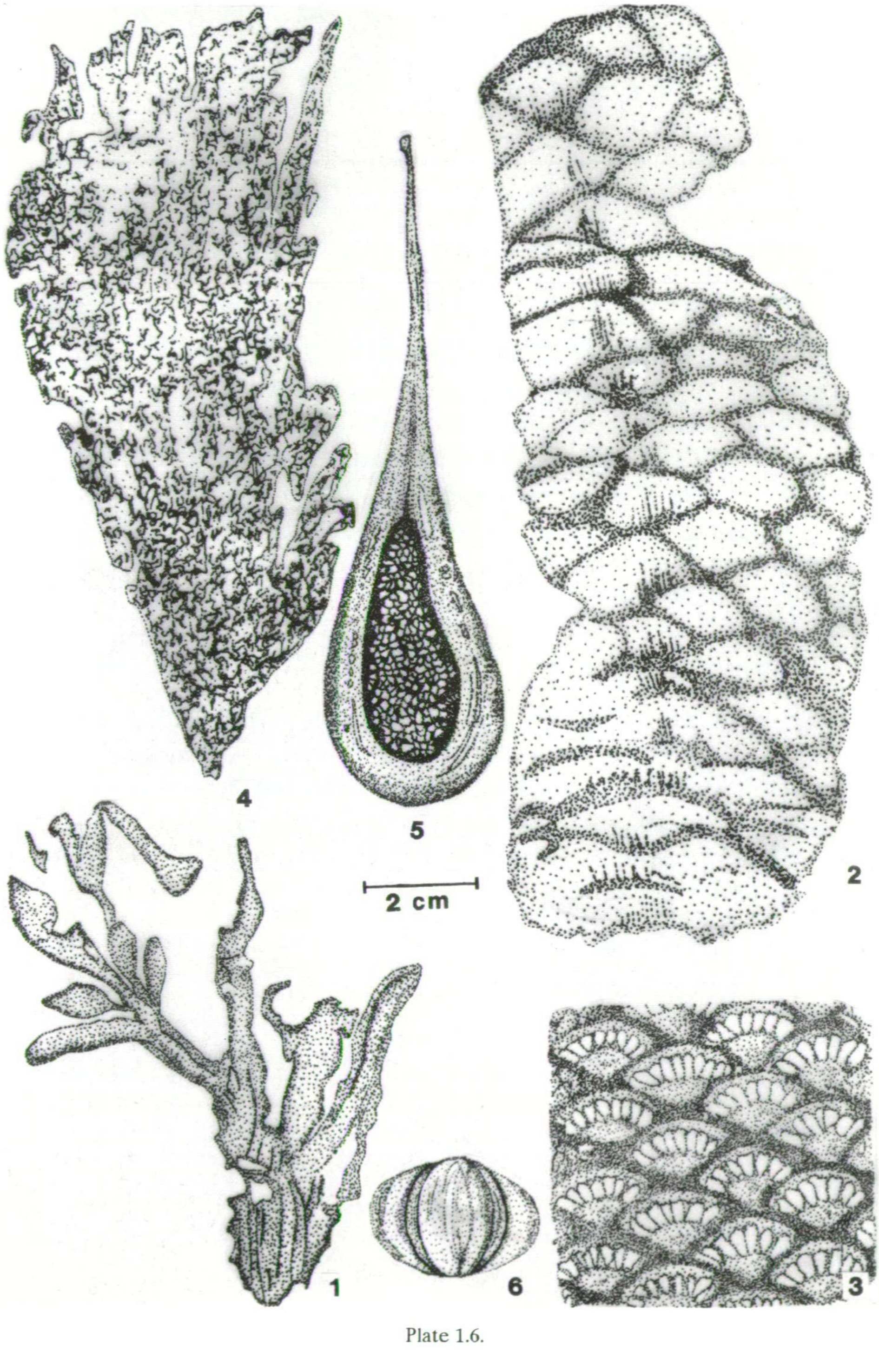

Plate 1.6.

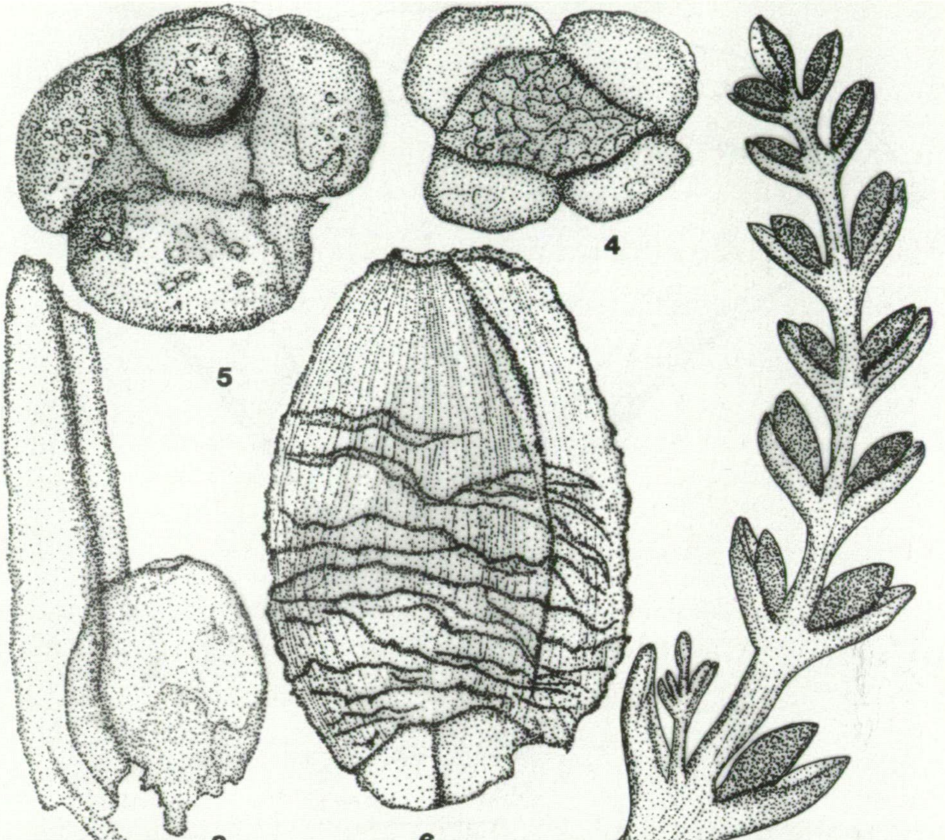

Plate 1.7.

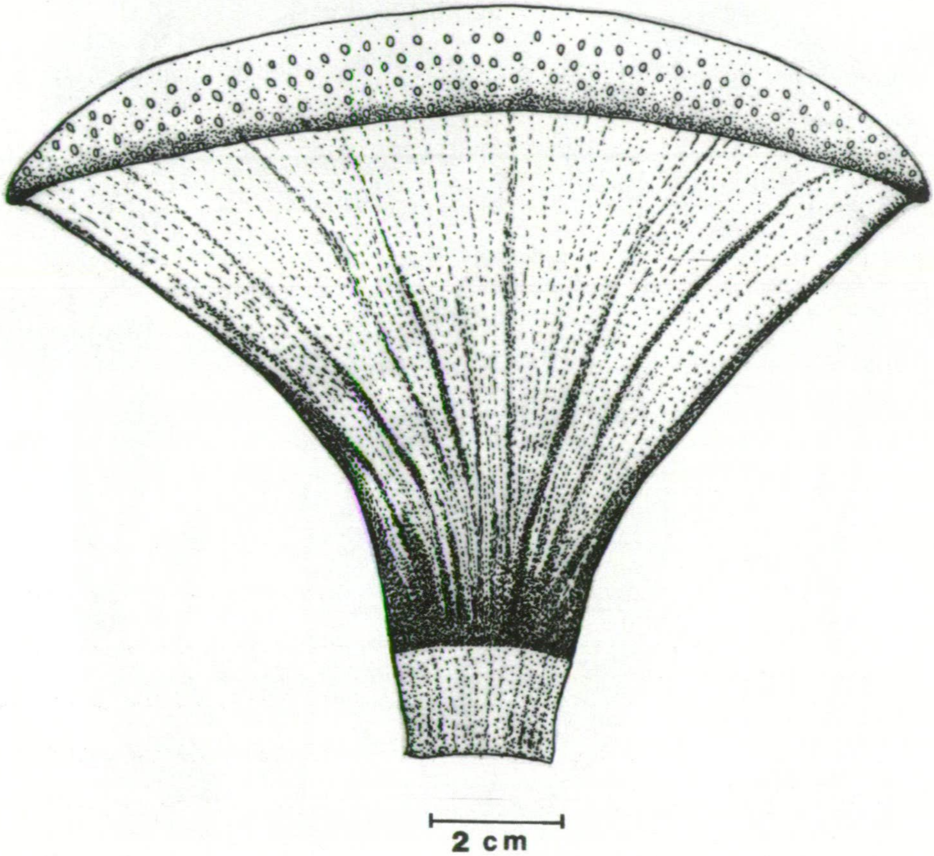

Plate 1.8.
Satsangia campanulata SRIVASTAVA and MAHESHWARI 1973, a diagrammatic reconstruction.

continent far apart from peninsular India. This clearly shows that there occurred parallel formation of similar plants but with little modifications, which could be possible due to geographical and stratigraphical separation.

The evolutionary pattern within the *pteridosperms* has led to most of the features of reproductive biology that are commonly associated with extant forms of *conifers*. *Rostrumaspermum* can be best cited for such a reference where the seed bears archegonia having tubular neck identical with *Pinus laricio* and *P. sylvestris* where the archegonia bears a short tubular neck, too. Depiction of such *pineaceous* features in Triassic seed is indicative of that *coniferous* traits must have been differentiated during Triassic time through a transitional stage and also supports that the separation of modern *conifers* took place at this stage. Such macroplants are useful and serve as a link for intercontinental correlations.

Conclusions

In conclusion diverse affinities of superficially similar forms tremendously increase their usefulness in interpreting systematics and the time of origin of major groups of Gondwana flora. Characterization based upon assemblages of fertile organs increase our understanding of what general types of plants may have existed and broad data base for the initial formulation of ideas regarding paleofloristics all over the Gondwanic countries.

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References

BOSE, M. N. and SRIVASTAVA, SHYAM C. (1973a): *Nidistrobus* gen. nov., a pollen bearing fructification from the Lower Triassic of Gopad River Valley, Nidpur. – Geophytology *2*, 211–212.

BOSE, M. N. and SRIVASTAVA, SHYAM C. (1973b): Some micro and megastrobili from the Lower Triassic of Gopad River Valley, Nidpur. – Geophytology *3*, 69–80.

PANT, D. D. and BASU, N. (1973): *Pteruchus indicus* sp. nov. from the Triassic of Nidpur, India. – Palaeontographica B, *144*, 11–24.

PANT, D. D. and BASU, N. (1977): On some seeds, synangia and scales from the Triassic of Nidpur, India. – Palaeontographica B, *163*, 162–178.

PANT, D. D. and BASU, N. (1978): On two structurally preserved *bryophytes* from the Triassic of Nidpur, India. – Palaeobotanist *25*, 340–352.

PANT, D. D. and BASU, N. (1979a): Some further remains of fructifications from the Triassic of Nidpur, India. – Palaeontographica B, *168*, 129–146.

PANT, D. D. and BASU, N. (1979b): On some megaspores from the Triassic of Nidpur, India. – Rev. Palaeobot. Palynol. *28*, 203–221.

PANT, D. D. and BASU, N. (1981): Further contribution on the Non-Vascular *Cryptogams* from the Middle Gondwana (Triassic) Beds of Nidpuri, India – Part II. – Palaeobotanist *28–29*, 188–200.

SRIVASTAVA, SHYAM C. (1974): *Pteridospermic* remains from the Triassic of Nidpur, M. P., India. – Geophytology *4*, 54–59.

SRIVASTAVA, SHYAM C. (1975): A new microsporangiate fructification from the Triassic of Nidpur, India. – Palaeobotanist *22*, 19–22.

SRIVASTAVA, SHYAM C. (1984): *Lelestrobus:* a new microsporangiate organ from the Triassic of Nidpur, India. – Palaeobotanist *32*, 86–90.

SRIVASTAVA, SHYAM C. (1990): *Rostrumaspermum venkatachalae* gen. et sp. nov., an archegoniatae seed from Triassic of Nidpur, India. – In: Proc. Symposium Vistas in Indian Palaeobotany eds.: K. P. JAIN and R. S. TIWARI, Palaeobotanist *38*, 98–104.

2. FIRST OCCURRENCE OF VANCAMPOPOLLENITES TRIANGULUS KEDVES AND PITTAU 1979 IN HUNGARIAN UPPER CRETACEOUS SEDIMENTS

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Abstract

The form-genus *Vancampopollenites (Eunormapolles)* was first described from Senonian (Santonian-Campanian) sediments of Portugal (Preza). The spore-pollen assemblages of the Senonian layers of the Iberian Peninsule are quite different from those of the Carpathian Basin. In this way the scarce occurrence of this kind "Iberian type" of *Normapolles* in Hungary is interesting. In this paper we present the *V. triangulus* from Hungarian and Portuguese localities together with some selected paleophytogeographically important *Normapolles* types from both localities.

Key words: Palynology, fossil, *Eunormapolles*, Senonian, Hungary and Portugal.

Introduction

The spore-pollen assemblages of the Upper Cretaceous layers of Hungary were first investigated by GÓCZÁN (1961, 1964a,b). Rich *Normapolles* data were published in the monograph of GÓCZÁN, GROOT, KRUTZSCH and PACLTOVÁ (1967). Further papers by: GÓCZÁN et al. (1986), GÓCZÁN and SIEGL-FARKAS (1989, 1990), KEDVES (1983, 1984), KEDVES and DINIZ (1983), SIEGL-FARKAS (1983, 1984, 1985, 1986, 1988, 1993a,b). The first palynological paper from the Upper Cretaceous layers of Portugal (Aveiro) was published by KEDVES and DINIZ (1967), DINIZ, KEDVES and SIMONCSICS (1974), KEDVES and DINIZ (1979a,b, 1980-81, 1983), KEDVES and HEGEDÜS (1975), PÁRDUTZ, JUHÁSZ, DINIZ and KEDVES (1974), etc. Paleophytogeographically, on palynological basis the following sub-regions were distinguished by KEDVES and DINIZ (1983) within the Mesogean (=Mediterranean) region: 1. Ibero-lusitanian, 2. Pyrenean, 3. Carpathian (Cf. KEDVES, 1985).

The form-genus *Vancampopollenites* was described by KEDVES and PITTAU (1979) from Preza (Portugal) with the following species: *V. lusitanus, V. triangulus, V. subporatus, V. endotriangulus, V. aradaensis, V. minor.*

Materials and Methods

During the last years, a large research program was completed on the Hungarian Senonian spore–pollen assemblages in the Hungarian Geological Institute of Budapest. The results of the new investigations enlarged our previous knowledge, and interesting pollen grains were also observed in very small quantities. It seems that in this case this occurrence of *Vancampopollenites triangulus* in Hungary is particularly interesting in this respect. The Hungarian locality is the following: Bakony Mts, Borehole Bj-528, depth 76.5–76.6 m., marine sedimented Jákó Marl Formation, Latest Santonian, *Hungaropollis* Dominance-Zone, *H. oculus* – *H. oculoglomeratus* subzone. From Portugal, the spore-pollen material of the locality type of *Vancampopollenites* fgen. was used for comparison; Preza-III-2. The LM pictures were taken in the Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, Szeged on a JENAVAL (Carl Zeiss, Jena) instrument with oil immersion objective GF–Planachromat HI 100x/1, 2500/0,17–A, except for the pictures on Plate 2.2. designated with asterix. In these cases mentioned later the negatives taken with an NFPK light-microscope were used.

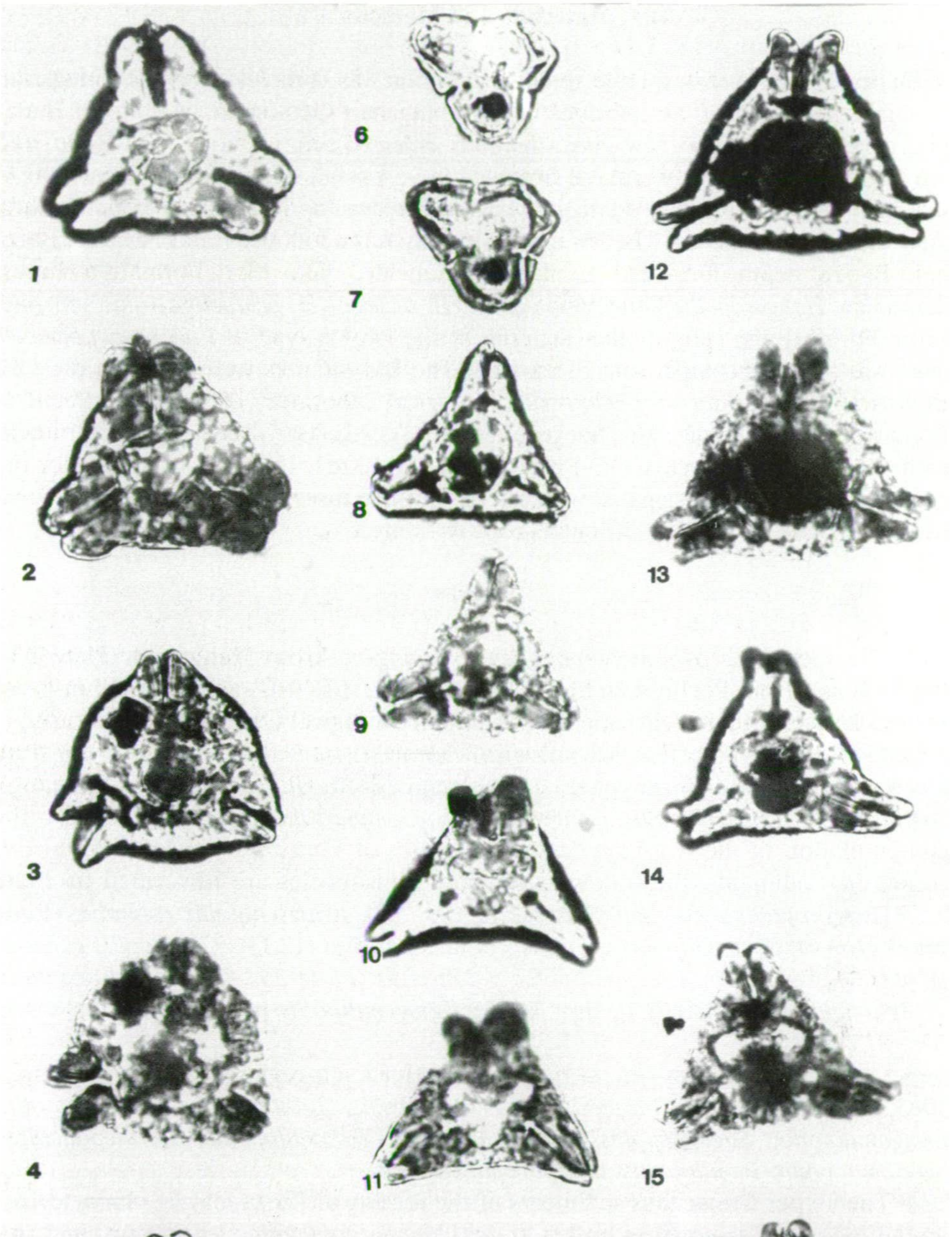
Results

1. The specimens of *Vancampopollenites triangulus* from Hungarian (Plate 2.1., figs. 6,7) and from Portuguese localities (Plate 2.2., figs. 6,7) are identical in every respect based on their light–microscopical morphological characteristic features.

2. As the most important palynological characteristic features for the Hungarian locality, the following form-genera can be emphasized: *Hungaropollis* – dominant–, *Suemegipollis, Krutzschipollis, Longanulipollis, Complexiopollis, Schulzipollis.* To the contemplation of the *Normapolles* pollen grains of *Vancampopollenites triangulus* containing sediments, the following selected form-species are illustrated on Plate 2.1.: *Hungaropollis rectilineus* (Plate 2.1., figs. 1,2), *Krutzschipollis rotundus* (Plate 2.1., figs. 3,4), *Krutzschipollis* cf. *crassis* (Plate 2.1., figs. 12,13), *Cuneipollis cuneolis* (Plate 2.1., figs. 5,16), *Longanulipollis polanyensis (Plate 2.1., figs. 8,9), Longanulipollis longianulus* (Plate 2.1., figs. 14,15), *Longanulipollis monstruosis* (Plate 2.1., figs. 10,11).

3. Characteristic form-genera in the Carpathian sub-region (Kedves and Diniz, 1983, Kedves, 1985): *Complexiopollis, Oculopollis, Laudaypollis, Hungaropollis, Longanulipollis, Suemegipollis, Krutzschipollis, Verruoculopollis, Portaepollenites, Semioculopollis, Papillopollis, Interporopollenites.*

4. The Upper Cretaceous sediments of the locality of Preza may be characterized by the following *Angiosperm* pollen grains: *Interporopollenites* – dominant and rich in form-species – *I. initium, I. subgranulosus, I. vancampoae, I. proporus, I. ornatus, I. rugulatus, I. weylandi, I. nagyae, I. zaklinskaiae, I. microporus, I. triangulus, I. thomsoni, I. concavus, I. stanleyi, I. prezaensis, I. dinizae, I. goczani.* For detailed descriptions, see the paper of Kedves and Hegedűs (1975). Further *angiosperm* pollen grains: *Complexiopollis prezensis, C. lusitanicus, Prezaipollenites concavus, Magnoporopollis prezensis, Boltenhagenipollenites magnoporatus, Vacuopollis orthopyramis*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parva, V. venustus, V. proconcavus magna, V. microconcavus, V. stanleyi, V. prezensis, Triangulipollis turonicus, T. triangulus, T. parvus, T. magnus, Trevisanaepollenites triangulus, Prenudopollis endocirculus, P. prezensis, Mediterraneipollenites lusitanicus, Plicapollis silicatus, Stanleypollenites prezensis, Tschudyipollenites magnus, Proteacidites fsp. Detailed data can be seen in the paper of KEDVES and DINIZ (1980–81). Data of the form-genus *Vancampopollenites* were mentioned previously. On Plate 2.2. the following form-species are represented: *Interporopollenites prezaensis* (Plate 2.2., figs. 1–4), *Vancampopollenites subporatus* (Plate 2.2., figs. 5,17), *V. triangulus* (Plate 2.2., figs. 6,7), *V. lusitanus* (Plate 2.2., figs. 8–12), *Triangulipollis turonicus* (Plate 2.2., figs. 13,14), *Prenudopollis prezensis* (Plate 2.2., figs. 15,16).

