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DISPERSED MATONIACEAE SPORES FROM THE HUNGARIAN LOWER AND MIDDLE CRETACEOUS SEDIMENTS

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Abstract

The author studied spores of Matoniaceae affinity coming from Lower and Middle Cretaceous sediments of Hungary. 13 species were separated, among them are described five new species and four new combination. Seven laevigate, valvate species were classified among *Matonisporites* genus, one ornamented, valvate species into the *Trilobosporites*, four laevigate forms with uniformly thickened exine into *Phlebopterisporites* new genus and one ornamented species with uniformly thickened exine into *Phanerosorisporites* new genus. It may be supposed that the acme of the Matoniaceae fern family was in the Wealden and the Albian of the Cretaceous.

Introduction

The Matoniaceae, one of the ancient fern families of Filicales, are, as a relict, inhabitants of a narrow ecological area of the Earth, the humid, hot tropical Indo-Malaysian Archipelago (Sumatra, Borneo), with a low number of species (2 genera, 3 species). The questions arise: when was the acme-stage of the Matoniaceae, and what were its ancient representatives and their spores like?
In the present paper, on the basis of studying the literature on mega-and microfossils, as well as of our own palynological researches, we should like to look for answers to these questions.

Previous investigations

The "past" of the Matoniaceae is evidenced by data from several mega- and microfossils. Their first representatives were found in sediments from the Triassic, but there are available several data from the Jurassic and Cretaceous as well. It can be ascertained on the basis of megafossils that the fossil Matoniaceae species were generally ferns of large size, with long creeping rhizomes, siphonosteles; their leaves reached as much as 2 m long, the petiole forks into two lateral branches, which in turn branch again many times, resulting in a fan-shaped frond with pinnate branches radiating from the end of the petiole. Among the leaf remains, sterile and fertile leaves have been found. The sori were arranged in two rows and each sorus consists of from six to 13 sporangia, which covered by indusium. To date, the following fossil genera have been selected: *Phlebopteris (Laccopteris)* BRONGNIART 1828, *Matonidium* SCHENK 1871, *Selenocarpus* SCHENK 1866, *Matoniella* HIRM. et HOERH. 1936, *Piazopteris* LORCH 1967.

The morphologically more different *Weichselia* STIEHLER 1857 genus, of uncertain taxonomical place, is also counted here by some authors, on the sole basis of the matoniaceous structure of spores (ALVIN, 1968; DABER, 1968).

In situ spores have been obtained from the sporangia of several specimen:

a) Data have been published by several authors on spores from fossils of *Phlebopteris muensteri* (SCHENK) HIRM. et HOERH. 1936, found in the Rhaeto-Liassic of Greenland, France and Germany and in the Mid-Jurassic of the Soviet Union;

b) Spores of *Phlebopteris angustiloba* (PRESL) HIRM. et HOERH. 1936 have been also described from several places in Europe, from sediments of the Upper Triassic and Jurassic;

c) The species *Phlebopteris hirsuta* and *Phlebopteris indica* were described by SAHNI et SITHOLEY (1945); they published photographs of specimens in a very good state of preservation;

d) Phlebopteris utensis ARNOLD 1956 from the Upper Triassic in Arizona and *Phlebopteris galleyi* ARNOLD 1956 from the Upper Cretaceous in Kansas are also spore-bearing megafossils.

e) The in situ spores of *Selenocarpus munsterianus* (PRESL) SCHENK and *Matonidium goepperti* (ETT.) SCHENK were obtained by HIRMER et HOERHAMMER (1936).

It was established by Couper (1958) that many forms among the Mesozoic dispersed spores are very similar to in situ spores of the fossil species of Matoniaceae. He created the formgenus *Matonisporites* with two species: *Matonisporites phlebopteroides* and *Matonisporites equiexinus*. At same time, on the basis of analysing morphologically the recent and fossil matoniaceous spores, he established two types of in situ spores:

1. "phlebopteroides" — type: the exine is smooth, thick, strongly thickened at the corners. To be classified here are: *Phlebopteris hirsuta, Phlebopteris indica, Phlebopteris muensteri.*

2. "equiexinus" — type: the exine is smooth, very thick, but uniformly thickened. The species to be classified here are: the recent *Matonia pectinata,* as well as the fossil *Phlebopteris angustiloba, Selenocarpus muensterianus, Matonidium goepperti.*

The *Matonisporites* formgenus, created by COUPER, included botanically related but — on the basis of the morphological system customary in palynology — heterogenous forms. First DETTMANN (1963) tried to abolish this contradiction by emending the *Matonisporites* to leave it for the spores with smooth or nearly smooth walls but with strongly thickened corners (valvate), and transferring the *Matonisporites equiexinus* to the *Dictyophyllidites* genus, created also by COUPER (1958) for taking in the smooth-walled spores with cheiropleuriaceous character. The taxonomic position of *Matonisporites equiexinus* is not resolved at present. DÖRING (1965) places it into the large genus *Leiotriletes* which is suitable for taking in almost any smooth spores. POCOCK (1970), asserting the invalidity of *Matonisporites,* mentions it as falling into the genus *Harrisispora,* created by himself. SUKH DEV (1961) sets up the formgenus *Boseisporites,* the type species of which, *Boseisporites praeclarus* has a valvate wall-thickening, similar to *Matonisporites phlebopteroides,* but is described as having an infragranulate surface. DETTMANN (1963) considers *Boseisporites* as a junior synonym of *Matonisporites,* and its "laevigate, infragranulate" surface as a corroded smooth surface. SINGH et al. (1964) and BHARADWAY et KUMAR (1971) emended the *Boseisporites* in a rather contradictory way. But, in our opinion, together with the other genera created for triangular, valvate spores (*Lametratriletes* SINGH et

