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GLEICHENIACEAE SPORES FROM LOWER CRETACEOUS DEPOSITS OF HUNGARY

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Abstract

The present palynological study discusses Gleicheniaceae-type spores isolated from the Lower Cretaceous sediments of Hungary.

Twenty species were identified and placed into the following organgenera as follows:

Gleicheniidites (11 species), *Clavifera* (4 species), *Plicifera* (2 species), and *Ornamentifera* (3 species).

Stratigraphically the Gleicheniaceae spores play an important part in the spore-pollen complexes of the Upper Barremian to Lower Aptian deposits of the Mts Bakony, and Albian sediments of the Mts Villány, where mainly species of the *Gleicheniidites* and *Plicifera* organgenera predominate.

Both the actual number of spores and the number of species decreases for the Gleicheniaceae spores in the Albian assemblages of the Transdanubian Central Mts, but here appear the typical forms of the *Ornamentifera* and *Clavifera* species.

Introduction

The Gleicheniaceae is one of the Filicales order widest known ancient fern families.

The recent Gleicheniaceae species number about 160.

Their zone of distribution ranges from the Korean pensinula and Florida to New Zealand (SEWARD, 1912).

The shoots of recent species usually crawl on the ground or are slightly raised; in the latter instances they climb on shrubs or trees. Their sori are arranged in row, lack indusia, and have few (2—8) sporangia. The spores are trilete or monolete homoiospores.

The Gleicheniaceae ancestral representatives have been traced from the Carboniferous age, but significantly they became widespread only in the Mesozoic. The number of fossil leaf records traced from Jurassic and Cretaceous is large. We can find the tabulated summary of these megafossils in the excellent work of BOLCHOVITINA (1968). The associated and dispersed „gleicheniid" spores of Lower Cretaceous rocks are very similar to modern Gleicheniaceae spores. Shared characteristics of the modern and fossil „gleicheniid" spores are the following:

triangular equatorial outline;
interradial crassitudes at the equator;
presence of arcuate folds on the distal surface;
usually smooth, rarely ornamented exosporium.

Besides the above, certain fossil forms also have the following characteristics:
presence of processes or clavate projections at the corners (radial crassitudes);
a broad equatorial thickening on the distal face (distal crassitudes).

Previous works

COPELAND (1947), NAKAI (1950), HOLTTUM (1957) have studied the recent Gleicheniaceae family classification the most extensively. From among them we consider most important the work of NAKAI, who also included the spores' characteristics on the classification. He distinguished three subfamilies: Gleichenioideae and Stromatopterideae have trilete spores, Sticherioideae has monolete spores. From among the Gleicheniaceae spores of the Cretaceous time we know only trilete forms, the classification of which is based on the spore morphology. The most widely known of these works are those of KRUTZSCH (1959), and BOLCHOVITINA (1966, 1968).

The first fossil „gleicheniid" spore was described by ROSS (1949) as *Gleicheniidites senonicus,* from the Senonian of ÅSEN (Sweden), but he did not give a generic diagnosis. Upon the suggestion of DELCOURT and SPRUMONT (1955) the genus name *Gleicheniidites,* was retained with *Gl. senonicus* as its type species. BOLCHOVITINA (1953), COOKSON (1953), ROUSE (1957), and GRIGORJEVA (1961) described many „gleicheniid" types and placed the forms into the natural genus *Gleichenia* SMITH. KRUTZSCH (1959) created six subgeneric categories within the *Gleicheniidites* ROSS, on the basis of interradial thickenings, the ornamentation, and the projections at the apices. BOLCHOVITINA (1966) divided the *Gleicheniidites* genus into four new organ genera, where the *Clavifera* n. gen. essentially corresponds to the *Gleicheniidites (Triplexisporis)* W. KR. 1959 subformgenus, and *Ornamentifera* n. gen. to the *Gleicheniidites (Peregrinisporis)* W. KR. 1959 subformgenus.

Bolchovitina's third new genus, *Plicifera,* has three arcuate folds on the distal surface and equatorially uniformly thin walls on the spore.

At the same time she didn't attribute subgenus status to KRUTZSCH's four other subgenera. One can agree with BOLCHOVITINA's opinion since KRUTZSCH designated as the main differences between the *Gleicheniidites (Gleicheniidites), Gleicheniidites (Toridistalisporis), Gleicheniidites (Radiatisporis),* and *Gleicheniidites (Laticrassisporis)* subgenera the deviation in the interradial wall thickenings and the location of the „Tori" on the proximal or distal surface. From our material it is also apparent that the arcuate folds, referred to by KRUTZSCH as the „Tori" practically always appear on the distal surface. Although in Middle-European palynological literature KRUTZSCH's nomenclature is becoming widespread, we consider the names created by BOLCHOVITINA more acceptable and follow them in the present work.

