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MONOLETE SPORES OF SCHIZAEACEAE FROM HUNGARIAN ALBIAN DEPOSITS

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Abstract

The author studied monolete spores with striate, foveolate, foveo-reticulate and verrucate sculpture coming from Albian deposits of the Transdanubian Central Mountains. Among the 13 species separated out were seven *Corniculatisporites* sp., four *Microfoveolatosporis* sp., one *Cicatricososporites* sp., and one *Verrucatosporites* species representatives. Three new *Microfoveolatosporis* species are proposed, and four new name combinations are suggested.

All of the examined spores fell into the family Schizaeaceae of the Schizaeales order. It may be supposed that the Schizaeaceae family, with monolete spores, continually differentiated as an independent group from the species belonging to the more ancient, trilete spored Schizaeales during the Lower Cretaceous.

Introduction

A striking characteristic in the examination series of Hungarian Lower Cretaceous deposits is the dominance of fern spores. Among them the well ornamented, trilete Schizaeales forms play a prominant part. The monolete spores with striate, foveolate, foveo-reticulate and verrucate ornamentation, occur mainly in the Albian stage. The object of this examination is to find out to which species the monolete spores belong and on the basis of their probable relationship to modern fern species, to which fern family they belong.

Previous works

Several author (BOLCHOVITINA, 1961; POCOCK, 1964) have established that the striate spores of the Lower Cretaceous are related to those fern species belonging to the Schizaeales order that have striate spores.

According to one classification system the living genera *Anemia, Lygodium, Mohria* and *Schizaea* are placed into the Schizaeaceae family of Filicales order. Others raise the Schizaeaceae to the rank of Schizaeales. Thus REED (1947), for example, divided the Schizaeales order into the four following families on the basis of the leaf and spore morphology:

1. Schizaeaceae (KAULF.) PRESL;
2. Anemiaceae (PRESL) REED;
3. Lygodiaceae PRESL;
4. Mohriaceae (PRESL) REED.

On the basis of her examination of recent and fossil spores, BOLCHOVITINA (1961) also accepts this classification. MARÓTI (1965) completed a histological examination of the leaves of recent Schizaeales. Because of their great similarity, MARÓTI groups the *Mohria* and *Anemia* genera together under the name of Ornithopteridaceae (BERNH.) MARÓTI; he accepts the Lygodiaceae PRESL. and the Schizaeaceae (KAULF.) PRESL family statuses.

We examined the spores of recent Schizaeaceae species and found the following characteristics:

1. the spores are bean-shaped, bilaterally symmetrical, and monolete;
2. the exosporium of spores is variously sculptured:

a) laevigate: *Schizaea poeppigiana* STURM,
Sch. fluminensis STURM,
Sch. sprucei HOOK,
Sch. biroi RICHT.

b) striate: *Actinostachys digitata* (L.) WALL.,
A. laevigata (METT.) REED
A. melanesica (SELL.) REED.

c) verrucate-tuberculate:
Schizaea incurvata SCH.,
Sch. bifida WILLD.,
Microschizaea tenella (KAULF.) REED.

d) foveate-foveolate:
Schizaea pectinata (L.) SW.,
Microschizaea pusilla PURSH.

e) granulate: *Schizaea elegans* (VAHL) SW.,
Sch. pectinata (L.) SM.

We also find these sculpture forms in the publications concerned with Mesozoic monolete spores, as in SELLING (1944), KRUTZSCH (1959), BOLCHOVITINA (1961), SRIVASTAVA (1971), and KUVAEVA (1972, 1973).

Their works serve as the basis for the supposition that a part of the monolete spores from the Transdanubian Central Mts (Albian) belong to fossil representatives of the Schizaeaceae family.

Systematic description

Turma: MONOLETES IBRAHIM 1933
Suprasubturma: *Acavatomonoletes* DETTMANN 1963
Subturma: **AZONOMONOLETES** Luber 1938
Infraturma: *Ornati* R. POT. 1956

Genus: *CORNICULATISPORITES* KUVAEVA 1972

Welwitschiapites BOLCH. 1953, p. 61.
Welwitschiapites BOLCH. ex POT. 1958, p. 123.
Welwitschiapites BOLCH. ex R. POT. (in DEÁK, 1963)

Type species: *Corniculatisporites magniolobatus* (BOLCH. 1953) KUVAEVA 1972

1953 *Welwitschiapites magniolobatus* BOLCHOVITINA (pars).
Pl. 19, Fig. 19 (non 18). South-Urals, Albian-Cenomanian.