KUMAR 1970, *Venusteaesporites* SINGH et KUMAR 1970, *Callispora* (DEV. 1961) BHARADWAY et KUMAR 1971), they demonstrate the raising of differences at species level to the rank of genus. The above mentioned formgenera can be drawn into the *Matonisporites* (COUPER) DETTMANN 1963. DÖRING (1965) draws the valvate spore-forms of smooth and richly ornamented surfaces together in the genus *Trilobosporites: Trilobosporites (Trilobosporites)* subformgenus for the smooth, valvate spores, *Trilobosporites (Tuberosisporites)* subformgenus for the ornamented, valvate spores. This grouping, on a strictly morphological basis, which is clumsy because of the use of subgenera, draws the attention, from the botanical point of view, to two facts: 1. In the Wealden flora of Western Europe the presence of matoniaceous spores is not rare; the ascribing of the four valvate, smooth spore-forms, described by DÖRING from the Wealden of Germany, to the Matoniaceae is therefore not excluded; 2. The structure of several valvate spore-forms, classified in *Trilobosporites* (with the exception of the ornamenting elements) is very similar to that of the smooth, valvate forms. Thus, although ornamented valvate in situ spores, have not been found, as yet from megafossils; nevertheless, there may have existed some ancient Matoniaceae species that produced the spores of this type.

From the sediments of the Lower Cretaceous of Hungary, Matoniaceae-type spores were first described by DEÁK (1964), from the clayey-marl sediments of the Bakony, then thought to be of the Upper-Aptian but actually of the Middle-Albian. She described three new species: *Matonisporites major* DEÁK 1964, *Matonisporites simplex* DEÁK 1964, *Matonisporites minor* DEÁK 1964.

On the basis of the spores of the species of recent *Matonia* and *Phanerosorus* and of the in situ spores of the fossil species of Matoniaceae, we should compare the following morphological characters in considering the placing of Lower and Middle Cretaceous dispersed spores in the Matoniaceae:

1. thickness of the spore-wall,
2. ornamentation,
3. presence of the torus, accompanying the laesura.

1. Thickness of the spore-wall:

the thick exine is uniformly characteristic of the recent and fossil matoniaceous spores. The exine can be of two kinds:

a) valvate exine: stronger thickening occuring at the corners,

b) uniformly thickened exine.

The thickness of the exine is to be regarded as the most important character!

2. Ornamentation:

a) The decisive majority of the valvate and nonvalvate spores is of smooth exine (laevigate, unornamented).

b) The exine is almost smooth (scabrate, punctate, microrugulate). A finely ornamented surface occurs mainly in recent species. ERDTMAN (1957) reports on spores of microrugulate surface from *Phanerosorus*. ERDTMAN et SORSA (1971) described "blunt spinulose to granulum-like processes" in *Matonia pectinata.*

c) It can be supposed that valvate forms of verrucate ornamentation occur among the fossil forms.

3. Presence or absence of the torus:

a) In recent and fossil spores the torus can sometimes be also ornamented;
b) The torus may also be absent. Its presence or absence may also be the function of the state of preservation! In spores of comparatively thinner wall (possibly "abortiv spores") it can be found more rarely.

In our opinion, apart from the *Matonisporites,* which serves to take in the valvate, laevigate spores, it is necessary to set up tow new genera:

1. one to take in the matoniaceous forms of smooth, uniformly thick exine, sometimes having a torus instead of *Dictyophyllidites* (COUPER) DETTMAN (1963), which is very heterogeneous both from the morphological and botanical points of views;

2. another to take in the spores of uniformly thick exine but of slightly ornamented surface, a genus which suggest similarity with the recent species of *Matonia* and *Phanerosorus.*

We propose *Phlebopterisporites* nov. genus for the former forms and *Phanerosorisporites* nov. genus for the latter.

Taxonomic part

Anteturma: Sporites H. POT. 1893
Turma: Trilites (REINSCH) DETT. 1963
Suprasubturma: Acavatriletes DETT. 1963
Subturma: *Zonotriletes* WALTZ 1933
Infraturma: *Auriculati* (SCHOPF) DETT. 1963
Genus: *MATONISPORITES* (COUPER 1958) DETTMANN 1963

Type species: *Matonisporites phlebopteroides* COUPER 1958.

