

MIOCENE PALYNOMORPHS OF TAIWAN—III. spores

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Abstract: Forty-three form genera and 92 taxa of the Miocene fossil sporomorphs are reported in this paper. Thirty-six form genera and 69 taxa are here described for the first time in Taiwan.

INTRODUCTION

The palynological investigation of Miocene sedimentary rocks in Taiwan began in 1971 which was financially supported by the U.S.-China Cooperative Science Program. The sediments of the Chuhuangkeng oil field along the Houlung River, Miaoli county was selected for pollen analysis. As it was the initial period for pollen analysis in Taiwan, the result of this investigation (Canright, 1971; Huang, 1973) was not significant, and reinvestigation of the same project is highly desirable.

During 1974 and 1975, I collected again the sedimentary rocks of the Miocene in Taiwan at four different locations: namely along the highway route between Keelung and Yeliu, Shihiting, and Sanhsia in Taipei county, also along the road between Chuhuangkeng and Nanliao in Miaoli county, 101 rock samples were collected. These rock samples were brought to palynological laboratory of the Botany Department of National Taiwan University for the preparation of pollen slides. Permanent slides were completed in two years. These slides were taken to Abteilung für Palynologie der Universität, Göttingen, West Germany for examination from September 1975 to July 1976. The preliminary study was supported by Prof. Dr. Hans-jürgen Beug and Alexander von Humboldt-Stiftung, West Germany. As a result of the examination, more than 150 fossil palynomorphs were recognized. The description of these fossil palynomorphs was started in September 1976 and was supported by the Biological Research Center of Academia Sinica of National Science Council, and the work is still continuing. It will take years to finish this work so the writer plans to report his taxonomical findings of fossil palynomorph in a series. The last complete report will include detailed information for sampling, methods of preparation of pollen slides, a checklist of the fossil flora and pollen stratigraph of the Miocene of Taiwan.

The taxonomic treatment of Tertiary fossil palynomorph has been debated by many palynologists for a long time. In this paper, I have adopted artificial form genera names for nomenclature. Sixty-eight taxa are reported here for the first time in Taiwan. They belong to three classes and 36 form genera; namely one taxon for the class Alete; 14 form genera and 39 taxa for the class Monolete; and 22 form genera and 29 taxa for the class Trilete. Besides, seven form genera and 23 taxa are added in keys and their scientific names are listed in the taxonomic arrangement without description because they have been published previously. Several questionable sporomorphs still require for further study.

TAXONOMIC TREATMENT

KEY TO THE CLASSES

1. Spores without dehiscent mark or tetrad scar.....1. Alete
1. Spores with dehiscent mark or tetrad scar.....2
2. Spores with a single tetrad scar.....2. Monolete

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2. Spores with a triradial tetrad scar.....3. Trilete

Class 1. ALETE

There are several taxa found in the Miocene fossil spores, but only one taxon is described here.

Genus 1. LAEVIGATASPORITES Potonié & Gelletich 1933.

Spores lacking a dehiscence scar and having a more or less smooth surface.

1. *Laevigatasporites taiwanensis* Huang sp. nov. Pl. 11, Figs. 1-2.

Spores alete; amb elliptic; $45 \times 58 \mu$. Exine $1.5-2 \mu$ thick, psilate, smooth.

Type locality: Tungken Formation.

Type slide: 42-1L.

Taxonomic affinity: This species is closely related with the extant *Equisetum* species.

Class 2. MONOLETE

Fourteen fossil form genera and 41 taxa are recorded here.

KEY TO THE FORM GENERA

1. Spores with perine.....11. *Perinomonoletes*
1. Spores without perine.
 2. Spores wall with thick margin.....16. *Zonomonoletes*
 2. Spores wall without thick margin.
 3. Exine striate.....14. *Schizaeosporites*
 3. Exine not striate.
 4. Exine with various kinds of processes.
 5. Sexine reticulate or areolate.
 6. Sexine areolate, with LO-pattern.....15. *Verrucatosporites*
 6. Sexine reticulate, with OL-pattern.
 7. Lumina less than 1μ wide; exine with short baculate, scabrate, verrucate, or echinate processes.....10. *Microfoveolatosporis*
 7. Lumina more than 1μ wide; exine with scabrate or verrucate processes.....12. *Polypodioidites*
 5. Sexine granulate or tuberculate.
 8. Exine with echinate processes, the echini less than 1μ long; sexine finely granulate, the granules less than 1μ wide.....13. *Punctatosporites*
 8. Exine with various kinds of processes, the echini more than 1μ long; sexine coarsely granulate or tuberculate, the granules or tubercles more than 1μ wide.
 9. Spores large, more than 30μ wide in polar axis; exine with a loosely verrucate, clavate, gemmate and echinate processes.....5. *Gemmatosporis*
 9. Spores small, less than 30μ wide in polar axis; exine with scattered gemmate processes.
 10. Exine with echinate processes.....2. *Echinosporis*
 10. Exine with gemmate processes.....4. *Gemmamonoletes*
 4. Exine psilate.
 11. Sexine smooth.
 12. Amb nearly circular.....8. *Latosporites*
 12. Amb elliptic or lunate.
 13. Side view of spores in crescent shape.....9. *Lunulasporites*
 13. Side view of spores not in crescent shape.....7. *Laevigatosporites*

11. Sexine granulate or punctate.

14. Granules on outside wall 3. *Extrapunctatosporis*

14. Granules on inside wall 6. *Intrapunctatosporis*

Genus 2. *ECHINOSPORIS* Krutzsch 1967.

Spores monolete. Exine with echinate processes, the echini more than 2μ long.

2. *Echinosporis taiwanensis* Huang sp. nov. Pl. 11, Figs. 3-5.

Spores monolete; amb elliptic; $17 \times 27\mu$. Exine 1μ thick, with echinate or baculate processes, the echini $4 \times 4\mu$, the bacula $4 \times 2\mu$; sexine reticulate, with OL-pattern, the lumina $5 \times 7\mu$.

Type locality: Shuliufen Shale Member.

Type slide: 54-2L (fig. 3, holotype), 52-1R (figs. 4-5).

Taxonomic affinity: This species is similar to the extant *Cystopteris moupinensis* Franchet of the Athyriaceae and also the fossil species of *Echinosporis echinatus* Krutzsch.

Note: Differs from other fossil related genera in the typically echinate sculpture.

Genus 3. *EXTRAPUNCTATOSPORIS* Krutzsch 1959.

Spores monolete; amb lunate. Exine psilate or subsilate; sexine extrapunctate.

3. *Extrapunctatosporis taiwanensis* Huang sp. nov. Pl. 1, Figs. 1-2.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; $49 \times 58\mu$; furrow 38μ long. Exine $2-3.5\mu$ thick, psilate or subsilate; sexine extrapunctate.

Type locality: Tungkeng Formation.

Type slide: 41-5R.

Taxonomic affinity: Unknown.

Genus 4. *GEMMAMONOLETES* Pierce 1961.

Spores monolete; amb reniform; $15 \times 23\mu$. Exine with scattered gemmate processes or wart-like appearance, 1.3μ thick.

KEY TO THE SPECIES

1. Spores elliptic, $26-29 \times 34-36\mu$ 4. *G. formosensis*

1. Spores lunate, $22 \times 52\mu$ 5. *G. oblongo-lunatus*

4. *Gemmamonoletes formosensis* Huang sp. nov. Pl. 2, Figs. 1-9.

Spores monolete; amb elliptic on proximal view; $27 \times 36\mu$; furrow 19μ long, with line-like margo, the margo 1μ wide. Exine $1-1.5\mu$ thick, with gemmate processes, the gemmae $2 \times 2\mu$; sexine tuberculate, the tuberculae $1-2\mu$ wide.

Type locality: Tungkeng Formation.

Type slide: 42-2L (figs. 1-3, holotype), 42-1L (figs. 5-6, 8), 42-2L (fig. 4), 54-2L (fig. 9).

Taxonomic affinity: This species is similar to the extant *Crypsinus tosaensis* (Makino) H. Ito of Polyodiaceae.

Note: The same palynomorph is also found in Yutengping Sandstone Member (58-1R figs. 7). The size of spores is $26-29 \times 34-36\mu$.

5. *Gemmamonoletes oblongo-lunatus* Huang sp. nov. Pl. 2, Figs. 10-11.

Spores monolete; amb lunate, the proximal face concave, the distal face convex; $22 \times 52\mu$.

Exine 1μ thick, with gemmate processes, the gemmae $1.5 \times 1-1.5\mu$; sexine reticulate, the tuberculae $1.5-2.5 \times 1.5-2\mu$, with LO-pattern.

Type locality: Yutengping Sandstone Member.

Type slide: 59-5 L.

Taxonomic affinity: Unknown.

Note: The same palynomorph is also found in Kuantaoshan Sandstone Member (50-2 L.).

Genus 5. GEMMATOSPORIS Krutzsch 1959.

Spores monolet; amb lunate or elliptic; furrow simple, closed or open. Exine with loosely verrucate, clavate, gemmate or echinate processes; sexine tuberculate.

KEY TO THE SPECIES

1. Furrow open; tuberculae $1(-2) \times 1(-2)\mu$6. *G. lato-apertus*
 1. Furrow closed; tuberculae $1(-2)-3 \times 1(-2)-4(-5)\mu$7. *G. taiwanensis*

6. *Gemmatosporis lato-apertus* Huang sp. nov. Pl. 3, Figs. 1-6.

Spores monolet; amb oblong-elliptic in proximal view; $40 \times 61\mu$; furrow simple, open widely, $8 \times 30\mu$. Exine 1μ thick, with gemmate processes, the gemmae less than $1 \times 1\mu$; sexine granulate.

Type locality: Taliao Formation.

Type slide: TR₃-4L. (figs. 5-6, holotype).

Taxonomic affinity: This species is similar to the extant *Crypsinus engleri* (Luerss) Copel. of the Polypodiaceae.

Note: The same palynomorphs are also found in Talu Shale (10-31R, figs. 1-2), and Peliao Sandstone (32-2R, figs. 3-4). The sizes are $40-50 \times 58-70\mu$.

7. *Gemmatosporis taiwanensis* Huang sp. nov. Pl. 4, Figs. 1-7.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $52 \times 64\mu$; furrow indistinct. Exine 1μ thick, with gemmate processes, the gemmae $1-3 \times 1.5-4\mu$; sexine tuberculate, the tuberculae $1.2 \times 1-4\mu$.

Type locality: Taliao Formation.

Type slide: TR₃-4L (figs. 6-7, holotype), TR₃-2R (fig. 5).

Taxonomic affinity: This species is similar to the extant species of *Polypodium* and *Saxiglossum*.

Note: The same palynomorphs are also found in Kuantaoshan Sandstone Member (50-2R, 53-3R, figs. 2-3), and Shuliufen Shale Member (54-2R, fig. 4). The size of spores $35-52 \times 55-64\mu$. It can be found in Chinshui Shale of Pliocene (63-2R, fig. 1).

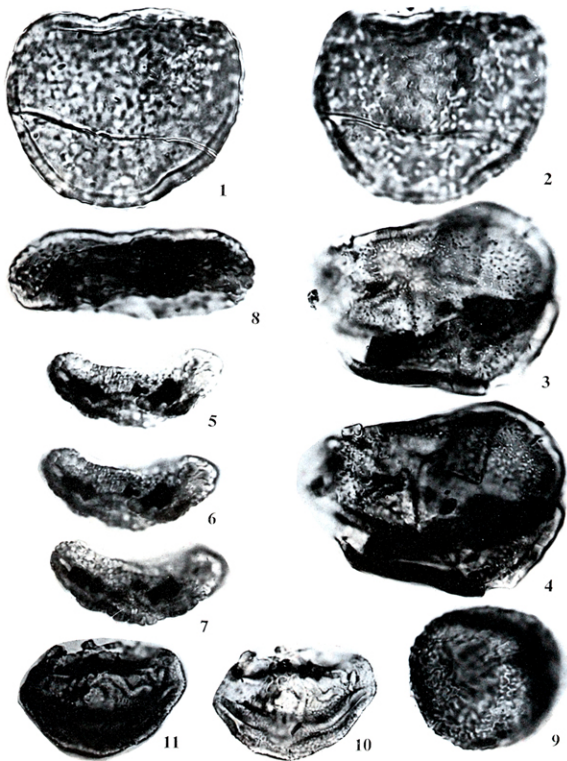
Genus 6. INTRAPUNCTOSPORIS Krutzsch 1967.

Spores monolet; amb lunate, the proximal face slightly concave, the distal face convex. Exine psilate; sexine intrapunctate, intramicrofoveolate or intramicrobaculate.

8. *Intrapunctosporis taiwanensis* Huang sp. nov. Pl. 1, Figs. 3-4.

Plate 1. All figures, $\times 1000$.

1-2. *Extrapunctatosporis taiwanensis* Huang (41-5R); 3-4. *Intrapunctosporis taiwanensis* Huang (51-6L); 5-7. *Microfoveolatosporis lunatus* Huang (11-9L, 11-9R); 8. *Microfoveolatosporis-ellipticus* Huang (35-1L); 9. *Microfoveolatosporis taiwanensis* Huang (34-1L); 10-11. *Punctatosporites taiwanensis* Huang (51-6R).