Diagnosis: Monolete, bilaterally symmetrical spores, polarly oval or bobbin-shaped, equatorially bean-shaped; spore body with protrusions at the two longitudinal axes. The thick exosporium is ribbed.

Remarks: BOLCHOVITINA (1953) described and indicated this species as *Welwitschiapites magniolobatus*. Its figure shows two forms that are morphologically unlike. Some authors keep on record the hitherto described *Welwitschiapites* form species -on the basis of a true resemblance to the pollen of the recent *Welwitschia mirabilis* HOOK — as pollen, and suppose they are relatives of *Welwitschia*. In our opinion KUVAEVA (1972) properly recognized that these forms are spores and transfered Welwitschiapites magniolobatus to her new spore genus Corniculatisporites, as a type species of the genus.

Corniculatisporites virgatus (DEÁK 1963) KUVAEVA 1972
Pl. I., Figs. 1, 2.

1963 *Welwitschiapites virgatus* DEÁK, p. 408, Pl. I., Figs. 1, 2.

Remarks: Large, richly ribbed form. The spore body is sculptured by 2—2,5 μ wide muri, which end by ones or twos in the irregularly conical shaped protrusions at the two ends of the longitudinal axis. Muri number: 26—28. Protrusions 7—9 μ long and 11—13 μ wide. Size range: 76×52 μ.

Occurrence: A rare form which occurs from the Tés Formation (Middle Albian) and Pénzeskút Formation (Upper Albian) in the Mts Bakony and Mts Vértes.

Corniculatisporites alekhinii (BOLCH. 1953) KUVAEVA 1972
Pl. I., Figs. 3, 4.

1953 *Welwitschiapites alekhinii* BOLCHOVITINA, p. 61, Pl. 9, F. 20.
1972 *Corniculatisporites alekhinii* (BOLCH. 1953) KUVAEVA, p. 7, Pl. I, Figs. 5—7.

Remarks: A monolete spore ornamented by 12 (5—7 μ wide) muri, which running parallel to each other and to the laesura and fuse by threes into the protrusions at the two longitudinal ends.

Occurrence: The species was described from Campanian strata of the northern Urals (BOLCHOVITINA, 1953), from the Upper Albian of Crimea (KUVAEVA, 1972) in USSR, and from the Aptian of Wienerwald (ČORNA, 1972) in Austria.

In Hungary this species first appears in strata of Lower Albian (Vértessomló Formation), ranges into the Albian, but is common only in the Upper Vraconian sediments of the Mts Bakony.

Corniculatisporites tudariensis KUVAEVA 1972
Pl. I., Figs. 5, 6.

1972 *Corniculatisporites tudariensis* KUVAEVA, p. 9. Pl. I, F. 8—10.

Remarks: the species containing the smallest *Corniculatisporites* forms. The 36×22 μ large spore body is ornamented by 16 muri which fuse to the protrusions by fours.

Occurrence: KUVAEVA recorded it from Cenomanian deposits of the Caucasus, USSR.

Occurs infrequently in the Pénzeskút Formation (Upper Albian) of Mts Bakony.

Corniculatisporites magniolobatus (BOLCH. 1953) KUVAEVA 1972
Pl. I., Figs. 7, 8.

1953 *Welwitschiapites magniolobatus* BOLCHOVITINA, p. 61, Pl. 9., Fig. 19 (non 18).
1972 *Corniculatisporites magniolobatus* (BOLCH. 1953) KUVAEVA, p. 6, Pl. I, Figs. 1—4.

Remarks: On the spore body there are 20 muri parallel to each other. They are 2,5—3 μ wide, and fuse by twos or rarely threes into the short but wide extensions at the two ends of the long axis. (Among the Corniculatisporites species this extension is the shortest.) Size range: 57 μ.