SKARBY's (1964) work is very important from the point of view of species diagnosis. Aided by a re-examination of ROSS' (1949) original material, she gave exact genus and species descriptions on the basis of the *Gleicheniidites senonicus* lectotype. Also, by examining and demonstrating disperse and associated spores, collected from the type location, she revised some that were described as other forms, designating them as synonyms of *Gleicheniidites senonicus.* The most important among them are:

a) *Gleicheniidites circinnidites* COOKSON 1953.
We find many forms published and illustrated with this name in Lower

Cretaceous works, that give a very heterogeneous picture of the species. Most of them resemble *Gl. senonicus* Ross.
However, in our opinion, based on the photograph of Cookson's type species, it is rather a synonym of *Gleicheniidites umbonatus* (Bolch. 1953) Bolch. 1968 than of *Gl. senonicus* Ross 1949.

b) *Gleichenia stellata* Bolch. 1953, *Leiotriletes orientalis* Bolch. 1953, *Gleichenia angulata* Bolch. 1953 species Bolchovitina (1968) herself admits that Skarby's photographs convinced her that these forms belong to *Gl. senonicus*. She herself would not write them as individual species in her above works! It is also significant that after 1968 mainly Soviet-work publishes these species names as „gleicheniid" forms.

c) *Gleichenia dicarpoides* Grigorieva 1961 is also a synonym of *Gl. senonicus* Ross.

d) Skarby (1964) placed the *Gleichenia laeta* Bolch. 1953, *Gleichenia umbonata* Bolch. 1953, and *Gleicheniidites (Toridistalisporis) toriconcavus* W. Kr. 1959 species in she synonymy. We do not agree with this opinion.

The following works from the Hungarian literature on the Lower Cretaceous are concerned with Gleicheniaceae spores: Deák (1963) from the Albian of Mts Bakony, Góczán (in Fülöp, 1966) from the Albian of Mts Villány, Rákosi (1972) from the Neocomian of the Basin Dorog, and Miháltz—Faragó and Juhász (1972) from recycled sporomorphs of Borehole 11. at Lőkösháza.

Systematic description

Anteturma: SPORITES H. Pot. 1893
Turma: TRILETES Reinsch 1881
Subturma: ZONOTRILETES Waltz 1935
Infraturma: TRICRASSATI Dettmann 1963

Organ genus: *GLEICHENIIDITES* (Ross 1949) Bolch. 1968.

Remarks: Dettmann's (1963), Skarby's (1964), and Bolchovitina's (1968) diagnoses are very similar. They all contain the characteristics listed below: Triangular, trilete microspores. Smooth or almost smooth exosporium with equatorial thickenings (interradial crassitudes). Usually arcuate folds may be found on the distal surface.

Gleicheniidites senonicus Ross 1949
Pl. I., Figs. 1—4.

1949 *Gleicheniidites senonicus* Ross, p. 31—32. Pl. 1. Fig. 3.

Remarks: Skarby (1964), and Bolchovitina (1968) both publish a synonym list where various authors consider *Gl. senonicus* Ross as synonym of the published species of *Gl. senonicus* or of another species (38 names appear on each list).

Distribution: A widely distributed species in the Lower Cretaceous of Europe and North America. In Hungary it is one of the most abundant forms in the Barremian to Lower Aptian sediments.

Gleicheniidites umbonatus (BOLCH. 1953) BOLCH. 1968
Pl. I., Figs. 5, 6.

1953 *Gleichenia umbonata* BOLCHOVITINA, p. 53, Pl. 8. Figs. 4—7.
1968 *Gleicheniidites umbonatus* (BOLCH. 1953) BOLCHOVITINA, p. 41, Pl. 9., Figs. 1—9.

Description: Amb triangular, apices sharp; the outer margin of the crassitudes sinuous, inner wall-contour straight. The interradial crassitudes are 3,5—4 μ thick, becoming much thinner at the apices. On the distal face there are narrow, strongly concave folds. Size: 25—33 μ.

Remarks: The description of *Gleicheniidites (Triremisporites) bolchovitinae* DÖRING 1965 agrees with that of *Gl. umbonatus* (BOLCH. 1953) BOLCH. 1968, it is a junior synonym of the latter species.

Occurrence: A common species of Sümeg Formation in the Bakony Mts.

Gleicheniidites delcourti DÖRING 1965
Pl. I., Figs. 7, 8.

1965 *Gleicheniidites delcourti* DÖRING, p. 29, Pl. 18, F. 9, 10.

Description: A triangular spore with straight or slightly convex sides, acute corners. The interradial crassitudes are well developed, 5—8 μ at centre, exosporium smooth, approximately 1 μ thick near apices. The 3—4 μ thick arcuate folds on the distal surface are so strongly concave that they almost touch each other. Size range: 40—44 μ.

Occurrence: The species is recorded from Wealden of GDR, Belgium and the Netherlands. In Hungary it occurs throughout the Neocomian of the Dorog Basin (RÁKOSI, 1972), and Sümeg Formation of the Bakony Mts (Barremian-Aptian).

Gleicheniidites radiatus (BOLCH. 1953) BOLCH. 1968
Pl. I., Figs. 9, 10.

1953 *Gleichenia radiata* BOLCHOVITINA, p. 54, Pl. 8, Figs. 14, 15.
1968 *Gleicheniidites radiatus* (BOLCHOVITINA 1953) BOLCHOVITINA, p. 43, Pl. 9, Figs. 8—10.

Description: Triangular spore with straight or concave sides and pointed apices. The interradial thickenings are 2—3 μ wide. On the distal surface are three, 3,5—4 μ wide folds on which little stripes, parallel to each other are perpendicularly located. Size range: 28 μ.

Occurrence: A rare form which occurs in the Tés Formation (Middle Albian) of the Bakony Mts, Hungary.

Bolchovitina described this form from Aptian of Russian Platform and from Cenomanian of Middle Urals.

Gleicheniidites rasilis (BOLCH. 1953) BOLCH. 1968
Pl. I., Figs. 11, 12.