Further species to be placed here are as follows:

1. *Matonisporites conspicuus* (BOLCH. 1953) DETT. 1963
2. *Matonisporites* (al. *Dicksonia*) *paragaudius* (BOLCH. 1953) n. comb.
3. *Matoniporites* (al. *Triquitrites*) *rotalis* (WEYL. et KR. 1953) n. comb.
4. *Matonisporites crassiangulatus* (BALME 1957) DETT. 1963
5. *Matonisporites praeclarus* (DEV. 1961) DETT. 1963
6. *Matonisporites cooksonii* DETT. 1963
7. *Matonisporites* (al. *Toroisporis*) *planitorosus* (DÖR. 1964) n. comb.
8. *Matonisporites major* DEÁK 1964
9. *Matonisporites simplex* DEÁK 1964
10. *Matonisporites minor* DEÁK 1964
11. *Matonisporites* (al. *Trilobosporites*) *weylandi* (DÖR. 1965) n. comb.
12. *Matonisporites* (al. *Trilobosporites*) *aornatus* (DÖR. 1965) n. comb.
13. *Matonisporites* (al. *Trilobosporites*) *crassiangularis* (DÖR. 1965) n. comb.
14. *Matonisporites* (al. *Trilobosporites*) *tenuiparietalis* (DÖR. 1965) n. comb.
15. *Matonisporites suemegensis* n. fsp.

Matonisporites weylandi (DÖRING 1965) n. comb.
Pl. 1., figs. 1, 2

1965 *Trilobosporites (Trilobosporites) weylandi* n. fsp.
DÖRING, p. 53, Pl. 19. figs. 4, 5. Westmecklenburg (GDR), Wealden A.

1963 *Matonisporites phlebopteroides* COUPER 1958
BRENNER, p. 55, Pl. 12., fig. 1. Maryland (USA) Potomac Group, Albian.

Remarks: This form — on the basis of its larger size (70–90 μ), its strongly thickened valvae (10–15 μ), as well as the absence of a torus accompanying the laesura — can be clearly isolated from the Jurassic form *Matonisporites phlebopteroides* COUPER. Several specimens were examined we have never found any very thick tori like that to be seen in the holotype of the latter species. The spore described by BRENNER (1963) quite agrees with the Albian forms of Hungary.

Occurrence: It occurs in the Barremian—Albian deposits of the Bakony and Gerecse in Hungary. In the Sümeg Formation it is rare, in the Vértessomló Formation most frequent, while in some samples of the Tés Formation (Mid-Albian) it is abundant spore form.

Matonisporites simplex DEÁK 1964
Pl. 1., fig. 4

1964 *Matonisporites simplex* n. sp.
DEÁK, p. 100, Pl. 2, figs. 12–13. Zirc (Mts Bakony), "Munieria" marl. Mid-Albian (non Upper Aptian).

Remarks: The size range of this type is given by DEÁK (1964) as up to 50 μ. We have generally found specimens between the limits 35–40 μ, mostly with straight outer sides and pointed valvae.

Occurrence: It has so far been found only in the clayey-marl sediments in the Tés Formation of Mts Bakony. (Mid-Albian).

Matonisporites major DEÁK 1964
Pl. 1., figs. 3, 5

1964 *Matonisporites* major n. sp.
DEÁK, p. 99, Pl. 1, figs. 1–4. Eplény (Mts Bakony), "Munieria marl" Mid-Albian (non Upper Aptian)

Remarks: this form is very similar to *Triquitrites rotalis* WEYL. et KRIEG. 1953, and *Dicksonia paragaudia* BOLCHOVITINA 1953, but the defective description of these two forms does not convince us of their identity with Matonisporites major DEÁK 1964.

Occurrence: It appears in larger numbers in the aleurolit of Lower Albian (Mts Gerecse, Vértessomló Formation); in the clayey-marl sediments of the Tés Formation is dominant. It is the most frequent matoniaceous species of the Hungarian Lower and Middle Cretaceous.

Matonisporites minor DEÁK 1964
Pl. 1., fig. 6

1964 *Matonisporites minor* n.sp.
DEÁK, p. 99–100, Pl. 1, figs. 5, 6. Eplény (Mts Bakony), "Munieria" marl, Middle Albian (non Upper Aptian).

Remarks: It differs from the other species in its smaller size and thick, strongly rounded corners.

Occurrence: This form is a rare species from Lower and Middle Albian rocks of Hungary.

Matonisporites cf. *minor* DEÁK 1964
Pl. 1., fig. 8

Remarks: In the illustrated specimen, a ring of 21 μ lumen, 2 μ thick wall can be seen well on the distal surface of the spore.

Matonisporites suemegensis n. fsp.
Pl. 1., fig. 9.

Holotype: Pl. 1., fig. 9. Preparation Süt—17, 320 m/1. P: 27/91.5.
Locus typicus: Sümeg (Mts Bakony), Borehole Süt—17. 320,2 m.
Stratum typicum: Sümeg Formation, aleurolit. Upper Barremian.
Diagnosis: trilete, triangular miospores, with concave outer and inner sides and pointed corners. Laesura is simple, straight, r-1. The exine is smooth. At the corners 10–14 μ long, 7–9 μ wide valvae are to be found.
Size: 43–55 μ.
Comparison: *Matonisporites suemegensis* n. fsp. differs from the other *Matonisporites* species in its strongly concave sides and very strongly elongated valvae at the corners, which are long in comparison to the size of the spores.
Occurrence: To date it has only been found occasionally in the Barremian and Lower Aptian layers of Sümeg Formation.