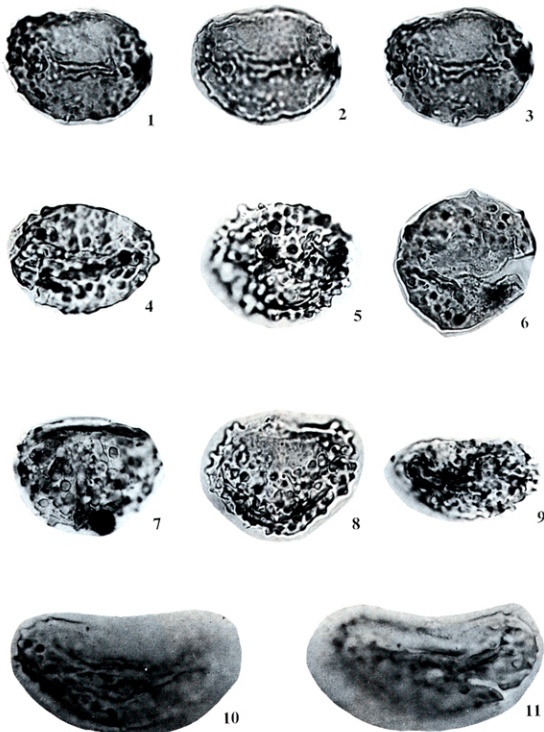


Plate 2. All figures, $\times 1000$.

1-9. *Gemmamonoletes formosensis* Huang (42-2L, 42-1L, 58-1R, 54-2L);

10-11. *Gemmamonoletes oblongo-lunatus* Huang (59-5L).

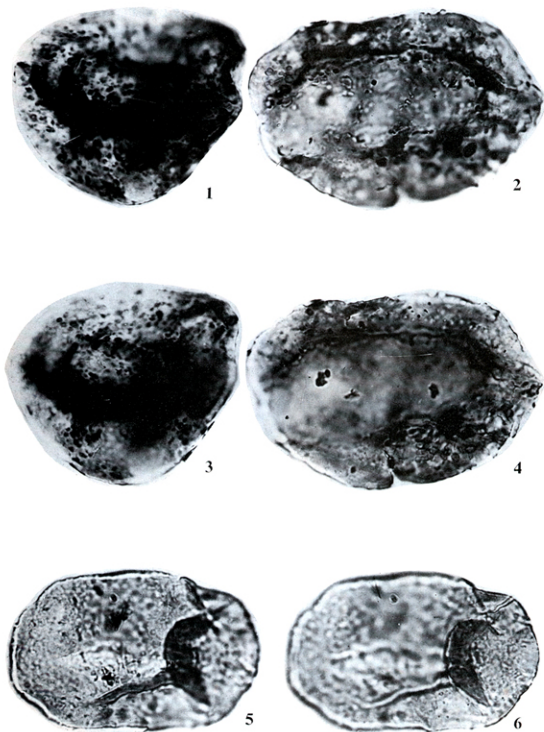


Plate 3. All figures, $\times 1000$.

1-6. *Gemmatosporis lato-apertus* Huang (10-31R, 32-2R. TR₃-4L).

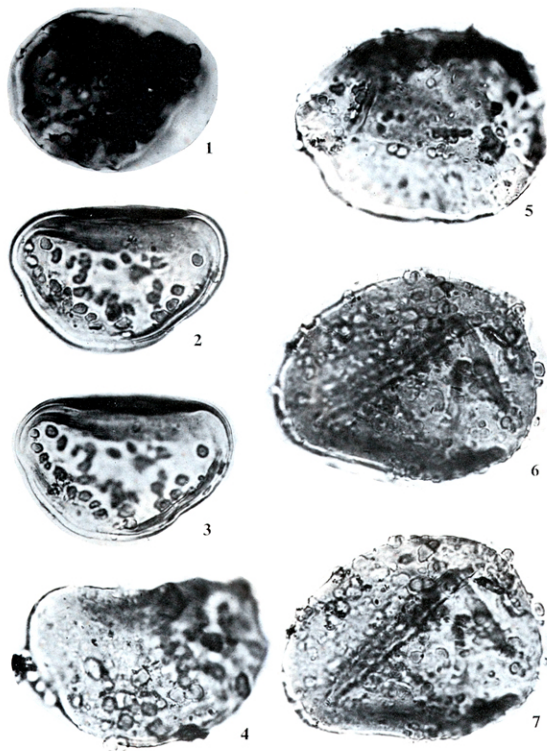


Plate 4. All figures, $\times 1000$.

1-7. *Gemmatosporis taiwanensis* Huang (63-2R, 53-3R, 54-2R, TR₃-2R, TR₃-4L).

Spores monolete; amb lunate, the proximal face slightly concave, the distal face convex; $33 \times 63 \mu$. Exine psilate, $2-2.5 \mu$ thick, with intramicrobaculate processes, the bacula less than 1μ long; sexine intrapunctate or intramicrofoveolate, less than 1μ wide.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 51-61.

Taxonomic affinity: This species is similar to the fossil species of *Intrapunctosporis pliocenicus* Krutzsch.

Genus 7. *LAEVIGATOSPORITES* Ibrahim 1933.

Spores monolete; amb bean-shaped. Exine psilate, smooth.

KEY TO THE SPECIES

1. The ratio between length and width of spores larger than 1.5.
 2. Spores less than $30 \times 40 \mu$ 10. *L. gracilis*
 2. Spores more than $30 \times 40 \mu$.
 3. Exine 2.5μ thick. 9. *L. crasso-lunatus*
 3. Exine 1.5μ thick. 15. *L. tenui-lunatus*
1. The ratio between length and width of spores less than 1.5.
 4. Spores more than $50 \times 60 \mu$; ratio between length and width of spores 1.42. 11. *L. magniformis*
 4. Spores less than $50 \times 60 \mu$.
 5. Spores elliptic; ratio between length and width of spores 1.2-1.33. 12. *L. reniformis*
 5. Spores oblong-elliptic; ratio between length and width of spores 1.2.
 6. Spores six angular-shaped. 13. *L. sexangulariformis*
 6. Spores oblong-elliptic. 14. *L. taiwanensis*

9. *Laevigatosporites crasso-lunatus* Huang sp. nov.

Pl. 6, Fig. 1.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; $45 \times 75 \mu$. Exine 2.5μ thick, psilate, smooth.

Type locality: Shuliufen Shale Member.

Type slide: 54-2R.

Taxonomic affinity: This species is similar to the extant *Vittaria* species.

10. *Laevigatosporites gracilis* Wilson & Webster, S. 273/4. Fig. 4 ($27-30 \mu$). Fort. Union Kohle, Montana, U. S. A. 1946. Pl. 5, Figs. 1-2.

Spores monolete; amb lunate, the proximal face concave, the distal face convex; $13-20 \times 20-32.5 \mu$. Exine psilate, smooth, $1-1.5 \mu$ thick.

Locality: Wutzeshan Formation and Shuliufen Shale Member.

Selected slides: Mw₃-10L, 54-2L.

Taxonomic affinity: This species is similar to the extant *Asplenium* species or *Parathelypteris beddomei* (Bak.) Ching.

Note: Known also from middle Oligocene to old Pleistocene of middle Europe.

11. *Laevigatosporites magniformis* Huang sp. nov.

Pl. 6, Fig. 2.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; $70 \times 100 \mu$. Exine psilate, smooth, 2μ thick.

Type locality: Peliao Sandstone.

Type slide: 30-2R.

Taxonomic affinity: This species is similar to the extant *Vittaria* species.

12. *Laevigatosporites reniformis* Huang sp. nov. Pl. 6, Fig. 3.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; $40 \times 50 \mu$; furrow 30μ long, Exine $1-2 \mu$ thick, psilate, smooth, partially with fine corrusion.

Type locality: Taliao Formation.

Type slide: TR1-2L.

Taxonomic affinity: This species is similar to the fossil species of *L. haardti* (R. Pot. & Van. 1934) Th. & Pf. 1953.

Note: The same palynomorphs are also found in Kuantaooshan Sandstone Member (51-6R) and Tungkeng Formation (42-1L).

13. *Laevigatosporites sexangulariformis* Huang sp. nov. Pl. 6, Figs. 4-5.

Spores monolete; amb six angular form; $42.5 \times 50 \mu$; furrow 30μ long. Exine 2.5μ thick, psilate; sexine smooth, or obscurely punctate.

Type locality: Kuantaooshan Sandstone Member.

Type slide: 49-1L (fig. 4, holotype), 49- 4L (fig. 5).

Taxonomic affinity: Unknown.

14. *Laevigatosporites taiwanensis* Huang sp. nov. Pl. 6, Figs. 6-7.

Spores monolete; amb elliptic, both proximal and distal faces nearly flat, the lateral surface convex; $42.5 \times 50 \mu$; furrow 30μ long. Exine 2.5μ thick, psilate; sexine smooth, with fungus rods.

Type locality: Shuliufen Shale Member.

Type slide: 54-2L (fig. 1, holotype).

Taxonomic affinity: This species is similar to the fossil species of *L. haardti* (Pot. & Van. 1934) Krutzsch subsp. *haardtoides* Krutzsch 1967.

15. *Laevigatosporites tenui-lunatus* Huang sp. nov. Pl. 6, Fig. 8.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; $45 \times 83 \mu$. Exine 1.5μ thick, psilate, smooth.

Type locality: Shuliufen Shale Member.

Type slide: 54-1L.

Taxonomic affinity: This species is similar to the extant *Vittaria* species.

Note: The same palynomorphs are also found in Peliao Sandstone (26-1R) and Kuantaooshan Sandstone Member (51-6R).

Genus 8. LATOSPORITES Potonié & Kremp 1954.

Spores monolete; amb circular. Exine psilate, smooth.

16. *Latosporites taiwanensis* Huang sp. nov. Pl. 5, Figs. 3-4.

Spores monolete; amb circular; 47.5μ wide; furrow 45μ long. Exine 1μ thick, psilate, smooth.

Type locality: Kuantaooshan Sandstone Member.

Type slide: 50-2R.

Taxonomic affinity: Unknown.

Genus 9. LUNULASPORITES Wilson 1962.

Spores monolete; side view crescentic, the proximal face concave, the distal face convex. Exine psilate.

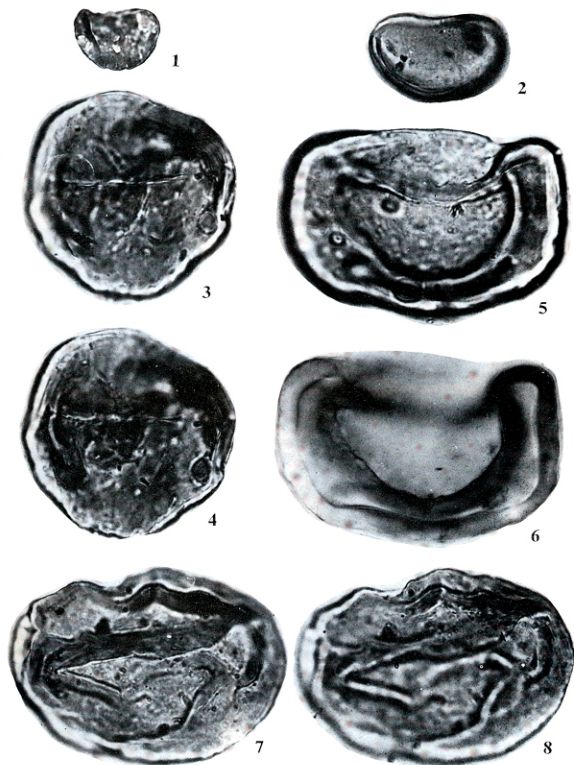
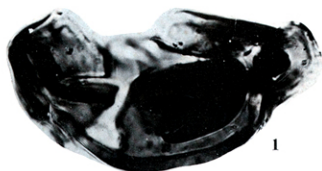


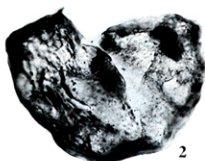
Plate 5. All figures, $\times 1000$.

1-2. *Laevigatosporites gracilis* Wilson & Webster (Mw₈-10L, 54-2L);

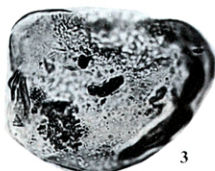
3-4. *Latosporites taiwanensis* Huang (50-2R); 5-8. *Lunulasporites taiwanensis* Huang (49-4L, 58-1R).



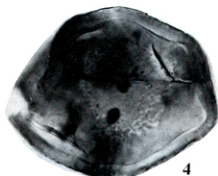
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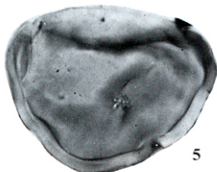
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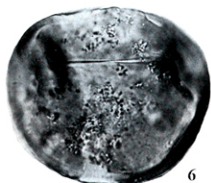
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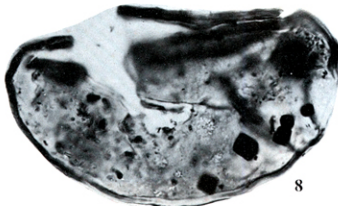
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5



6



8



7

17. *Lunulasporites taiwanensis* Huang sp. nov.

Pl. 5, Figs. 5-8.