5. Abundant form-genera in the Ibero-lusitanian sub-region; (KEDVES and DINIZ, 1983, KEDVES, 1985): *Interporopollenites, Vacuopollis, Papillopollis.* By their presence, important form-genera: *Vancampopollenites, Triangulipollis, Trevisanaepollenites, Prenudopollis, Mediterraneipollenites, Boltenhagenipollenites, Magnoporopollis, Aveiropollenites.*

Discussion and Conclusions

These new data to the Upper Cretaceous early *angiosperm* "pollen flora" of Hungary are new contributions to the richness in taxa and the pecularities of the Carpathian Basin. Here the first European occurrence of the *Endoinfundibulapollis distinctus* TSCHUDY 1975 in the Senonian layers of Csávoly (Hungary) is worth mentioning (cf. KEDVES, 1983, 1984). Previously, this pollen form-genus was believed to be a *Normapolles*, which is characteristic genus of the North American *Normapolles* territories (sub-province: Atlantic Coast of North America, region: North Atlantic Coastal Plain).

◂ Plate 2.1.

1,2. *Hungaropollis rectilineus* GÓCZÁN and SIEGL-FARKAS 1989, slide: 95698, Bj-528, cross-table number: 9.8/142.2.

3,4. *Krutzschipollis rotundus* GÓCZÁN and SIEGL-FARKAS 1989, slide: 95698, Bj-528, cross-table number: 23.5/151.8.

5,16. *Cuneipollis cuneolis* GÓCZÁN and SIEGL-FARKAS 1989, slide: 95698, Bj-528, cross-table number: 10.2/146.3.

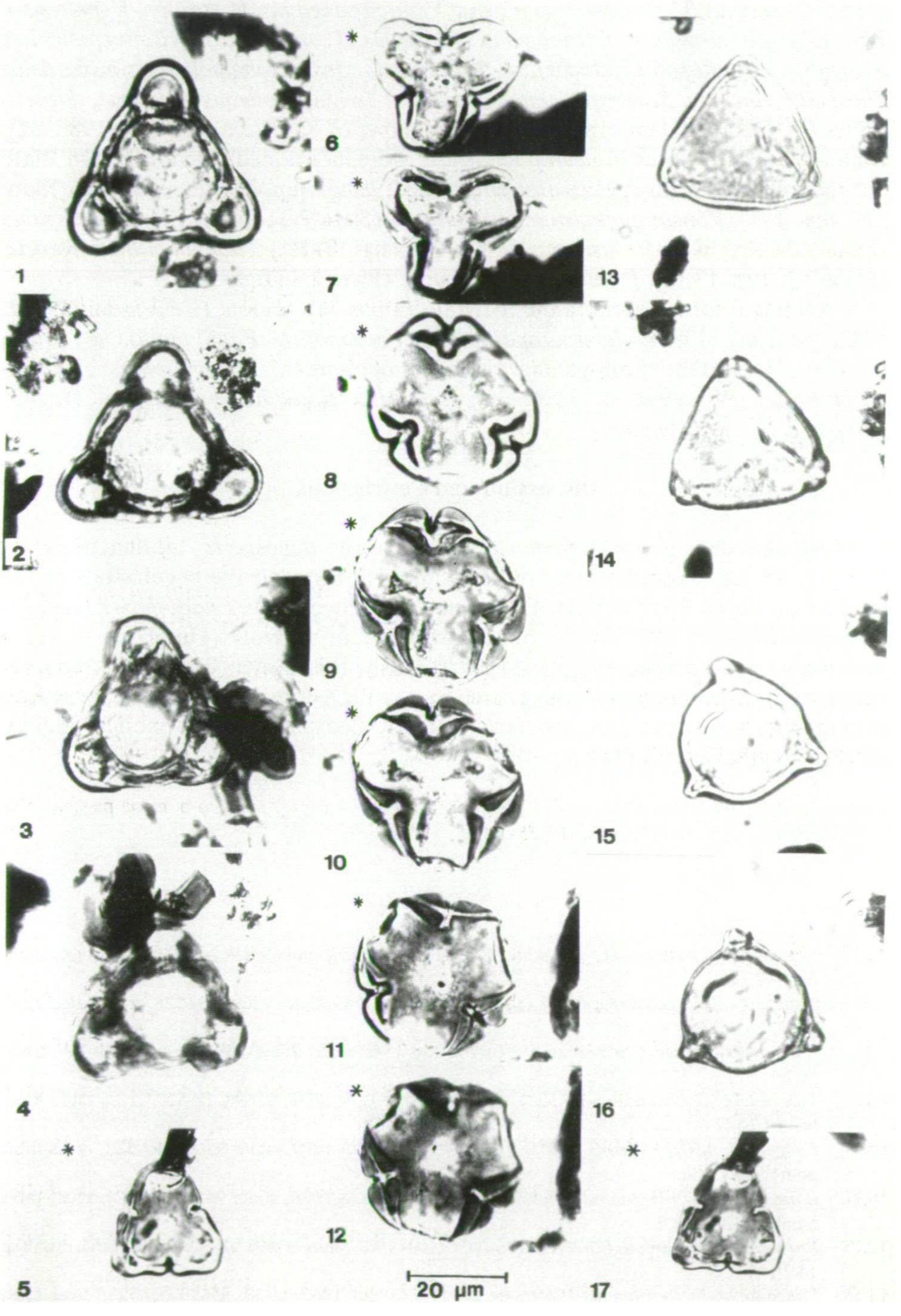
6,7. *Vancampopollenites triangulus* KEDVES and PITTAU 1979, slide: 95698, Bj-528, cross-table number:10.7/142.6.

8,9. *Longanulipollis polanyensis* GÓCZÁN and SIEGL-FARKAS 1989, slide: 95698, Bj-528, cross-table number: 8.1/136.6.

10,11. *Longanulipollis monstruosis* GÓCZÁN and SIEGL-FARKAS 1989, slide: 95698, Bj-528, cross-table number: 13.7/146.7.

12,13. *Krutzschipollis* cf. *crassis* (GÓCZÁN 1964) GÓCZÁN 1967, slide: 95698, Bj-528, cross-table number: 14.2/144.7.

14,15. *Longanulipollis longianulus* (GÓCZÁN 1964) GÓCZÁN 1967, slide: 95698, Bj-528, cross-table number: 10.2/146.3.



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Acknowledgements

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References

DINIZ, F., KEDVES, M. et SIMONCSICS, P. (1974): Les sporomorphes principaux de sédiments crétacés de Vila Flor et de Carrajão, Portugal. – Com. dos Serv. Geol. de Portugal *48,* 161–178.

GÓCZÁN, F. (1961): Die Palynologie der Senon-Bildungen des Süd-Bakony. – Ann. Inst. Geol. Publ. Hung. *49,* 789–799.

GÓCZÁN, F. (1964a): Standard palynologique du Sénonien de la Montagne Bakony. (En hongrois résumé en français et en russe). – M. Á. F. I. évi jel. az 1961. évről, 253–261.

GÓCZÁN, F. (1964b): Stratigraphic Palynology of the Hungarian Upper Cretaceous. – Acta Geol. *8,* 229–264.

GÓCZÁN, F., GROOT, J. J., KRUTZSCH, W. und PACLTOVÁ, B. (1967): Die Gattungen des "Stemma *Normapolles* PFLUG 1953b" *(Angiospermae)* Neubeschreibungen und Revision europäischer Formen (Oberkreide bis Eozän). – Paläont. Abh. B, *2,* 427–633.

GÓCZÁN, F. and SIEGL-FARKAS, Á. (1989): Palynostratigraphy of the Rendek Member of the Polány Marl Formation. – M. Á. F. I. évi jel. az 1988. évről, 47–85.

GÓCZÁN, F. and SIEGL-FARKAS, Á. (1990): Palynostratigraphical zonation of Senonian sediments in Hungary. – Rev. Palaeobot. Palynol. *66,* 361–377.

GÓCZÁN, F., SIEGL-FARKAS, Á., MÓRA-CZABALAY, L., RIMANÓCZY, Á., VICZIÁN, I., RÁKOSI, L., CSALAGOVITS, I. and PARTÉNYI, Z. (1986): Ajka Coal Formation: Biostratigraphy and Geohistory. – Acta Geol. Hung. *29,* 221–231.

KEDVES, M. (1983): *Endoinfundibulapollis distinctus* R. TSHUDY 1975, from the Upper Cretaceous from the southern part of Hungary, first occurrence of this form-genus from Europe. – Acta Biol. Szeged. *29,* 199–200.

KEDVES, M. (1984): Upper Cretaceous sporomorphs from the southern part of Hungary (Csávoly). – Acta Biol. Szeged. *30,* 75–89.

KEDVES, M. (1985): The present day state of Upper Cretaceous palaeophytogeography on palynological evidence. – Acta Biol. Szeged. *31,* 155–127.

◂ Plate 2.2.

1,2. *Interporopollenites prezaensis* KEDVES and HEGEDÜS 1975, slide: Preza-III-2, cross-table number: 19.2/135.1.

3,4. *Interporopollenites prezaensis* KEDVES and HEGEDÜS 1975, slide: Preza-III-2, cross-table number: 16.2/136.6.

5,17. *Vancampopollenites subporatus* KEDVES and PITTAU 1979, slide: Preza-III-2, cross-table number: 15.0/114.3.

6,7. *Vancampopollenites triangulus* KEDVES and PITTAU 1979, slide: Preza-III-2, *cross-table number: 8.1/116.7.

8–10. *Vancampopollenites lusitanus* KEDVES and PITTAU 1979, slide: Preza-III-2, *cross-table number: 21.2/114.8.

11,12. *Vancampopollenites lusitanus* KEDVES and PITTAU 1979, slide: Preza-III-2, *cross-table number: 12.6/112.8.

13,14. *Triangulipollis turonicus* KRUTZSCH 1967, slide: Preza-III-2, cross-table number: 12.8/136.5.

15,16. *Prenudopollis prezensis* KEDVES and DINIZ 1980–81, slide: Preza-III-2, cross-table number: 7.9/144.4.

KEDVES, M. et DINIZ, F. (1967): Quelques types de sporomorphes de sédiments crétacés d'Aveiro, Portugal. – Com. dos Serv. Geol. de Portugal *52,* 17–25.

KEDVES, M. et DINIZ, F. (1979a): Les pollens d'*Angiospermes* du Crétacé de Vila Flor, Portugal. Genres de forme *Atlantopollis* et *Limaipollenites.* – Bol. Soc. Geol. de Portugal *21,* 203–216.

KEDVES, M. et DINIZ, F. (1979b): Étude au microscope électronique à balayage de quelques espèces du genre de forme *Interporopollenites* du Crétacé d'Arada, Portugal. – Bol. Soc. Geol. de Portugal *21,* 217–226.

KEDVES, M. et DINIZ, F. (1980–81): Contribution à la conaissance des pollens d'*Angiospermes* du Crétacé supérieur du Portugal. – Bol. Soc. Geol. de Portugal *22,* 19–32.

KEDVES, M. et DINIZ, F. (1983): Les *Normapolles* du Crétacé supérieur en Europe: Implications paléobiogéographiques. – Geobios *16,* 329–345.

KEDVES, M. and HEGEDŰS, M. (1975): Pollen grains of the *Interporopollenites* fgen. from sediments of the Upper Cretaceous period in Portugal. – Acta Biol. Szeged. *21,* 43–62.

KEDVES, M. et PITTAU, P. (1979): Contribution à la connaissance des pollens des *Normapolles* du "Groupe papilloïde" du Crétacé supérieur du Portugal. – Pollen et Spores *21,* 107–209.

PÁRDUTZ, Á., JUHÁSZ, M., DINIZ, F. et KEDVES, M. (1974): *Teixeraipollenites globosus* n. fgen. et fsp. du Crétacé supérieur de Portugal et étude de l'ultrastructure de son exine. – Com. dos Serv. Geol. de Portugal *58,* 181–189.

SIEGL, KÁROLYNÉ (1983): Palynology of the Senonian Formations at Magyarpolány. (Hungarian with English summary) – Őslénytani Viták (Discussiones Palaeontologicae) *29,* 59–69.

SIEGL-FARKAS, Á. (1984): Palynostratigraphy of the Upper Cretaceous in the Uppony Mts. (Hungarian with English summary). – M. Á. F. I. évi jel. az 1982. évről, 101–117.

SIEGL-FARKAS, Á. (1985): Palynostratigraphy of the Senonian in the Zalagyömrő–Gyepükaján Area, W Hungary (Hungarian with English summary). – M. Á. F. I. évi jel. az 1983. évről, 213–218.

SIEGL-FARKAS, Á. (1986): Palynostratigraphy of the Senonian from the borehole Bácsalmás 1. (S. Great Hungarian Plain) (Hungarian with English summary). – M. Á. F. I. évi jel. az 1984. évről, 425–459.

SIEGL-FARKAS, Á. (1988): Palynostratigraphy and evolution history of the Ajka Coal Formation, W Hungary (Hungarian with English summary). – M. Á. F. I. évi jel. az 1986. évről, 179–209.

SIEGL-FARKAS, Á. (1993a): Palynostratigraphy of the Upper Cretaceous in Hungary. – Cretaceous Research (1993) *14,* 663–668.

SIEGL-FARKAS, Á. (1993b): A contribution to the palynology of central European areas of the *Normapolles* province. – Paleoflor. and Paleoclim. changes during Cretaceous and Tertiary. Proc. of the Int. Symp. 1992, Bratislava, 39–42.

TSCHUDY, R. H. (1975): *Normapolles* pollen from the Mississippi embayment. – U. S. Geol. Surv. Prof. Paper *865,* 1–42.

3. CHARACTERIZATION OF DIFFERENT FORMS OF ORGANIC MATTER IN UPPER CRETACEOUS LEVELS FROM CERRO DE LA MESA (MADRID, SPAIN)

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Abstract

In addition to the palaeobotanical study of the Cretaceous levels from Cerro de la Mesa (Madrid), the most representative types of organic matter have been analyzed by pyrolysis – gas – chromatography-mass spectrometry. Both megarests and palynomorphs suggested a warm humid forest including large diversity of Angiosperms, Araucariaceae, Taxodiaceae and Cheirolepidiaceae the latter represented mainly by well-preserved cuticles of *Frenelopsis oligostomata.* The main pyrolysis products from these cuticles were alkyl-substituted polycyclic aromatic molecules such are naphthalenes, anthracenes, and phenanthrenes, as well as some aliphatic hydrocarbons. This pyrolysis pattern was considered to reflect vascular plant remains altered by intense maturation processes. The lignitiferous levels showed, after pyrolysis, similar qualitative composition, but yielded greater amounts of hydroxylated derivatives (phenols, catechols, naphthalenols and biphenylols) and only traces of alkanes and fatty acids, which point to the terrestrial origin of the organic matter. The greatest amounts of the latter two products, as well as of hydroaromatic molecules (tetralins, fluorenes and indenes) and heterocyclic molecules (dibenzofurans and xanthenes) were obtained from the layers consisting of carbonaceous marls, which – in agreement with the palaeobotanic results – could correspond to heavily carbonized material with the most significant input of aliphatic molecules from microorganism and algal biomass, and/or to an early diagenesis in aquatic environment.

Key words: Cretaceous flora, palynomorphs, *Frenelopsis,* pyrolysis, kerogen, Spain.

Introduction

The Upper Cretaceous basement in Cerro de la Mesa (Madrid, Spain) contains one of the nicest paleobotanical samples of the Mesozoic microflora. This formation includes a number of plants with well-preserved cuticles, especially in the mummified specimens. In addition, the sediments are very rich in palynomorphs.

The present study is included into the Spanish-Hungarian Project of the Dirección General de Cooperación Científica y Técnica del Ministero de Asuntos Exteriores (1992) entitled “Estudio de diversos aspectos paleobotánicos del Cretácico superior del Cerro de la Mesa (Norte de la Provincia de Madrid)”, the financial support being provided by the DGICYT Project PB92–0101 (Estudio palinológico de las Angiospermas primitivas halladas en el Cretácico superior del Borde Sur de la Sierra de Guadarrama).

The palaeontological characteristics were studied in the laboratorio de Paleobotánica, Departamento de Paleontología, and in the Instituto de Geología Económica (CSIC), whereas the chemical analyses were studied in the laboratorio de Química del Humus del Centro de Ciencias Medioambientales del CSIC. The relative richness of organic remains, mainly plants, found throughout the lithostratigraphic series of Cerro de la Mesa, has been the subject of several palaeontological, stratigraphic and palaeoecological studies, the results of which being reported elsewhere (ALVAREZ-RAMIS, 1981, ALVAREZ-RAMIS and FERNÁNDEZ MARRÓN, 1993 and ALVAREZ-RAMIS et al., 1994a and b).

From the viewpoint of the organic geochemistry analyses, the most representative materials in the stratigraphic series are found in the gray marls and in the lignitiferous levels.

LOCATION AND GEOLOGICAL FEATURES OF CERRO DE LA MESA QUARRY

The samples studied were taken from a quarry located in the neighbourhood of Guadalix de la Sierra village (Madrid, Central Spain), that is currently exploited in the extraction of calcareous building blocks.

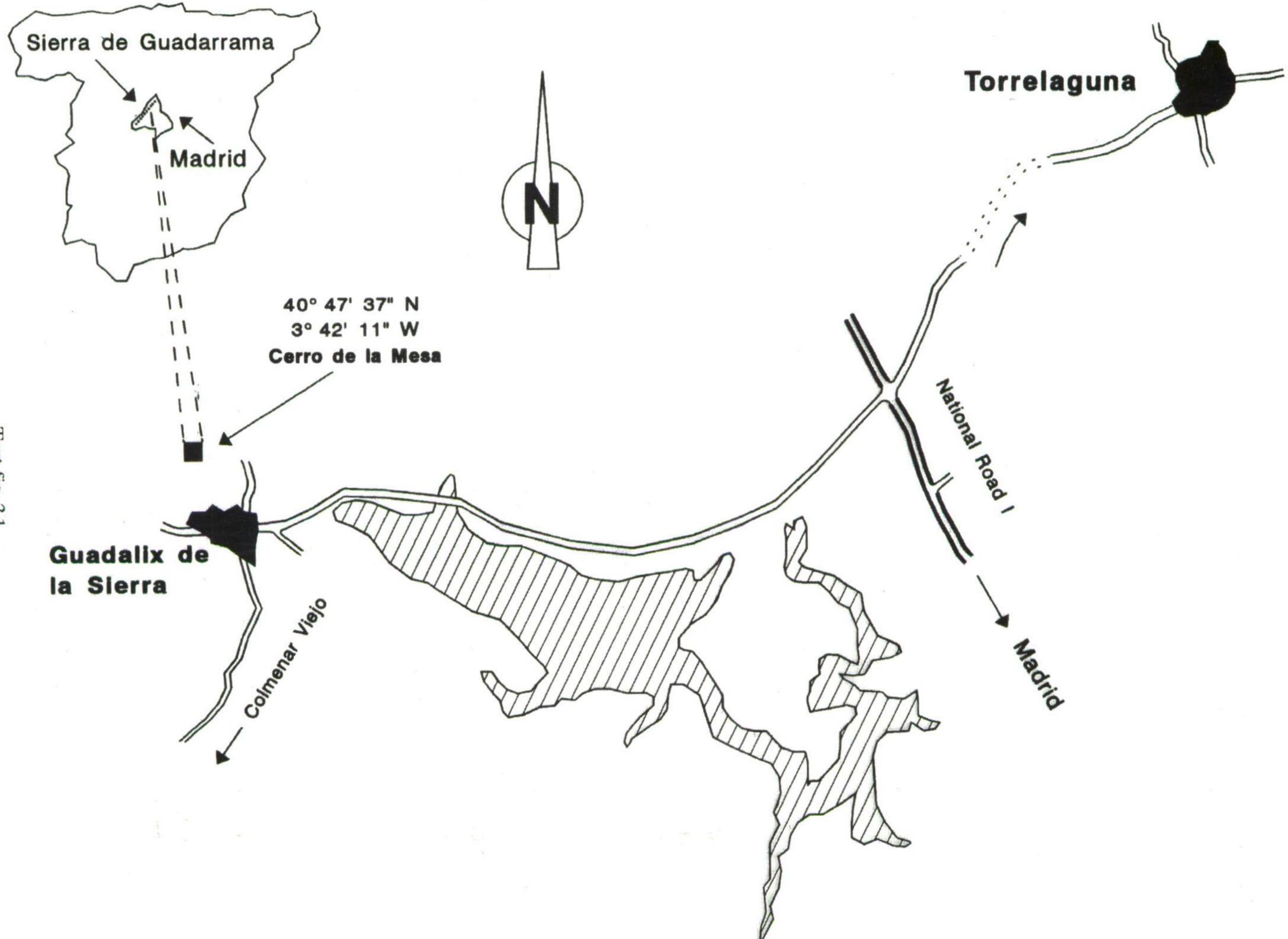
The coordinates of the basement correspond to 40° 47' 37" N and 3° 42' 11" W (Greenwich), the access to which being provided by two independent ways, ie., the road between the villages of Colmenar Viejo and Guadalix de la Sierra, or the road from Guadalix de la Sierra to Torrelaguna (Text-fig. 3.1.). The rock exploitation in the quarry has brought into light the different types of materials of the lithological series in the Upper Cretaceous, characteristic for the Southern side of the Sierra de Guadarrama (Central System of Spain). Plate 3.1. corresponds to a partial view of the quarry, showing the lithological features.

Basically, the materials consist of limestones and marls, more or less compacted and sandy, in cyclic alternance with dolomitized limestones and some small and irregular lignitiferous levels. The marly and carbonaceous levels are very rich in fragmented and coalified plant remains.

LITHOSTRATIGRAPHIC FEATURES

The lithostratigraphic series we have studied in Cerro de la Mesa consists of eight members. The marly material dominates in the lower part (members 8 and 6); whereas the most frequent material in the upper parts are limestones, in some cases dolomitized, and subjacent marly sandy limestones (member 4) include lignite layers of small thickness and irregular distribution (Text-fig. 3.2.).