Matonisporites planitorosus (DÖRING 1964) n. comb.
Pl. 2., fig. 10

1964 *Toroisporis (Crassiangulisporis) planitorosus* n. fsp.
DÖRING, p. 1102, Pl. 3, figs. 7–9.

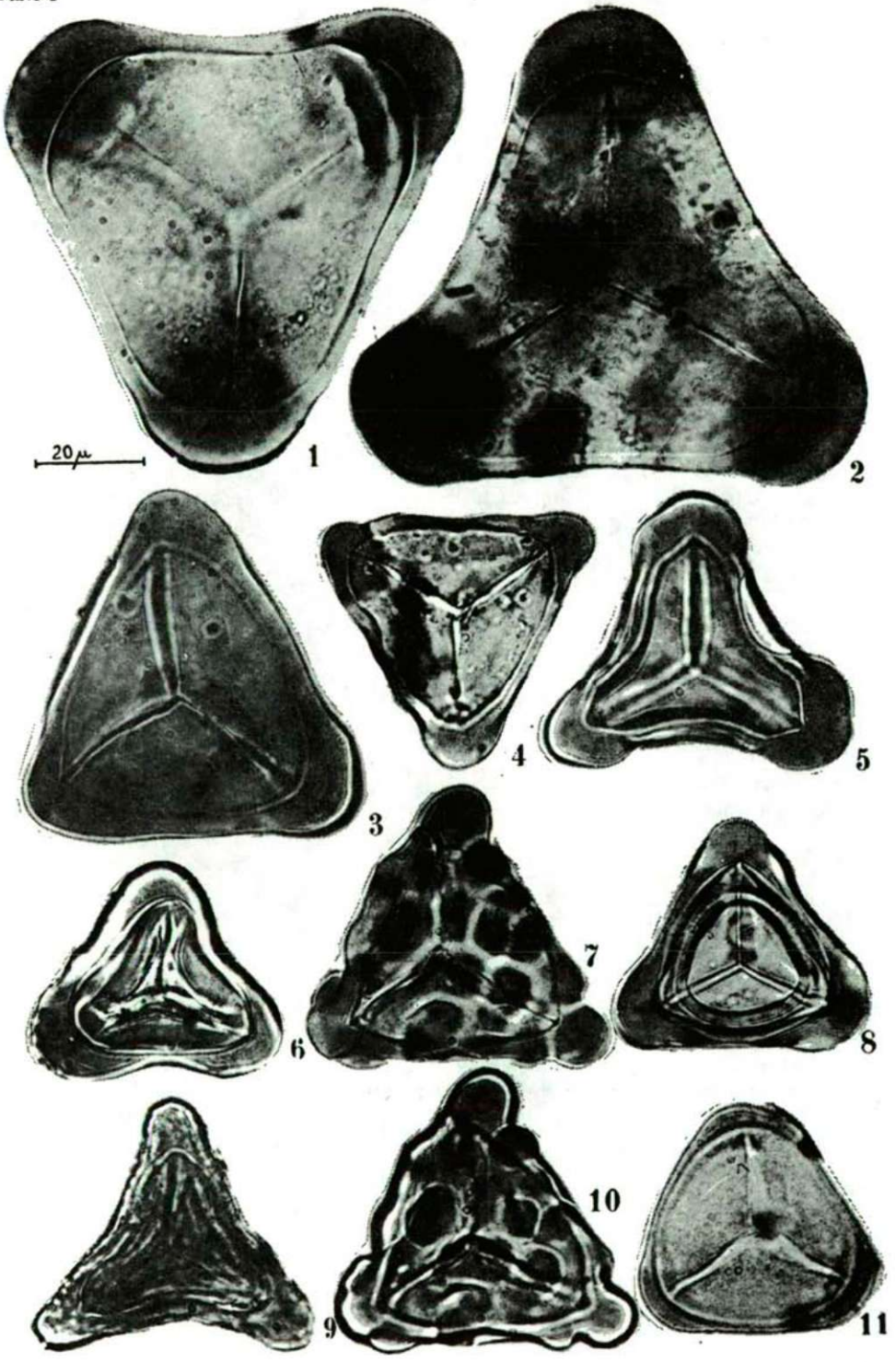
Remarks: This form is described by SRIVASTAVA (1972) as a synonym of *Matonisporites phlebopteroides*. He has observed great differences among the spores described by him as *M. phlebopteroides*, in the size of the spores and the length of valvae. Similarly, he has also found specimens with slightly thickened cor-