Occurrence. BOLCHOVITINA (1953) described it from the Cenomanian of Caucasus; KUVAEVA (1972) recorded it from the Upper Albian of Crimea. This species enters the Hungarian mid-Cretaceous succession to present knowledge, in the Lower Albian (Vértessomló Fm) of the Mts Gerecse.

Corniculatisporites bolchovitinae KUVAEVA 1972
Pl. I., Figs. 9, 10.

1972 *Corniculatisporites bolchovitinae* KUVAEVA, p. 11, Pl. I, F. 14—16.

Remarks: attached to the ends of the spore body of this 56×23 μ large form, — that is somewhat smaller than the holotype, — are comparatively long (12—14 μ) cylindrical, pointed protrusions. The spore surface is covered by parallelly running, and at places crosswise running, 2—2,5 μ thick muri. The muri number is 16—18. The muri reach by ones to 3/4 of the length of the protrusions.

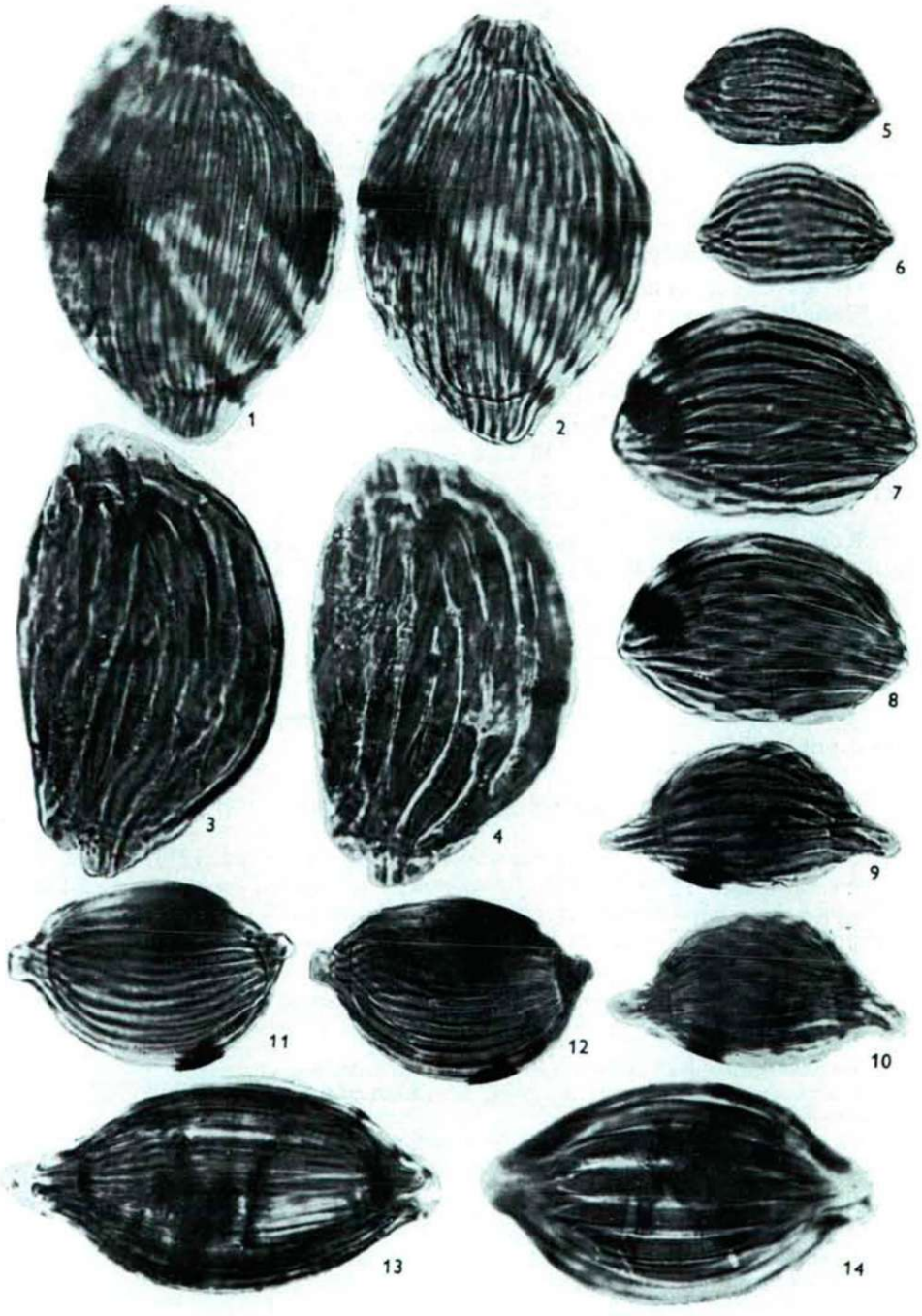
Occurrence: The holotype was described from Cenomanian rocks of the Caucasus (KUVAEVA, 1972), in USSR.