1953 *Gleichenia rasilis* BOLCHOVITINA, p. 53, Pl. 7, Figs. 16—18.
1968 *Gleicheniidites rasilis* (BOLCH. 1953) BOLCHOVITINA, p. 43. Pl. 11, Figs. 1—7.

Description: Trilete spore with triangular or rounded triangular amb and rather convex sides. Compared to the spore size it has wide, 3—4 μ, *lens-shaped* interradial crassitudes. (This lends to the form the rounded equator contour!). The arcuate distal folds are narrow. Size range: 32 μ.

Occurence: The species is of widespread geographic and stratigraphic distribution in the USSR. It appears in strata of Albian age in the Transdanubian Central Mts, Hungary.

Gleicheniidites compositus (BOLCH. 1953) DEÁK 1964
Pl. I., Figs. 15. 16.

1953 *Stenozonotriletes compositus* BOLCHOVITINA, p. 46, Pl. 6, F. 8.
1964 *Gleicheniidites compositus* (BOLCH. 1953) DEÁK, p. 97, Pl. 1., Fig. 10.

Description: Triangular form with pointed apices. The outer contour of the equatorial sides is slightly sinuous, the inner contour is almost straight. The distal folds are slightly arcuated, thus the area enclosed by them is relatively large. Size range: 22—28 μ

Occurrence: Occurs infrequently throughout the Tés Formation (Middle Albian) in Hungary.

Gleicheniidites minor DÖRING 1965
Pl. I., Figs. 13, 14.

1965 *Gleicheniidites (Triremisporites) minor* DÖRING, p. 28, Pl. 5., Figs. 9—11.

Remarks: The fact that *Gleicheniidites* minor has an interradial thickening that reaches 7 μ, and that both the inner and outer contours of the spore wall are both sinuous distinguishes it from *Gl. umbonatus* and *Gl. compositus* that possess 3—4 μ and 2—3 μ thick exosporium respectively and sinuous outer, straight inner wall contours.

Occurrence: Gl. minor is of widespread distribution in the early Lower Cretaceous sediments: in GDR from Wealdien at Mecklenburg; in USSR from the Neocomian of Basin Donec; in Hungary from the Neocomian of the Dorog Basin, and from the Sümeg Formation.

Gleicheniidites laetus (BOLCH. 1953) BOLCH. 1968
Pl. I., Figs. 17—20.

1953 *Gleichenia laeta* BOLCHOVITINA, p. 22, Pl. 2, Figs. 5—7.
1968 *Gleicheniidites laetus* (BOLCH. 1953) BOLCHOVITINA, p. 40. Pl. 6., Figs. 35—46.

Remarks: The smallest sized Gleicheniaceae species. Spore size: 16—22 μ. It possesses straight or concave sides and triangular amb. The interradial crassitudes are 1—1,5 μ wide, and may narrow down to 0,5 μ at the corners. The distal folds are very thin and easily wrinkle.

Occurrence: The species is common throughout the Lower Cretaceous of USSR.

GÓCZÁN (1966) recorded a large number from the Albian of Villány Mts; a frequent form in the Vértessomló Formation (Lower Albian) in Hungary.

Gleicheniidites carinatus (BOLCH. 1953) BOLCH. 1968
Pl. I., Figs. 25, 26.

1953 *Gleichenia carinata* BOLCHOVITINA, p. 53, Pl. 7, Figs. 14, 15.
1968 *Gleicheniidites carinatus* (BOLCH. 1953) BOLCHOVITINA, p. 42, Pl. 9, Figs. 1—15.

Description: Subtriangular, rarely rounded amb with straight or convex sides. The *trapezoid-shaped* interradial crassitudes are 6—8 μ wide. The distal folds may be as thick as 4—5 μ. Size range: 45—64 μ. (This is the largest sized „gleicheniid" spore).

Occurrence: USSR: wide geographical and stratigraphical distribution in Lower Cretaceous. In Hungary: a common form from Vértessomló Formation of Gerecse Mts (Lower Albian), and the Tés Formation of the Bakony Mts (Middle Albian).

Gleicheniidites latifolius DÖRING 1965
Pl. II., Figs. 1, 2.

1965 *Gleicheniidites (Triremisporites) latifolius* DÖRING, p. 30, Pl. 6, Figs. 9, 10.