The eight levels studied from the palynological viewpoint (ALVAREZ-RAMIS and FERNÁNDEZ MARRÓN, 1990, 1993, ALVAREZ-RAMIS et al., 1994a, 1994b) are shown at the right side of Text-fig. 3.2. The position of the three levels sampled for the organic matter studies are presented at the left side. The samples were taken from the 4^{th} member, basically consisting of sandy limestones, and in the lowest level of lignites (L). One sample (CM), was taken in the calcareous marls (6^{th} member) in



Text-fig. 3.1.
Location of the site studied in Cerro de la Mesa.

Plate 3.1.
Partial view of the Cerro de la Mesa quarry.

a point placed between levels 2–3. Just below it, a branch of *Frenelopsis* included into compact marls was isolated for analysis (F) (ALVAREZ-RAMIS, 1981, ALVAREZ-RAMIS et al., 1982).

PALAEONTOLOGICAL FEATURES

The megaflora identified (ALVAREZ-RAMIS et al., 1989) come almost exclusively from the marl layers in member 6. Nevertheless, plant remains dominate on the lignite layers in member 4, but they are difficult to classify due to their large coalification and fragmentation. The main forms correspond to the following parataxons, included in Gymnosperms and Angiosperms:

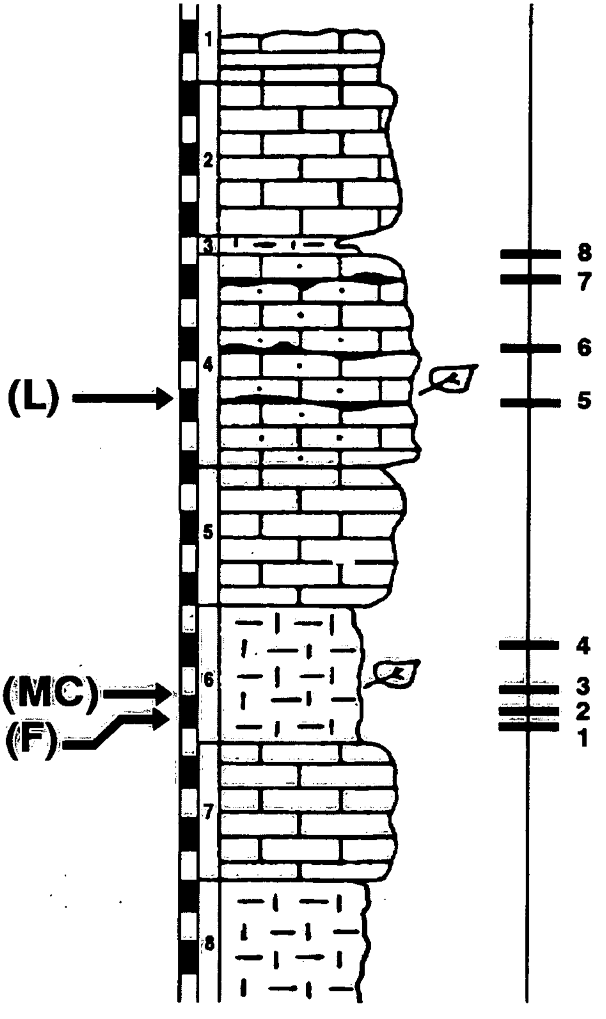
Gymnosperms	Angiosperms
Araucariacites fspp.	aff. *Banksia tenuifolia* BERRY
Frenelopsis oligostomata (ROM.) ALVIN	*Caesalpinites* fsp.
Sequoia fsp.	*Dewalquea* fsp.
	Eucalyptus geintzi HEER ?
	Myrica fsp.
	Lauraceae

The greatest number of megaremains corresponds to Gymnosperms, the most abundant being Araucariaceae, Taxodiaceae, and Cheirolepidiaceae. In the case of Angiosperms, there are a scarce number of megarests, but they show large diversity. As expected, the remains of reproductive structures, especially of Conifers, are abundant.

Concerning the microrests, the results of the analysis of palynomorphs are in agreement with the species of the above megarests. The most frequent forms are *Araucariacites, Inaperturopollenites, Classopollis* and mainly Normapolles (ALVAREZ-RAMIS and FERNÁNDEZ MARRÓN, 1990, 1993, ALVAREZ-RAMIS and DOUBINGER, 1994, ALVAREZ-RAMIS et al., 1994a and 1994b). The dominant palynomorphs correspond to the Plant Kingdom. Amongst them (ca. 60%), the most frequent are pollens from primitive Angiosperms (Normapolles), mainly *Interporopollenites, Papillopollis* and *Triatriopollenites,* and less proportion of *Vacuopollis, Complexiopollis* and *Atlantopollis.* The pollen grains from Gymnosperms amount ca. 25%, and the spores from vascular Cryptogams represent ca. 9%. There are additional amounts (2–8%) of sporomorphs from the Protista, Fungi and Animalia Kingdoms, with a dominance of cysts from Dinoflagellates.

PALAEOENVIRONMENTAL AND STRATIGRAPHIC NOTES OBTAINED FROM PALAEOBOTANIC STUDIES

The dominance of Angiosperms as regards the other groups, mainly of Conifers, suggests a warm humid climate in the site studied during the Upper Cretaceous. Nevertheless, the large diversity of their forms contrasts with their reduced amount, suggesting an allochthonous origin for the remains. This is in agreement with a large amount of remains, and a low proportion of arid or/and xerophytic species,



Text-fig. 3.2.

Calcareous series of Cerro de la Mesa bed, with indication of the material studied: *Frenelopsis oligostomata* (ROMARIZ) ALVIN (F) included into marls, calcareous marls (MC) (both in member 6), and lignites (L) in the lowest levels of member 4.

such are Cheirolepidaceae, and other plants adapted to saline conditions, frequent in coastal environments (Taxodiaceae).

The coastal location during the Upper Cretaceous of Cerro de la Mesa, is reinforced by the presence of internal lodges of Foraminiferae, Dinocysts and euryhaline elements such as Botryococcaceae. From palynological studies of ALVAREZ-RAMIS et al., (1994b) the age of Cerro de la Mesa is attributed to the Campanian-Maastrichtian interval.

Material and Methods

For chemical analyses, the geological samples are subjected to different pretreatments. The *Frenelopsis* (F, Text-fig. 3.2., and Plate 3.2.) are scrapped from the rock, grounded in an agate mortar, washed with 0.5M HCl to remove carbonates, and finally washed on a 0.1 mm screen. The same is used for the lignite material (L).

In order to concentrate the organic matter in sample MC, the grounded material is decarbonated with HCl and dried, and an organic matter-rich fraction is separated by flotation in the $CHBr_3$–CH_3CH_2OH mixture of density 1.9.

The analysis of the organic fraction is carried out by pyrolysis-gas-chromatography-mass spectrometry in the experimental conditions reported elsewhere (ALMENDROS et al., 1993). The pyrolysis products released at 500°C are condensed in liquid nitrogen and injected in a HEWLETT-PACKARD 5890 gas chromatograph, and the compounds are identified from their 70 eV mass spectra. For quantitative comparisons, the integration routine of the instrument is used on the single ion chromatograms corresponding to the molecular ions of the different homologues series of compounds, except in the case of alkanes and fatty acids, where the ions 85 and 83 are used, respectively. Such data are referred as percentages of the total ion counts in the chromatogram.

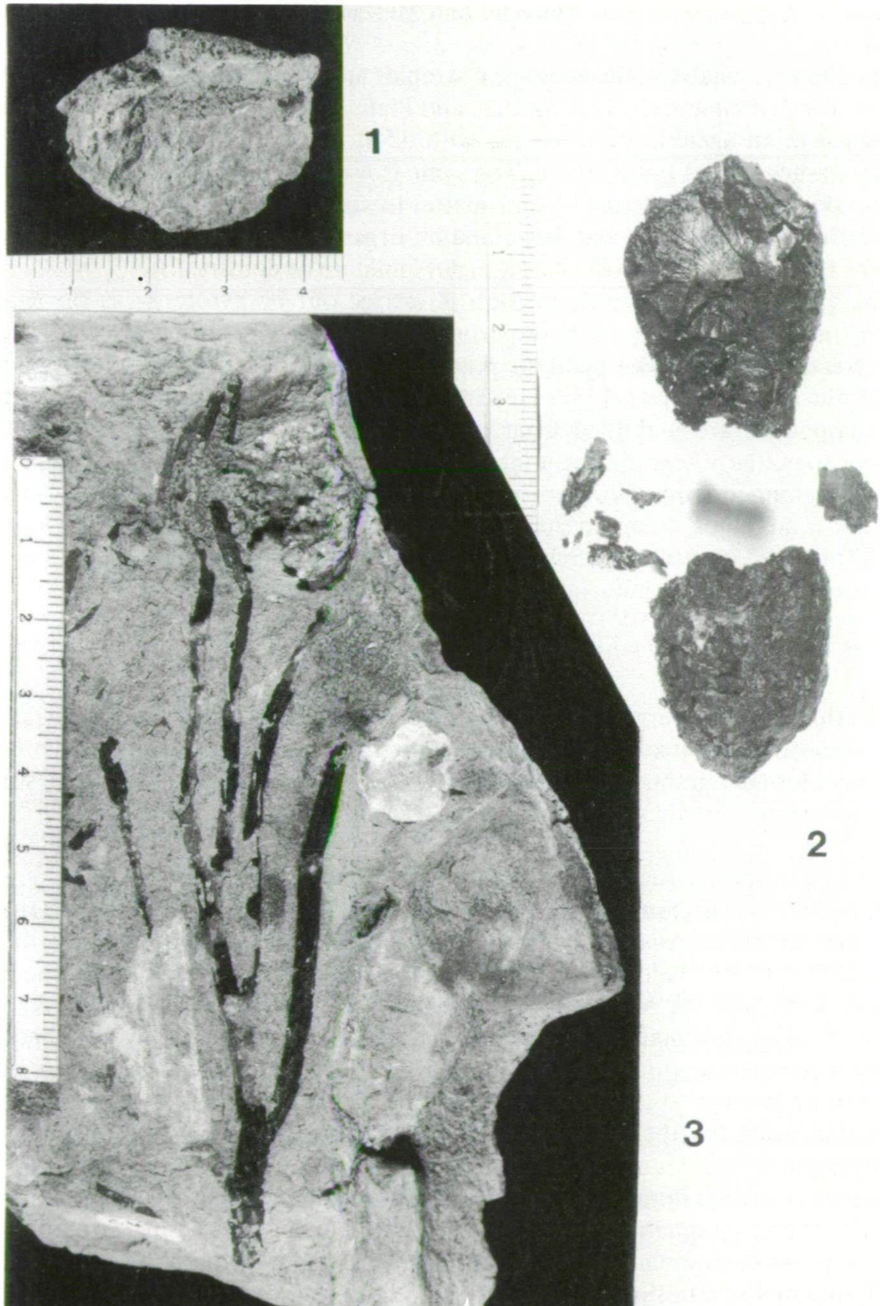
Results and Discussion

The three forms of organic matter studied in Cerro de la Mesa yield quite different qualitative and quantitative compound assemblages after analytical pyrolysis. The gas chromatograms show about 200 major peaks, the most frequent series being shown in Text-fig. 3.3.

Most of the pyrolysis products correspond to alkyl-substituted polycyclic aromatic hydrocarbons (naphthalenes, anthracenes, phenanthrenes, and pyrenes), some including hydroaromatic rings (tetralins, fluorenes and indenes) or heterocyclic rings (dibenzofurans and xanthenes) as well as some of their OH-substituted derivatives (phenols, catechols, naphthalenols, and biphenylols). In general the lack of fatty acids, and the low yields of aliphatic hydrocarbons point to a terrestrial origin of the organic matter. As expected, no traces of typical carbohydrate-derived pyrolysis products are found in the three materials studied. In general, the products obtained are similar to those reported by SCHULTEN et al., (1991) after pyrolysis of soil humic acids, but the present patterns showed greater proportion of polycyclic products.

Sample (L) yields dominant series of OH-substituted mono- and polycyclic compounds, whereas aliphatic molecules are practically lacking. The major chromatographic peaks correspond to cresols. Such patterns, in addition to the presence of small amounts of vanillyl and syringyl-type ketones similar to those produced by pyrolysis of lignins, point to an origin from the accumulation of vascular plant remains altered by intense diagenetic and catagenetic process.

By contrast, the organic matter in sample (MC) yields no methoxyl-containing ketones, and shows reduced amounts of oxygen-containing molecules. The domi-


1
2
3

nant products are alkyl-substituted polycyclic aromatic hydrocarbons (1 to 4 benzenic rings) in addition to aliphatic series consisting of alkanes and olefins. Such pattern could correspond to heavily carbonized organic matter with the most significant input of aliphatic molecules from microorganism and algal biomass, and/or to an early diagenesis in aquatic environment. This coincides with the paleobotanical results, that showed the presence of rests from the Protista and Fungi Kingdoms.

Finally, the composition of the organic matter remaining in *Frenelopsis* rests should be interpreted as the result of large maturation of an original material consisting of aromatic and lipid biopolymers (ALMENDROS et al., 1982, 1985, ALVAREZ-RAMIS et al., 1984). There are considerable diversity of aromatic and hydroaromatic oxygen-containing structures, and moderate amounts of ketones, alkanes, and olefins, some of them being similar to those formed during the pyrolysis of lignins or cutins from extant and fossil Gymnosperms.

In general, the relatively large maturity of the fossil organic matter in Cerro de la Mesa precludes more detailed palaeobiochemical considerations, as corresponds to the transformation of most of the diagnostic fossil biomarker molecules.

References

ALMENDROS, G., ALVAREZ-RAMIS, C. and POLO, A. (1982): Estudio paleobioquímico de la materia orgánica de restos fosilizados de *Frenelopsis* procedentes del supracretácico de Torrelaguna (Madrid). – Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales *76*, 285–302.

ALMENDROS, G., MARTIN, F., GONZÁLEZ-VILA, F. J. and ALVAREZ-RAMIS, C. (1985): Caracterización de las distintas formas de materia orgánica fósil de dos canteras del Cretácico superior de la provincia de Madrid. – Anales de Edafología y Agrobiología *44*, 1–121.

ALMENDROS, G., MARTIN, F., GONZÁLEZ-VILA, F. J. and DEL RIO, J. C. (1993): The effect of various chemical treatments on the pyrolytic pattern of peat humic acid. – Journal of Analytical and Applied Pyrolysis *25*, 137–147.

ALVAREZ-RAMIS, C. (1981): Estudio de *Frenelopsis oligostomata* (ROMARIZ) ALVIN, procedente del Cretácico superior de Torrelaguna (Madrid). – Estudios Geológicos *37*, 83–87.

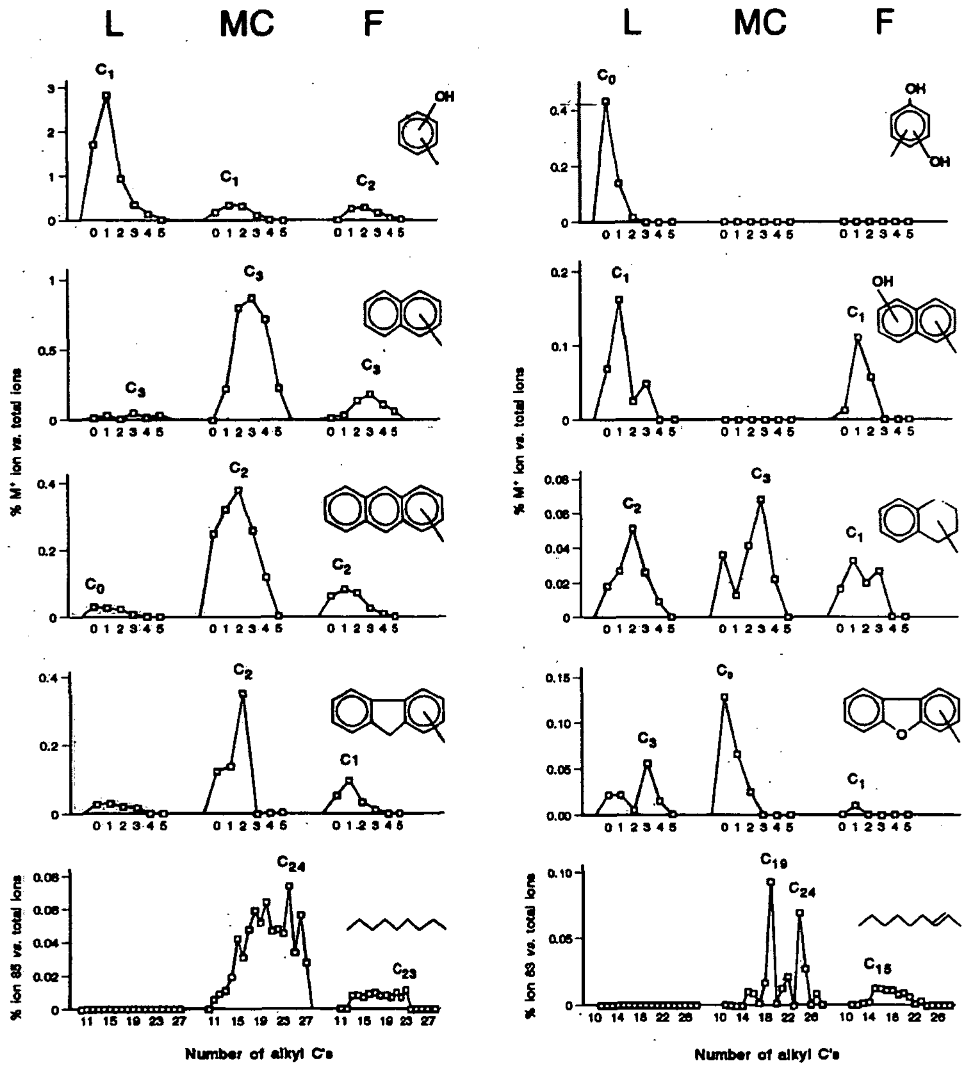
ALVAREZ-RAMIS, C., ALMENDROS, G. and POLO, A. (1982): Sur la présence du genre *Frenelopsis* dans le gisement de Guadalix de la Sierra (Madrid, Espagne). – Sciences (M. E. N.) *1*, 85–95.

ALVAREZ-RAMIS, C., ALMENDROS, G. and POLO, A. (1984): Precisiones histológicas y bioquímicas acerca de los ejemplares de *Frenelopsis* procedentes de Torrelaguna (Madrid). – Estudios Geológicos *40*, 107–113.

ALVAREZ-RAMIS, C. and DOUBINGER, J. (1994): Contribución al conocimiento de la palinoflora cretácica de la provincia de Madrid. Los Alcores, Guadalix de la Sierra. – Revista Española de Micropaleontología *26*, 1–18.

◂ Plate 3.2.

1. Fragment of gray calcareous marl including different fossil impressions, from member 6 of the local series of Cerro de la Mesa (MC).
2. Fragments of compact lignites, including plant tissues remains and seeds isolated from member 4 (L).
3. Very compact limestone, rich in macrofossils, showing a mummified conifer rest of *Frenelopsis oligostomata* (ROMARIZ) ALVIN, in member 6 (F).



Text-fig. 3.3.

Series of homologues compounds released by pyrolysis on the main forms of organic matter from Cerro de la Mesa: L = lignites, MC = carbonaceous marls, F = fossil rests of *Frenelopsis oligostomata.* Left to right, top to bottom: phenols, catechols, naphthalenes, naphthalenols, C_{14}-tricyclic aromatic hydrocarbons (anthracenes + phenanthrenes), tetralins, fluorenes, dibenzofurans, alkanes and olefins.

ALVAREZ-RAMIS, C. and FERNÁNDEZ MARRÓN, T. (1990): Caracterización palinológica del Cretácico superior del Cerro de la Mesa (Guadalix de la Sierra, Madrid). – 8. Simposio de Palinología A. P. L. E., Tenerife (Islas Canarias), 24/28. Septiembre 1990, Resúmenes.

ALVAREZ-RAMIS, C. and FERNÁNDEZ MARRÓN, T. (1993): Estudio palinológico preliminar de los niveles terminales del Cretácico superior del Cerro de la Mesa (Guadalix de la Sierra, Madrid). – In: Polen y esporas: Contribución a su conocimiento, ed: I. DE LA SERNA, 315–322.

ALVAREZ-RAMIS, C., FERNÁNDEZ MARRÓN, T. and GÓMEZ PORTER, P. (1989): Avance del estudio macropaleobotánico de la flora supracretácica del Cerro de la Mesa (Sierra de Guadarrama, Madrid). – II. European Palaeobotanical Conference, Madrid, September 1989, Abstracts, 15.

ALVAREZ-RAMIS, C., KEDVES, M. and FERNÁNDEZ MARRÓN, T. (1994a): Asociaciones esporopolínicas del Cretácico superior del Cerro de la Mesa (Guadalix de la Sierra, Provincia de Madrid). – Botánica Macaronésica.

ALVAREZ-RAMIS, C., KEDVES, M. and FERNÁNDEZ MARRÓN, T. (1994b): Consideraciones en torno a las asociaciones esporopolínicas del Cretácico superior del Cerro de la Mesa (Guadalix de la Sierra, Madrid). – Plant Cell Biology and Development (Szeged) *5*, 34–45.

SCHULTEN, H.-R., PLAGE, B. and SCHNITZER, M. (1991): A chemical structure for humic substances. – Naturwissenschaften *78*, 311–312.

4. RADIAL FIVEFOLD ROTATION: A NEW METHOD IN THE STUDY OF THE BIOPOLYMER ORGANIZATION OF THE SPORODERM

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Abstract

The two major constituents, the quasi-crystalloid skeleton and its stabilizing molecular system were established previously on partially degraded sporoderms. A peculiar and heterogeneous biopolymer skeleton was discovered in the wall of *Botryococcus braunii* KÜTZ. isolated from a Hungarian oil shale. Quasi-periodic and quasi-equivalent symmetry was observed on the different levels of organization of the biopolymer system of this species. The new method was elaborated on the peculiar quasi-periodic units of the biopolymer skeleton. Two kinds of radial rotations methods were elaborated for the first time. One with a positive, the other with a negative secondary points of symmetry centre. The rotation area was introduced as a new methodical term. Single and combined, inside of the combined outest and innermost summarized areas were distinguished. In some cases secular alterations in the size and shape of the rotation areas were established.