PLATE 1

1 *Matonisporites weylandi* (DÖR. 1965) n. comb.
Súr-1, 556,7 m/1. P: 41, 2/102,2. Tés Formation, Middle Albian.
2 *Matonisporites weylandi* (DÖR. 1965) n. comb.
Süttő-3 (Mts Gerecse), 82/2. P: 33,2/98. Vértessomló Fm, Lower Albian.
3 *Matonisporites major* DEÁK 1964.
Környe-24, 242/2. P: 41,5/105. Vértessomló Fm., Lower Albian.
4 *Matonisporites simplex* DEÁK 1964.
Súr-1, 520 m/3. P: 32,5/107,2. Tés Fm., Middle Albian.
5 *Matonisporites major* DEÁK 1964.
Olaszfalu, Ot-84, 106 m/1. 45/108,2. Tés Fm., Middle Albian.
6 *Matonisporites minor* DEÁK 1964.
Oroszlány, O-1891, 533 m/1. P: 31,2/107. Tés Form., Middle Albian.
8 *Matonisporites* cf. *minor*
Súr-1, 556,7/1. P: 35,4/99,2. Tés Fm., Middle Albian.
9 *Matonisporites suemegensis* n. fsp. Holotypus.
Süt-17, 320,2/1. P: 27/91,5. Sümeg Formation, Upper Barremian.
11 *Matonisporites* sp.
Hárskút, Hk-4, 126,3/3. P: 29,1/106. Pénzeskút Fm., Lower Cenomanian.
7, 10 *Trilobosporites góczáni* n. fsp. Holotypus.
Súr-1, 533,6/1. P:31,9/96. Tés Fm., Middle Albian.

x1000

Plate 1



ners, similar to *Matonisporites planitorosus* (DÖRING) n. comb., in the assemblages of the Maestricht age.

Occurrence: It is a spore that often occurs in the Hungarian Lower Cretaceous (Barremian or older ages).

Matonisporites sp.
Pl. 1., fig. 11

Remarks: This form shows a great similarity to the species published by SRIVASTAVA (1972, Pl. 21, figs. 3–10) under the name *M. phlebopteroides*. In Hungary, it was found in the young — Lower Cenomanian — sediments of Mid-Cretaceous. Thus, it is nearer in age to the spores published from the Edmonton Formation than to *M. phlebopteroides*, which was already absent from the younger sediments of the Cretaceous.

Genus: PHLEBOPTERISPORITES nov. gen.

Diagnosis: trilete miospores, rounded, or rounded-triangular amb, with convex or straight sides. The laesura is straight, long, running generally as far as the inner spore-wall. It is accompanied by a torus or a thickened laesurate margin. The exine is smooth, and thick, on both the proximal and distal surfaces, its thickness being 1/4 to 1/7 of the spore-radius.

Differential diagnosis: *Phlebopterisporites* n.gen. differs from the other laevigate spore-genus in its thick exine, generally convex sides, as well as in the presence of the torus, which often accompanies the laesura. The exine of *Leiotriletes, Todisporites, Dictyophyllidites, Toroisporis, Harrisispora* is generally thinner; in the first two there is no torus. In the genus *Deltoidospora* MINER, there are also species of thicker exine to be found but the shape of these is deltoid and they have no torus.

Remarks: This genus contains the spores of matoniaceous affinity, with smooth exine and uniformly thickened wall. It is a tendency to put the laevigate spores together in large genera *(Deltoidospora, Leiotriletes, Dictyophyllidites)*, with

PLATE 2

1, 3 *Phlebopterisporites hungaricus* n. fsp. Holotypus.
Súr-1, 498,6 m/2. P: 36/104. Tés Fm., Middle Albian.

2 *Phlebopterisporites hárskutensis* n. fsp. Holotypus.
Hárskút, Hk-4, 404/1. P: 42,5/106,5. Pénzeskút Fm., Lower Cenomanian.

5 *Phlebopterisporites hárskutensis* n. fsp.
Csehbánya, Cseh-5, 225,5 m/2. P: 44/113,9. Tés Fm., Middle Albian.

4 *Phlebopterisporites* cf. *equiexinus* (COUPER) n. comb.
Csehbánya, Cseh-5, 262 m/3. P: 41,3/106,1. Tés Fm., Middle Albian.

6 *Phlebopterisporites equiexinus* (COUPER 1958) n. comb.
Tatabánya, Ta-1363, 124/1. P: 45/92,3. Vértessomló Fm., L-Albian.

9 *Phlebopterisporites equiexinus* (COUPER 1958) n. comb.
Sümeg, Süt-17, 297 m/1. P: 37/103. Sümeg Fm., Upper Barremian.