Spores monolete; amb nearly quadrangular, the side view crescentic, the proximal face concave, the distal face convex; $45 \times 65 \mu$; furrow 40μ long. Exine psilate, smooth, 4μ wide, the marginal ridge 4μ wide.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 49-4L (figs. 5-6, holotype).

Taxonomic affinity: Unknown

Note: The same palynomorphs are also found in Yutengping Sandstone Member (58-1R, figs. 7-8), and Shuliufen Shale Member (54-2R). The size of spore is $40 \times 60 \mu$.

Genus 10. *MICROFOVEOLATOSPORIS* Krutzsch 1959.

Spores monolete. Exine with scabrate, verrucate or short baculate processes; sexine foveolate.

KEY TO THE SPECIES

1. Exine with short baculate processes; amb circular.....20. *M. taiwanensis*
1. Exine with verrucate or scabrate processes; amb lunate or oblong-elliptic.
 2. Spores elliptic, $13 \times 43 \mu$18. *M. lunatus*
 2. Spores oblong-elliptic, $20 \times 60 \mu$19. *M. oblongo-ellipticus*
18. *Microfoveolatosporis lunatus* Huang sp. nov. Pl. 1, Figs. 5-7.

Spores monolete; amb lunate, the proximal face concave, the distal face convex; $13 \times 43 \mu$. Exine 1μ thick, with verrucate processes, the verrucae $1 \times 2 \mu$; sexine foveolate.

Type locality: Talu Shale.

Type slide: 11-9L (figs. 5-6, holotype), 11-9R (fig. 7).

Taxonomic affinity: This species is closely related with extant *Psilotum nudum* (L.) Beauv.

Note: The same palynomorphs are also found in Yutengping Sandstone Member (58-1R), and Shuliufen Shale Member (54-2R). The size of spore is $40 \times 60 \mu$.
19. *Microfoveolatosporis oblongo-ellipticus* Huang sp. nov. Pl. 1, Fig. 8.

Spores monolete; amb oblong-elliptic; $20 \times 60 \mu$; Exine $1-1.5 \mu$ thick, with scabrate or verrucate processes, the verrucae $1 \times 2 \mu$; sexine foveolate, the pores 1μ wide.

Type locality: Kuanyinshan Sandstone.

Type slide: 35-1L.

Taxonomic affinity: Unknown.
20. *Microfoveolatosporis taiwanensis* Huang sp. nov. Pl. 1, Figs. 9.

Spores monolete; amb circular; $36-37 \mu$ wide. Exine 1μ thick, with short baculate processes, the bacula 1μ long; sexine reticulate, with OL-pattern.

Type locality: Peliao Sandstone.

Type slide: 34-1 L.

Taxonomic affinity: Unknown.

Plate 6. Figures 1, 3-8, $\times 1000$; Figure 2, $\times 500$.

1. *Laevigatosporites crasso-lunatus* Huang (54-2 R); 2. *Laevigatosporites magniformis* Huang (30-2R); 3. *Laevigatosporites reniformis* Huang (TR₁-2L); 4-5. *Laevigatosporites sexangulariformis* Huang (49-1L, 49-4L); 6-7. *Laevigatosporites taiwanensis* Huang (54-2L); 8. *Laevigatosporites tenui-lunatus* Huang (54-1L).

Genus 11. PERINOMONOLETES Krutzsch 1967.

Spores monolete; amb lunate, the proximal face flat or slightly concave, the distal face convex. Exine psilate, smooth. Perine closely envelops the outer spore wall, with loose folds, or rugulate to hamulate appearance.

KEY TO THE SPECIES

1. Perine granulate.....21. *P. granulatus*
1. Perine reticulate or folded.
 2. Perine folded or wrinkled.
 3. Perine with scattered short baculate margin, compactly enclosed on spore wall.....23. *P. oliocaenicus*
 3. Perine with irregular margin, 3-5 μ extending out spore wall.
 4. Spores 16 $\times$ 20 μ24a. *P. plicatus plicatus*
 4. Spores 20 $\times$ 32 μ24b. *P. plicatus rugosus*
 2. Perine reticulate.
 5. Perine with baculate margin.....25a. *P. reticulatus reticulatus*
 5. Perine with scabrate margin.
 6. Lumina 3-5 $\times$ 5-7 μ25b. *P. reticulatus scabrato-marginatus*
 6. Lumina 7-8 $\times$ 8-10 μ .
 7. Spores 47 $\times$ 78 μ22a. *P. lato-reticulatus lato-reticulatus*
 7. Spores 31 $\times$ 47 μ22b. *P. lato-reticulatus punctatus*
21. *Perinomonoletes granulatus* Huang sp. nov. Pl. 7, Figs. 1-5.

Spores monolete; amb elliptic; 21 $\times$ 28 μ ; furrow 13 μ long. Exine 1 μ thick, psilate. Perine granulate, with minutely scabrate processes, 3 μ extending away from spore wall.

Type locality: Kuanyinshan Sandstone.

Type slide: 38-33R (fig. 1).

Taxonomic affinity: This species is similar to the extant *Quercifilix zeylanica* (Houtt.) Copel., *Dryopteris atrata* (Jacq.) Wagner or *Asplenium* species.

Note: The same palynomorphs are also found in the Talu Shale (1-2R), and Kuantaoshan Sandstone Member (50-2L, 51-4R, 53-3L).
22. *Perinomonoletes lato-reticulatus* Huang sp. nov.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; 47 $\times$ 78 μ ; furrow 56 μ long. Exine 1(-3) μ thick. Perine reticulate, the reticula 7-13 $\times$ 7-10 μ , the lumina smooth, 7 μ extending out spore wall, with irregular margin.

 - 22a. *Perinomonoletes lato-reticulatus lato-reticulatus*. Pl. 8, Figs. 1-3.

Type locality: Yutengping Sandstone Member.

Type slide: 58-3R.

Taxonomic affinity: This species is similar to the extant *Elaphoglossum lepidopodum* C. Chr., and *Cyclogranina omeiensis* (Bak.) Tagawa.
 - 22b. *Perinomonoletes lato-reticulatus* var. *punctatus* Huang var. nov. Pl. 8, Figs. 4-5.

Spores monolete; amb lunate, the proximal face flat, the distal face convex; 31 $\times$ 47 μ . Exine 1 μ thick, psilate. Perine closely attached to the spore wall, with irregular margin, the surface reticulate, the lumina dotted with granulate, 7-8 $\times$ 8-10 μ .

Type locality: Talu Shale.

Type slide: 10-7R.

Taxonomic affinity: This species is similar to the extant *Athyrium drepanopterum* (Kunze) A. Br.

23. *Perinomonoletes oliocaenicus* Krutsch Atlas, Parts 4-5: 222. 1967. Pl. 7, Figs. 6-8.

Spores monolet; amb lunate, the proximal face slightly concave, the distal face convex; $17 \times 42 \mu$; furrow 38μ long. Exine psilate, 1.5μ on proximal face, 1μ on distal face; sexine smooth. Perine closely envelops the outer spore wall, with loose folds or rugulate to hamulate appearance.

Locality: Chinshui Shale of Pliocene. It can be found in Miocene sediments.

Selected slide: 63-2L.

Taxonomic affinity: This species is possibly related with species of *Paesia*, *Asplenium*, *Athyrium* or *Blechnum*.

24. *Perinomonoletes plicatus* Huang sp. nov.

Spores monolet; amb elliptic; $16 \times 20 \mu$. Exine 1μ thick. Perine wrinkled into rugulate, $4-5 \mu$ extending out of spores.

- 24a. *Perinomonoletes plicatus plicatus*.

Pl. 7, Figs. 9-12.

Type locality: Yutengping Sandstone Member.

Type slide: 59-5L.

Taxonomic affinity: This species is similar to the extant *Dryopteris* species.

Note: The same palynomorph is also found in Kuanyinshan Sandstone (37-7R).

- 24b. *Perinomonoletes plicatus* var. *rugosus* Huang var. nov. Pl. 7, Fig. 13.

Spores monolet; amb elliptic; $20 \times 32 \mu$. Exine 1μ thick. Perine rugulate or with wrinkled into ridges, closely attached spore wall, with irregular margin, partially $3-4 \mu$ extending out spore wall.

Type locality: Kuanyinshan Sandstone.

Type slide: 37-7R.

Taxonomic affinity: This species is similar to the extant *Dryopteris varia* (L.) Ktze.

25. *Perinomonoletes reticulatus* Huang sp. nov.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $24 \times 34 \mu$. Exine 1μ thick. Perine reticulate, with baculate processes, the bacula 3μ long, the lumina $3-4 \times 8-10 \mu$, the muri 1μ wide.

- 25a. *Perinomonoletes reticulatus reticulatus*.

Pl. 7, Fig. 14.

Type locality: Talu Shale.

Type slide: 1-3R.

Taxonomic affinity: This species is similar to the extant *Hypodematum crenatum* (Forsk.) Kuhn.

- 25b. *Perinomonoletes reticulatus* var. *scabrato-marginatus* Huang var. nov. Pl. 7, Figs. 15-16.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $25 \times 32 \mu$; furrow 22μ long. Exine psilate, 1μ thick; sexine smooth. Perine reticulate, with scabrate processes, the lumina $3-5 \times 5-7 \mu$.

Type locality: Peliao Sandstone.

Type slide: 27-15L (fig. 16, holotype), 23-7R (fig. 15, s.d. type).

Taxonomic affinity: This species is similar to the extant *Woodsia polystichoides* Eaton.

Genus 12. **POLYPODIIDITES** Ross 1949.

Spores monolete; amb lunate. Exine 2μ thick, with scabrate or verrucate processes; sexine reticulate, the lumina $1-2 \times 4-7\mu$.

KEY TO THE SPECIES

1. Spores $32 \times 44\mu$26. *P. reniformis*
1. Spores $30 \times 60\mu$27. *P. taiwanensis*
26. *Polypodiidites reniformis* Huang sp. nov. Pl. 11, Fig. 6.
 Spores monolete; amb lunate, the proximal face flat, the distal face convex; $32 \times 44\mu$; furrow 23μ long. Exine 1μ thick, with verrucate or scabrate processes; sexine reticulate or vermiculato-reticulate, the vermiculae $1 \times 4\mu$.
 Type locality: Kuantashan Sandstone Member.
 Type slide: 50-2L.
 Taxonomic affinity: Unknown.
 Note: The same palynomorph is also found in Shuliufen Shale Member (54-2R).
27. *Polypodiidites taiwanensis* Huang sp. nov. Pl. 11, Fig. 7.
 Spores monolete; amb lunate, the proximal face flat, the distal face convex; $30 \times 60\mu$; furrow 55μ long. Exine $1-2\mu$ thick, with verrucate processes, the verrucae $2 \times 10\mu$; sexine irregularly vermiculato-reticulate, the lumina $2 \times 7\mu$.
 Type locality: Kuantashan Sandstone Member.
 Type slide: 51-5R.
 Taxonomic affinity: Unknown.

Genus 13. **PUNCTATOSPORITES** Ibrahim 1933, emend Krutzsch 1959.

Spores monolete; amb lunate. Exine with short baculate processes, the bacula less than 1μ long; sexine granulate.

28. *Punctatosporites taiwanensis* Huang sp. nov. Pl. 1, Figs. 10-11.
 Spores monolete; amb lunate, the proximal face flat, the distal face convex; $25 \times 38\mu$; furrow 27μ long. Exine 1μ thick, with short baculate processes, the bacula less than 1μ long; sexine granulate.
 Type locality: Kuantashan Sandstone Member.
 Type slide: 51-6R.
 Taxonomic affinity: Unknown.

Genus 14. **SCHIZAEOSPORITES** Potonié 1951 ex Delcourt & Sprumont 1935.

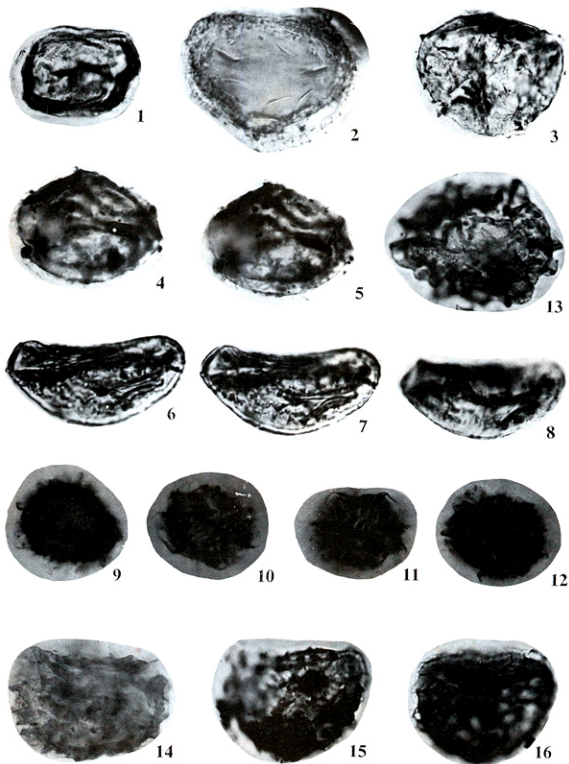
Spores monolete, bilaterally symmetrical. Exine striate.