Key words: Botryococcus braunii, oil shale, biopolymer symmetry, new method.

Introduction

The peculiar algue, *Botryococcus braunii* KÜTZ. has been the subject of several investigations, and a number of papers have appeared in different aspects of this subject. The result of the LM studies have been summarized recently by VÉR (1994). The combined investigations of the Transdanubian oil shale in Hungary was reviewed in this paper and will be reviewed in further ones. TEM results of intact colonies were published by KEDVES (1983), and later by GLIKSON, LINDSAY and SAXBY (1989). Experimental investigations were carried out with different methods (cf. KEDVES, 1986, KEDVES, ROJIK and VÉR, 1991, KEDVES, TÓTH and FARKAS, 1993). The peculiarities of the biopolymer structure were also established particularly on the partially degraded and fragmented wall of the *Botryococcus* colonies isolated from the Hungarian oil shale. As the most important peculiarity, we can emphasize that the quasi-periodic and quasi-equivalent biopolymer organization is present in the wall of the colonies of *Botryococcus braunii.*

As it has been emphasized in several papers, one of the research programs of our laboratory is the investigation of the symmetry and the organization of the biopolymer system of different kinds of plant cell walls. The most important fields of research are the following:

1. Investigation of the quasi-crystalloid biopolymer skeleton.
2. Investigation of the symmetry and organization of the stabilizing biopolymer system of quasi-crystalloid skeleton.
3. On the biopolymer and molecular level it is necessary to pay special attention to the outer and inner bordering surfaces.

Modellings are very important in the investigation of the biopolymer structure of the plant cell wall. We have used the following methods so far:

1. Two-dimensional modelling with the modified MARKHAM rotation method (cf. KEDVES, 1988, 1989, 1990, 1991a, KEDVES and FARKAS, 1991, KEDVES, PÁRDUTZ, FARKAS and VÉR, 1991, KEDVES, ROJIK and VÉR, 1991, etc.).

2. Three-dimensional modelling of the quasi-crystalloid skeleton (KEDVES, 1991b, 1992, KEDVES, TÓTH and FARKAS, 1993).

3. Computer modelling of the quasi-crystalloid skeleton and the stabilizing system (cf. M. KEDVES and L. KEDVES, 1995, in this number).

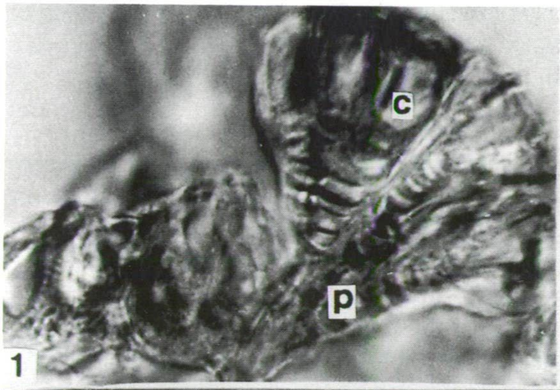
The aim of this paper is to complete the opportunities of two-dimensional rotation, essentially with the modified MARKHAM rotation method. This method was elaborated for the peculiar biopolymer system of the *Botryococcus braunii* KÜTZ., but it seems to be useful for other quasi-crystalloid biopolymer structures, as well.

Materials and Methods

The material of investigation is identical with those published previously (KEDVES, TÓTH and FARKAS, 1993, p. 41). In the paper mentioned above the basic biopolymer pentagons of number I, II, and III were used for biopolymer symmetry operations. Now further biopolymers, designated with IV and V were the subjects of our studies (Plate 4.1., fig. 3). The description of the method was published in our paper (KEDVES, TÓTH and FARKAS, 1993), p. 41, as follows: "*Botryococcus braunii* KÜTZ., from the Upper Tertiary Oil Shale, Pula, Hungary. (Experiment No. 924). Ten mg of air dried colonies was added to one ml of merkaptoethanol. A temperature of 30 °C was maintained for 24 hours. The residue was washed and fragmented with a magnetic stirrer in an aqueous medium for 30 minutes. The fragmented wall remnants were dropped onto a grid, covered with a collodium pellicule and then dried. The EM investigations were made on a Tesla BS-500 TEM (resolution 6 Å) at the J. A. University, Faculty of Science, Electron Microscope Laboratory."

Concerning the biopolymer units investigated, biopolymer no IV is a so-called "normal" regular pentagonal biopolymer unit.
Biopolymer no V is peculiar, because in the middle of the regular pentagon there is another globular biopolymer unit. This latter was used for the first radial rotation as follows:

A) The ten dark globular units of the pentagon which appeared after the fivefold rotation C.P.5.A.5.5.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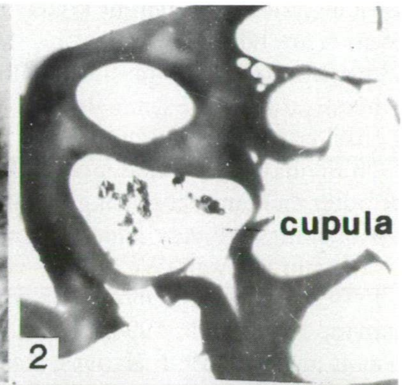
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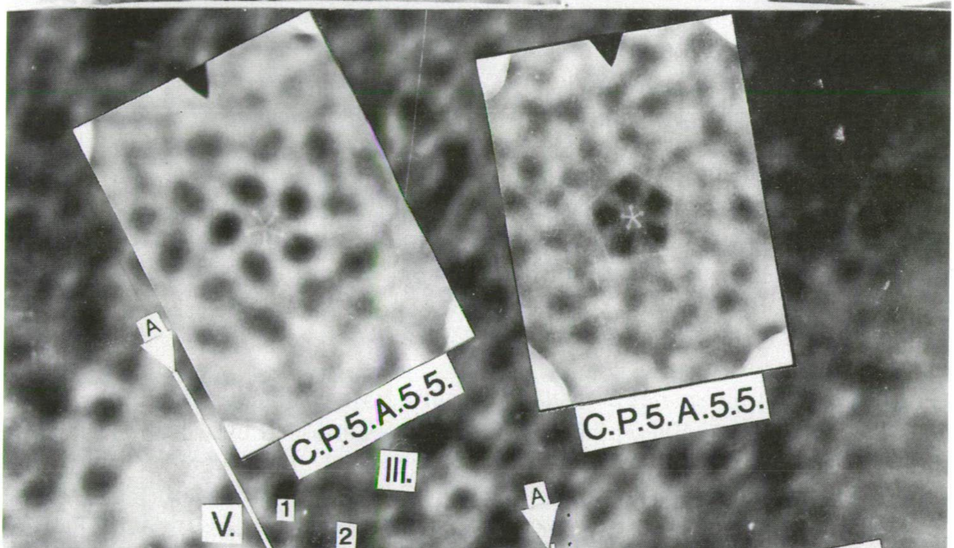
C.P.5.A.5.5.
C.P.5.A.5.5.
III.
A
V.
1
2
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3
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IV.
1
2
5
P
3
4
C.P.5.A.5.10.
C.P.5.A.5.10.
3

B) The ten light points of symmetry (holes of biopolymer dimension) of the tenfold rotation (C.P.5.A.5.10.).

Results

The recently elaborated radial rotation is always a kind of secondary rotation, and it is two-dimensional.

The secondary points of symmetry of a fivefold or tenfold primary rotation are used as rotation centres.

The axes are linear between the centre (P) of the basic biopolymer unit of the primary rotation and one of the secondary point of symmetry.

The centrum of the radial rotation is always a secondary point of symmetry.

The centrum of the radial secondary rotation can be positive or negative; one globular biopolymer unit,

or a hole of the dissolved exine.

Designations; for example C.S.5.R.$_{1+1/10}$.5.5.

C = complete rotation – the total of the angles of rotation is 360°.

S = secondary rotation – the centre of rotation is one of the new points of symmetry which appeared after a primary rotation.

5 = fivefold rotation.

R = radial rotation; see above.

1+1/1-10 = the first circle, +1 first positive, dark points of symmetry, 1-10 – ten secondary biopolymer units were radially rotated.

5.5. = number of exposition – 5 x 5.

C.S.5.5.$_{1-1/1-10}$.5.5. indicates the tenfold radial rotation of the ten light points of symmetry (holes). There is one difference only in the designation, 1-1/1-10 indicates that the points of symmetry of the centres of the radial rotation are light (holes of one biopolymer unit).

The common results of the two kinds of rotations are the following:

1. In both cases the secondary radial rotations resulted in positive and negative points of symmetry.
2. Characteristic outer and inner areas can be established after the radial rotations.

◂ Plate 4.1.

1. LM picture of *Botryococcus braunii* KÜTZ. isolated from Hungarian oil shale, slide: Pula 1/1, cross-table number: 9.3/115.1. c = cupula, p = pedunculus. 1000x.
2. TEM picture from non-experimental colony. The compact substance of the wall is well illustrated. 8.000x.
3. Detail of a partially degraded colony. Experiment No: 924, negative no: 586. The basic pentagonal biopolymer units designated with IV and V were the subject of fivefold and tenfold rotations. The basic TEM picture, the investigated biopolymer units with the PA rotation axes, and the rotation pictures are illustrated here. 500.000x.

3. The points of symmetry of the outest and innermost areal borders may be useful for further biopolymer symmetry operations.
4. The summarized border is composed from the outest limits of the outest areas.
5. There are points of symmetry outside of this summarized border. Its origin is interesting and doubtful; using these points of symmetry as rotation centrums, we may hope for interesting results.

Regarding the details, we can point out the following:

RADIAL ROTATION WITH THE POSITIVE POINTS OF SYMMETRY IN THE CENTRUM

(Plate 4.2., text-fig. 4.1., 4.2., 4.3.)

At the inner and the outer rotation areas several periodicities may be established.

The outer rotation areas. – The summarized outer areas indicate that there are several irregular inner fields which overlap one another, resulting in dark fields (Text-fig. 4.1.). The drawings were made with altered perpendicular and horizontal streakings. (The first one is horizontal, the second one is perpendicular, the third one is horizontal again). The contour of the overlapping areas – the darkest area is irregular in form.

Inner rotation areas. – The smaller, inner rotation areas overlap very poorly, they can be seen relatively easily in their contour. In this case the following similarities can be established: In some cases the opponent inner fields may be identical or more or less similar; areas no 2 and 7 are the best examples in this respect (Text-fig. 4.2.). As contrary examples for the inner area no 5 and 10 can be pointed out. The greatest number of the inner areas are more or less identical, cf. 1–6. The border of the summarizing outer areas with the so-called extra-areal points of symmetry are represented on Text-fig. 4.2. The disposition of the points of symmetry following the origin between the rotation axes is the following.

	1	2	3	4	5	6	7	8	9	10
1 – 2	2	7								
2 – 3		2	3	1						
3 – 4			3	5						
4 – 5				5	6	2				
5 – 6				4	8					
6 – 7						11	6	2		
7 – 8						1	4	6		
8 – 9							1	10	8	
9 – 10									6	9
10 – 1	3	1								7

Some points of symmetry are on the axes. The different kinds of rotation of these extra-areal points of symmetry will make another interesting methodical problem.

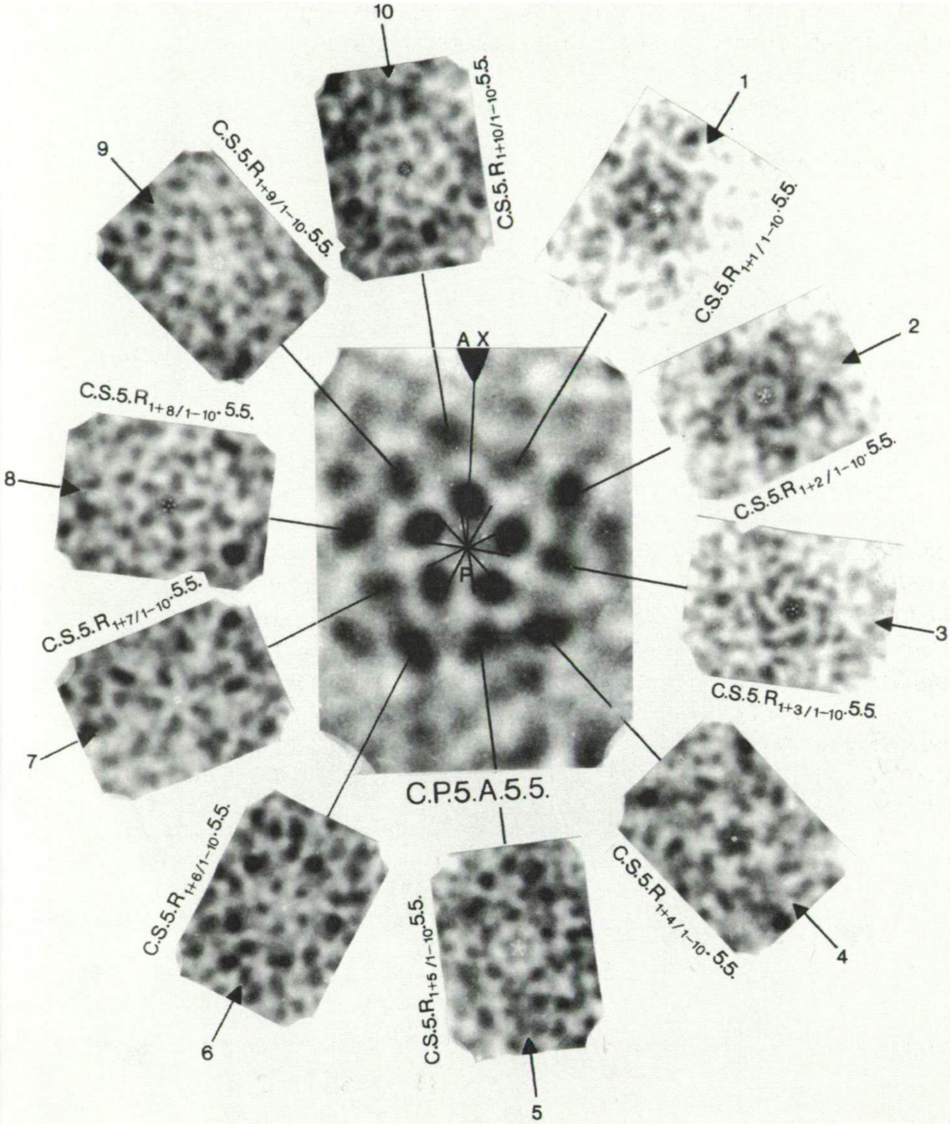
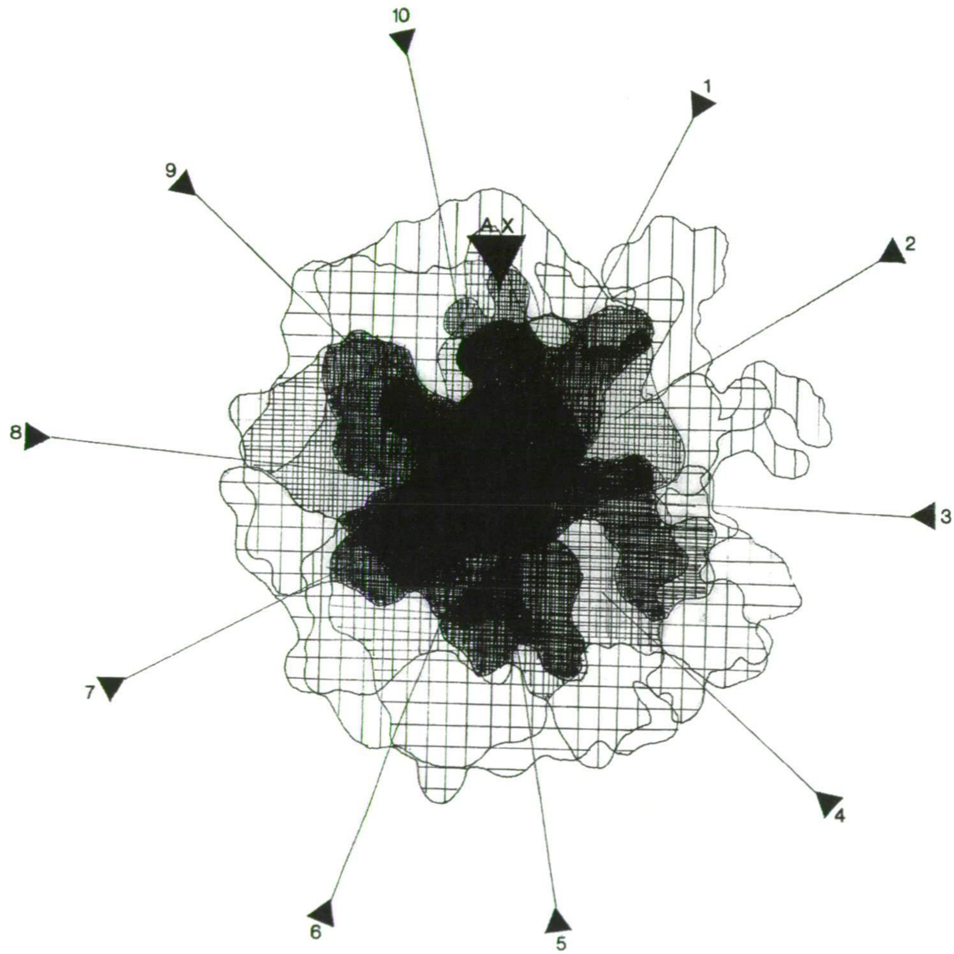


Plate 4.2.

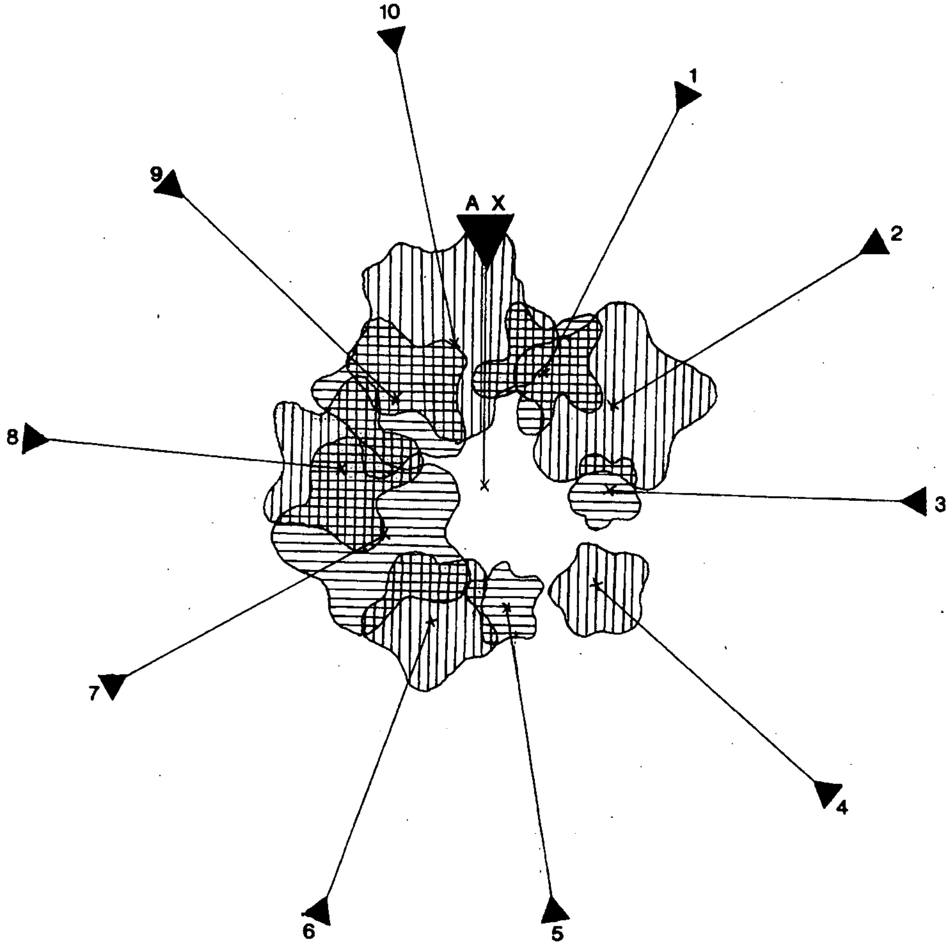
The fivefold rotation picture of the basic biopolymer unit no V as a basis for positive radial rotation. The ten rotation centres are the positive points of symmetry which are surrounding the basic pentagon. The pictures of the radial rotation are placed in the direction of the axes of the radial rotation.
$R_{1+1/1-10} - R_{1+10/1-10}$

József Attila Tudományegyetem Központi Könyvtár SZEGED



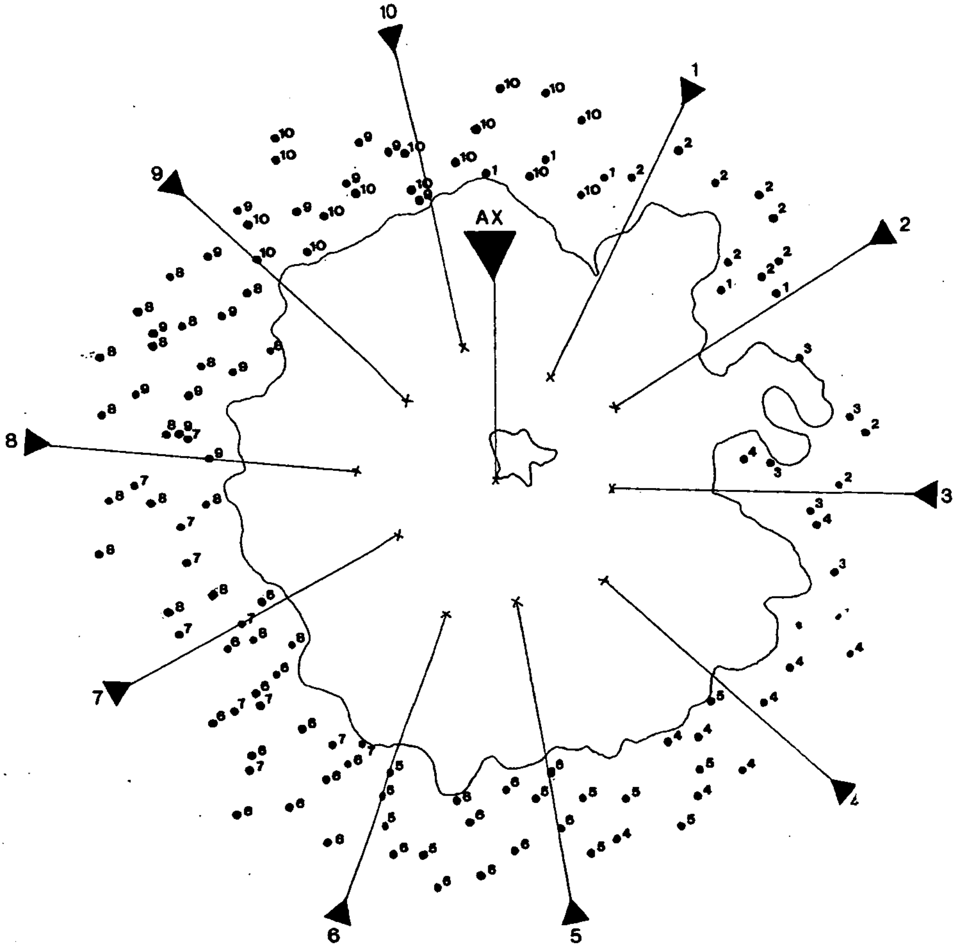
Text-fig. 4.1.