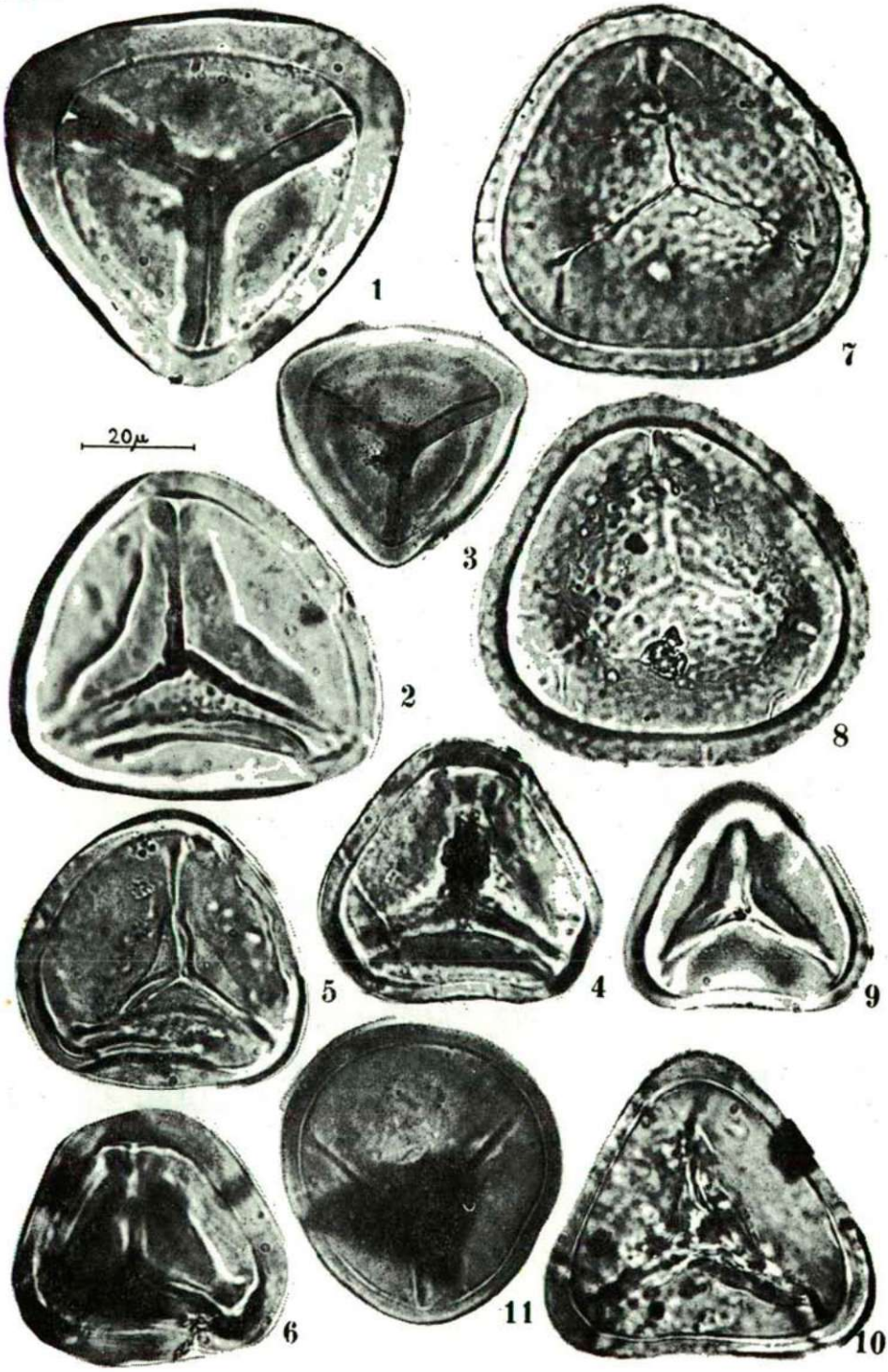
7, 8 *Phanerosorisporites surensis* n. fsp. Holotypus.
Csehbánya, Cseh-5, 262/3. P: 46,5/94,3. Tés Fm., Middle Albian.

10 *Matonisporites planitorosus* (DÖR, 1965) n. comb.
Tés, Tt-27, 46,0 m/2. P: 38,5/116,4. Tés Fm., Middle Albian.

11 *Phlebopterisporites globosus* (KIMYAI 1966) n. comb.
Ta-1363, 369,2/1. P: 45/110,7. Vértessomló Fm., Lower Albian.

(Fig. 3=x600, the others=x1000.)

Plate 2



which it is not practicable to work in the course of further research on botanical connections. Under such circumstances the probable botanical affnity may also grow blurred. DETTMANN (1963) to remove the heterogeneity of *Matonisporites*, transferred *M. equiexinus* COUPER 1958 into the genus *Dictyophyllidites*: in the course of emending the genus, she considered the presence of a thickened laesurate margin as a primary diagnostic character. In this way, the thick-walled "equiexinus" and the thin-walled *Dictyophyllidites harrisii* (of affinity with the Cheiropleuriaceae) got into one genus.

Type species: *Phlebopterisporites hungaricus* n. fsp.
Other species:

1. *Phlebopterisporites harskutensis* n.fsp.
2. *Phlebopterisporites equiexinus* (COUPER 1958) n. comb.
3. *Phlebopterisporites globosus* (KIMYAI 1966) n. comb.

Phlebopterisporites hungaricus n. fsp.
Pl. 2., figs. 1, 3.

Holotype: Pl. 2., figs. 1, 3. Preparation: Súr-1, 498/2. P: 36/104.
Locus typicus: Súr (Mts Bakony), Borehole Súr-1, 498.6 m.
Stratum typicum: Tés Formation, clayey-marl, Middle Albian.

Diagnosis: trilete miospores, amb triangular, with convex sides, rounded corners. Laesura is straight, slightly open, reaching as far as the inner border of the spore-wall. The laesura is accompanied by a 2–4 μ wide torus. The proximal and distal surfaces are smooth, the exine is uniformly thickened, very thick: 7–10 μ, 1/4–1/5 of the spore-radius.
Spore size: 60–72 μ.

Differential diagnosis: *Phlebopteris*porites *hungaricus* n. fsp. differs from the other smooth, trilete, spores with uniformly thickened exine, by its extremely thick spore-wall and the presence of torus.