KEY TO THE SPECIES

1. Spores small, $26 \times 33.5\mu$29. *S. digitatus*
1. Spores large, $50-75 \times 85-100\mu$30. *S. taiwanensis*
29. *Schizaeosporites digitatus* Huang in Bot. Bull. Academia Sinica 19: 23. pl. 6, fig. 1. 1978. Pl. 12, Fig. 1.

Plate 7. Perinomolette, all figures, $\times 1000$.

1-5. *P. granulatus* Huang (38-33R, 53-3L, 51-4R, 50-2L); 6-8. *P. oliocenicus* Krutzsch (63-2L); 9-12. *P. plicatus* Huang (59-5L); 13. *P. plicatus rugosus* Huang (37-7R); 14. *P. reticulatus* Huang (1-3R); 15-16. *P. reticulatus scabrato-marginatus* Huang (28-7R, 27-15L).



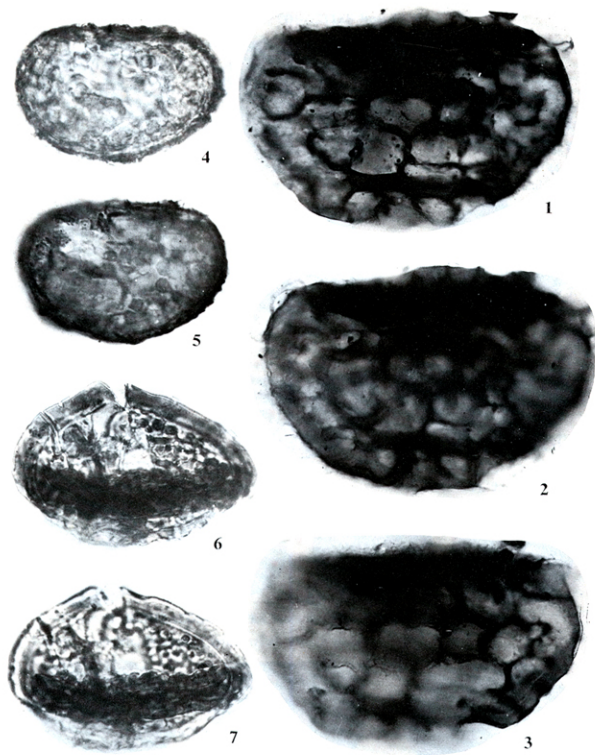


Plate 8. All figures, $\times 1000$.

1-3. *Perinomonoletes lato-reticulatus* Huang (58-3R); 4-5. *Perinomonoletes lato-reticulatus punctatus* Huang (10-7R); 6-7. *Zonomonoletes taiwanensis* Huang (51-4R).

30. *Schizaeisporites taiwanensis* Huang, loc. cit. pl. 6, figs. 2-3.

Pl. 12, Figs. 2-3.

Genus 15. *VERRUCATOSPORITES* Pflug & Thomson 1953

Spores monolet; amb lunate or elliptic. Exine with verrucate processes; sexine areolate, the areolae being formed by compact tuberculae, with LO-pattern.

KEY TO THE SPECIES

1. The ratio between length and width of spores (L/W) larger than 1.5.
 2. Exine 1-1.2 μ thick; spores $27 \times 68 \mu$34. *V. oblongus*
 2. Exine 1 μ thick; spores $15-28 \times 35-52 \mu$.
 3. L/W=2.08-2.2; tuberculae $2-4 \times 4-6 \mu$33. *V. lunatus*
 3. L/W=1.5-1.85; tuberculae $1-3 \times 1.5-5 \mu$35. *V. pseudobalticus*
1. The ratio between length and width of spores (L/W) less than 1.5.
 4. Aperture widely open; L/W<1.15.
 5. Spores $40-44 \times 45-47 \mu$32a. *V. lato-apertus*
 5. Spores $24 \times 26 \mu$32b. *V. lato-apertus minor*
 4. Aperture closed; L/W>1.25.
 6. Tuberculae $1-1.5 \times 2-3 \mu$36. *V. reniformis*
 6. Tuberculae $2-6 \times 2-7 \mu$.
 7. Spores $39 \times 54 \mu$31a. *V. balticoides balticoides*
 7. Spores $30 \times 38 \mu$31b. *V. balticoides minor*
31. *Verrucatosporites balticoides* Huang sp. nov.

Spores monolet; amb lunate, the proximal face slightly convex, the distal face convex; $39 \times 54 \mu$; furrow 40μ long. Exine less than 1 μ thick, with verrucate processes, the verrucae $2-3 \times 3-8 \mu$ on distal face, $1-2 \times 2-4 \mu$ on proximal face; sexine tuberculate, the tuberculae $2-6 \times 4-7 \mu$.

31a. *Verrucatosporites balticoides balticoides*.

Pl. 9, Figs. 1-4.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 50-1L (figs. 3-4, holotype), 50-3L (figs. 1-2, syntype).

Taxonomic affinity: This species is similar to the extant *Humata trifoliata* Cav.

Note: The same palynomorph is also found in Tungken Formation (42-2L).

The sizes of spores and tuberculae are intermediate between *V. balticus* Krutzsch subsp. *major* Krutzsch and *V. favius* (R. Pot. 1931c) Tu. & Pr. 1953.

31b. *Verrucatosporites balticoides* var. *minor* Huang var. nov.

Pl. 9, Fig. 5.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $30 \times 38 \mu$. Exine less than 1 μ thick, with scabrate processes; sexine tuberculate, the tuberculae $2-5 \times 2-5 \mu$.

Type locality: Taliao Formation.

Type slide: TR₃-3R.Taxonomic affinity: This species is similar to the extant *Humata* species.32. *Verrucatosporites lato-apertus* Huang sp. nov.

Spores monolet; amb elliptic; $44 \times 47 \mu$; furrow open, $10 \times 40 \mu$. Exine 1 μ thick, with scabrate processes; sexine tuberculate, the tuberculae $2-3 \times 3-4 \mu$.

32a. *Verrucatosporites lato-apertus lato-apertus*.

Pl. 9, Figs. 6-9.

Type locality: Peliao Sandstone.

Type slide: 26-1R (figs. 8-9).

Taxonomic affinity: This species is similar to the extant *Davallia griffithiana* Hook.

Note: The same palynomorphs are also found in Talu Shale (10-21R), and Peliao Sandstone (27-17R, figs. 6-7).

32b. *Verrucatosporites lato-apertus* var. *minor* Huang var. nov. Pl. 9, Figs. 10-11.

Spores monolet; amb elliptic; $24 \times 26 \mu$. Exine 1μ thick, with scabrate processes; sexine tuberculate, the tuberculae $1.3 \times 3.4 \mu$.

Type locality: Peliao Sandstone.

Type slide: 25-8R.

Taxonomic affinity: This species is similar to the extant *Humata pectinata* (J. Sm.) Desv.

Note: The same palynomorph is also found in Kuanyinshan Sandstone (37-8L).

33. *Verrucatosporites lunatus* Huang sp. nov. Pl. 10, Figs. 1-4.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $21 \times 44 \mu$; furrow 32μ long. Exine less than 1μ thick, with verrucate processes, the verrucae $2.4 \times 4.5 \mu$; sexine tuberculate, the tuberculae $4 \times 5 \mu$.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 50-2L (figs. 1-2).

Taxonomic affinity: This species is similar to the extant *Histiopteris incisa* (Thunb.) J. Sm., and also the fossil species of *V. megabalticus* Krutzsch.

Note: The same palynomorphs are also found in Talu Shale (1-4L), Peliao Sandstone (26-2L, figs. 3-4), Shuliufen Shale Member (54-2L). The sizes of spores are $15-25 \times 35-52 \mu$.

34. *Verrucatosporites oblongus* Huang sp. nov. Pl. 10, Fig. 5.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $27 \times 68 \mu$. Exine 1.2μ thick, with verrucate processes, the verrucae $1 \times 3.5 \mu$; sexine tuberculate, the tuberculae $3 \times 4 \mu$.

Type locality: Shuliufen Shale Member.

Type slide: 54-2R.

Taxonomic affinity: This species is similar to the extant *Humata* or *Davallia* species.

35. *Verrucatosporites pseudobalticus* Huang sp. nov. Pl. 10, Figs. 6-7.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $21 \times 41 \mu$; furrow 23μ long. Exine less than 1μ thick, with verrucate processes, the verrucae $1 \times 3 \mu$; sexine tuberculate, the tuberculae $1.3 \times 2.5 \mu$.

Type locality: Kuanyinshan Sandstone.

Type slide: 37-3L (fig. 6, holotype).

Taxonomic affinity: This species is similar to the fossil species of *V. balticus* subsp. *major* Krutzsch, and also the extant *Polypodium amoenum* Wall and *Araistegia perdurans* (Christ) Copel.

Note: The same palynomorphs are also found in Kuantaoshan Sandstone Member (50-2L), and Shuliufen Shale Member (55-1L, fig. 7).

36. *Verrucatosporites reniformis* Huang sp. nov. Pl. 10, Figs. 8-10.

Spores monolet; amb lunate, the proximal face flat, the distal face convex; $37 \times 53 \mu$. Exine 1μ thick, with verrucate processes, the verrucae $1 \times 5 \mu$; sexine tuberculate, the tuberculae $1-1.5 \times 2-3 \mu$.

Type locality: Mushan Formation.

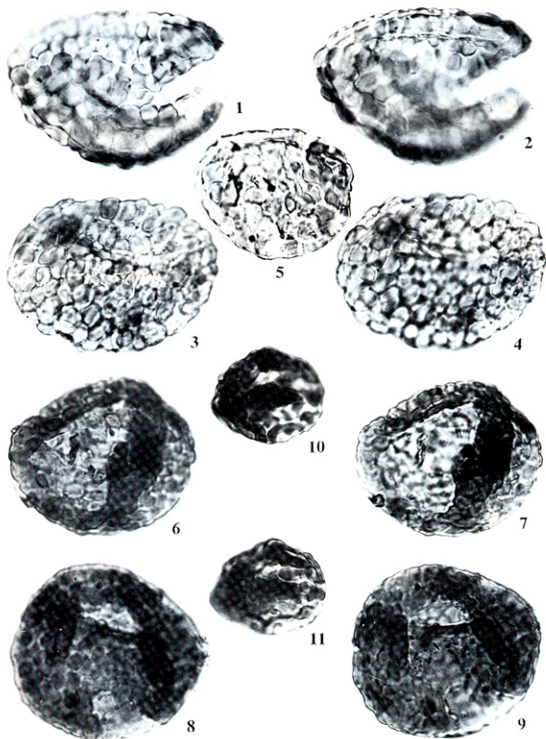


Plate 9. *Verrucatosporites*, all figures, $\times 1000$.

1-4. *V. balticoides* Huang (50-3L, 50-1L); 5. *V. balticoides minor* Huang (TR₁-3R); 6-9. *V. lato-apertus* Huang (27-27R, 26-1R); 10-11. *V. lato-apertus minor* Huang (25-8R).

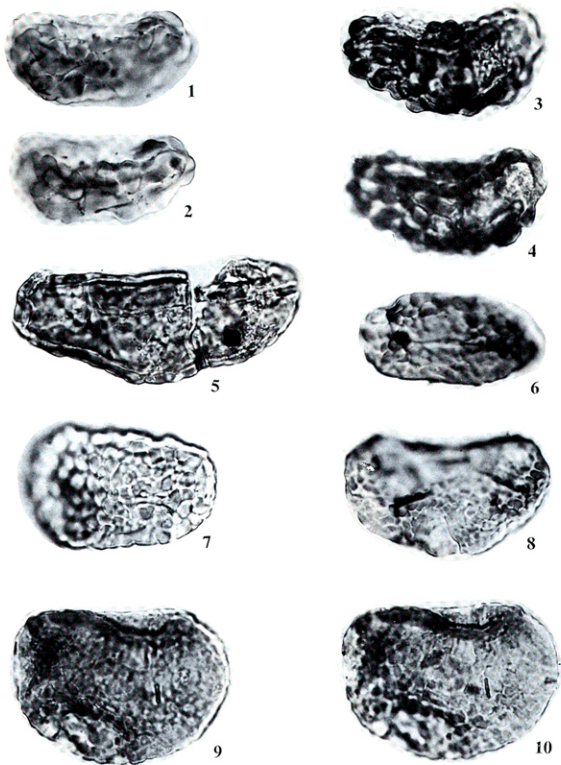


Plate 10. *Verrucatosporites*, all figures, $\times 1000$.

1-4. *V. lunatus* Huang (50-2L, 26-2L); 5. *V. oblongus* Huang (54-2R); 6-7, *V. pseudobalticus* Huang (37-3L, 55-1L); 8-10. *V. reniformis* Huang (51-3L, Mml-2R).

Type slide: Mm1-2R. (figs. 9-10, holotype).

Taxonomic affinity: This species is similar to the extant *Davallia* species.

Note: The same palynomorphs are also found in Peliao Sandstone (27-17R) and Kuantaoshan Sandstone Member (fig. 8, 51-3L).

Genus 16. ZONOMOLETEs Naunova 1939 ex Bolhovitina 1933.

Spores monolet, with a thick margin.

37. *Zonomoletes taiwanensis* Huang sp. nov.

Pl. 8, Figs. 6-7.

Spores monolet; amb elliptic; $40 \times 61 \mu$; furrow 50μ long. Exine 1.5μ thick, psilate, with thick, smooth margin, the margin 4μ thick; sexine extervermiculae on proximal face or tuberculae on distal face; tuberculae $2-3 \times 2 \mu$.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 51-4R.