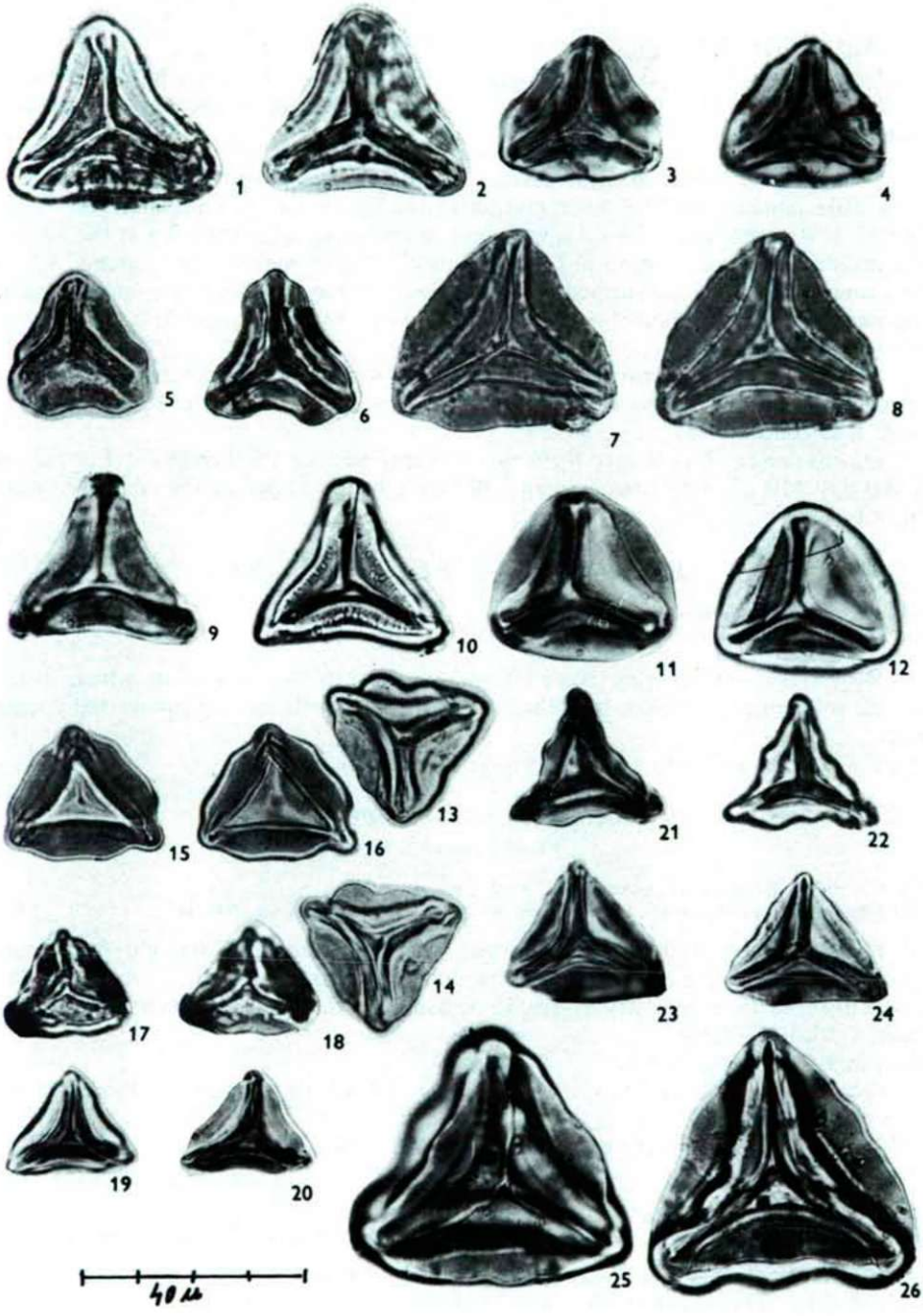
Description: A subtriangular spore form with a strongly concave amb, and corners rounded in a wide arc. The interradial crassitudes are very wide, 6—8 μ, and narrow down suddenly to 1 μ toward the corners. The three, comparatively thin, 1—1,5 μ wide arcuate folds are on the distal surface. Size range: 37 μ.

Occurrence: Its appearance in the Upper Jurassic—Wealdien rocks at Mecklenburg in GDR is, described by DÖRING (1965). In Hungary it is a rare form which occurs in the Albian and Neocomian sediments of the Transdanubian Central Mts.

Plate I

1, 2 *Gleicheniidites senonicus* (ROSS 1949) BOLCH. 1968
Bakony Mts, Sümeg, Süt-17: 202,5. P: 44,7/91,5. Lower Aptian.
3, 4 *Gleicheniidites senonicus* (ROSS 1949) BOLCH. 1968
Bakony Mts, Tés. Té-27: 49/2. P: 29/104,4. Middle Albian.
5 *Gleicheniidites umbonatus* (BOLCH. 1953) BOLCH. 1968
Gerecse Mts, Bikol. Süttő-3: 125/1. P: 33,6/99,1. Lower Albian.
6 *Gleicheniidites umbonatus* (BOLCH. 1953) BOLCH. 1968
Bakony Mts, Sümeg, Süt-17: 332/1. P: 35/98. Upper Barremian.
7, 8 *Gleicheniidites delcourti* DÖRING 1965
Bakony Mts, Sümeg. Süt-17: 217,3/1. P: 41,1/92,5. Lower Aptian.
9, 10 *Gleicheniidites radiatus* (BOLCH. 1953) BOLCH. 1968
Bakony Mts, Sur. Sur-1: 556,7/1. P: 33,7/109. Middle Albian.
11, 12 *Gleicheniidites rasilis* (BOLCH. 1953) BOLCH. 1968.
Bakony Mts, Sur. Sur-1: 556,7/1. P: 38,9/102. Middle Albian.
13, 14 *Gleicheniidites minor* DÖRING 1965
Bakony Mts, Devecser. Dv-3: 1288,6/1. P: 41,5/95,5. Barremian.
15, 16 *Gleicheniidites compositus* (BOLCH. 1953) DEÁK 1964.
Bakony Mts, Úrkút. Ú-5: 71,2/5. P: 31,6/110,2. Middle Albian.
17, 18 *Gleicheniidites laetus* (BOLCH. 1953) BOLCH. 1968.
Gerecse Mts, Bikol. Süttő-3: 125/4. P: 32/104,2. Lower Albian.
19, 20 *Gleicheniidites laetus* (BOLCH. 1953) BOLCH. 1968.
Gerecse Mts, Vértessomló. Vst-5: 42/1. P: 44/100. Lower Albian.
21, 22 *Clavifera negra* (BOLCH. 1953) n. comb.
Bakony Mts, Úrkút. Ú-5: 71,2/5. P: 31,6/110,4. Middle Albian.
23, 24 *Clavifera* cf. *nigra* (BOLCH. 1953) n. comb.
Bakony Mts, Úrkút. Ú-5: 73,2/6. P: 37,2/102,6. Middle Albian.
25, 26 *Gleicheniidites carinatus* (BOLCH. 1953) BOLCH. 1968.
Gerecse Mts, Bikol. Süttő-3: 90/1. P: 41,5/99,3. Lower Albian.