Its appearance in the Vértessomló Formation of the Mts Gerecse is common.

Plate I

1, 2 *Corniculatisporites virgatus* (DEÁK 1963) KUVAEVA 1972.
Mts Bakony, Balinka. Ba-237: 95/3. P: 46,5/112,1. U. Albian.
3, 4 *Corniculatisporites alekhinii* (BOLCH. 1953) KUVAEVA 1972.
Mts Bakony, Balinka. Ba-237: 54/2. P: 32/93. Upper Albian.
5, 6 *Corniculatisporites tudariensis* KUVAEVA 1972.
Mts Bakony, Pénzeskút: 5/2. P: 34,5/105. Upper Albian.
7, 8 *Corniculatisporites magniolobatus* (BOLCH. 1953) KUV. 1972.
Basin Tatabánya, Ta-1369: 317/2. P: 33,5/113,5. Lower Albian.
9, 10 *Corniculatisporites bolchovitinae* KUVAEVA 1972.
Mts Gerecse, Bikol. Süttő-3: 125/4. P: 31,2/103,5. L. Albian.
11, 12 *Corniculatisporites auritus* (SINGH 1971) n. comb.
Basin Tatabánya, Ta-1329: 695/6. P: 35,5/103,5. Lower Albian.
13, 14 *Corniculatisporites nemanicensis* (PACLTOVÁ 1961) n. comb.
Mts Bakony, Hárskút. Hk-4: 641/3. P: 33,5/95,9. Upper Albian.

Plate I



Corniculatisporites auritus (SINGH 1971) n. comb.
Pl. I., Figs. 11, 12.

1971 *Cicatricososporites auritus* SINGH, p. 81, Pl. 10, Figs. 11—15.

Remarks: On the monolete form that SINGH (1971) described 6—8 μ long protrusions may be found at the two ends of the longitudinal axis. The spore is ornamented by 1—2 μ wide muri which continue onto the auriculate protrusions to coalesce with one another at a point; that is the reason for transferring this form into the *Corniculatisporites* genus. The specimen reported by us is somewhat smaller than the holotype. The holotype is 66×35 μ, and our specimen is 53×33 μ. The protrusions are also proportionately smaller.

Occurrence: Its appearance in the Loon River Fm. and Shaftesbury Fm. of the Peace River area, Canada, is described by SINGH (1971). In Hungary it occurs infrequently throughout the Vértessomló Formation (Lower Albian) of the Basin Tatabánya.

Corniculatisporites nemanicensis (PACLTOVÁ 1961) n. comb.
Pl. I., Figs. 13, 14.

1961 *Ephedripites nemanicensis* PACLTOVÁ, p. 63, Pl. 9, Figs. 1—3.

Remarks: A monolete spore with a polarly elliptical amb, and ornamented by thick ribs. The ribs running parallel to each other and to the laesura, fuse by threes to the 6—8 μ long, 5—6 μ wide protrusions at the two longitudinal ends. Ribs 5—6 μ are spaced apart 1 μ, and they are 12 in number. Size range: 76×38 μ.

Occurrence: PACLTOVÁ (1961) recorded it from the Senonian of Nemanice, Czechoslovakia.

A rare form which occurs in the lower part of Pénzeskút Formation (Upper Albian) of the Mts Bakony.