Taxonomic affinity: Unknown.

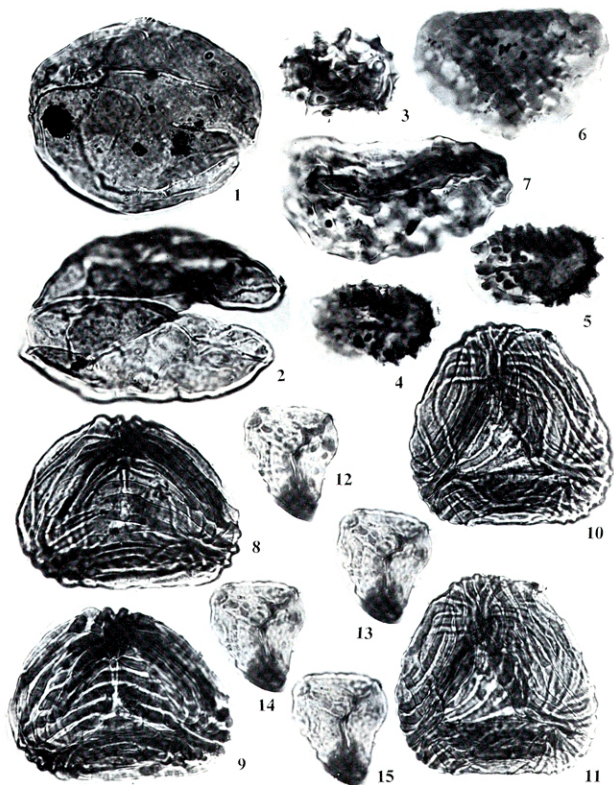
Note: The same palynomorph is also found in the Shuliufen Shale Member (54-2R).

Class 3. TRILETES

Twenty-seven form genera and 49 taxa are recorded here.

KEY TO THE GENERA

1. Spores azonotrite.
 2. Polar axis longer than equatorial axis.....40. *Triplanosporites*
 2. Polar axis shorter than equatorial axis.
 3. Perine present, granulate.....32. *Perotrilites*
 3. Perine absent.
 4. Exine smooth, without torus; laesural arms simple, with marginal folds or with line-like margo.
 5. Laesural arms with line-like margo or fold.
 6. Amb deltoid; laesural arms with folds.....25. *Deltoidospora*
 6. Amb rounded triangular; laesural arms with line-like margo.....19. *Cibotumsporites*
 5. Laesural arms simple.
 7. Amb rounded triangular.....29. *Leiotrilites*
 7. Amb triquetre or trilobate.....22. *Concavitrilites*
 4. Exine ornamented by various elements or torate.
 8. Exine striate.
 9. Ridges of exine remotely apart from laesurae and forming concentric 3-7-triangles around the proximal face.....30. *Magnastriatites*
 9. Ridges of exine immediately bordering the laesura.
 10. Ridges of exine numerous, anastomosing.....20. *Cicatricosisporites*
 10. Ridges of exine only three, triangular.....33. *Plicatella*
 8. Exine not striate.
 11. Torus or laesural ridges present.
 12. Equatorial ridges and proximal ridges present.....28. *Gleicheniidites*
 12. Equatorial ridges absent, but laesural ridges present.
 13. Exine with scabrate processes; furrow with tuberculate laesural ridge.....41. *Verrucatriletes*



13. Exine psilate; furrow with long plane field laesural ridge....38. *Toroisporis*
11. Torus or laesural ridges absent.
 14. Sexine granulate, tuberculate, rugulate or extervermiculate.
 15. Exine with scabrate or gemmate processes; sexine granulate or tuberculate.
 16. Exine with gemmate processes; sexine granulate.....27. *Gemmatotritiletes*
 16. Exine with scabrate processes; sexine tuberculate....43. *Verrucosiporites*
 15. Exine with baculate processes; sexine rugulate or extervermiculate.
 17. Sexine rugulate.....17. *Bacutritiletes*
 17. Sexine extervermiculate.....31. *Osmundacidites*
 14. Sexine reticulate, overlapping vermiculate or foveolate.
 18. Sexine reticulate.
 19. Exine with echinate, capitate and branched echinate processes.....18. *Bohemiasporis*
 19. Exine with scabrate processes.
 20. Spores small, less than 30μ wide; sexine reticulate; exine 1μ thick....36. *Retitritiletes*
 20. Spores large, more than 45μ wide; sexine vermiculate-reticulate; exine 2.5μ thick.....24. *Crassoretitritiletes*
 18. Sexine foveolate or overlapping vermiculate.
 21. Exine with scabrate processes; sexine overlapping vermiculate.....23. *Convolutispora*
 21. Exine subpsilate or with verrucate processes; sexine foveolate.
 22. Exine subpsilate; amb triquete to rounded triangular...26. *Foveotritiletes*
 22. Exine with verrucate processes; amb triquete to trilobate.....39. *Trilobosporites*
1. Spores zonotritilete.
 23. Exine with verrucate processes; sexine extervermiculate.....42. *Verrucingulatisporites*
 23. Exine psilate.
 24. Sexine rugulate or tuberculate.....34. *Polypodiaeaceosporites*
 24. Sexine smooth.
 25. Laesural arms simple.....21. *Cingulatisporites*
 25. Laesural arms with circumfluent laesural ridges or torate.
 26. Both distal and proximal ridges present.....35. *Pterisporis*
 26. Both distal and proximal ridges absent.....37. *Toriculatisporites*

Genus 17. *BACUTRILETES* van der Hammen 1954.

Spores azonotritilete; amb triangular. Laesural arms simple, straight, longer than $2/3$ radius. Exine with baculate processes; sexine rugulate.

38. *Bacutritiletes desobaculus* Huang sp. nov.

Pl. 14, Figs. 1-4.

Spores trilete; amb subtriangular; $14-32 \times 22-33\mu$. Laesural arms 12μ long. Exine 2.5μ thick, with baculate processes, the bacula $6 \times 5\mu$; sexine rugulate, rarely reticulate on proximal face.

Plate 11. Figures 1-7, 12-15, $\times 1000$; Figures 8-11, $\times 500$.

1-2. *Laevigatasporites taiwanensis* Huang (42-1L); 3-5. *Echinosporis taiwanensis* Huang (54-2L, 52-1R); 6. *Polypodioidites reniformis* Huang (50-2L); 7. *Polypodioidites taiwanensis* Huang (51-5R); 8-11. *Magnastriatites howardii* G. H. M. (57-5R, 58-1R); 12-15. *Verrucatritiletes taiwanensis* Huang (35-3R).

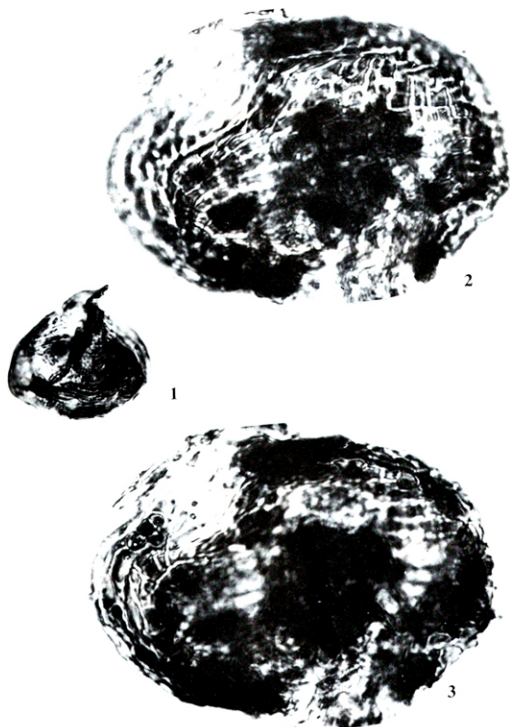


Plate 12. SCHIZAEACEAE, $\times 1000$.

1. *Schizaeosporites digitatus* Huang (35-1L); 2-3, *S. taiwanensis* Huang (40-2L).

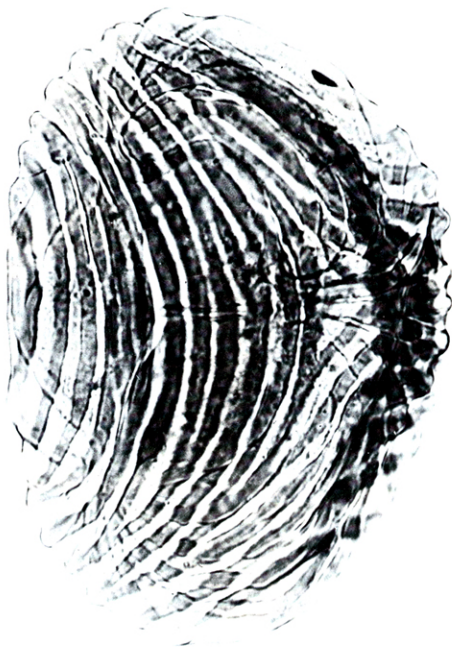


Plate 13. PARKERIACEAE, $\times 1000$.

Magnastriatites taiwanensis (Huang) Huang (58-2R).

Type locality: Kuantaoshan Sandstone Member.

Type slides: 49-2R (figs. 1-2, holotype), 49-2L, (fig. 3), 50-2L (fig. 4).

Taxonomic affinity: Unknown.

Note: The same type of palynomorph appeared also in Tungken Formation (44-2R).

Genus 18. *BOHEMIASPORIS* Krutzsch 1967.

Spores azonotrilete; amb rounded triangular. Laesural arms straight, with line like margo, as long as radius. Exine with echinate, capitate and branched echinate processes; sexine reticulate with warts raising from the meeting of the muri.

39. *Bohemiasporis taiwanensis* Huang sp. nov.

Pl. 14, Figs. 5-6.

Spores trilete; amb rounded triangular, the side slightly convex, the angle rounded; 34-36 μ wide. Laesural arms straight, 12-15 μ long, with line-like margo, the margo less than 1 μ wide, as long as radius. Exine 1 μ thick, with echinate, capitate, and branched echinate processes, the echini 3-4 μ long; sexine reticulate, with warts raising from the meeting of the muri, the muri 1 μ thick, the lumina variously shaped.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 49-1R.

Taxonomic affinity: This species is possibly related with extant *Lycopodium* species.

Genus 19. *CIBOTUMSPORITES* Rouse 1957.

Spores azonotrilete; amb rounded triangular, the side nearly straight or slightly concave and convex, the angle pointed acute or slightly rounded obtuse. Laesural arms straight, with obscure line-like margo, as long as radius. Exine psilate, smooth.

40. *Cibotumsporites cumingus* Huang sp. nov.

Pl. 14, Figs. 8-10

Spores trilete; amb rounded triangular, the side nearly straight or slightly concave and convex, the angle acute or obtuse; 53-58 $\times$ 54-64 μ . Laesural arms straight, as long as radius, 28-31 μ long, with line-like margo, the margo 1 μ wide. Exine 2-3 μ thick, psilate; sexine smooth.

Type locality: Tungken Formation.

Type slide: 43-2L.

Taxonomic affinity: This species is similar to the extant *Cibotium cumingii* Kunze.

Genus 20. *CICATRICOSISPORITES* Potonié & Gelletich 1933.

Spores trilete, with external sculpture or muri or striae of even width and height, mostly parallel, occasionally branching or anastomosing.

KEY TO THE SPECIES

- 1 Spores triangular, with notched angles.....41. *C. australiensis*
- 1 Spores semi-circular, with obtuse or broadly rounded angles.....42. *C. taiwanensis*
- 41. *Cicatricosisporites australiensis* (Cookson) Potonié in Beih. Geol. Jahrb. 23: 103. 1956; Dettmann in Proc. Royal Soc. Victoria 77(1): 52-56. 1963; Huang in Bot. Bull. Academia

Plate 14. All figures $\times 1000$.

1-4. *Bacutritiles densobaculus* Huang (49-2R, 49-2L, 50-2L); 5-6. *Bohemiasporites taiwanensis* Huang (49-1R); 7. *Verrucosisporites taiwanensis* var. *scabriformis* Huang (35-2L); 8-10. *Cibotumsporites cumingus* Huang (43-2L).

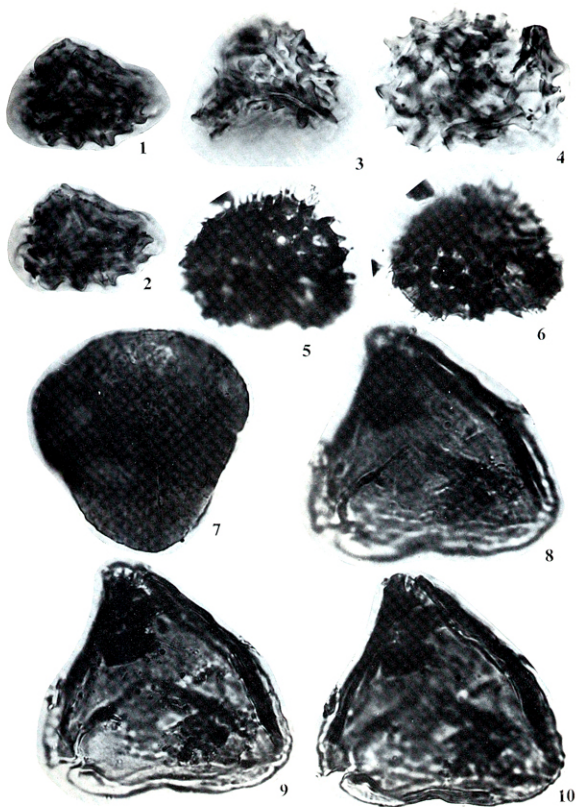




Plate 15. SCHIZAEACEAE, $\times 1000$.