The outer rotation areas of the ten positive radial rotations, cf. Plate 4.2.



Text-fig. 4.2.

The inner rotation areas of the ten positive radial rotations, cf. Plate 4.2. A certain periodicity may be established in the shape and size of some of the opposite inner rotation areas (1–6, 2–7), these are more or less identical. 3–8, 4–9, 5–10 are similar in contour, but the size of the rotation areas of the lower values (3, 4, 5) is much smaller than those of the higher ones (8, 9, 10).



Text-fig. 4.3.

The summarized outer and inner borders of the positive rotation areas with axes of rotations, and the extra-areal points of symmetry. The numbers of the extra-areal points of symmetry indicate the "origin" of these points of symmetry, e. g.: the number of the radial rotations.

RADIAL ROTATION WITH NEGATIVE POINTS OF SYMMETRY IN THE CENTRUM

(Plate 4.3., text-fig. 4.4., 4.5., 4.6.)

The outer rotation areas. – The summarized outer areas in this case are more or less regular than previously. One dark centrum appears rounded with by and by lighter concentric zones (Text-fig. 4.4.). On the contour of the outest summarized border a certain asymmetry may be established.
Inner rotation areas (Text-fig. 4.5.). – In this case it is not so easy to establish similarities or differences between the opposite areas. The summarized outer border of these areas is more asymmetrical than previously.
The border of the summarized outer areas with the so-called extra-areal points of symmetry (Text-fig. 4.6.). The disposition of the points of symmetry following its origin between the rotation areas is the following.

	1	2	3	4	5	6	7	8	9	10
1 – 2	3	7								
2 – 3		4	4							
3 – 4		1	3	6						
4 – 5				4	6					
5 – 6					2	5				
6 – 7						4	3			
7 – 8							6	6	1	
8 – 9								5	3	3
9 – 10								1	3	6
10 – 1	6								1	7

Discussion and Conclusions

1. The results of the newly elaborated and applied two-dimensional rotation methods support the complexity of the biopolymer structure of the sporoderm.
2. On the basis of the first data, the rotation areas may be useful in the investigation of highly organized biopolymer structures. These areas may be highly organized units of the sporopollenin.
3. The highly organized biopolymer structures may have taxonomic and/or phylogenetic significance.
4. The quasi-crystalloid skeleton and the stabilizing biopolymer system are the structural and probably universal units of the plant cell wall.
5. There is still a lot of work to do, our knowledge is not sufficient in this field yet.
6. Finally, for the first attempt a peculiar biopolymer structure was chosen. This one and such fragments will also be used later because one part of this fragment is a quasi-crystalloid with "normal" and peculiar basic units, and another is quasi-

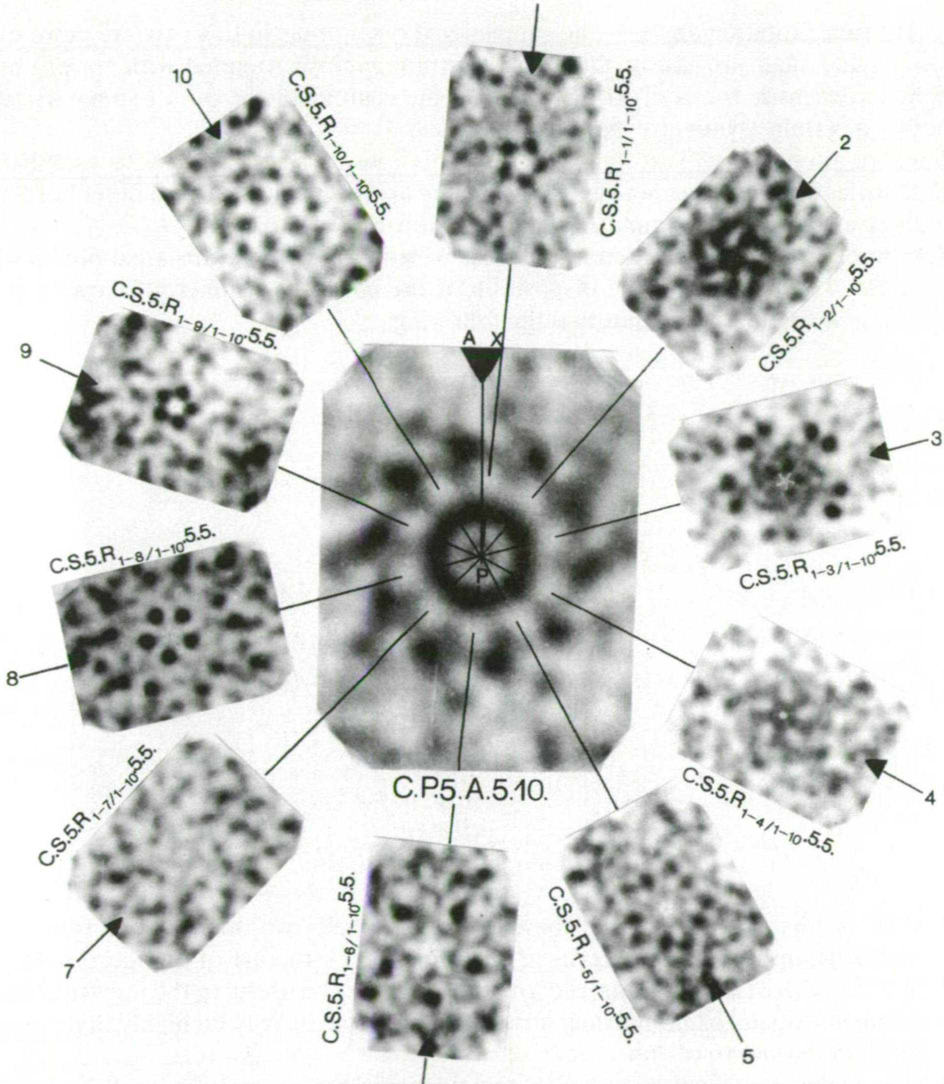
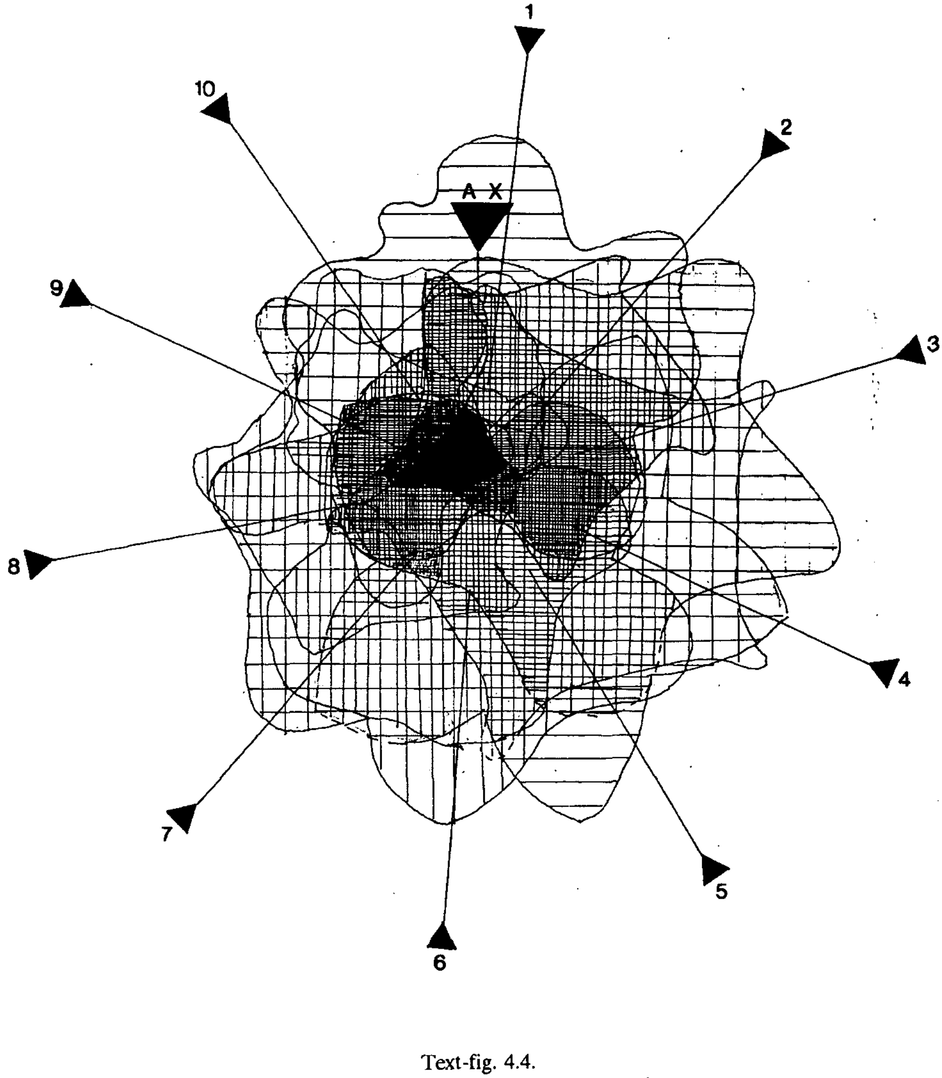


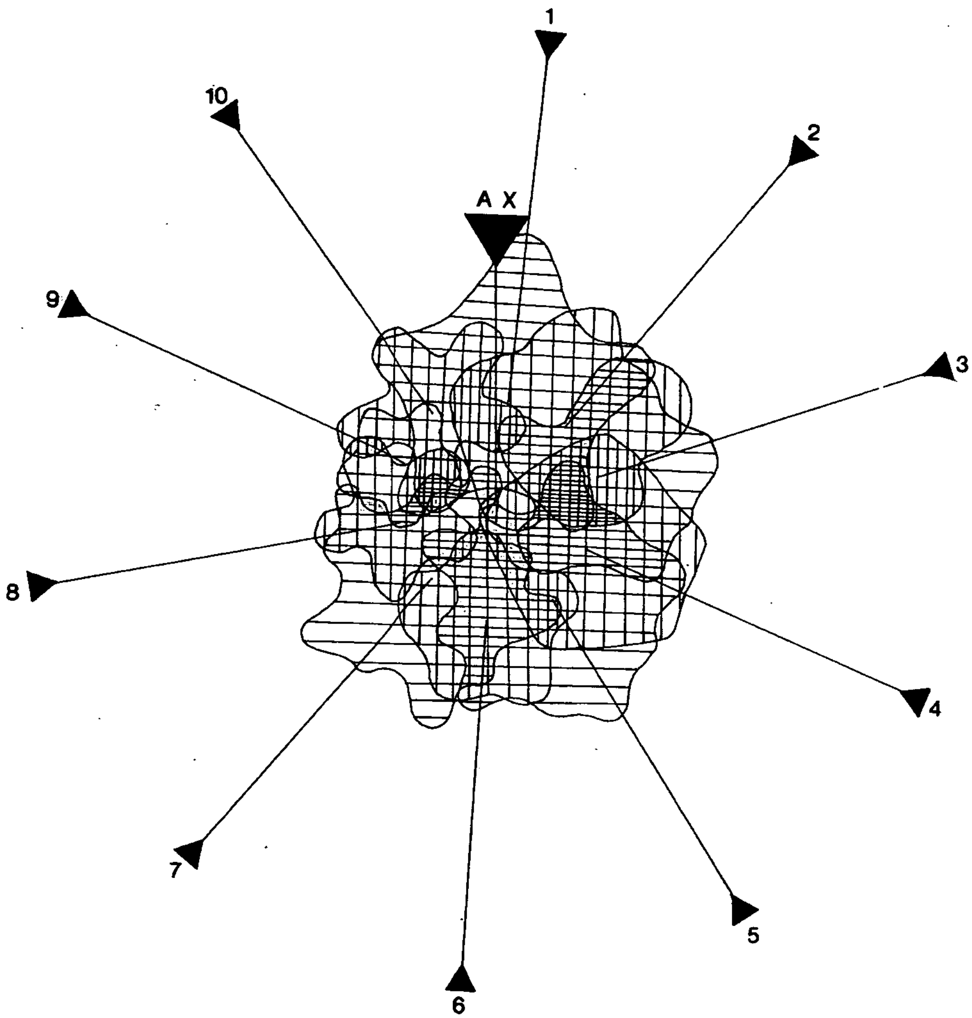
Plate 4.3.

The tenfold rotation picture of the basic biopolymer unit no V as a basis for negative radial rotation. The ten centres of rotation are the light (negative) points of symmetry of the first circle around the centre of the basic biopolymer unit. The results of the radial rotations are oriented in the axes of the radial rotations. $R_{1\text{-}1/1\text{-}10} - R_{1\text{-}10/1\text{-}10}$



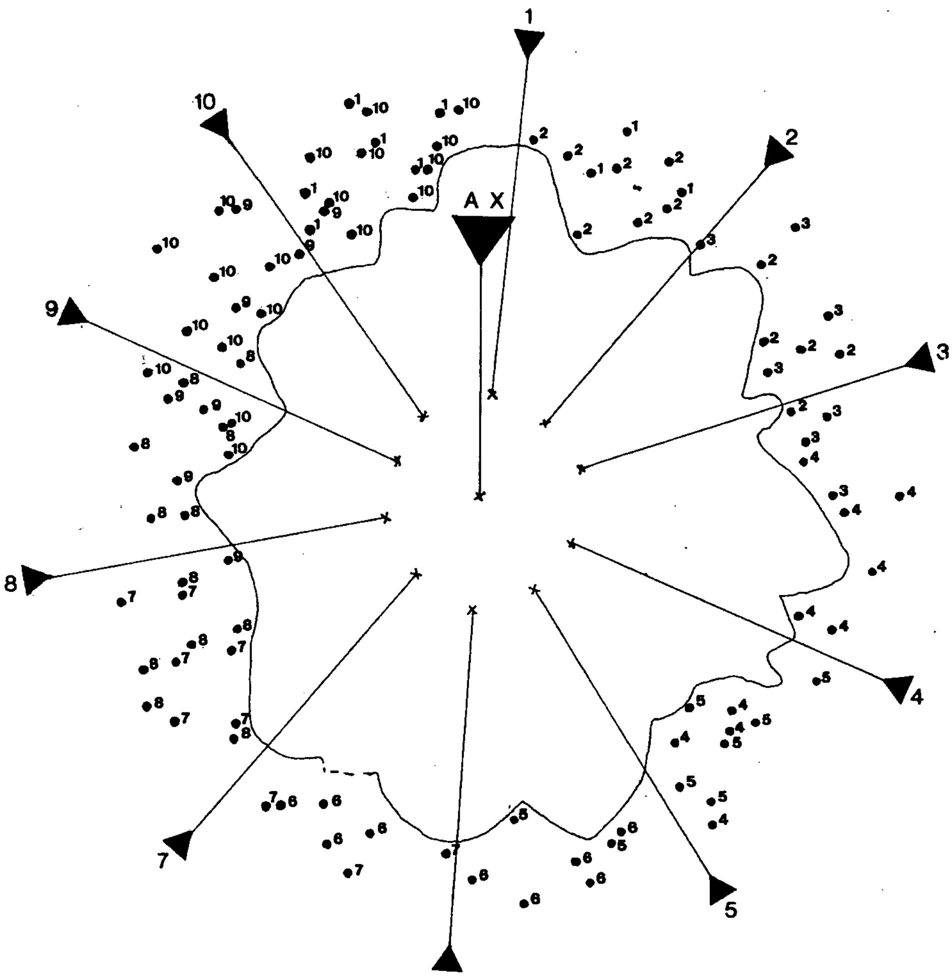
Text-fig. 4.4.

The outer rotation areas of the ten negative radial rotations, cf. Plate 4.3.



Text-fig. 4.5.

The inner rotation areas of the ten negative radial rotations cf. Plate 4.3. In this case it is not possible to establish a periodicity or relationships between the opposite areas.



Text-fig. 4.6.

The summarized outer border of the negative rotation areas with axes of rotations, and the extra-areal points of symmetry. The numbers of the extra-areal points of symmetry indicate the "origin" of these points of symmetry, e. g.: the number of radial rotations.

equivalent with a highly organized structure. The relations between these two kinds of biopolymer systems will be investigated later.

7. These two kinds of biopolymers are probably present in further cell walls, as well, we have found them in the pollen grains of *angiosperms*. (Cf. KEDVES and ROJIK, 1994).

Acknowledgements

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References

GLIKSON, M., LINDSAY, K. and SAXBY, J. (1989): *Botryococcus* – A planktonic green alga, the source of petroleum through the ages: Transmission electron microscopical studies of oil shales and petroleum source rocks. – Org. Geochem. *14,* 595–608.

KEDVES, M. (1983): Étude paléobotanique sur les schistes pétrolifères du Tertiaire supérieur de Hongrie. – Rev. de Micropaléontologie *26,* 48–53.

KEDVES, M. (1986): Dégradation expérimentale des colonies du genre *Botryococcus* des schistes pétrolifères du Tertiaire supérieur de Hongrie. – Acta Biol. Szeged. *32,* 39–48.

KEDVES, M. (1988): About the symmetry of the pentagonal basic biopolymer units of the pollen wall. – Acta Biol. Szeged. *34,* 157–159.

KEDVES, M. (1989): Méthode d'étude des biopolymères de la paroi pollinique à structure quasi-cristalloïde. A method of investigation of the quasi-crystalloid structure of pollen wall biopolymers. – Rev. de Micropaléontologie *32,* 226–234.

KEDVES, M. (1990): Quasi-crystalloid basic molecular structure of the sporoderm. – Rev. Palaeobot. Palynol. *64,* 181–186.

KEDVES, M. (1991a): TICOS polyhedra as a model in the pentasporan organization. – Plant Cell Biology and Development (Szeged) *2,* 63–74.

KEDVES, M. (1991b): Three dimensional modelling of the biopolymer structure of the plant cell wall I. – Plant Cell Biology and Development (Szeged) *2,* 63–74.

KEDVES, M. (1992): Three dimensional modelling of the biopolymer structure of the plant cell wall II. – Plant Cell Biology and Development (Szeged) *3,* 67–87.

KEDVES, M. and FARKAS, E. (1991): Basis of the tertiary rotation and TICOS modelling of the quasi-crystalloid biopolymer skeleton of the plant cell. – Plant Cell Biology and Development (Szeged) *2,* 36–42.

KEDVES, M. and KEDVES, L. (1995): Computer modelling of the quasi-crystalloid biopolymer structures I. – Plant Cell Biology and Development (Szeged) *6,* 68–77.

KEDVES, M., PÁRDUTZ, Á., FARKAS, E. and VÉR, A. (1991): Basic establishments of the biological objects molecular structure containing quasi-crystalloid skeleton. – Plant Cell Biology and Development (Szeged) *1,* 35–37.

KEDVES, M. and ROJIK, I. (1994): Buckminsterfullerene-like biopolymer units from the exine of *Thalictrum flavum* L. – Plant Cell Biology and Development (Szeged) *5,* 58–66.

KEDVES, M., ROJIK, I. and VÉR, A. (1991): Biopolymer organization of the partially degraded oil shale with the fragmentation method. – Plant Cell Biology and Development (Szeged) *1,* 28–31.

KEDVES, M., ROJIK, I. and VÉR, A. (1992): Ultrastructure and biopolymer organization of the *Botryococcus* colonies from Hungarian alginite. – Workshop on Pyrolysis in Organic Geochemistry. International Workshop, Abstracts, 21–22.

KEDVES, M., TÓTH, A. and FARKAS, E. (1992): Experimental investigation of the biopolymer organization of the sporoderm (recent and fossil). – 8th Internat. Palynol. Congress, Aix-en-Provence, Abstracts, 75.

KEDVES, M., TÓTH, A. and FARKAS, E. (1993): An experimental investigation of the biopolymer organization of both recent and fossil sporoderm. – Grana Suppl. *1,* 40–48.

VÉR, A. (1994): LM investigations of different stained fossil *Botryococcus* colonies. – Plant Cell Biology and Development (Szeged) *5,* 11–19.

5. ÉTUDES PALYNOLOGIQUES ET PÉDOLOGIQUES SUR LES SÉDIMENTS HOLOCÈNES DE LA PISCINE DU MONASTÈRE DU MONT JAKAB

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Sommaire

Ces études on été effectuées dans le cadre du programme de recherche de la reconstitution et de la protection de la végétation ancienne du monastère des alentours et des plantes cultivées dans le jardin près de la piscine. Les données palynologiques qui concernent les plantes cultivées dans le jardin du monastère sont pauvres; *Umbelliferae, Fabaceae, Caryophyllaceae, Gramineae, Allium, Galanthus, Corylus, Moraceae, Juglans* et *Castanea.* Pour ce qui est de la végétation de la piscine et les alentours, nous avons obtenu les résultats suivants: 1. Plantes aquatiques: 1.1. *Hystrichosphaeridae, Pseudoschizaea (Concentricystes),* pour le zooplancton le genre *Arcella.* 1.2. *Salvinia, Sphagnum, Sagittaria, Stratiotes, Spurganium, Typha, Carex, Iridaceae.* 2. *Chenopodiaceae, Ambrosia, Amaranthaceae* et *Urticaceae* représentent les mauvaises herbes. 3. Éléments des buissons de la végétation rupestre: *Viburnum, Ilex, Dictamnus, Saxifraga, Achillea, Solidago, Geranium, Cruciferae.* 4. *Conifères: Pinus, Picea, Abies, Tsuga, Larix-Pseudotsuga, Taxus.* 5. Arbres feuillus: *Acer, Tilia, Fraxinus, Quercus, Carpinus, Fagus, Alnus, Salix, Betula.* 6. Pour la végétation de sous-bois: *Daphne, Polypodiaceae, Helleborus, Boraginaceae, Asperula, Impatiens, Compositae* type fenestrate. 7. Formes remaniées: *Schizaeaceae (Cicatricosisporites), Disaccites, Plicapollis, Trudopollis.*

Mots clés: Palynologie, pédologie, Holocène, Hongrie.