Genus: *CICATRICOSOSPORITES* (TH. PF. 1953) W. KR. 1959

Type species: *Cicatricososporites pseudodorogensis* (TH. & PF. 1953) W. KR. 1959.

W. KRUTZSCH (1959) placed the monolete, cicatricose-canaliculate sculptured forms into this genus, distinguishing them from the similarly ornamented alete forms which are representatives of the Schizaeoisporites genus.

Cicatricososporites phaseolus (DELCOURT&SPRUMONT 1955) W. KR. 1959
Pl. II., Figs. 1, 2.

1955 *Schizaeoisporites phaseolus* DELCOURT&SPRUMONT, p. 46, Fig. 13.
1959 *Cicatricososporites phaseolus* (DEL.&SPR. 1955) KRUTZSCH, p. 223.

Remarks: The spore examined by us has a 3—3,5 μ thick exosporium on which muri run obliquely across the spore body and attach parallelly toward the laesura. The muri are 2 μ wide, apart 0,5 μ. Laesura is 25 μ long. Size range: 52×35 μ.

Occurrence: The species is widely distributed in the Albian-Cenomanian deposits of North America and Europa. In Hungary it occurs in the mid-Albian rocks of the Tés Formation, Mts Bakony.

Genus: *VERRUCATOSPORITES* (TH.&PF. 1953) W. KR. 1959

Type species: *Verrucatosporites alienus* (R. POT. 1931c) TH.&PF. 1953.
Verrucatosporites contractus (BOLCH. 1953) W. KR. 1959
Pl. II., Figs. 3, 4.

1953 *Aspidium contractum* BOLCHOVITINA, p. 57, Pl. 9, Figs. 6, 7.
1959 *Verrucatosporites contractus* (BOLCH. 1953) KRUTZSCH, p. 205

Remarks: This monolete spore which is bean-shaped polarly, is sculptured by 3—4 μ high, 3—4,5 μ broad at the base conical formed verrucae that are some places more rare and other places more dense in their distribution. Around the 34 μ long laesura the verrucae are smaller, or may be lacking. Size range: 52×38 μ. (Somewhat larger than the holotype.)

Occurrence: BOLCHOVITINA described it from the Upper Albian of the Southern Urals, USSR. Present in the majority of Vértessomló Formation in the Basin Tatabánya, Oroszlány, Hungary.

Genus: *MICROFOVEOLATOSPORIS* (W. KR. 1959) R. POT. 1966

Type species: *Microfoveolatosporis pseudodentatus* W. KR. 1959

This genus includes monolete spores with foveolate-foveoreticulate ornamentation on the basis of POTONIÉ's emendation. He places the *Reticulosporis*, also created by KRUTZSCH, here as the two genera are very similar morphologically.

Microfoveolatosporis baconicus n. sp.
Pl. II., Figs. 5—7.

Holotype: Plate II., Figs. 5. 6. Prep.: Pe—31, 161/1:32,2/102,3.

Locus typicus: Bakony Mts, Olaszfalu. Borehole Pe—31.

Stratum typicum: Pénzeskút Fm., Turrillites marl (Upper Albian)

Diagnosis: monolete, bilaterally symmetrical spore with convex to concave amb. The straight, simple laesura reach to 2/3 of the spore length. The exosporium is 1 μ thick with finely granulate or rarely chagrenate ornamentation on the surface. Among the granulae may be found irregularly placed foveolae. Its maximum diameter 0,5 μ. Size range: 48—55×22—24 μ.

Differential diagnosis: The *M. baconicus* n. sp. can be distinguished from the other *Microfoveolatosporis* species by its sparse, scattered, small foveolae and by its finely granulate surface.

Occurrence: A frequent form in the Bakony Mts and Vértes Mts, from Tés Formation and Pénzeskút Formation (Middle and Upper Albian).

Microfoveolatosporis surensis n. sp.
Pl. II., Figs. 8—11.

Holotype: Plate II., Figs. 10, 11. Prep.: Sur—1, 498,3/3:36,7/90.

Locus typicus: Bakony Mts, Súr. Borehole Súr—1.