Plate I



Gleicheniidites saparicus n. sp.
Pl. II., Figs. 3, 4.

Holotype: Pl. II., Figs. 3, 4. Prep.: Sz—42, 80:3/6. P: 38/103.
Locus typicus: Bakony Mts, Szápár. Borehole Sz—42, 115,8 m.
Stratum typicum: Turrillites marl. Upper part of Pénzeskút Formation (Lower Cenomanian).

Diagnosis: Trilete miospore with rounded amb and convex sides. The apices are a little pinched in. The outer margin of the spore wall is undulated, the inner contour is straight. The 3,5—4,5 μ wide interradial crassitudes are 0,7 μ at the apices. The proximal surface is smooth. Laesura simple, slightly sinuous and extends 4/5 of the radius. On the distal surface there are three scarcely arching, 1 μ broad, folds. The part enclosed by them is occasionally decorated by the perisporium remainders. Size range: 34 μ.

Differential diagnosis: The *Gl. saparicus* n. sp. distinct from the other „gleicheniid" species by its rounded amb, and its sinuous outer and straight inner spore wall contour.

Occurrence: Not a rare form in the upper part of the Pénzeskút Formation of Bakony Mts (Lower Cenomanian). It hasn't occurred yet in the older (Albian) deposits.

Organ genus: *PLICIFERA* BOLCH. 1966

1966 *Plicifera* BOLCHOVITINA, p. 68.
1967 *Plicifera* BOLCHOVITINA, p. 62.

Remarks: *Bolchovitina* placed those forms into this genus on which distal arcuate folds may be found, but which have smooth walls lacking interradial crassitudes.
Type species: *Plicifera delicata* (BOLCH. 1953) BOLCH. 1966.

Plicifera decora (CHLONOVA 1960) BOLCH. 1968
Pl. II., Figs. 5, 6.

1960 *Gleichenia decorus* CHLONOVA, p. 18, Pl. 2, Figs. 4—6.
1968 *Plicifera decora* (CHLONOVA 1960) BOLCHOVITINA, p. 36, Pl. 6, Figs. 20—34.

Description: Trilete miospore with triangular amb and straight or slightly concave sides, rounded apices. The exosporium is thin and smooth. The arcuate folds on the distal surface may vary in length, occasionally they may even reach the apices. Their width is 1—1,5 μ.
Size range: 20—26 μ.
Occurrence: A rare form which occurs in the Albian sediments of Bakony Mts.

Plicitera delicata (BOLCH. 1953) BOLCH. 1966
Pl. II., Figs. 7, 8.

1953 *Gleichenia delicata* BOLCHOVITINA, p. 22, Pl. 2, Figs. 1—4.
1968. *Plicifera delicata* (BOLCH. 1953) BOLCHOVITINA, p. 35, Pl. 5, Figs. 14—21, and Pl. 6, Figs. 1—19.

Description: A triangular spore with rounded apices, and slightly convex or straight sides. The exosporium smooth, is uniformly thin, 0,5—1 μ thick. On the

distal surface the three folds are strongly arcuate, the ends of the single folds usually reach the apices. Spore size: 30—42 μ.

Remarks: *Bolchovitina* places those forms smaller than 26 μ into *Plicifera decora*, and those larger than 26 μ into *Plicifera delicata*.

Occurrence: A widely distributed species in Lower Cretaceous of USSR. In Hungary a frequent form from Vértessomló Fm. of the Gerecse Mts and Basin Tatabánya.

Organ genus: *ORNAMENTIFERA* BOLCH. 1966

1966 *Ornamentifera* BOLCHOVITINA, p. 69.
1967 *Ornamentifera* BOLCHOVITINA, p. 63.

Remarks: Bolchovitina placed those „gleicheniid" spores here that have interradial crassitudes and distal folds, and that also have an ornamented surface. The exosporium may have granulate, tuberculate-verrucate, or echinate ornamentation. This organ genus corresponds to the *Gleicheniidites (Peregrinisporis)* W. KR. 1959 subgenus, and to the *Gleicheniidites* GRIGORJEVA 1961 (pars) genus.

The type species: *Ornamentifera echinata* (BOLCH. 1953) BOLCH. 1966

Ornamentifera tuberculata (GRIG. 1961) BOLCH. 1968
Pl. II., Figs. 9, 10.

1961 *Gleicheniidites tuberculatus* GRIGORJEVA, p. 62, Pl. 16, F. 4, 5.
1968 *Ornamentifera tuberculata* (GRIG. 1961) BOLCHOVITINA, p. 51, Pl. 16, Figs. 21—23.

Description: trilete spore with triangular-subtriangular amb, and straight or slightly convex sides, and rounded apices. The 3,5—4 μ wide interradial crassitudes thin down to 2 μ toward the apices. The exosporium is proximally smooth, on the distal surface is finely tuberculate.