1-4. *Cicatricosisporites australiensis* Cookson (1-2R, figs. 1-2, holotype; 40-2L, figs. 3-4).

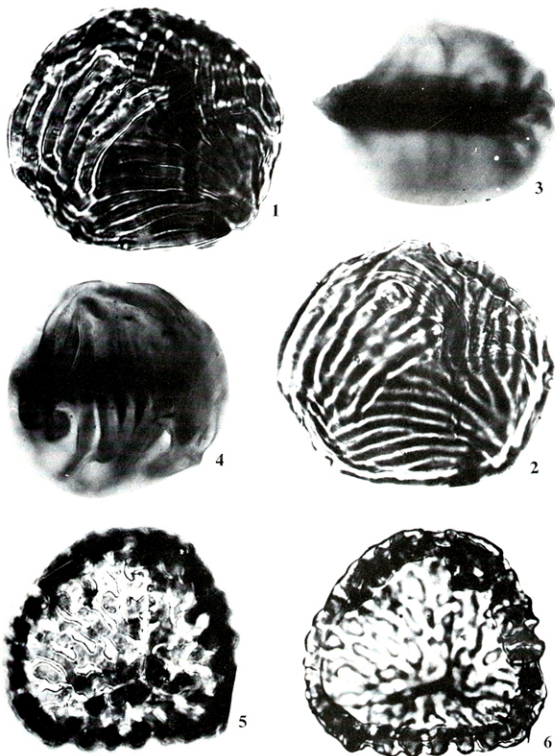


Plate 16. SCHIZAEACEAE, $\times 1000$.

1-4, *Cicatricosisporites taiwanensis* Huang (35-2R, figs. 1-2, holotype, 59-5L, figs. 3-4); 5-6, *Crassoretitriletes vanraadshooveni* GHM (TR₃-2R).

Sinica 19: 21. pl. 3, figs. 1-4. 1978.

Pl. 15, Figs. 1-4.

Mohriopsis australiensis Cookson in Aust. J. Bot. 1: 462-473. 1953.

42. *Cicatricosisporites taiwanensis* Huang in Bot. Bull. Academia Sinica 19: 21. pl. 4, figs. 1-4. 1978.

Pl. 16, Figs. 1-4.

Genus 21. **CINGULATISPORITES** Thomson in Thomson & Pflug 1953.

Spores zonotrilite; amb rounded triangular. Laesural arms simple, longer than $2/3$ radius. Exine smooth, with uniformly developed equatorial ring, the ring more or less wedged shaped cross-sectioned, and its width not surpassing $1/5$ of the total spore diameter.

43. *Cingulatisporites taiwanensis* Huang sp. nov.

Pl. 17, Figs. 1-2.

Spores trilete; amb rounded triangular, the side straight or slightly convex, the angle obtuse; $42-46 \times 42-56 \mu$. Laesural arms simple, straight, 21μ long, nearly as long as radius. Exine 1μ thick, psilate, smooth, equatorial cingulum, with the cingulum $1-2 \mu$ wide.

Type locality: Tungkeng Formation.

Type slide: 44-3L.

Taxonomic affinity: This species is possibly related with the extant *Cibotium* species.

Genus 22. **CONCAVITRILETES**, Krutzsch 1959.

Spores azonotrilite; amb triquete to trilobate, the side concave, the angle broadly rounded. Laesural arms clearly defined, simple, at least $2/3$ radius, without tori. Exine psilate; sexine smooth.

44. *Concavitriletes taiwanensis* Huang sp. nov.

Pl. 17, Figs. 3-4

Spores trilete; amb triquete toward trilobate, the sides concave, the angle broadly rounded; $27-32.5 \times 27-32.5 \mu$. Laesural arms $15-20 \mu$ long, straight, simple, at least $2/3$ radius. Exine 1μ thick, psilate; sexine smooth.

Type locality: Shuliufen Shale Member.

Type slide: 54-2R (fig. 3), 52-1R (fig. 4, holotype).

Taxonomic affinity: This species is similar to the extant *Dicranopteris* species.

Note: The same type of palynomorphs appeared also in Kuantashan Sandstone Member (50-2L), Taliao Formation (TR₁-3R), and Tungkeng Formation (41-3R). The palynomorphs found in the last two formations show granulate sexine which also appear on the sexine of the extant *Dicranopteris* species.

Genus 23. **CONVULUTISPORE** Hoffmeister, Staplin & Malloy 1955.

Spores azonotrilite; amb circular. Laesural arms indistinct. Exine with scabrate processes; sexine packed overlapping vermiculate causing reticulate appearance, the lumina circular or elliptic.

45. *Convolutispora taiwaniana* Huang sp. nov.

Pl. 17, Figs. 5-6.

Spores azonotrilite; amb circular; $56-65 \mu$ wide. Laesural arms indistinct. Exine with scabrate processes; sexine overlapping vermiculate or reticulate, the lumina circular or elliptic, $2-5 \times 2 \mu$, the ridges $2-4 \mu$ wide.

Type locality: Shuliufen Shale Member.

Type slide: 54-2R (fig. 5, holotype), 2-2L (fig. 6).

Taxonomic affinity: Unknown.

Note: The same palynomorphs are also found in Mushan Formation and Shiht Formation.

Genus 24. **CRASSORETITRILETES** Germeraad, Hopping & Muller 1968.

Spores trilete, entirely and coarsely reticulate with undulating muri, thick-walled; laesural indistinct.

46. *Crassoretitrites vanraadshooveni* GHM. in Rev. Palaeobot. Palynol. 5: 286. 1968; Huang in Bot. Bull. Academia Sinica 19: pl. 4, figs. 5-6. 1978. Pl. 16, Figs. 5-6.

Genus 25. **DELTOIDOSPORA** Miner 1935.

Spores azonotrilite; amb deltoid or subdeltoid, the sides nearly straight or slightly concave, the angle obtuse. Laesural arms more than $2/3$ radius, with or without marginal exinal folds. Exine smooth.

47. *Deltoidospora taiwaniana* Huang sp. nov. Pl. 17, Fig. 7.

Spores trilete; amb deltoid triangular to subtriangular, the sides nearly straight or slightly concave, the angle acute or obtuse; $33 \times 33-35 \mu$. Laesural arms straight, $17-21 \mu$ long, as long as radius, with circumfluent laesural folds, the folds 1μ wide. Exine 1μ thick, psilate; sexine smooth.

Type locality: Shuliufen Sandstone.

Type slide: 44-1L.

Taxonomic affinity: This species is similar to the extant *Dicranopteris* species.

Note: The same palynomorphs are also found in Taliao Formation (TR3-3R), and Kuanyinshan Sandstone (37-1R).

Genus 26. **FOVEOTRILETES** Potonié 1956.

Spores azonotrilite; amb rounded triangular, with concave sides and rounded angles. Laesural arms delicate, more than $2/3$ radius. Exine subpsilate; sexine foveolate.

48. *Foveotrilites serratus* Huang sp. nov. Pl. 17, Figs. 8-9.

Spores trilete; amb triquete or rounded triangular with concave sides and broadly rounded angles; $23 \times 26-27 \mu$. Laesural arms simple, $10-14 \mu$ long, more than $2/3$ radius. Exine subpsilate; sexine foveolate.

Type locality: Talu Shale.

Type slide: 11-9L.

Taxonomic affinity: This species is similar to the extant *Lycopodium serratum* Thunb. var. *longipetiolatum* Spring.

Genus 27. **GEMMATOTRILETES** Huang, gen. nov.

Spores azonotrilite; amb rounded triangular, the side convex, the angle rounded. Laesural arms as long as $1/2$ radius, with line-like margo. Exine with gemmate processes; sexine granulate.

49. *Gemmatotrilites taiwanensis* Huang sp. nov. Pl. 17, Figs. 10-13.

Spores trilete; amb rounded triangular, the side convex, the angle rounded; $24-28 \mu$ wide. Laesural arms $7-8 \mu$ long, as long as $1/2$ radius, with line-like margo, the margo less than 1μ thick. Exine less than 1μ thick, with gemmate processes, the gemmae less than 1μ long; sexine granulate.

Type locality: Kuantaoshan Sandstone Member.

Type slide: 49-1R (fig. 12, holotype), 53-2R (fig. 13).

Taxonomic affinity: This species is possibly related with the extant *Crepidomanes latemarginale* (Eaton) Copeland or *Vandenboschia naseana* (Christ) Ching of Hymenophyllaceae.

Genus 28. **GLEICHENIIDITES** Ross 1949, Krutzsch 1949.

Spores azonotrilite; amb triquete, two sides concave, one side convex; proximal torus present along laesural arms; spore wall in equatorial region unequal thickness, along the sides gradually thickened toward center, around the angles thin. Exine smooth.

KEY TO THE SPECIES

1. Angle obtusely acute; circumfluent field proximal ridge present.....50. *G. rasilis*
 1. Angle broadly rounded; circumfluent laesural ridge present.....51. *G. taiwanensis*
50. *Gleicheniidites rasilis* Krutzsch Geologie, Beih. 21-22: 113. 1959. Pl. 18, Figs. 1-3.

Spores trilete; amb subtriangular, the side convex, the angle obtusely acute; $33-36 \times 33-40 \mu$. Laesural arms simple, $15-20 \mu$ long, as long as radius. Exine thin, less than 1μ thick, smooth, with circumfluent field-proximal ridge, the ridge 4μ wide at center, and also with annulotrilite equatorial ridge, the ridge 6μ wide at center.

Locality: Talu Shale.

Selected slide: 10-13L.

Taxonomic affinity: This species is closely related with the extant species of *Gleicheniaceae*.

Note: Mostly found on Cretaceous; type species was found at Aptian, USSR. The same palynomorphs are also found in Peliao Sandstone (34-2R), and Kuantaoshan Sandstone Member (50-2L).

51. *Gleicheniidites taiwanensis* Huang sp. nov. Pl. 18, Figs. 4-6.

Spores trilete; amb triquete, two sides concave, one side convex, all sides thickened toward center; $30-31 \times 31-37 \mu$. Laesural arms straight, 16μ long, with circumfluent laesural ridges, the side ridge $3-5 \mu$ wide, the angle ridge 2μ wide. Exine less than 1μ thick, smooth, with annulotrilite equatorial ridges, the side ridge 4μ wide, the angle 1μ thick.

Type locality: Shangfuchi Sandstone.

Type slide: 46-1L.

Taxonomic affinity: This species is similar to the extant *Geleichenia* species.

Genus 29. **LEIOTRILETES** Naumova 1939 ex Ishchenko 1952.

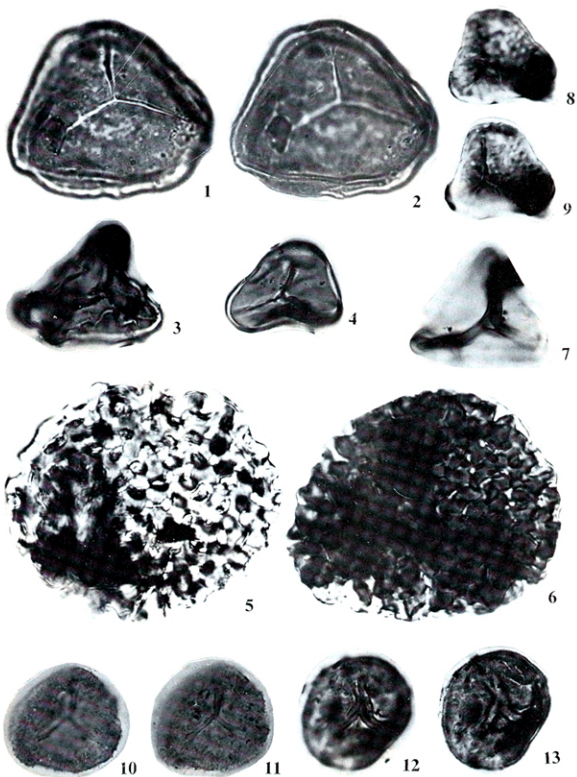
Spores azonotrilite; amb rounded triangular, the side usually concave, the angle rounded. Laesural arms straight, simple, longer than $1/2$ radius. Exine smooth, rarely infrapunctate.

KEY TO THE SPECIES

1. Radial arms not uniformly one type; amb one side convex and two sides suddenly concave into as particular tailed.....53. *L. obovatus*
1. Radial arms uniformly one type.
 2. Spores subspheroidal or circular; ratio of length and width nearly 1....55. *L. taiwanensis*
 2. Spores ellipsoidal or deltoid.
 3. Spores ellipsoidal; ratio of length and width more than 1.....52. *L. ellipticus*

Plate 17. All figures $\times 1000$.