Stratum typicum: Tés Formation, clayey-marl (Middle Albian).

Diagnosis: monolete, bilaterally symmetrical spore with concave-convex amb. The simple laesura is bordered by a thin lips, and may be as long as 4/5 of the length of the long axis. The 1—1,5 μ thick exosporium has a rugulate surface. The rugulae

are shaped like crooked sticks, and are about 1 μ high, and 2—4 μ long. They form an irregular reticulum that contains 0,5—1 μ diameter foveolae at a medium density. Size range: 45—66×25—45 μ (Holotype: 66×45 μ).

Differential diagnosis: The *M. surensis* n. sp. distinct from *Microfoveolatosporis baconicus* n. sp. by the presence of rugulae and among them the occurrence of larger and more densely spaced foveolae.

Remarks: The individual specimens of *M. surensis* n. sp. show large variations in form and size. On the form illustrated in Pl. II. Figs. 8, 9. the ornamentation is finer.

Occurrence: First appears in strata of Middle Albian clayey marl of Tés Formation in the Bakony Mts and is unknown from sediments younger than the lower part of Upper Albian.

Microfoveolatosporis gallicus (DEÁK&COMBAZ 1967) n. comb.
Pl. II., Figs. 12—14.

1967 *Reticulosporis gallicus* DEÁK&COMBAZ, p. 80, Pl. 1, Fig. 22.

Remarks: Monolete spore, with straight laesura which reach 3/4 the length of the long axis. The two-layered exosporium is 1,5—2 μ thick; the ect-exosporium is densely perforated with foveolae that are 0,2 μ in diameter, and the endexosporium is covered with 1,5 μ thick larger pitted and more sparsely spaced foveolae. Thus under high focus the spore surface appears to be foveo-reticulate, with pentagonal reticulae surrounded by 4—5 foveolae. Size range: 52—65×28—38 μ.

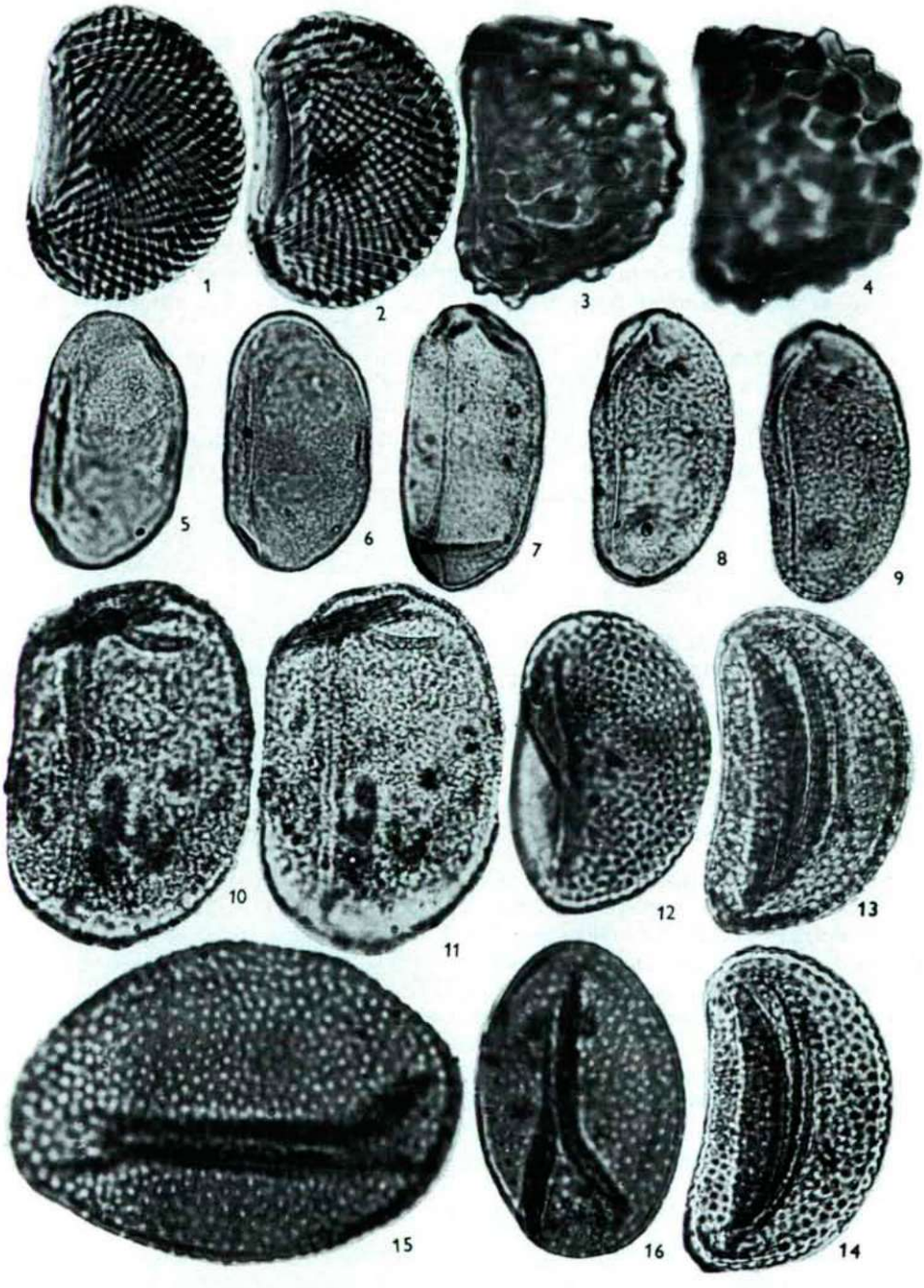
Occurrence: It has been reported from Albian-Cenomanian of Saintogne, France by DEÁK&COMBAZ (1967).