The tubercules are very small, being 1 μ high at the maximum. Size range: 39 μ.

Occurrence: Its appearance in the Albian—Cenomanian of West-Siberia, USSR, is described by BOLCHOVITINA (1968).

Occurs infrequently throughout the Tés Formation of Bakony Mts in Hungary (Middle Albian).

Ornamentifera granulata (GRIG. 1961) BOLCH. 1968
Pl. II., Figs. 11, 12.

1961 *Gleicheniidites granulatus* GRIGORJEVA, p. 60, Pl. 15, F. 11—13.
1968 *Ornamentifera granulata* (GRIG. 1961) BOLCHOVITINA, p. 51, Pl. 16, Figs. 5—20.

Description: Trilete spore with a triangular amb, slightly convex sides and rounded apices.

The 2 μ thick exosporium is two-layered. The 1,5 μ thick endexosporium is smooth, the ectexosporium, 0,5 μ thick, is granulate. The interradial crassitude is 4—5 μ wide. On the distal surface the strongly arcuate folds are 2 μ wide. Size range: 38 μ.

Occurrence: It occurs in the Tés Formation of Bakony, Hungary.

Ornamentifera peregrina (BOLCH. 1953) BOLCH. 1968
Pl. II., Figs. 21, 22.

1953 *Gleichenia peregrina* BOLCHOVITINA, p. 55, Pl. 8, Fig. 18.
1968 *Ornamentifera peregrina* (BOLCH. 1953) BOLCHOVITINA, p. 52, Pl. 16, Fig. 24.

Description: Trilete spore with triangular amb, straight or concave sides, and rounded apices. For the spore size its interradial crassitudes are comparatively wide, 4 μ. The distal folds are strongly arcuate and sometimes even touch each other. The exosporium is 1,5 μ thick at the apices. Its entire surface is very densely covered with irregularly shaped, and various sized, around 1 μ, small verrucae. Size range: 26—34 μ.

Occurrence: This species is one of characteristic forms of the upper part of Vértessomló Formation in Mts Gerecse.

Organ genus: *CLAVIFERA* BOLCH. 1966

1966 *Clavifera* BOLCHOVITINA, p. 68.
1967 *Clavifera* BOLCHOVITINA, p. 63.

Remarks: This genus includes those triangular „gleicheniid" forms that possess interradial crassitudes and distal folds, and which may have apical projections or extension (radial crassitudes), and distal equatorial thickenings (distal crassitudes). The exosporium is smooth or more rarely, tuberculate-verrucate.

Type species: *Clavifera triplex* (BOLCH. 1953) BOLCH. 1966.

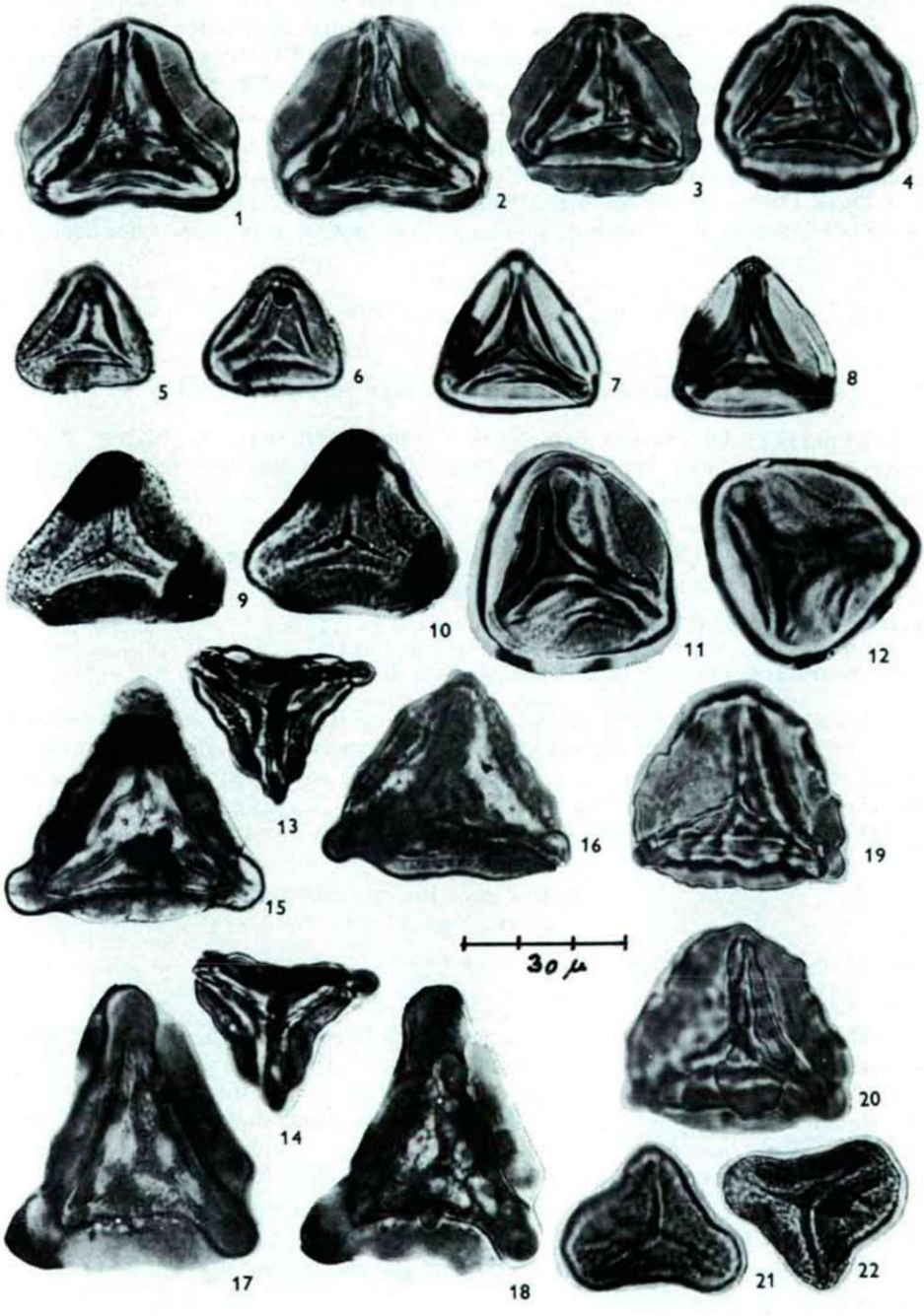
Clavifera nigra (BOLCH. 1953) n. comb.
Pl. I., Figs. 21, 22.