Introduction

Le Conseil National du Sud de la Transdanubie nous a sollicités de continuer des recherches sur les sédiments de la piscine. Les problèmes à résoudre ont été subordonnés à l'intérêt de la reconstitution des environnements historiques du monastère du Mont Jakab, c'est-à-dire:

1. Reconstituer – si possible – les espèces ou les groupes des plantes cultivées dans le jardin du monastère,
2. donner des documents sur la végétation de la piscine et de ses environs,
3. étudier la possibilité de reconstitution des altérations dans la végétation des Mecsek, en se basant aux données de la Palynologie.

Matière et Méthode

Les échantillons ont été prélevés par dix centimètres de 7 court sondages jusqu'à la roche basale de la piscine (grès Permien, etc.) Le sédiment holocène était en général très mince, soixante cm. maximum, et dix cm. minimum. Une partie de la piscine n'était pas convenable pour échantillonnage. Les échantillons pour les études palynologiques ont été effectués afin de réduire au minimum la fossilization sélective ultérieure. Seul de l'acide chlorique et de l'acide fluorhydrique ont été utilisés. Au cours des études pédologiques les paramètres suivants ont été mesurés:
1. Le caractère du sédiment (argiles, sable, etc.) y compris l'humidité hygroscopique et la dimension des particules.
2. Le caractère qualitatif du sol; le contenu organique, le pH (n ClK) pH (OH_2), lactate soluble potasse et phosphates.

Géologie et végétation actuelle de la région de Mecsek

La hauteur du Mont Jakab est de 602 m. au-dessus de la Mer Adriatique. La roche originelle est du grès rouge, du Permien supérieur. Les macrofossiles du Permien de cette région ont été le sujet de plusieurs études depuis longtemps. HEER (1877) a publié plusieurs genres et espèces, par exemple; *Baiera digitata, Ulmannia* spp., *Voltzia* spp., *Carpolithes* spp., etc. L'anatomie des bois silicifiés a été étudiée pour la première fois par TUZSON (1906), après SIMONCSICS (1955), puis GREGUSS (1961, 1967). La structure est "araucarioïde" de type primitif; *Dadoxylon,* où le genre *Baieroxylon* GREGUSS 1961 a été décrit. Des spores et de grains de pollen ont été étudiés par BARABÁS-STUHL (1975, 1981) et in FÜLÖP (1990), concernant les recherches du minérai d'uranium. Il y a des couches Mésozoiques et Tertiaires dans cette région. Le Jurassique inférieur – le charbon du Lias, avec beaucoup de macrorestes et de sporomorphes bien conservés est encore à mentionner. Les spores et les grains de pollen ont été publiés par GÓCZÁN (1956), et par BÓNA (1966, 1969, 1983) dans plusieurs études.

Les forêts de la végétation actuelle (HORVÁTH, 1954, 1957, 1958, 1959, PRISZTER et BORHIDI, 1967) peuvent être caractérisées par les arbres du *Quercus, Carpinus* et *Fagus.* Il est intéressant de noter la présence de *Castanea sativa* MILL. avec une origine douteuse – peut-être c'est une relique de la cultivation de l'Empire Romaine. Pour la végétation de sous-bois: *Galium odoratum* (L.) SCOP. (= *Asperula odorata), Melica uniflora* RETZ., *Allium ursinum* L. sont à mentionner. Élément méditerranéen: *Tamus communis* L. des *Dioscoréacées.*

Reconstruction de l'histoire de la piscine en se basant aux études pédologiques

Le fond de la piscine n'est pas uniforme. Trois types ont été distingués:
1. Débris de grès rouge – Permien supérieur. Sondages: 1, 4, 8.
2. Débris de roche brune – Mésozoique. Sondages: 3, 5, 6, 7.
3. Probablement argile marneuse. Sondage: 2.

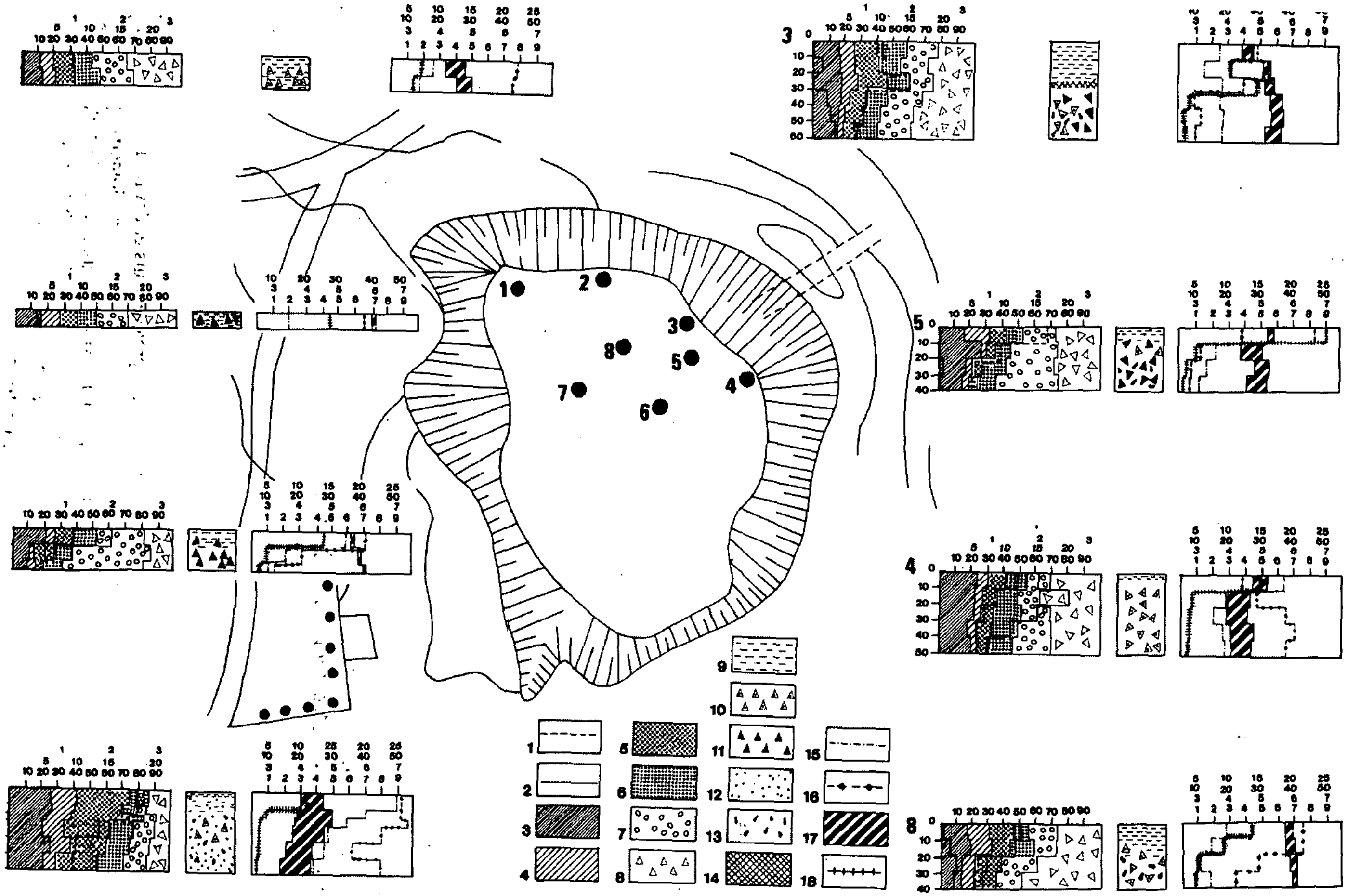
Pour la reconstruction de l'histoire de la piscine, le sondage No: 3 est le plus convenable (Fig. 5.1.). Les événements peuvent être récapitulés comme suit:
1. Quand la piscine était pleine d'eau une sédimentation modérée s'est déroulée.
2. Après la diminution du niveau de l'eau, une végétation caractérisée par le genre *Carex* a apparu, et le rythme de la sédimentation s'est accéléré. Cette végétation qui a produit une grande quantité de matière organique a été probablement brulée. Une eutrophisation a commencé. Les phosphates qui se sont libérés du grès rouge ont aussi accéléré cette eutrophisation.
3. On peut établir une périodicité dans le dessèchement de la piscine.

Les données palynologiques
(Fig. 5.2.)

1. La préservation des sporomorphes dans les sédiments étudiées.
De ce point de vue les types suivants peuvent être établis:
1.1. Les sporomorphes sont en général en bon état de conservation. Sondage: 1.
1.2. Par contre, la plus grande partie des sporomorphes ont disparu au cours de la fossilisation. Sondages: 6, 7.
1.3. Il y a une périodicité dans les conditions de la sédimentation. Sondages: 2, 3.
1.4. Les sporomorphes dans la partie supérieure sont en bon état de conservation. Sondages: 4, 5.
1.5. Le contraire. Sondage: 8.
2. Les grains de pollen qui peuvent être à l'origine des plantes cultivées du jardin du monastère sont peu connus. Les pollens des genres et familles suivants sont à mentionner de ce point de vue: *Ombellifères (Carotte), Fabacées (Léguminosae), Graminées, Allium, Galanthus, Rosacées, Corylus, Moracées, Juglans, Castanea.* Naturellement il n'est pas exclu que quelques types de pollen deviennent des espèces de plantes sauvages.
3. Les microfossiles de la piscine et ses alentours.
3.1. *Hystrichosphaeridae* – indique la salinité de l'eau. *Pseudoschizaea* (=*Concentricystes, Chomotriletes,* pro parte), ce type est connu depuis du Paléozoique. Il y a une grande quantité de publications, mais l'origine de ce type est inconnue. (cf. WOLFF, 1934, THIERGART et FRANTZ, 1962, ROSSIGNOL, 1962, 1964, CHRISTOPHER, 1976, KEDVES, 1977, etc.). *Arcella vulgaris* EHRBG. représent le zooplancton.

Fig. 5.1 ►

Schéma de la piscine et de ses environs, avec les points des prélèvements et des résultats pédologiques. 1 = pourcentages de l'humidité hygroscopic, 2 = cailloux, 3 = argile – granulométrie plus ou moins dépassant 0,002 mm., 4 = granulométrie de 0,002 à 0,01 mm., 5 = sable$_1$, granulométrie de 0,01 à 0,05 mm., 6 = sable$_2$, granulométrie de 0,05 à 0,2 mm., 7 = sable$_3$, granulométrie de 0,2 à 0,4 mm., 8 = sable$_4$, granulométrie de 0,4 à 2,0 mm., 9 = sédiment marécageux, 10 = débris du grès rouge, 11 = débris du grès brun, 12 = argile marneuse, 13 = nodules argileux, 14 = traces d'une brûlure, 15 = OK_2 mg/100 g de sol, 16 = O_5P_2 mg/100 g de sol, 17 = pH (n ClK), pH (OH_2), 18 = matière organique.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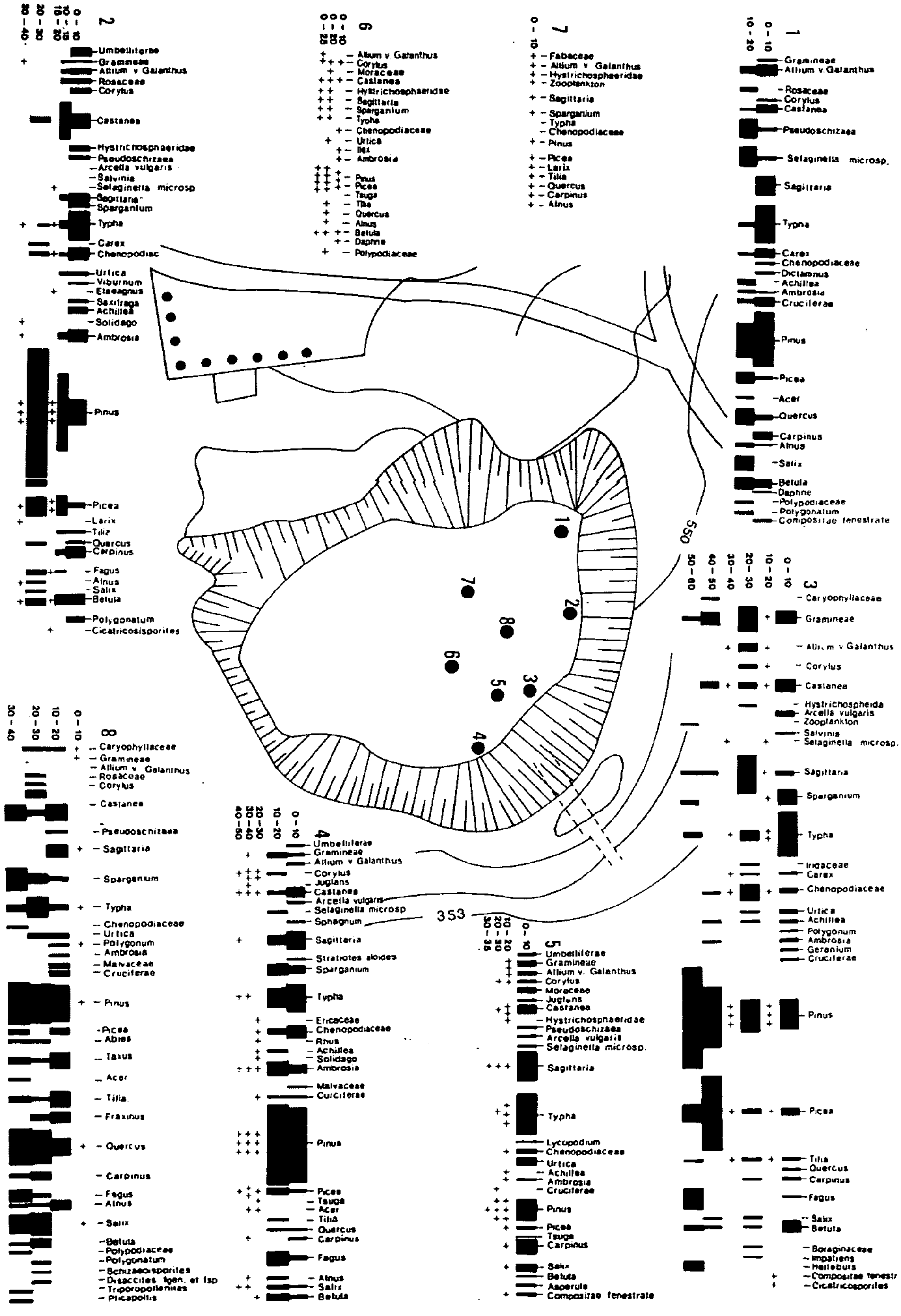

1
0 - 10
10 - 20
Gramineae
Allium v. Galanthus
Rosaceae
Corylus
Castanea
Pseudoschizaea
Selaginella microsp.
Sagittaria
Typha
Carex
Chenopodiaceae
Dictamnus
Achillea
Ambrosia
Cruciferae
Pinus
Picea
Acer
Quercus
Carpinus
Alnus
Salix
Betula
Daphne
Polypodiaceae
Polygonatum
Compositae fenestrate
2
0 - 10
10 - 20
20 - 30
30 - 40
Umbelliferae
Gramineae
Allium v. Galanthus
Rosaceae
Corylus
Castanea
Hystrichosphaeridae
Pseudoschizaea
Arcella vulgaris
Salvinia
Selaginella microsp
Sagittaria
Sparganium
Typha
Carex
Chenopodiac
Urtica
Viburnum
Elaeagnus
Saxifraga
Achillea
Solidago
Ambrosia
Pinus
Picea
Larix
Tilia
Quercus
Carpinus
Fagus
Alnus
Salix
Betula
Polygonatum
Cicatricosisporites
6
Allium v. Galanthus
Corylus
Moraceae
Castanea
Hystrichosphaeridae
Sagittaria
Sparganium
Typha
Chenopodiaceae
Urtica
Ilex
Ambrosia
Pinus
Picea
Tsuga
Tilia
Quercus
Alnus
Betula
Daphne
Polypodiaceae
7
0 - 10
Fabaceae
Allium v. Galanthus
Hystrichosphaeridae
Zooplankton
Sagittaria
Sparganium
Typha
Chenopodiaceae
Pinus
Picea
Larix
Tilia
Quercus
Carpinus
Alnus
550
353
3
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
Caryophyllaceae
Gramineae
Allium v Galanthus
Corylus
Castanea
Hystrichospheida
Arcella vulgaris
Zooplankton
Salvinia
Selaginella microsp.
Sagittaria
Sparganium
Typha
Iridaceae
Carex
Chenopodiaceae
Urtica
Achillea
Polygonum
Ambrosia
Geranium
Cruciferae
Pinus
Picea
Tilia
Quercus
Carpinus
Fagus
Salix
Betula
Boraginaceae
Impatiens
Helleburs
Compositae fenestr
Cicatricosporites
8
0 - 10
10 - 20
20 - 30
30 - 40
Caryophyllaceae
Gramineae
Allium v. Galanthus
Rosaceae
Corylus
Castanea
Pseudoschizaea
Sagittaria
Sparganium
Typha
Chenopodiaceae
Urtica
Polygonum
Ambrosia
Malvaceae
Cruciferae
Pinus
Picea
Abies
Taxus
Acer
Tilia
Fraxinus
Quercus
Carpinus
Fagus
Alnus
Salix
Betula
Polypodiaceae
Polygonatum
Schizaeoisporites
Disaccites Igen. et Isp.
Triporopollenites
Plicapollis
4
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
Umbelliferae
Gramineae
Allium v Galanthus
Corylus
Juglans
Castanea
Arcella vulgaris
Selaginella microsp
Sphagnum
Sagittaria
Stratiotes aloides
Sparganium
Typha
Ericaceae
Chenopodiaceae
Rhus
Achillea
Solidago
Ambrosia
Malvaceae
Cruciferae
Pinus
Picea
Tsuga
Acer
Tilia
Quercus
Carpinus
Fagus
Alnus
Salix
Betula
5
0 - 10
10 - 20
20 - 30
30 - 35
Umbelliferae
Gramineae
Allium v. Galanthus
Corylus
Moraceae
Juglans
Castanea
Hystrichosphaeridae
Pseudoschizaea
Arcella vulgaris
Selaginella microsp.
Sagittaria
Typha
Lycopodium
Chenopodiaceae
Urtica
Achillea
Ambrosia
Cruciferae
Pinus
Picea
Tsuga
Carpinus
Salix
Betula
Asperula
Compositae fenestrate

3.2. Plantes aquatiles ou littorales: *Salvinia, Sphagnum, Selaginella, Sagittaria, Stratiotes* cf. *aloides, Sparganium, Typha, Iridaceae, Carex, Ericaceae.*
3.3. Mauvaises herbes: *Chenopodiaceae, Ambrosia, Amaranthaceae, Urticaceae.*
3.4. Éléments des buissons de la végétation rupestre: *?Viburnum, Ilex, Dictamnus, Saxifraga, Achillea, Solidago, Geranium, Malvaceae, Cruciferae.*
3.5. Sapins: *Pinus, Picea, Abies, Tsuga, Larix-Pseudotsuga, Taxus.* Ici il y a lieu de souligner que la production et la dispersion des grains de pollen des sapins est extrémement grande. L'exine des pollens à ballonnets est relativement résistante. Le résultat est une surreprésentation. Pour ce problème voir par exemple l'étude de MARGUIER (1993).
3.6. Arbres feuillus: *Quercus, Carpinus, Fagus, Acer, Tilia, Fraxinus, Alnus, Salix, Betula.*
3.7. Pour la végétation de sous-bois: *Daphne, Impatiens, Polypodiaceae, Boraginaceae, Polygonatum, Asperula, Helleborus, Compositae* type fenestrate.
Formes remaniées: l'exemplaire de *Conodontes;* Sondage no: 5, 0–10 cm., *Schizaeaceae (Cicatricosisporites), Disaccites,* cf. *Plicapollis, Trudopollis* (Crétacé supérieur).

Discussion et Conclusions

Pour la palynologie des sédiments lacustres Quaternaires et Holocènes en Hongrie les travaux de ZÓLYOMI (1936, 1952, 1961, 1971, 1980, 1987), ZÓLYOMI et PRÉCSÉNYI (1985), ZÓLYOMI et E. NAGY (1992), et JÁRAI-KOMLÓDI (1966) sont fondamentaux. Nous avons aussi poursuivi des recherches sur les sédiments Holocènes avec une conception semblable (KEDVES et KÖRMÖCZI, 1985). En ce qui concerne nos résultats actuels nous pouvons souligner les faits suivants:

La préservation de la matière organique est hétérogène. Ce problème peut être étudié sur plusieurs niveaux, mais finalement on peut trouver la solution au niveau moléculaire.

Concernant la valeur taxonomique des spores et de grains de pollen, le caractère hétérogène est à souligner. Il y a des sporomorphes qui peuvent être caractéristiques aux espèces qui sont extrémement rares. La plus grande partie peut caractériser des genres, ou familles ou des catégories plus hautes, pour ce dernier les grains de pollens monosulqués sont à mentionner (*Cycadales, Ginkgoales, Palmales,* etc.).

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◂ Fig. 5.2.

Schéma de la piscine et de ses environs, avec les points des prélèvements et des résultats palynologiques.

Bibliographie

BARABÁS-STUHL, Á. (1975): Contribution to the biostratigraphy of the Upper Paleozoic in Transdanubia (W – Hungary). (Hungarian with English summary). – Földt. Közl. *105,* 320–334.