1-2. *Cingulatisporites taiwanensis* Huang (44-3L); 3-4. *Concavitriletes taiwanensis* Huang (54-2R, 52-1R); 5-6. *Convolutispora taiwaniana* Huang (54-2R, 52-1R); 7. *Deltoidospora taiwaniana* Huang (44-1L); 8-9. *Foveotrilites serratus* Huang (11-9L); 10-13. *Gemmatotrilites taiwanensis* Huang (49-1R, 53-2R).



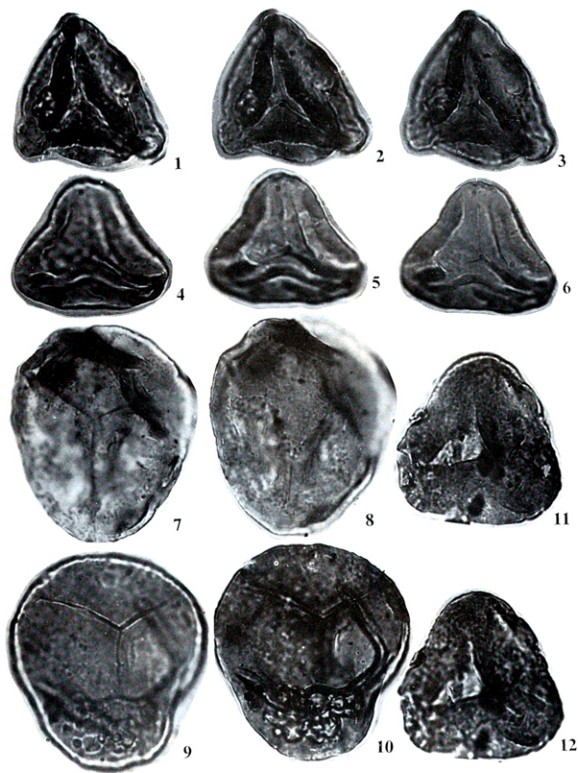


Plate 18

3. Spores deltoid; ratio of length and width less than 1. 54. *L. sphaerotriangulus*
52. *Leiotriletes ellipticus* Huang sp. nov. Pl. 18, Figs. 7-8.
- Spores trilete; amb rounded triangular; $45-52 \times 43-52 \mu$. Laesural arms two short and one long, as long as or more than $2/3$ radius, $20-25 \mu$ long. Exine 1.5μ thick, psilate; sexine obscure pattern.
- Type locality: Yutengping Sandstone Member.
- Type slide: 58-1R.
- Taxonomic affinity: Unknown.
- Note: The same palynomorphs are also found in Chuhuangkeng Formation, Kuanyinshan Sandstone, Tungkung Formstion, Shangfuchi Sandstone and Yutengping Sandstone Member.
53. *Leiotriletes obovatus* Huang sp. nov. Pl. 18, Figs. 9-10.
- Spores trilete; amb obovatus or rounded triangular, one side convex, two sides suddenly constricted at center, the angle broadly obtuse; $40-52 \times 48-50 \mu$. Laesural arms simple, two short, one long, $18-23 \mu$ long. Exine 1.5μ thick, psilate, smooth.
- Type locality: Tungkung Formation.
- Type slide: 41-5L (figs. 9-10, holotype), 41-5R.
- Taxonomic affinity: Unknown.
54. *Leiotriletes sphaerotriangulus* (Loose) Potonié & Kremp in Geol. Jahrb., Bd. 69: 120. 1954. Pl. 18, Figs. 11-12.
- Spores trilete; amb rounded triangular, the side more or less convex. the angle broadly obtuse; $38-41 \times 40-42 \mu$. Laesural arms simple, as long as $1/2$ radius, $13-15 \mu$ long. Exine less than 1μ thick, psilate, smooth.
- Locality: Chuhuangkeng Formation.
- Selected slide: 18-2L.
- Taxonomic affinity: Unknown.
- Note: The same palynomorphs are also found in Taliao Formation (38-27R) and Kuanyinshan Sandstone.
55. *Leiotriletes taiwanensis* Huang sp. nov. Pl. 19, Figs. 1-2.
- Spores trilete; amb circular to subspheroidal; 55μ wide. Laesural arms simple, 15μ long, more than $1/2$ radius. Exine 1.5μ thick, psilate, smooth.
- Type locality: Kuanyinshan Sandstone and Yutengping Sandstone Member.
- Type slides: 37-6L (fig. 1, holotype), 57-2R (fig. 2).
- Taxonomic affinity: This species is possibly related with the extant *Equisetum* species.
- Note: The same palynomorphs are found in Shuliufen Shale Member (54-2R), and Kuantaoshan Sandstone Member (52-6L).

Genus 30. **MAGNASTRIATITES** Germeraad, Hopping & Muller 1968.

Spores trilete; amb spherical. Exine coarsely striate, except on the proximal contact area which is surrounded by a circular ridge; striae continuous; grooves about as wide as ridges; size around 100μ wide.

Plate 18. All figures $\times 1000$.

- 1-3. *Gleicheniidites rasilis* Krutzsch (10-13L); 4-6. *Gleicheniidites taiwanensis* Huang (46-1L); 7-8. *Leiotriletes ellipticus* Huang (58-1R); 9-10. *Leiotriletes obovatus* Huang (41-5L); 11-12. *Leiotriletes sphaerotriangulus* (Loose) Potonié & Kremp. (18-2L).

KEY TO THE SPECIES

1. The ratio between height and width of spores more than 0.9.....56. *M. howardii*
 1. The ratio between height and width of spores less than 0.857. *M. taiwanensis*
 56. *Magnastriatites howardii* G.H.M. Rev. Palaeobot. Palynol. 5(6):288. 1968; Huang in Bot. Bull. Academia Sinica 18:78-81. 1977. Pl. 11, Figs. 8-11.

Spores trilete; amb circular or subconical on distal face; $67-86 \times 74-100 \mu$; ratio between height and width of spores more than 0.9. Laesural arms nearly straight without margo, extending to joints of angles, $31-50 \mu$ long, 1μ wide. Exine striate, the ridges six or eight jointed at three points, and forming 3- or 4-concentric triangles, each side of triangles concave, $4-5 \mu$ wide, the grooves 1μ wide.

Locality: Mushan Formation, Chuhuangkeng Formation, Talu Shale and Yutengping Sandstone Member.

Selected slides: Mm1-2L, 10-21R, 26-8L, 57-5R (figs. 8-9), 58-1R (figs. 10-11).

Taxonomic affinity: This species is possibly the same species as the extant *Ceratopteris pteridoides* (Hook.) Hieron. of Parkeriaceae.

57. *Magnastriatites taiwanensis* (Huang) Huang transf. nov. Pl. 13.
Ceratopteris taiwanensis Huang in Bot. Bull. Academia Sinica 18: 78-81. figs. 1-2. 1977

Spores trilete; amb ellipsoidal, the proximal face flat, the distal face subconical; $110 \times 155 \mu$. Laesural arms almost straight, nearly extending to the joints of ridges, 22μ long, with margo of 1μ wide. Exine striate, about 0.4μ thick, the ridges about 6-7, dichotomously branched, jointed at three points, and forming 6-7-concentric triangle around the proximal face. and transversally parallel striate on the distal face, $3-5 \mu$ wide, the grooves $1-2 \mu$ wide.

Type locality: Yutengping Sandstone Member.

Type slide: 58-2R.

Taxonomic affinity: This species is one of the extant *Ceratopteris* species.

Genus 31. *OSMUNDA CIDITES* Couper 1953.

Spores azonotrilite; amb circular to rounded triangular. Laesural arms simple, moderately long. Exine 1μ thick, with baculate processes; sexine extervermiculate.

58. *Osmundacidites taiwanensis* Huang sp. nov. Pl. 19, Figs. 3-4.

Spores trilete; amb rounded triangular; $35-60 \mu$ wide. Laesural arms line-like, $17-27 \mu$ long; Exine 1μ thick, with baculate processes, the bacula $1.5-2 \times 1 \mu$; sexine extervermiculate.

Type locality: Mushan Formation.

Type slide: M₃₃-2L.

Taxonomic affinity: This species is similar to the extant *Osmunda* species.

Note: The same palynomorphs are also found in Wuzheshan Formation (M₃₃-6L), Peliao Sandstone (21-2L, 24-5L, 26-6L) and Tungkeng Formation (41-3R).

Genus 32. *PEROTRILITES* Erdtman 1945 ex Couper 1953.

Spores azonotrilite; amb circular or rounded triangular. Laesural arms simple or with lip-like margo, as long as radius. Exine smooth, psilate. Perine subpsilate, finely granulate, light yellow.

59. *Perotriletes minor* Krutzsch, Atlas der mittel-und jungtertiären dispersen Sporen-und Pollen sowie der Mikroplanktonformen des nördlichen Mitteleuropas 4-5:100, pl. 32, figs. 5-8, 1967. Pl. 19, Figs. 5-6.

Spores trilete; amb circular; 18-20 μ wide. Laesural arms undulate as long as radius and narrow extending toward the margin of perine, with lip-like margo, the margo 1 μ wide. Exine 1 μ thick, psilate. Perine light yellow, subpsilate, 1-3 μ extending out from spore wall. Locality: Talu Shale and Kuanyinshan Sandstone.

Selected slides: 11-9L, 37-1L.

Taxonomic affinity: This species is possibly related with the extant *Selaginella* species.

Genus 33. *PLICATELLA* Maijavkina 1949.

Spores trilete; amb triangular. Exine ribbed, with short appendices on the angles.

60. *Plicatella taiwaniana* Huang in Bot. Bull. Academia Sinica 19:22. pl. 5, figs. 5-6. 1978. Pl. 23, Figs. 5-6.

Genus 34. *POLYPODIACEOISPORITES* Potonié 1951.

Spores trilete; amb ellipsoidal, rounded triangular, subtriangular or triquete, the side convex, concave or straight, the angle usually obtuse, or acute, rarely broadly obtuse, emarginate. Laesural arms usually straight, with proximal irregularly sinuous laesural ridges. Exine 0.5 μ thick, the proximal face extervermiculate, tuberculate and the distal face tuberculate, extervermiculate or lophate. Equatorial ridge annulate, rarely annulotrilite, the margin smooth.

KEY TO THE SPECIES

1. Equatorial ridge evenly thick.
 2. Amb ellipsoidal66. *P. intragigantibalticus*
 2. Amb subtriangular.
 3. Spores 21-24 $\times$ 24-27 μ ; equatorial ridge 2 μ wide67. *P. microconvexus*
 3. Spores 30-40 $\times$ 36-50 μ ; equatorial ridge 3 μ wide64. *P. gracillimus*
1. Equatorial ridge unevenly thick.
 4. Angle thicker than side.
 5. Amb triquete, the side concave, the angle emarginate; exine extervermiculate on both surfaces73. *P. taiwanensis*
 5. Amb subtriangular, the side straight, the angle rounded or truncate; exine rugulato-reticulate on distal face71. *P. semipinnatus*
 4. Angle thinner than side, obtuse or acute.
 6. Circumfluent field-distal ridge present; equatorial ridge annulotrilite61. *P. bellus*
 6. Circumfluent field-distal ridge absent.
 7. Equatorial ridge annulotrilite; laesural ridge circumfluent62. *P. dictylinus*
 7. Equatorial ridge annulate; laesural ridge not circumfluent.
 8. Side convex.
 9. Elements prominent on both faces.
 10. Angle less than 2 μ thick, acute.
 11. Spores 22-28 $\times$ 21-29 μ ; side 3.5-4 μ wide; proximal irregularly sinuous laesural ridge present68. *P. microconvexus*
 11. Spores 37-40 $\times$ 35-43 μ ; side 2-4 μ wide; laesural line-like70. *P. multifidus*
 10. Angle obtuse.