1953 *Gleichenia nigra* BOLCHOVITINA, p. 54, Pl. 8, Figs. 8—9.
1959 *Gleicheniidites (Triplexisporis) nigra* (BOLCH. 1953) W. KRUTZSCH, p. 114.

Plate II

1, 2*s* *Gleicheniidites latifolius* DÖRING 1965.
Basin Tatabánya. Ta-1329: 461,5/3. P: 43,3/112,1. Lower Albian.
3, 4 *Gleicheniidites saparicus* n. fsp.
Bakony Mts, Szápár. Sz-42/3/6—1. P: 32/103. Lower Cenomanian.
5, 6 *Plicifera decora* (CHLONOVA 1960) BOLCH. 1968
Bakony Mts, Úrkút. Ú-5: 71,2. P: 40,5/95. Middle Albian.
7, 8 *Plicifera delicata* (BOLCH. 1953) BOLCH. 1966
Bakony Mts, Sur. Sur-1: 556,7/1. P: 42,4/111. Middle Albian.
9, 10 *Ornamentifera tuberculata* (GRIG. 1961) BOLCH. 1968.
Bakony Mts, Sur. Sur-1: 520,9/1. P: 46/90,5. Middle Albian.
11, 12 *Ornamentifera granulata* (GRIG. 1961) BOLCH. 1968.
Gerecse Mts, Vértessomló; Vst-5: 72,1/1. P: 39,1/99,4. L. Albian.
13, 14 *Clavifera triplex* (BOLCH. 1953) BOLCH. 1966
Bakony Mts, Csehbánya. Cseh-5: 277/1. P: 41,5/108. Middle Albian.
15 *Clavifera triplex* (BOLCH. 1953) BOLCH. 1966
Vértes Mts, Oroszlány. O-1884: 238/2. P: 42,4/110,9. L. Albian.
16 *Clavifera triplex* (BOLCH. 1953) BOLCH. 1966
Bakony Mts, Sümeg. Süt-17: 297,9/1. P: 33/95. Lower Aptian.
17, 18 *Clavifera rudis* BOLCH. 1968.
Bakony Mts, Bakonynána: 2/1—2. P: 40,4/83,9. Upper Albian.
19, 20 *Clavifera tuberosa* BOLCH. 1968.
Bakony Mts, Bakonynána: 2/3—1. P: 32,6/103. Upper Albian.
21, 22 *Ornamentifera peregrina* (BOLCH. 1953) BOLCH. 1968.
Gerecse Mts, Bikol. Süttő-3: 104/2. P: 39/103,6. Lower Albian.

Plate II



Description: The spore's amb resembles an equilateral triangle. It has slightly concave sides. The outer and inner contours of the spore wall are sinuous. Laesurae are simple, narrow and reach the apices. The interradial crassitudes, each 2,5 μ wide, are even and thin down a little bit toward the apices. The distal folds are strongly arcuate; they fuse and take up a large part of the distal surface. Size range: 24—26 μ.

Remarks: Accepting SKARBY's opinion on the properties of juvenile forms originating from the sporangia of one and the same species, BOLCHOVITINA considers *Clavifera nigra* as an abortive spore of *Gleicheniidites senonicus*. During our study and DEÁK (1964) of the Middle Albian deposits (Tés Formation) in Mts Bakony this form consistently appeared, so that it does not go with other Gleicheniaceare species.

Clavifera cf. *nigra* (BOLCH. 1953) n. comb.
Pl. I., Figs. 23, 24.

1963 cf. *Gleicheniidites circinnidites* (COOKSON 1953) BRENNER, Pl. 11, Figs. 4, 5.

Remarks: This form's contour is a symmetrical triangular shape. With its apices protruding with the aid of the distal folds, it resembles *Clavifera nigra;* its zone of occurrence is also the same.

Clavifera triplex (BOLCH. 1953) BOLCH. 1966
Pl. II., Figs. 13—16.

1953 *Gleichenia triplex* BOLCHOVITINA, p. 55, Pl. 8, Figs. 10—13.
1959 *Gleicheniidites (Triplexisporis) triplex* KRUTZSCH, p. 114.
1968 *Clavifera triplex* (BOLCH. 1953) BOLCHOVITINA, p. 46—47. Pl. 11, 12.