BARABÁS-STUHL, Á. (1981): Microflora of the Permian and Lower Triassic sediments of the Mecsek Mountains (South Hungary). – Acta Geol. Acad. Sci. Hung. *24,* 49–97.

BÓNA, J. (1966): Spores de *Lycopodiacées* dans le charbon liassique du Mecsek. – Acta Bot. Acad. Sci. Hung. *12,* 27–32.

BÓNA, J. (1969): Unterlias–Kohlenserie des Mecsek–Gebirges (Geologie). (Ungarisch, mit Deutsche Zusammenfassung). – Ann. Inst. Geol. Publ. Hung. *51,* 625–707.

BÓNA, J. (1983): Palynological studies on the Upper Triassic and Lower Liassic of the Mecsek Mountains. (Hungarian with English summary). – Discussiones Palaeontologicae *29,* 47–57.

CHRISTOPHER, R. A. (1976): Morphology and taxonomic status of *Pseudoschizaea* THIERGART and FRANTZ ex R. POTONIÉ emend. – Micropaleontology *22,* 143–150.

FÜLÖP, J. (1990): Magyarország geológiája. Paleozoikum I. – M.Á.F.I., Budapest.

GÓCZÁN, F. (1956): A komlói liász feketekőszéntelepek azonosítására irányuló pollenanalitikai (palynológiai) vizsgálatok. – M.Á.F.I. Évk. *45,* 135–212.

GREGUSS, P. (1961): Permische fossile Hölzer aus Ungarn. – Palaeontographica B, *109,* 131–146.

GREGUSS, P. (1967): Fossil Gymnosperm Woods in Hungary from the Permian to the Pliocene. – Akadémiai Kiadó, Budapest.

HEER, O. (1877): Pécs vidékén előforduló permi növényekről. – M. Kir. Földt. Int. Évk. *5,* 1–16.

HORVÁTH, A. O. (1954): A Mecsek növénytakarója, a növényföldrajzi elemek és a hegyépítő kőzetek kapcsolata. – Földr. Közl. *2,* 153–162.

HORVÁTH, A. O. (1957): Mecseki tölgyesek erdőtípusai. – Jan. Pann. Múz. Évk., Pécs, 1956, 131–139.

HORVÁTH, A. O. (1958): Mecseki gyertyános-tölgyesek erdőtípusai. – Jan. Pann. Múz. Évk., Pécs, 1957, 137–154.

HORVÁTH, A. O. (1959): A mecseki bükkösök erdőtípusai. – Jan. Pann. Múz. Évk., Pécs, 1958, 31–48.

JÁRAI-KOMLÓDI, M. (1966): Études palynologiques des couches de la dernière époque glaciaire (Brorup, Pléniglaciaire) de la Grande Plaine Hongroise. – Pollen et Spores *8,* 479–496.

KEDVES, M. (1977): Contribution de l'ornamentation en stries concentriques à la connaissance des microfossiles. – Pollen et Spores *19,* 407–414.

KEDVES, M. et KÖRMÖCZI, L. (1985): Sur les problèmes de conservation des sporomorphes dans des conditions différentes. – An. Asoc. Palinol. Leng. Esp. *2,* 263–271.

MARGUIER, S. (1993): Mode de dépôt des pollens dans les lacs du Jura: Etude du sédiment superficiel et du seston. – APLF XIII^{e} Symposium, Livret–guide de l'excursion *1,* 153–158.

PRISZTER, SZ. és BORHIDI, A. (1967): A mecseki flórajárás (*Sopianicum*) flórájához. I. – Bot. Közl. *54,* 149–164.

ROSSIGNOL, M. (1962): Analyse pollinique de sédiments marins quaternaires en Israël. II. – Sédiments pléistocènes. – Pollen et Spores *4,* 121–148.

ROSSIGNOL, M. (1964): *Hystrichosphéres* du Quaternaire en Méditerranée orientale, dans les sédiments pléistocènes et les boues marines actuelle. – Rev. Micropal. *7,* 83–99.

SIMONCSICS, P. (1955): Verkieselte permische Stammreste von dem Mecsek-Gebirge. – Acta Biol. Szeged. *1,* 46–62.

THIERGART, F. and FRANTZ, U. (1962): Some spores and pollen grains from a Tertiary brown coal deposits in Kashmir. – Palaeobotanist *10,* 84–86.

TUZSON, J. (1906): A balatoni fosszilis fák monográfiája. – Balaton Tud. Tanulmányozásának Eredményei *1,* 3–55.

WOLFF, V. H. (1934): Mikrofossilien des pliozänen Humodils der Grube Freigericht bei Dettingen a. M. und Vergleich mit älteren Schichten der Tertiärs sowie posttertiären Ablagerungen. – Inst. Paläobot. Petrogr. Brennsteine *5,* 55–101.

ZÓLYOMI, B. (1936): Tízezer év története virágporszemekben. – Természettud. Közl. *68,* 504–516.

ZÓLYOMI, B. (1952): Magyarország növénytakarójának fejlődéstörténete az utolsó jégkorszaktól. – MTA Biol. Oszt. Közl. *1,* 491–530.

ZÓLYOMI, B. (1961): Virágpor vizsgálatok a Balaton feliszaposodásáról. In: K. SZESZTAY: A Keszthelyi öböl feliszaposodása. VITUKI, Budapest, Map 7.

ZÓLYOMI, B. (1971): 6000 jährige Geschichte der Agrikultur in der Umgebung des Balaton-See auf Grund von pollenstatistischen Untersuchungen der Sedimenten. – IIème Congr. Internat. des Musées d'Agricultur, Budapest, Résumés, 194–195.

ZÓLYOMI, B. (1980): Landwirtschaftliche Kultur und Wandlung der Vegetation im Balaton. – Phytoecologia *7*, 121–126.

ZÓLYOMI, B. (1987): Degree and rate of sedimentation in Lake Balaton. In: M. PÉCSI: Pleistocène environment in Hungary. – Contribution of the INQUA Hungarian National Committee of the XIIth INQUA Congress, Ottawa, Canada, 57–79.

ZÓLYOMI, B. és NAGY, LÁSZLÓNÉ (1992): A Balaton múltja a pollensztratigráfiai vizsgálatok tükrében. – 100 Éves a Balaton–Kutatás, 25–32.

ZÓLYOMI, B. und PRÉCSÉNYI, I. (1985): Pollenstatistische Analyse der Teichablagerungen des "mittelalterlichen" Klosters bei Pilisszentkereszt. Vergleich mit dem Grundprofil des Balaton. – Acta Archaeol. Acad. Sci. Hung. *37*, 153–158.

6. COMPUTER MODELLING OF THE QUASI-CRYSTALLOID BIOPOLYMER STRUCTURE I.

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Abstract

The necessity of using computer modelling for the metastable quasi-crystalloid biopolymer skeleton and its stabilizing molecular system was evident. The computer program was elaborated by the second author based on the TEM data of the partially degraded plant cell walls, and the results of the previous two- and three-dimensional modelling. During the modelling, the following were taken into consideration: 1. The quasi-crystalloid skeleton of the basic dodecahedron units. 2. The points of symmetry of the edges. 3. The points of symmetry of the centre of the regular pentagonal planes. 4. The centre of the dodecahedron. 5. The cavities and/or frustrations (sensu NELSON, 1986), of the metastable quasi-crystalloid skeleton, which are filled by the stabilizing molecular structure. Several, different kinds of modellings have been made so far. In this paper we present four examples. This method seems to be a very useful addition to interpret more precisely our TEM pictures of the partialy degraded plant cell walls, and moreover, it guarantees such opportunities in this field of research which are not possible to do by any other, previousy applied method.

Key words: Plant cell wall, biopolymer system, computer modelling.

Introduction

In the previous number of Plant Cell Biology and Development, which was dedicated to the Tenth Anniversary of the Discovery of The Quasicrystals, an attempt was made to sketch the extreme diversity of the investigations on this subject including the very rapid increasing of publications. On the other hand, a short summary was compiled from the most important results of the laboratory (M. KEDVES, 1994) to attitude the effect of the discovery on rapidly cooled AlMn alloys to Cell Biology.

The quasi-crystalloid biopolymer skeleton of the plant cell wall was first observed on partially degraded pollen grains (*Pinus griffithii* MCCLELL). By the way of the modified MARKHAM rotation method, the PENROSE unit was discovered in 1988 (M. KEDVES). Later a number of two-dimensional models and methods were elaborated, the last one can be seen in this number, M. KEDVES, TÓTH and VÉR (1995). For the better understanding of the metastable skeleton, three-dimensional modelling was also started (M. KEDVES, 1991, 1992, M. KEDVES, TÓTH and FARKAS, 1993). All of these methods are useful to interpret our TEM pictures about the metastable quasi-crystalloid skeleton better.

But the holes or the frustrations (sensu NELSON, 1986) which are filled with the stabilizing molecular system cannot be modelled with methods discussed previously. Regarding the stabilizing molecular system, we have had only one TEM data so far, which we tried to interpret better with the two-dimensional modelling method (cf. M. KEDVES and TÓTH, 1994). Our up-to-date methods are useful to dissolve stabilizing biopolymer structures, but the opposite method, namely the degradation or the dissolution of quasi-crystalloid skeletons is not yet elaborated. Moreover, the three-dimensional modelling of the stabilizing biopolymer system was not accomplished with all of the methods used previously. In this way the computer method seems to be a unique one for the modelling of the stabilizing biopolymer system.

The aim of this first paper is the following:

1. To elaborate and/or give the definition of the basic methodological principles, on the basis of our up-to-date knowledge about biopolymer structures of the sporoderm in angstroem dimension.

2. To present some selected data of our new results concerning this subject, from the point of view of demonstrating the advantages and the opportunities of this method.

Method

As it has been established with the first results, the basic quasi-crystalloid biopolymer unit is a regular pentagon in angstroem dimension; 8–18–22 Å. The further step of organization of the metastable skeleton is the pentagon dodecahedron unit composed of 12 pentagons. The PENROSE-I biopolymer unit (cf. M. KEDVES, 1991, 1992) is composed of a "central" dodecahedron and all its planes are connected with the surrounding further dodecahedrons. This skeleton can be investigated from two basic points of view, as follows.

A = the three-dimensional picture seen in M. KEDVES 1992, Plate 5.4., 1, p. 75: "Quasi-periodic view of the PENROSE-I skeleton. The contour is pentagonal." In the middle there is a plane of a regular pentagon.

B = the three-dimensional picture seen in M. KEDVES 1992, Plate 5.4., 2, p. 75: "The contour is hexagonal, and no central regular pentagon in the centre." In the centrum of the overview, there are three frustrations of an oblique triangle, surrounded with three regular pentagons.

The following characteristics were taken into consideration so far:

1. The quasi-crystalloid skeleton, PENROSE units, or network. Within this, two kinds of methods;

1.1. The complete network of the skeleton, for example, Text-fig. 6.1.

1.2. One side – more or less – the half of the surface (Text-fig. 6.3.).

2. The edges of the regular pentagonal planes (Text-fig. 6.2.).

3. The centrum of the planes of the regular pentagon (Text-fig. 6.2.).

4. The centrum of the pentagon dodecahedron (Text-fig. 6.1.).

5. The holes, and/or the frustrations (sensu NELSON, 1986) of the metastable quasi-crystalloid network.

We need to emphasize that the opportunities of computer modelling are extremely large, we may say endless. We have made several further models which will be published in further papers. But all our models are connected to our TEM data on partially degraded plant cell walls.

Results

THE COMPLETE QUASI-CRYSTALLOID SKELETON OF THE PENROSE-I UNIT, TOGETHER WITH THREE KINDS OF POINTS OF SYMMETRY (Text-fig. 6.1., A, B)

In the centrum there are three central stabilizing units, on the same axis (Text-fig. 6.1., A). Four pentagons in opposite positions are surrounding the centrum. This part is followed by five areas of ten edges. The ten central points of symmetry of the surrounding dodecahedrons are on two "circles". The inner five are touching the fourth ten-angle, the outer ones are near one another on five edges of the outer zone of the angles. All of these units can represent the inner or the central part of the quasi-crystalloid biopolymer system. Within this, the disposition of the three kinds of points of symmetry is interesting.

In the centrum of our figure (Text-fig. 6.1., A) there is a symbol for the centrum of the pentagonal plane, it represents six ones on the same axis. The larger one, the centrum of the dodecahedron represents three ones on the same axis. In this way this centrum is peculiar, we may be say heterogeneous. On the basis of the disposition of the points of symmetry of the edges further areas may be distinguished:

1. Three pentagons on each edge with points of symmetry.
2. Two kinds of radial arrangements.
2.1. One is linear until the point of symmetry of the inner central unit of the surrounding dodecahedron.
2.2. The linear arrangement is broken with clusters of four points of symmetry of the edges.

Text–fig. 6.1. ▸

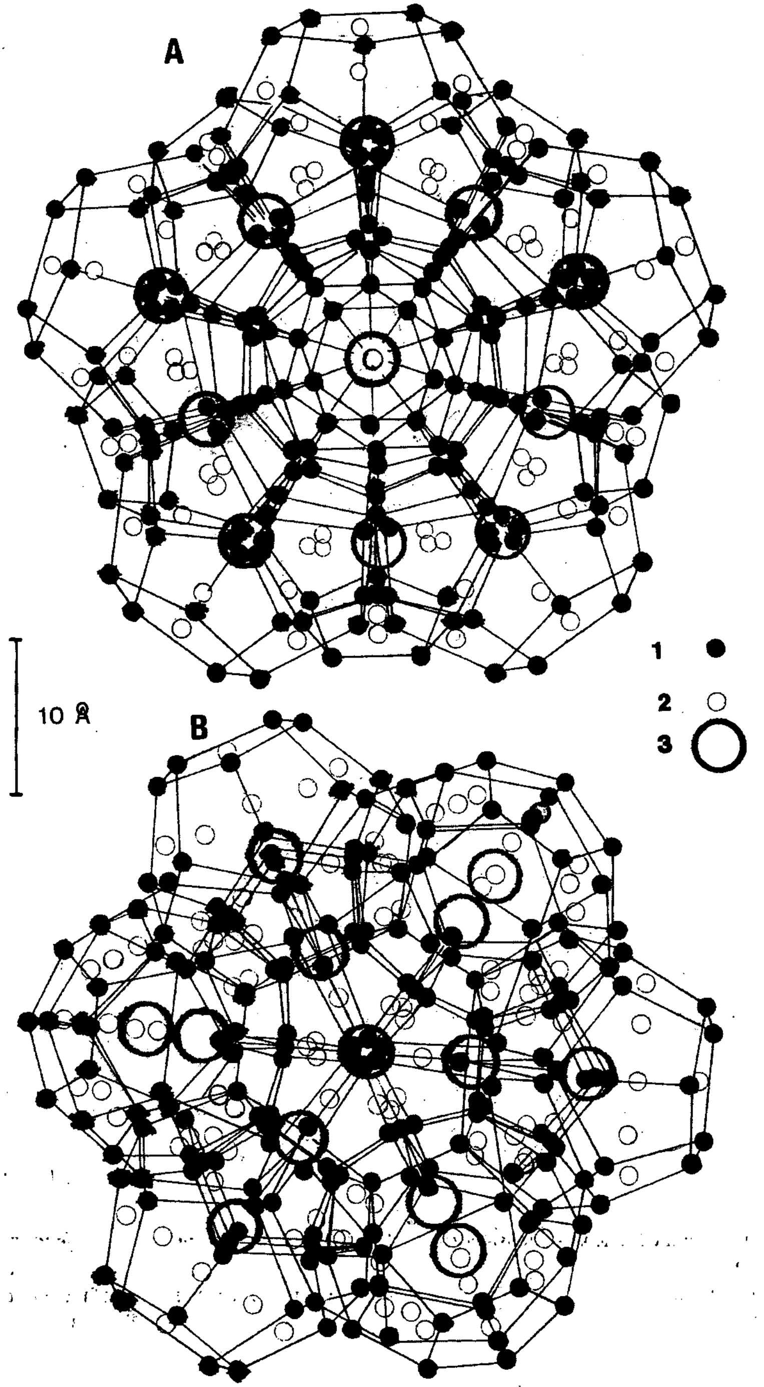
Computer model of the PENROSE–I quasi–crystalloid skeleton in two basic views; A = The PENROSE–I type skeleton is placed on one plane of one dodecahedron. On the basis there are five points of symmetry (edges) of the same dodecahedron unit. B = The PENROSE-I skeleton is placed on three sides of three dodecahedron units. On the basis there are three times two points of symmetry (edges of three dodecahedron units).

Legends:

1 - points of symmetry of the edges of the pentagon dodecahedron unit,

2 - the centres of the regular pentagon planes,

3 - the centrum of the pentagon dodecahedron unit.


A
10 Å
B
1
2
3

Further, outer points of symmetry of the edges are more or less on the axis of the central units of the surrounding dodecahedrons. On the basis of this arrangement, two kinds may also be distinguished:

1. Five points of symmetry are "inside" of the central unit, or better say near the perpendicular axis of the PENROSE-I type skeleton.
2. Three points of symmetry of the edges are in this kind of arrangement.

The modelled biopolymer system bordered with the ten central units of the surrounding pentagon dodecahedron, forming a not so characteristic TICOS polyhedra, represents another large biopolymer system. The outest region forms another peculiar TICOS polyhedra, but these units can be characterized only with the points of symmetry of the edges and/or with the centres of the pentagon planes.

Aspect "B" (Text-fig. 6.1., B) is quite different, which can be characterized by three or hexaradiate symmetries. The triangles of the hexaradiate system are also heterogeneous on the basis of the disposition of all kinds of points of symmetry.

It is also interesting, that the more or less concentric areas are not so characteristic in contrast to the previous aspect. This view may be characterized with the accumulation of the points of symmetry of the edges and planes of the surrounding dodecahedrons. From this point of view, three of them are extremely characteristic.

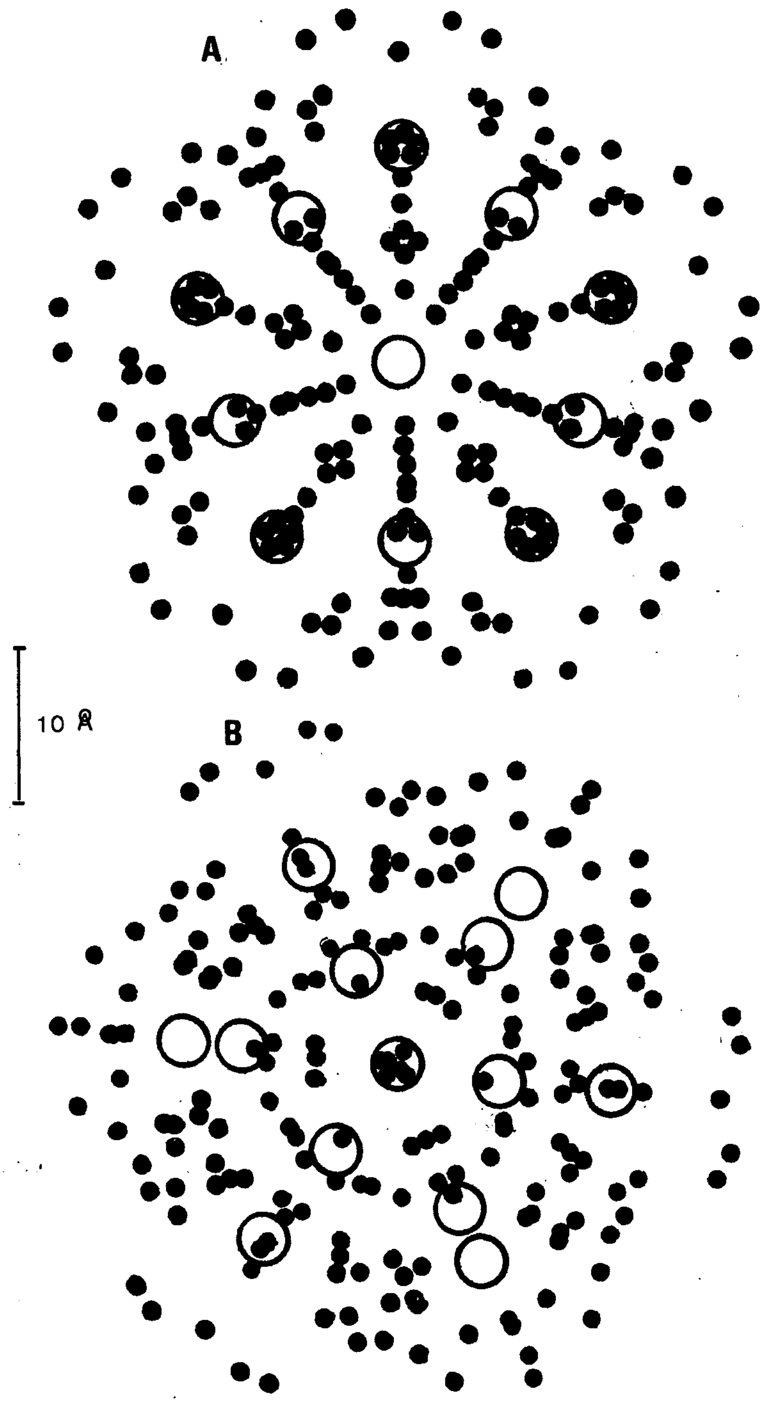
COMPUTER MODELLING OF TWO KINDS OF POINTS OF SYMMETRY OF THE PENROSE-I UNIT WITHOUT THE NETWORK OF THE SKELETON (Text-fig. 6.2., A, B)

At this modelling an attempt was made for the better understanding of the points of symmetry of our TEM pictures of the biopolymer systems after partial degradation and the modified MARKHAM rotation method. Taking the previous results into consideration, the quasi-crystalloid skeleton was omitted, and the arrangement of the points of symmetry of the centre of the dodecahedrons and those of the edges were illustrated from the two usual views.

Text-fig. 6.2., A. – Around the central units, ten points of symmetry of the edges are forming a pentagon. To this cf. the picture of Plate 4.1., fig. 3, C.P.5.A.5.5. of the biopolymer no V (M. KEDVES, TÓTH and VÉR, 1995, in this number). The pentagon mentioned above is followed by another larger one, in the same direction. The peculiarity of this pentagon is that on the edges there are clusters of points of symmetry composed of four points of edges. The outest pentagon together with the previous one forms a peculiar TICOS polyhedra. At the edges there are the points of symmetry of the centres of the surrounding polyhedrons, with five points of

Text–fig. 6.2. ►

Computer model of two kinds of points of symmetry of the PENROSE–I type quasi–crystalloid biopolymer unit, without network. The points of symmetry of the centrums and the edges of the dodecahedron units are illustrated here.