Of infrequent occurrence in certain horizons of the Tés Fm. in Bakony and Vértes Mts.

Plate II

1, 2 *Cicatricososporites phaseolus* (DEL.&SPR. 1955) W. KR. 1959.
Mts Bakony, Sur. Sur-1: 556,7/2. P: 35,5/103,3. Middle Albian.
3, 4 *Verrucatosporites contractus* (BOLCH. 1953) W. KR. 1959.
Mts Vértes, Oroszlány. O-1884: 217/1. P: 43,1/104. Lower Albian.
5—7 *Microfoveolatosporis baconicus* n. fsp.
5, 6: Mts Bakony, Olaszfalu. Pe-31: 161/1. P: 32,2/102,3 U. Alb.
7: Mts Bakony, Sur. Sur-1: 358,5/1. P: 37,3/106,9. M. Albian.
8, 9 *Microfoveolatosporis surensis* n. fsp.
Mts Bakony, Sur. Sur-1: 358,5/1. P: 31,9/108,7. Middle Albian.
10, 11 *Microfoveolatosporis surensis* n. fsp. Holotypus.
Mts Bakony, Sur. Sur-1: 498,3/1. P: 36,7/90. Middle Albian.
12 *Microfoveolatosporis gallicus* (DEÁK&COMBAZ 1967) n. comb.
Mts Vértes, Oroszlány. O-1891: 578/1. P: 39,6/108. Middle Albian
13, 14 *Microfoveolatosporis gallicus* (DEÁK&COMBAZ 1967) n. comb.
Mts Bakony, Sur. Sur-1: 556,7/2. P: 42/94,4. Middle Albian
15 *Microfoveolatosporis csaszari* n. fsp. Holotypus
Mts Bakony, Sur-1: 533/1. P: 32/110,8. Middle Albian
16 *Microfoveolatosporis csaszari* n. fsp.
Mts Vértes, Oroszlány. Ot-83: 23,3/1. P: 42,5/105. Middle Albian.

Plate II



Microfoveolatosporis csaszari n. sp.
Pl. II., Figs. 15, 16.

Derivatio nominis: In honor of GÉZA CSÁSZÁR, a Hungarian geologist.
HOLOTYPE: Plate II., Fig. 15. Prep.: Súr—1,533 (l. P: 32) 110,8.
Locus typicus: Bakony Mts, Súr. Borehole Súr—1, 533,3 m.
Stratum typicum: Tés Formation, clayey-marl, Middle Albian.