Remarks: A wide geographic distribution of the Lower Cretaceous bears this spore form; it is a well known, well characterized species. Although it occurs in several strata of the Lower Cretaceous, it is dominant in the Aptian-Albian deposits all over the world; the same is also true in Hungary. Its size: 32—54 μ. The form and size of radial crassitudes may vary greatly. The spore is smooth with straight or sinuous sides.

Clavifera rudis BOLCH. 1968
Pl. II., Figs. 17, 18.

1968 *Clavifera rudis* BOLCHOVITINA, p. 48, Pl. 13, Figs. 9—18, Pl. 14, Figs. 1—15, and Pl. 15, Figs. 1—12.

Description: This is a large spore with a triangular amb, straight or slightly convex sides and knobby extensions on the apices. The proximal surface is smooth and sharply distinguished from the equatorial part where there is a wide, 7—9 μ, interradial thickening. The central portion of the distal surface is sculptured with verrucae. These are possible: rarely spaced, large, irregular verrucae, or densely distributed, high or short warts (distal crassitudes). Size range: 52—76 μ.

Occurrence: This species enters the Russian Lower Cretaceous succession in the Aptian (at Harkow).

Its appearance is in the Upper Albian age (Pénzeskút Formation of the Mts Bakony) of Hungary.

Clavifera tuberosa BOLCH. 1968
Pl. II., Figs. 19, 20.

1968 *Clavifera tuberosa* BOLCHOVITINA, p. 47, Pl. 12, Figs. 21—24, Pl. 13, Figs. 1—8.

Description: A triangular spore with straight or slightly convex sides. The laesurae are simple and reach the apices. The extensions on the apices (radial crassitudes) do not protrude much. The proximal surface is smooth. On the distal surface there are large tuberculae (distal crassitudes), that are somewhat raised from the surface, and that run together. The interradial thickenings are wide, 6—8 μ. On certain specimens distal, arcuate folds may be also appear under the tuberculae. Size range: 36—54 μ.

Occurrence: This species is described by BOLCHOVITINA from the Aptian deposits of Donec Basin and Volgograd, USSR. In Hungary it appears in the Upper Vraconian deposits (Pénzeskút Fm.) of Bakony Mts.

Remarks: On the last two forms recorded by BOLCHOVITINA (1968) the distal surface ornamentation is not typical of *Clavifera*, and much resembles that of the *Trubasporites Vavrdova* genus into which DÖRING (1965) also already placed the verrucate surfaced forms. Here, however, the proximal surface is also richly ornamented, while in *Clavifera rudis*, *Cl. tuberosa*, and *Cl crassiuscula* the proximal surface is smooth.

Discussion

A series of examinations of the well developed Hungarian Lower Cretaceous deposits, thus Barremian-Aptian (Sümeg Formation) of Bakony, Albian-Lower Cenomanian (Tés Formation and Pénzeskút Formation) of Mts Bakony and Vértes, the Neocomian and Lower Albian (Vértessomló Formation) of Mts Gerecse, as well as the Albian rocks of Mts Villány have produced a rich collection of Gleicheniaceae spores. We separated twenty species during the study, as the systematic part shows. From among them we placed 11 species into the *Gleicheniidites* genus, 4 species into the *Clavifera*, 3 species into the *Ornamentifera*, and 2 species into the *Plicifera* genus.

The distribution percentage of the Gleicheniaceae spore species in the various aged Lower Cretaceous sediments has stratigraphical importance; that is to say, after the Schizaeales, the Gleicheniaceae family was the most powerful plant group in the Lower Cretaceous.

The probable center of origin and emination of the Gleicheniaceae was what is now the Russian Platform. Here the number of Gleicheniaceae spores comprised 60—80% of the total spore-pollen complex in the time of the Barremian-Aptian strata. The closeness of this area is also reflected in our spore picture.

In the Barremian age their percentage composition increases by degrees; we can date their time of flowering from the Lower Aptian deposits of the Mts Bakony, where they constitute 45—55% of the spore-pollen complex, and their species number increases. The following species are characteristic of the Barremian:

Gleicheniidites senonicus, *Gl. delcourti*, *Gl. umbonatus*, *Gl. minor*, and *Gl. laetus*.

In addition to the above *Plicifera delicata*, *Clavifera triplex*, *Gl. carinatus*, and *Gl. rasilis* appear in the Aptian age.

The importance of Gleicheniaceae suddenly diminishes in the Albian deposits. Only in the mid-Albian rocks of the Mts Villány and Mts Bakony we find some accidental enrichment. Representatives of *Gl. senonicus, Gl. laetus,* and *Gl. umbonatus* also form the species' bulk here; the other species only rarely occur. However new forms appear that just occasionally occurred in the older deposits or that did not appear at all; such forms in the Lower Albian are *Ornamentifera peregrina, Plicifera decora, Gleicheniidites latifolius,* and in the Middle Albian rocks *Gl. radiatus, Gl. compositus, Clavifera nigra, Clavifera tuberosa, Ornamentifera tuberculata.*

In the Upper Albian the mid-Albian forms dominate in addition to *Gl. senonicus* and *Gl. laetus.*

New forms are *Clavifera rudis* and *Ornamentifera granulata.* Furthermore, a characteristic new species of the Lower Cenomanian is *Gleicheniidites saparicus* n. sp. Here, however, members of Gleicheniaceae are very rarely present.

The percentage proportion of the various Gleicheniaceae spores in the Barremian and Aptian deserves more detailed attention, however the Albian does not; here the presence or absence of an individual characteristic form can give information together with the other spore types.

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