A
10 Å
B

symmetry of the edges. The opposite pentagon is "connected" with 2+1 points of symmetry of the edges.

Regarding the outest areas, they are as it was discussed previously.

Text-fig. 6.2., B. – This view is interesting from the point of view of the investigated points of symmetry. A well defined area of a shape of a triangle with convex sides is well illustrated. The peculiarity of this view is the clusters of three points of symmetry of the edges, in 2+1+2 arrangement. In this position they are nearly extra-areal.

SURFACE MODELLING OF THE PENROSE-I TYPE BIOPOLYMER UNIT (Text-fig. 6.3., A, B)

The superficial elements are modelled only, in this way without inner points of symmetry, namely without the centres of the dodecahedron.

From the point of view of Text-fig. 6.3., A, the following is well illustrated:

1. The frustrations between the central and the surrounding dodecahedron units.
2. Interesting clusters composed of three points of symmetry of the edges are characteristic, forming further pentagons. The edges of the outest, third pentagon are composed of two points of symmetry of edges, and one point of the centrum of the plane.
3. The outest areas are identical with the previous ones, cf. Text-fig. 6.1., A.

View "B" (Text-fig. 6.3., B) illustrates the shape of the frustrations between the dodecahedron units in the first place. The triangular "central" hole system is connected to three "V" shape holes.

ATTEMPT FOR THE MODELLING OF THE STABILIZING BIOPOLYMER SYSTEM OF THE QUASI-CRYSTALLOID SKELETON (Text-fig. 6.4., A, B)

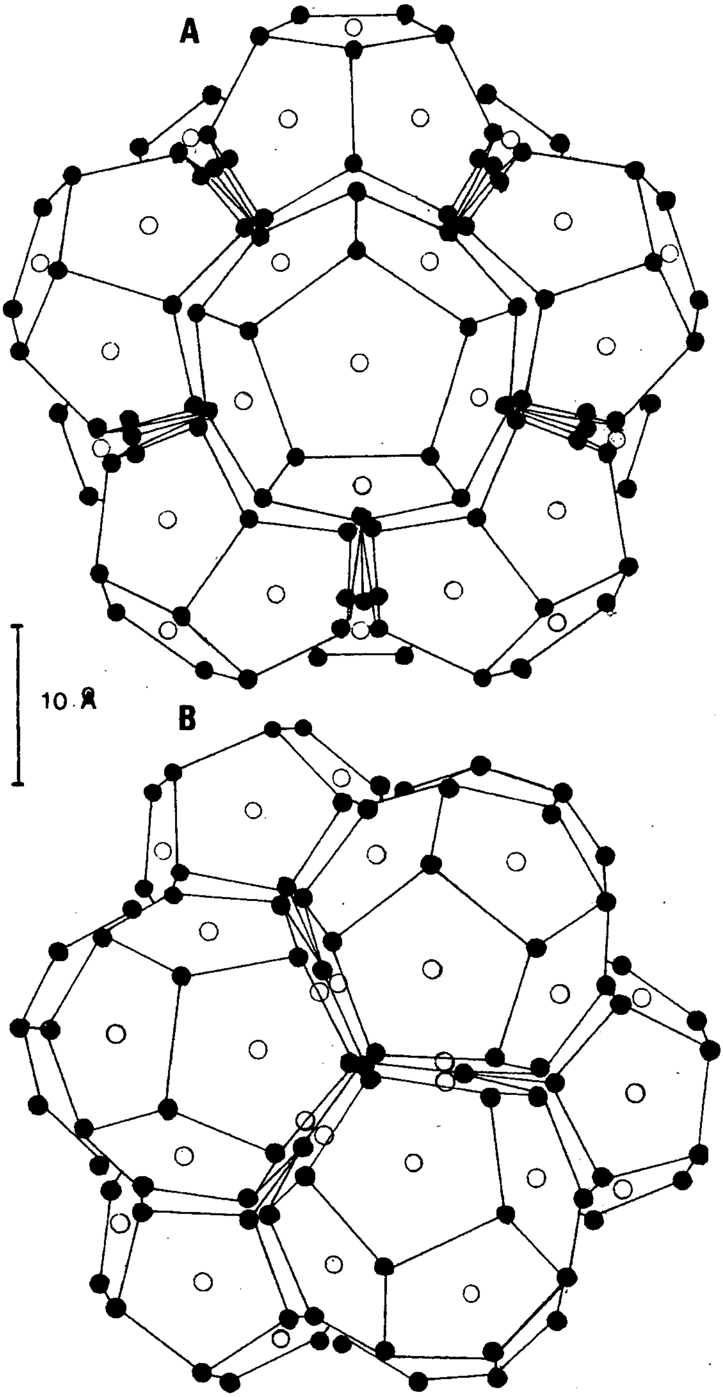
The starting points of this modelling were the frustrations and holes of the quasi-crystalloid PENROSE-I unit, and the centres of the dodecahedrons of the biopolymer skeleton.

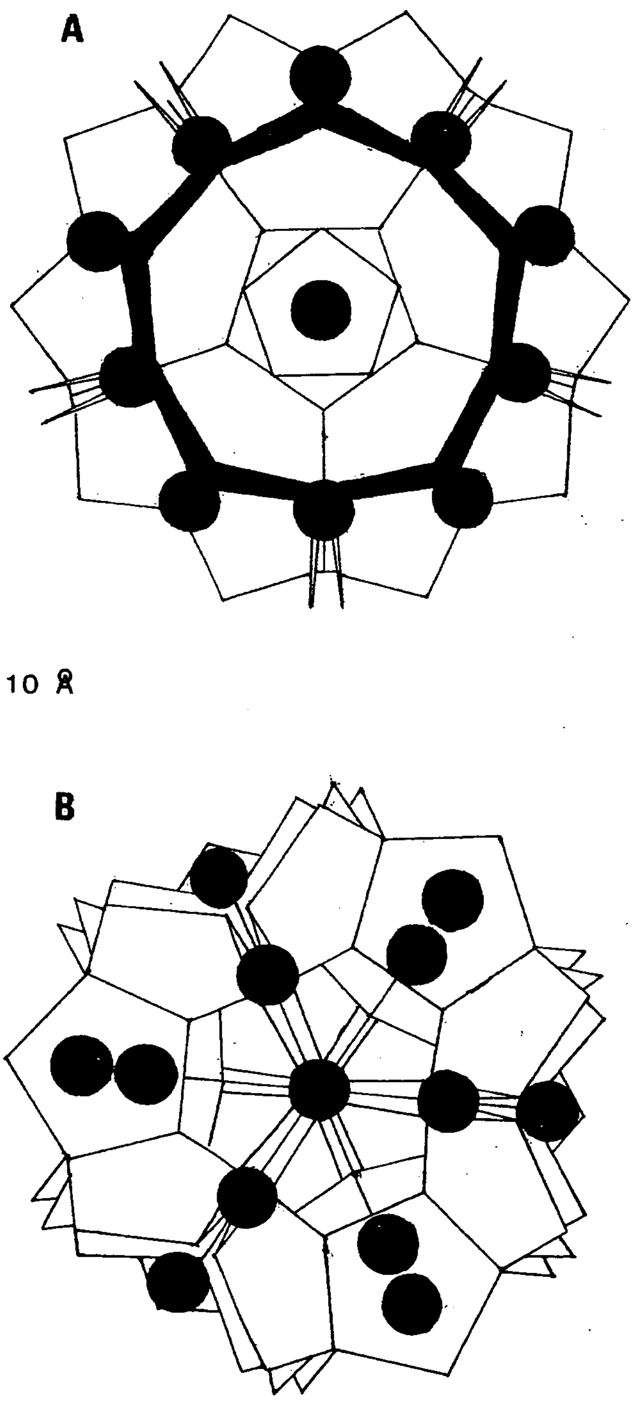
View "A" illustrates well that the central stabilizing unit is surrounded with a more or less circular ring really with a ten-edged shape in sectional view. Two times five points of symmetry of the centrums of the surrounding dodecahedrons are connected seemingly to this system. Such configurations may be seen at the TEM pictures, too.

View "B" seems to be very useful in the interpretation of our TEM pictures, because depending on the position, the settlements of the biopolymer units can be changed.

Text-fig. 6.3. ►

Computer model of the two basic views of the PENROSE-I unit from above. The superficial networks, together with the so-called superficial points of symmetry – the edges, and the centrums of the regular pentagon planes are illustrated here.


A
10 Å
B


A
10 Å
B

Discussion and Conclusions

As it has been emphasized several times, chemistry and the biopolymer organization of the plant cell wall, particularly of the sporoderm, are much more complicated than they were believed to be some years ago. It is necessary to repeat it again and again that the sporopollenin is not a "uniform biopolymer", but extremely heterogeneous, and its composition is alternating and not constant.

The quasi-crystalloid metastable skeleton, and its stabilizing molecular system concept is one way of interpreting and trying to understand this extremely complex molecular organization.

Now we have another method, and we will use the opportunities of this method to understand and know this complex system better. Here we have presented selected basic results from our models and further ones will follow them. We hope that this contribution is a step worth mentioning in the knowledge about this problem.

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References

KEDVES, L. (1994): Kvázikrisztalloid rendszerek számítógépes modellezése. – Diploma dolgozat, JATE, Szeged.

KEDVES, M. (1988): Quasi-crystalloid basic molecular structure of the sporoderm. – 7 Internat. Palynol. Congr., Brisbane, Abstracts, 82.

KEDVES, M. (1991): Three dimensional modelling of the biopolymer structure of the plant cell wall I. – Plant Cell Biology and Development (Szeged) *2*, 63–74.

KEDVES, M. (1992): Three dimensional modelling of the biopolymer structure of the plant cell wall II. – Plant Cell Biology and Development (Szeged) *3*, 67–87.

KEDVES, M. (1994): To the tenth anniversary of the discovery of quasicrystals. – Plant Cell Biology and Development (Szeged) *5*, 9–10.

KEDVES, M. et TÓTH, A. (1994): Premiers résultats du système de biopolymère stabilisateur du squelette quasi-cristalloïde de l'exine. – Plant Cell Biology and Development (Szeged) *5*, 79–86.

KEDVES, M., TÓTH, A. and FARKAS, E. (1993): An experimental investigation of the biopolymer organization of both recent and fossil sporoderms. – Grana Suppl. *1*, 40–48.

KEDVES, M., TÓTH, A. and VÉR, A. (1995): Radial fivefold rotation: A new method in the study of the biopolymer organization of the sporoderm. – Plant Cell Biology and Development (Szeged) *6*, 44–59.

NELSON, D. R. (1986): Quasicrystals. – Scientific American *254*, 42–51.

◄ Text–fig. 6.4.

Computer model of the stabilizing biopolymer system of the metastable quasi–crystalloid skeleton, PENROSE–I type unit. The centres of the dodecahedron and the so–called frustrations (sensu NELSON, 1986) are illustrated here. The more or less circular unit of view "A" has been emphasized.

7. LIST OF PUBLICATION OF THE LABORATORY UNTIL DECEMBER 1994

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Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the J. A. University, H–6701, P. O. Box 657, Szeged, Hungary

ALVAREZ RAMIS, C., KEDVES, M. – FERNÁNDEZ MARRÓN, T. (1994): Consideraciones en torno a las asociaciones esporopolinicas del Cretacico superior del Cerro de La Mesa (Guadalix de La Sierra, Madrid). – Plant Cell Biology and Development (Szeged) *5,* 42–51.

GOTTL, E. (1993a): The thermal alterations of the pollen grains of *Viscum album* L. (*Loranthaceae,* s. str. *Viscaceae*). Short communication. – Plant Cell Biology and Development (Szeged) *4,* 74–77.

GOTTL, E. (1993b): List of publication of M. Kedves I. – Plant Cell Biology and Development (Szeged) *4,* 81–88.

GOTTL, E. (1994): List of publication of M. Kedves II. – Plant Cell Biology and Development (Szeged) *5,* 87–99.

JELEN, B., BREZIGAR, A., BUSER, S., CIMERMAN, F., DROBNE, K., MONOSTORI, M., KEDVES, M., PAVLOVEC, R., PAVŠIČ, J. – SKABERNE, D. (1994): Razrešavanje problema stratigrafije Oligocena in spodnjega Miocena v Sloveniji. – Rudarsko-Metalurški Zbornik *33,* Abstracts, 11th Slovenian Geol. Meeting, Ljubljana 17–18.

JELEN, B., KEDVES, M., SKABERNE, D., BREZIGAR, A., BUSER, S., CIMERMAN, F., DROBNE, K., MONOSTORI, M., PAVLOVEC, R. – PAVŠIČ, J. (1994): Dorog type (Middle Eocene) spore-pollen assemblage in the Socka Beds of Slovenia I. – Plant Cell Biology and Development (Szeged) *5,* 20–28.

KEDVES, M. (1993): Plant microfossils from the Jurassic manganese ore layers of Úrkút, Hungary. – Plant Cell Biology and Development (Szeged) *4,* 11–21.

KEDVES, M. (1994a): Transmission electron microscopy of the fossil *gymnosperm* exines. – Szeged.

KEDVES, M. (1994b): To the tenth anniversary of the discovery of quasicrystals. – Plant Cell Biology and Development (Szeged) *5,* 9–10.

KEDVES, M. (1994c): Plant microfossils from the Upper Cretaceous and Lower Tertiary layers of Northern Spain I. – Plant Cell Biology and Development (Szeged) *5,* 29–41.

KEDVES, M. (1994d): Effect of the high temperature on the spores and pollen grains. – In: Polen y esporas: Contribucion a su conocimiento ed.: I. LA SERNA RAMOS. – VIII Simposio de Palinologia (A.P.L.E.), Ser. Inf. *35,* 63–69.

KEDVES, M. (1994e): Paléophytogéographie du Crétacé supérieur de l'Afrique sur base de données palynologiques. – 2ème Symp. Palynol. Africaine, résumés.

KEDVES, M., ALVAREZ RAMIS, C. – FERNÁNDEZ MARRÓN, M. T. (1993): Sobre pólenes breviaxones procedentes del Cretácico superior del Borde Sur de la Sierra de Guadarrama (Provincia de Madrid, España). – Plant Cell Biology and Development (Szeged) *4,* 22–25.

KEDVES, M. – BAGI, I. (1993): Études palynologiques et pédologiques sur les sédiments holocènes de la piscine du Monastère du Mont Jakab. – APLF XIII[e] Symposium "Homme – Milieu Palynologie et Evénements Cycliques", Besançon, programme et résumés, 56.

KEDVES, M. – GÁSPÁR, I. (1994a): Chronicle. – Plant Cell Biology and Development (Szeged) *5,* 101–102.

KEDVES, M. – GÁSPÁR, I. (1994b): Les altérations secondaires des spores et des grains de pollen dissous partiellement. – X Simposio de Palinologia A.P.L.E., Valencia, programa y resúmenes, 53.

KEDVES, M. – GÁSPÁR, I. (1994c): Les altérations sécondaires des spores et des grains de pollen dissous partiellement. – Trabajos de Palinología Básica y Aplicada X Simposio de palinología (A.P.L.E.), Univ. deValencia, 153–161.

KEDVES, M. – GÁSPÁR, I. (1994d): Altérations sécondaires de certain sporomorphes sous l'influence des rayon X. – 2ème Symp. Palynol. Africaine, résumés.

KEDVES, M. – KINCSEK, I. (1993): Biopolymer organization of the wall of the fossil spores and pollen grains. – Plant Cell Biology and Development (Szeged) *4*, 26–33.

KEDVES, M. – PÁRDUTZ, Á. (1993): Negative quasi-crystalloid biopolymer network from the exospore of *Equisetum arvense* L. Short communication. – Plant Cell Biology and Development (Szeged) *4*, 78–80.

KEDVES, M. – ROJIK, I. (1993): Biopolymer organization of the exine of *Juniperus virginiana* L., and *Taxus baccata* L. – Plant Cell Biology and Development (Szeged) *4*, 49–63.

KEDVES, M. – ROJIK, I. (1994a): TEM study of the "infected" pollen grains of *Thalictrum flavum* L. with *Gliocladium roseum* (LINK) BAINIER. Short communication. – Plant Cell Biology and Development (Szeged) *5*, 52–57.

KEDVES, M. – ROJIK, I. (1994b): Buckminsterfullerene-like biopolymer units from the exine of *Thalictrum flavum* L. – Plant Cell Biology and Development (Szeged) *5*, 58–66.

KEDVES, M. – TÓTH, A. (1993): High temperature effect on the spores of *Ustilago maydis* (DE CANDOLLE) CORDA. – Plant Cell Biology and Development (Szeged) *4*, 34–48.

KEDVES, M. – TÓTH, A. (1994): Premiers résultats du système de biopolymère stabilisateur du squelette quasi-cristalloïde de l'exine. – Plant Cell Biology and Development (Szeged) *5*, 79–86.

KEDVES, M., TÓTH, A. – FARKAS, E. (1993): An experimental investigation of the biopolymer organization of both recent and fossil sporoderms. – Grana Suppl. *1*, 40–48.

KEDVES, M., TÓTH, A. – GOTTL, E. (1994): Incomplete and non–fivefold rotation of the basic biopolymer unit of the exine of *Pinus griffithii* MCCLELL. – Plant Cell Biology and Development (Szeged) *5*, 67–78.

KEDVES, M., TÓTH, A., MÉSZÁROS, K., BORBOLA, A. – AILER, P. (1993): Recent modelling of the major evolutionary degrees of early *angiosperm* pollen types. – Plant Cell Biology and Development (Szeged) *4*, 64–73.

KEDVES, M., TÓTH, A. – VÉR, A. (1993): Radial fivefold rotation: A new method in the study of the biopolymer organization of the sporoderm. – XV Int. Bot. Congr. Yokohama, Abstracts, 28.

SAJGÓ, CS., HETÉNYI, M. – KEDVES, M. (1993): Palynology and organic geochemistry of Tertiary low-rank coals in Hungary – II. Non-aromatic hydrocarbons. – Organic Geochemistry, Poster sessions from the 16th Int. Meeting on Organic Geochemistry, Stavanger, 335–338.

VÉR, A. (1994): LM investigations of different stained fossil *Botryococcus* colonies. – Plant Cell Biology and Development (Szeged) *5*, 11–19.

Chronicle

Compiled by

I. GÁSPÁR

Visiting scientists

Dr. D. CERCEAU (Equipe COUSTEAU, Paris) made a short visit in our laboratory on 10th September 1994.

Dr. B. JELEN, Senior Research Associate (Geological Survey of Ljubljana, Institute for Geology, Geotechnics and Geophysics, Ljubljana, Republic of Slovenia) stayed in the laboratory from 18th to 23th December 1994. The purpose of his visit was to complete a new paper on the results of the joint research program on Eocene spore-pollen assemblages in Slovenia.

International laboratory activities

1–6 August, 1994 – Ljubljana

Dr. M. KEDVES spent a week with Dr. B. JELEN in Slovenia and Italy collecting samples from Mesozoic and Lower Tertiary (K–T boundary) sediments, for further joint research programs. In this work they were accompanied by many scientists such as Dr. S. BUSER, University Professor (Department of Geology and Paleontology, University of Ljubljana, Ljubljana, Slovenia) and Dr. F. CIMERMAN, Research Adviser (Paleontological Institute Ivan Rakovec, ZRCSAZU, Ljubljana, Slovenia) and Dr. K. DROBNE, Head of Paleontological Institute (Paleontological Institute Ivan Rakovec, ZRCSAZU, Ljubljana, Slovenia) as well as Dr. M. CAFFAU (Istituto di Geologia e Paleontologia, Universitá di Trieste, Trieste, Italy).

16–23 September, 1994 – Valencia

The Xth A.P.L.E. Symposium "Trabajos de Palinologia básica y aplicada, Valencia, 19–22 September, 1994, Spain. Dr. M. KEDVES took part in the Symposium, and presented the following paper:

KEDVES, M. et GÁSPÁR, I.: Les altérations sécondaires des spores et des grains de pollen dissous partiellement.

24 September, 1994 – Barcelona

Dr. M. KEDVES visited Prof. Dr. N. SOLÉ DE PORTA (Departament de Geologia Dinámica, Geofisica i Paleontologia, Facultad de Geologia, Zona Universitaria de Pedralbes, Barcelona). They planned a joint research program dealing with the spore-pollen assemblages of Eocene layers from Malagá paying special attention to pollen grains of certain palms.

Hungarian scientific activities

9th May, 1994 – Szeged

Statutory Meeting of the Symmetry Workshop (Szeged).

KEDVES, M.: A multidiszciplináris kutatások jelentősége. A határkérdés.

Laboratory meetings

21.2.1994, speaker: KEDVES, M.: Discussion of the up-to-date research programs of the laboratory.

26.3.1994, speaker: KEDVES, M.: Preparation of the present number of Plant Cell Biology and Development dedicated to the memory of Prof. Dr. G. ANDREÁNSZ-KY.

2.10.1994, speaker: KEDVES, M.: Report on the Xth Symposium of the A.P.L.E., Valencia, "Trabajos de Palinologia básica y aplicada", 19–22 September 1994, Valencia, Spain. Research work schedule for this semester.

25.11.1994, speaker: KEDVES, M.: Project of the participation in international scientific programs in 1995.

9.12.1994, speaker: GÁSPÁR, I.: The plans of his thesis and report of its bibliographical data.

Teaching program of the laboratory

During the first semester in 1994 the following lectures were delivered:

1. Introduction to the plant micropaleontology of pre-Quaternary deposits, 1+2 hours weekly.
2. Organization levels of the biopolymer system of the plant cell wall, 1+2 hours weekly.
3. Basics of the Supernova Theory, 1 lecture weekly.

In the second semester in 1994 the following lectures were delivered:

1. Organization and symmetry of biopolymer systems, 1+2 hours weekly.
2. Basic and applied palynology, 2+2 hours weekly.
3. Theory of evolution and its natural phylosophical relations, 1 lecture weekly.

Personalia

A. VÉR is a collaborator in our laboratory. She wrote her thesis here a year ago. Later she got a post in Barcs as a secondary school teacher, besides she attended a university postgraduate course on Environmental Protection. In November 1994 she was married.

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