DIAGNOSIS: equatorially bean-shaped, monolete spore. The laesura asymmetrically follow the long axis, reaching to about 2/3 of it. On most examples the laesura is bounded on two sides by a „labrum" which separates from the laesura as it approaches the poles. The 1—1,2 μ thick exosporium is one-layered. Foveolae extend into the exosporium. Regularly distributed over the spore surface, they are formed as half-sphaerical dents that are 0,5 μ in diameter. Size range: 60—80× ×40—58 μ.

Differential diagnosis: The *M. csaszari* n. sp. distinct from *Microfoveolatosporis skottsbergii* (SELLING 1944) SRIVASTAVA 1971 by its smaller size and by the fewer foveolae on its surface; from *Microfoveolatosporis gallicus* (DEÁK&COMBAZ 1967) n. comb. by its one-layered exosporium with its regularly distributed, uniform-sized foveolae; and from *Microfoveolatosporis canaliculatus* DETTMANN 1963 by its larger size and by its foveolae of uniform diameter.

Discussion

We examined the monolete spores occurring in the spore-pollen complexes from the palynological examination series on the Lower Cretaceous rocks of the Vértessomló Formation (Lower Albian), Tés Formation (Middle Albian), and Pénzeskút Formation (Upper Albian-Lower Cenomanian) from the Bakony, Vértes and Gerecse Mountains of Transdanubian Central Mts. It may be seen that these are largely striate, verrucate, foveolate, and foveo-reticulate in sculpture, and that they show a great resemblence to recent spores of the Schizaeales order. We distinguished the following 13 formspecies in our material on a morphological basis:

Corniculatisporites magniolobatus (BOLCH. 1953) KUVAEVA 1972
Corniculatisporites virgatus (DEÁK 1963) KUVAEVA 1972
Corniculatisporites alekhinii (BOLCH. 1953) KUVAEVA 1972
Corniculatisporites tudariensis KUVAEVA 1972
Corniculatisporites bolchovitinae KUVAEVA 1972
Corniculatisporites auritus (SINGH 1971) n. comb.
Corniculatisporites nemanicensis (PACLTOVÁ 1961) n. comb.
Cicatricososporites phaseolus (DELC.&SPR. 1955) W. KR. 1959.
Verrucatosporites constrictus (BOLCH. 1953) W. KR. 1959.
Microfoveolatosporis baconicus n. sp.
Microfoveolatosporis surensis n. sp.
Microfoveolatosporis csaszari n. sp.
Microfoveolatosporis gallicus (DEÁK&COMBAZ 1967) n. comb.

The study of the spores from Lower Cretaceous assemblages convinces us that the trilete spores of the families of the ancient Schizaeales order (Anemiaceae, Lygo-

diaceae, Mohriaceae and Klukiaceae) play a dominant part compared to the spores and pollen of the other plant groups. Thus the Schizaeales order experienced its acme-stage in the Lower Cretaceous. The monolete spores are phylogenetically younger than trilete spores, probably the monolete spore-producing genera and species developed later than the trilete spore possessing species within a given order or family.

Leaf histological and other studies, have established that among the recent genera Schizaea shows phylogenetically younger characteristics than the *Lygodium, Anemia* and *Mohria* genera. It may be supposed that the monolete spore species of the Schizaeaceae already began to differentiate in the Lower Cretaceous and that already by the Albian age palynologically valuable species and characteristics may be found.

On the basis of the above it is our opinion that most of spores dating from the Albian (here one can place several, including the smooth spores of the Laevigatosporites, because among the currently living species, most *Schizaea* have laevigate spores) are representatives of the Schizaeaceae family, and that the Polypodiaceae family only later developed in the branching progression.

In the Lower Cretaceous, — among the schizaeaceous monolete spores- the *Corniculatisporites* appeared first; it has the largest number of individuals and species in the Albian, and even at the Albian-Cenomanian boundary.

It is one of the „leading fossils" in the Turrillites marl of Bakony Mts (Upper Vraconian).

Microfoveolatosporis is, however, a more frequent form of the clayey-marl deposits of Bakony and Vértes Mts (Middle Albian).

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