Occurrence: From clayey-marl, marl sediments of Tés and Pénzeskút Formation in Mts Bakony (Middle- and Upper Albian).

Phlebopterisporites harskutensis n.fsp.
Pl. 2., figs. 2, 5.

Holotype: Pl. 2., figs. 2. Prep.: Hk-4, 404/1. P: 42.5/106.5.
Locus typicus: Hárskút (Mts Bakony), Borehole Hk-4, 234.3 m.
Stratum typicum: Pénzeskút Formation, "turrillites marl", Lower Cenomanian.

Diagnosis: trilete miospores, amb subcircular, with convex sides and slightly rounded corners. Laesura is straight, long, r=1; the laesura bordered by 2–6 μ wide torus. The proximal and distal surfaces are smooth, the distal part is strongly convex. Exine is thick, about 1/7 of the spore-radius, its thickness being 4–5 μ.
Spore size: 53–70 μ.

Differential diagnosis: *Phlebopterisporites harskutensis* n. fsp. differs from the other smooth trilete forms of subcircular shape in its comparatively thick exine and the frequent occurrence of a torus.

Occurrence: It is common form in the sediments of Tés and Pénzeskút Formation of Mts Bakony.

Phlebopterisporites equiexinus (COUPER 1958) n. comb.
Pl. 2., figs. 4, 6, 9.

1958 *Matonisporites equiexinus* n. sp.
COUPER, p. 140, Pl. 1, figs. 13, 14
1963 *Dictyophyllidites equiexinus* (COUPER 1958) n. comb.
DETTMANN, p. 27.
1965 *Leiotriletes equiexinus* (COUPER 1958) n. comb.
DÖRING, p. 20, Pl. 5, figs, 4–6.
1970 *Harrisispora equiexina* (COUPER 1958) n. comb.
POCOCK, p. 38–39, Pl. 6, fig. 15.

Remarks: Different authors placed this formspecies of COUPER into more than one genus, due to the fact that COUPER, in creating the genus *Matonisporites*, classified it the same genus as the morphologically different, valvate *"phlebopteroides"*.

DÖRING (1965) sees heterogeneity even in the two pictures of *M. equiexinus*, published by COUPER, and considers them as two different formspecies. The exine of one of the illustrated specimens is, in fact, somewhat thinner. In order to describe the species exactly, it would be necessary to re-examine the holotype and the forms similar to it.

Occurrence: It is frequent in the Neocomian and Albian sediments in Hungary, as a species of matoniaceous character.

Phlebopterisporites globosus (KIMYAI 1966) n. comb.
Pl. 2., fig. 11.

1966 *Matonisporites globosus* n. sp.
KIMYAI, p. 467, Pl. 1., fig. 9.

Description: trilete spores, amb circular, with convex sides. The laesura is simple, long, reaching to the inner surface of the spore-wall. Both the proximal and distal surfaces are smooth, the exine is 3–5 μ thick. Spore size: 45–52 μ.

Remarks: KIMYAI (1966) described a species of somewhat thinner walls, of matoniaceous character. In the specimens examined by us, the laesura often branched in the vicinity of the exine. A similar form was published by GRAY et GROOT (1966) under the name *Matonisporites equiexinus*, and by HEDLUND (1966) under the name *Matonisporites impensus* n. sp. The latter proposes an affinity of the latter species with the Lygodiaceae fern family.

Occurrence: This form is generally a species of the Lower Albian or older sediments of Hungary.

Genus: PHANEROSORISPORITES nov. genus

Diagnosis: trilete miospores, amb triangular or subcircular, with straight or convex sides, strongly rounded corners. Laesura is long, frequently bordered by a torus.

The proximal and distal surfaces are ornamented. The ornamenting elementare: punctae, granulae, microrugulae. The exine is thick, 1/7–1/8 of the spores radius.

Differential diagnosis: The *Phanerosorisporites* n.gen. differs from *Phlebopterisporites* n. gen. in its ornamented surface, and from the genera *Punctatisporites, Granulatisporites, Rugulatisporites* in its thick exine and the frequent occurrence of a torus, from other genera by ornamented surface in its thick exine, torus and subcircular outline.

Type species: *Phanerosorisporites surensis* n. fsp.

Other species:

1. *Phanerosorisporites* (al. *Matonia*) *pectinataeformis* (BOLCH. 1953) n. comb.
2. *Phanerosorisporites* (al. *Dictyophyllidites*) *pectinataeformis* (DETTMANN 1963) n. comb.
3. *Phanerosorisporites* (al. *Dictyophyllidites*) *adiaphoros* (PHILLIPS et FELIX 1971) n. comb.
4. *Phanerosorisporites* (al. *Dictyophyllidites*) sp. (PHILLIPS et FELIX 1971) n. comb.

Phanerosorisporites surensis n. fsp.
Pl. 2., figs. 7, 8.

Holotype: Pl. 2., figs. 7, 8. Prep.: Cseh-5, 262/3. P: 46.5/94.3.

Locus typicus: Csehbánya (Mts Bakony), Borehole Cseh-5, 262.5 m.

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

Diagnosis: trilete miospores, amb circular-subcircular, with convex sides and rounded corners. Laesura is simple, straight, reaching to 3/4 of the radius, sometimes branching at the end. The both proximal and distal surfaces are ornamented by microrugulate sculptur-elements. The rugulae are about 0.5 μ long, running irregularly, uniformly distributed on both surfaces. Exine is 4–5 μ thick, it 1/7 of the spore-radius.

Spore size: 58–70 μ.

Differential diagnosis: The *Phanerosorisporites surensis* n. fsp. is similar to some species, described under the name of *Cyathidites punctatus* or *Concavissimisporites punctatus* (BRENNER, 1963, Pl. 14, fig. 6) but it always has thicker exine and never has concave sides.

Occurrence: Primarily in the Middle Albian sediments of the Tés Formation, in the area of Csehbánya, Súr, Oroszlány.

Genus: TRILOBOSPORITES PANT 1954 ex POT. 1956

Type species: *Trilobosporites hannonicus* (DEL α SPR. 1955) POT. 1956.

Remarks: *Trilobosporites* contains the trilete, valvate forms with ornamented exine. VENKATACHALA et AL. (1968) assigned the non-valvate forms placed till then in *Trilobosporites,* to *Impardecispora* VENKAT. et al. 1968 genus. In this way the number of species belonging to the genus Trilobosporites, decreased. The more known species belonging here are: *Trilobosporites hannonicus* (DEL. et SPR. 1955) POT. 1956, TR. *bernissartensis* (DEL. et SPR. 1955) POT. 1956, *Tr. rarigranulatus* DÖRING 1965, *Tr. lantzae* DEÁK et COMBAZ 1967.

These forms show a great similarity to the species of Matonisporites which are also valvate but laevigate. Although, according to the literature these spores are of a connection with the Lygodiaceae, in our opinion the relationship with the Matoniaceae is not excluded.

Trilobosporites goczani n. fsp.
Pl. 1., figs. 7, 10.

Derivatio nominis: In honour of the Hungarian palynologist, DR. FERENC GÓCZÁN.

Holotype: Pl. 1., figs. 7, 10. Prep.: Súr-1, 533/1. P: 31.9/96.

Locus typicus: Súr (Mts Bakony). Borehole Súr-1, 233.6 m.

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

Diagnosis: trilete miospores, amb triangular, with straight or slightly convex sides, protruding valvate corners. Laesura is straight, r=1. The proximal surface is smooth or punctate; 6–9 large, semicircular verrucae are to be found in an irregular arrangement on the distal surface. The verrucae are generally 4–5 μ high, 7–11 μ wide. At the corners, 10–12 μ long, 10–14 μ wide valvae can be found. The interradial thickening is 2–4 μ.

Spore size: 50–60 μ.

Differential diagnosis: This new *Trilobosporites* species differs from the other species belonging to this genus, in the large verrucae and the button-like projecting valvae.

Occurrence: It mostly occurs in the Lower Albian sediments of Mts Gerecse (Vértessomló Formation), but the specimens in the best state of preservation were found in the clayey-marl rocks of the Tés Formation.

Conclusions

The recent representatives of Matoniaceae live on a narrow ecological range in the Indo-Malaysian regio, in the very rainy, lagoon-like areas of the tropical rain zone. It is to be supposed that their ancient ancestors, primarily in the Jurassic and Cretaceous, developed under similar ecological conditions. Megafossils, and more importantly, dispersed spores, that demonstrate the presence of spore formation by of Matoniaceae, were found in the largest numbers from the Wealden and Albian of the Cretaceous. Coal-deposits arose from remains of the marshy forests in the neighbourhood of the brackish waters and shoals of the Wealden.

Weichselia, probably of the Matoniaceae genus, is recorded by BATTEN (1974), in the course of the reconstruction of the Wealden deltaic flora in England, as a plant of riversides and coastal sand-banks. In Hungary, the spores of Matoniaceae were found in the best state of preservation, largest numbers and in variety of shape from the samples of the Tés Formation, which is attributed to sandy, fresh-water sedimentation. It was mentioned in our earlier work (JUHÁSZ, 1977) that the acme-stage of the Schizaeales (which are related to the Matoniaceae and mostly live today under similar ecological conditions) may have been in the Lower and Middle Cretaceous. Our proposition can also be extended to the Matoniaceae of which two acme centres may be stated as probable: one of these in Wealden in Western Europe, the other in the time of the Middle-Upper Albian in Hungary.

The latter one is proved by the palynological results summarized in our present paper, recording the occurrence of the following species in the Hungarian Lower and Middle Cretaceous: *Matonisporites weylandi* (DÖR., 1965) n. comb., *Matonisporites major* DEÁK 1964, *Matonisporites simplex* DEÁK 1964, *Matonisporites sueme-*

gensis n. fsp., *Matonisporites minor* DEÁK 1964, *Matonisporites planitorosus* (DÖR. 1965) n. comb., *Matonisporites* fsp., *Phlebopterisporites hungaricus* n. gen. et n. fsp., *Phlebopterisporites harskutensis* n. fsp., *Phlebopterisporites equiexinus* (COUPER 1958) n. comb., *Phlebopterisporites globosus* (KIMYAI 1966) n. comb., *Phanerosorisporites surensis* n. gen. et n. fsp., and *Trilobosporites goczani* n. fsp.

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