12. Angle $1.5-2\ \mu$ thick 75. *P. wallichianus*
 12. Angle more than $2\ \mu$ thick, obtuse; spores $38-40 \times 34-40\ \mu$; side $3-4\ \mu$ wide; laesurae with proximal irregularly sinuous ridges..... 65. *P. intrabalticus*
 9. Elements prominent on proximal face only 69. *P. microformis*
 8. Side concave or straight.
 13. Amb triquete; side $6-7\ \mu$ wide; angle $2-5\ \mu$ thick, acute or emarginate; spores $40-44 \times 40-50\ \mu$ 63. *P. emarginatus*
 3. Amb subtriangular; side $3-5\ \mu$ wide; angle obtuse.
 14. Spores $32-35 \times 31-37\ \mu$; angle $2-3\ \mu$ thick; side $3-4\ \mu$ wide. ... 72 *P. setuloso-costulatus*
 14. Spores $34-40 \times 40-41\ \mu$; angle $3.5-4\ \mu$ thick; side $4-5\ \mu$ wide. 74. *P. venustus*
 61. *Polypodiaceoisporites bellus* Huang in Bot. Bull. Academia Sinica 19: 16. pl. 1, figs. 1-3. 1978. Pl. 2, Figs. 1-3.
 62. *Polypodiaceoisporites dactylinus* Huang, loc. cit. 16. pl. 2, figs. 14-15. Pl. 22, Figs. 14-15.
 63. *Polypodiaceoisporites emarginatus* Huang, loc. cit. 16. pl. 1, figs. 6-7. Pl. 21, Figs. 6-7.
 64. *Polypodiaceoisporites gracillimus* Nagy in Pollen et Spores 5(2):397-412. 1963; Huang, loc. cit. 17. pl. 1, figs. 8-9. Pl. 21, Figs. 8-9.
 65. *Polypodiaceoisporites intrabalticus* Huang, loc. cit. 17. pl. 1, figs. 10-12. Pl. 21, Figs. 10-12.
 66. *Polypodiaceoisporites intragigantibalticus* Huang, loc. cit. 17. pl. 2, figs. 1-2. Pl. 22, Figs. 1-2.
 67. *Polypodiaceoisporites microconcavus* Krutzsch, Atlas der mittel-und jungtertiären dispersen Sporen-und Pollen—sowie der Mikroplanktonformen. der nördlichen Mitteleuropas Lieferung IV. 114. 1967. Verb. Gustav Fisher Verlag Jena; Huang, loc. cit. 17. pl. 2, figs. 6-7. Pl. 22, Figs. 6-7.
 68. *Polypodiaceoisporites microconvexus* Huang, loc. cit. 18. pl. 2, figs. 8-9. Pl. 22, Figs. 8-9.
 69. *Polypodiaceoisporites microformis* Huang, loc. cit. 18. pl. 2, fig. 10. Pl. 22, Fig. 10.
 70. *Polypodiaceoisporites multifidus* Huang, loc. cit. 18. pl. 1, figs. 4-5. Pl. 21, Figs. 4-5.
 71. *Polypodiaceoisporites semipinnatus* Huang, loc. cit. 19. pl. 2, figs. 3-5. Pl. 22, Figs. 3-5.
 72. *Polypodiaceoisporites setuloso-costulatus* Huang, loc. cit. 19. pl. 2, figs. 11-12. Pl. 22, Figs. 11-12.
 73. *Polypodiaceoisporites taiwanensis* Huang, loc. cit. 19. pl. 2, fig. 13. Pl. 22, Fig. 13.
 74. *Polypodiaceoisporites venustus* Huang, loc. cit. 19. pl. 2, figs. 16-17. Pl. 22, Figs. 16-17.
 75. *Polypodiaceoisporites wallichianus* Huang, loc. cit. 20. pl. 2, figs. 18-19. Pl. 22, Figs. 18-19.

Genus 35. **PTERISPORIS** Huang gen. nov.

Plate 19. All figures $\times 1000$.

1-2. *Leiotrilites taiwanensis* Huang (37-6L, 57-2R); 3-4. *Osmundacidites taiwanensis* Huang (Mw3-2L); 5-6. *Perotrilites minor* Krutzsch (11-9L, 37-1L); 7. *Pterisporis concavus* Huang (35-3R); 8. *Pterisporis taiwanensis* Huang (54-2L); 9-10. *Retitrilites taiwanensis* Huang (34-4R).

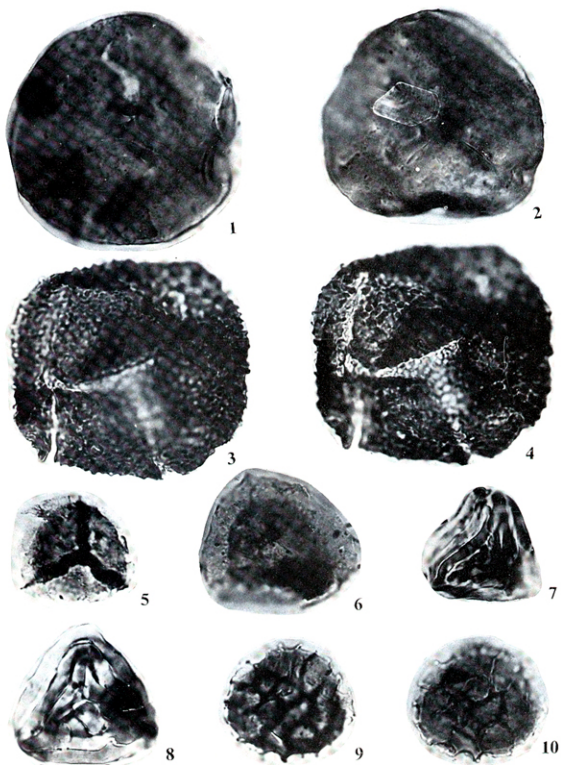


Plate 19

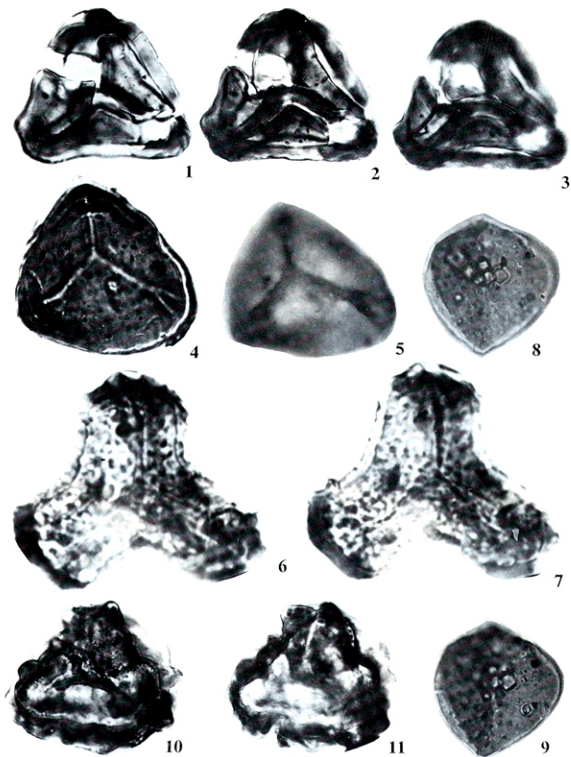


Plate 20. All figures $\times 1000$.

1-3. *Toriculatisporites taiwanensis* Huang (40-1R); 4-5. *Toroisporis bifidus* Huang (46-1L); 6-7. *Trilobosporites taiwanensis* Huang (St1-3); 8-9. *Triplanosporites taiwanensis* Huang (54-3R); 10-11. *Verrucingulatisporites taiwanensis* Huang (26-3R).

Spores zonotrilite; amb subtriangular. Laesural arms nearly as long as radius, with confluent laesural ridges. Exine smooth, thin, less than 1μ thick, with proximal, distal and equatorial ridges.

The genus is closely related to the extant *Anogramma* or *Pteris*. The genus is also similar to *Concavisporites* Pflug in Thomson and Pflug 1953 excepting for the larger size and that the laesural arms not rotated near their apices.

KEY TO THE SPECIES

1. Amb two sides concave, one side convex; spores $27-32 \times 30-32\mu$ 76. *P. concavus*
 1. Amb nearly all sides straight, $35-37 \times 35-37\mu$ 77 *P. taiwanensis*
 76. *Pterisporis concavus* Huang sp. nov. Pl. 19, Fig. 7.

Spores trilete; amb subtriangular, two sides concave, one side convex or straight; $27-32 \times 30-32\mu$. Laesural arms straight, $12-20\mu$ long, with circumfluent laesural ridges. Exine very thin, with equatorial ridges, circumfluent field proximal and distal ridges, the ridges $2-3\mu$ thick.

Type locality: Kuanyinshan Sandstone Member.

Type slide: 33-3R.

Taxonomic affinity: This species is similar to the extant species of *Pteris* or *Anogramma*.

77. *Pterisporis taiwanensis* Huang sp. nov. Pl. 19, Fig. 8.

Spores trilete; amb subtriangular, all sides nearly straight or slightly convex; $35-37 \times 35-37\mu$. Laesural arms $15-20\mu$ long, with circumfluent laesural ridges. Exine very thin, with equatorial ridges, circumfluent field proximal and distal ridges, all ridges about 2.5μ thick.

Type locality: Shuliufen Sandstone Member.

Type slide: 54-2L.

Taxonomic affinity: This species is similar to the extant species of *Pteris* or *Anogramma*.

Genus 36. RETITRILETES Pierce 1961.

Spores azonotrilite; amb circular or rounded triangular. Laesural arms simple, as long as $2/3$ radius. Exine with scabrate processes; sexine reticulate, the meshes large, more than 5μ wide, and the number of meshes about 15 in one face.

78. *Retitriletes taiwanensis* Huang sp. nov. Pl. 19, Figs. 9-10.

Spores trilete; amb circular or rounded triangular; $26-27\mu$ wide. Laesural arms indistinct. Exine reticulate, the lumina $4-5$ -angular, $5-10\mu$ wide, the muci 0.5μ wide, $1-2\mu$ high, with scabrate processes.

Type locality: Peliao Sandstone.

Type slide: 34-4R.

Taxonomic affinity: This species is similar to the extant *Lycopodium veitchii* Christ.

Genus 37. TORICINGULATISPORITES Simonesies 1964, emend Huang.

Spores zonotrilite. Exine with more or less uniformly thick smooth cingulum (or equatorial ridges) and also with either very prominent proximal tori or circumfluent laesural ridge on proximal face.

79. *Toricingulatisporites taiwanensis* Huang sp. nov. Pl. 20, Figs. 1-3.

Spores trilete; amb rounded triangular, the side straight or slightly concave and convex, the angle rounded obtuse; $35-43.5 \times 37.5-42.5\mu$. Laesural arms straight, $15-20\mu$ long, as long

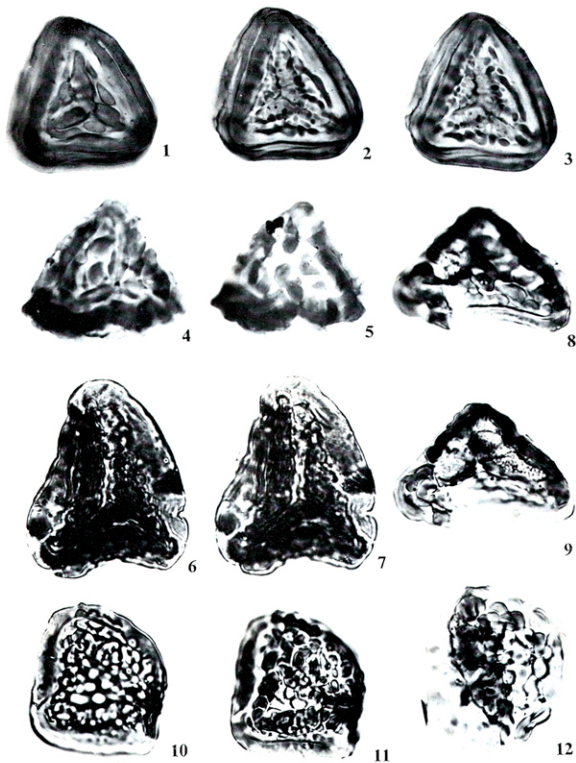


Plate 21. 1. *Polypodiaceoisporites* (PTERIDACETE) $\times 1000$.

1-3, *P. bellus* Huang (49-1R); 4-5, *P. multifidus* Huang (49-2L); 6-7, *P. emarginatus* Huang (50-2L, fig. 12); 8-9, *P. gracillimus* Nagy (34-4L); 10-12, *P. intrabalticus* Huang (55-1L, figs. 10-11, holotype; 54-2L, fig. 12).

as radius, with circumfluent laesural ridges, the ridge $2.5-3\ \mu$ wide. Exine $1\ \mu$ thick, with equatorial annulate ridges, the annulus $3-4\ \mu$ wide.

Type locality: Kuanyinshan Sandstone.

Type slide: 40-1R.

Taxonomic affinity: This species is similar to species of *Cibotium* or *Pteris faurie* Hieronymus.

Genus 38. **TOROISPORIS** Krutzsch 1959.

Spores azonotrilite; amb rounded triangular or triquete. Laesural arms as long as radius, torate or with laesural ridge.

KEY TO THE SPECIES

1. Spores $38-42 \times 38-42\ \mu$; laesural arms biforked branching at ends.....80. *T. bifidus*
 1. Spores $60-82 \times 62-82\ \mu$; laesural arms not branching at ends81. *T. taiwanensis*

80. *Toroisporis bifidus* Huang sp. nov.

Pl. 20, Figs. 4-5.

Spores trilete; amb rounded triangular, the side slightly convex, the angle obtuse; $38-42 \times 38-42\ \mu$; Laesural arms $(17-27)\ \mu$ long, as long as radius, biforked branching at ends, with long plane field laesural ridges, the ridge $1\ \mu$ wide. Exine $1.5\ \mu$ thick, psilate, smooth.

Type locality: Shangfuchi Sandstone.

Type slide: 46-1L.

Taxonomic affinity: This species is possibly related with extant *Alsophila* species of Cyatheaceae, and also similar to *Toroisporis welzewense* Krutzsch 1962.

81. *Toroisporis taiwanensis* Huang in Bot. Bull. Academia Sinica 19:23. pl. 5, fig. 1. 1978.

Pl. 23, Fig. 1.

Genus 39. **TRILOBOSPORITES** Pant 1954 ex Potonié 1956, emend Huang

Spores azonotrilite; amb triquete to trilobate. Laesural arms straight, simple, as long as radius, without kyrtoms. Exine unevenly thick, the angles thicker than the sides, with verrucate processes; sexine foveolate.

82. *Trilobosporites taiwanensis* Huang sp. nov.

Pl. 20, Figs. 6-7.

Spores trilete; amb triquete to trilobate, the sides convex, the angle rounded to broadly obtuse; $42-52 \times 54-60\ \mu$. Laesural arms straight, simple, $24-31\ \mu$ long, as long as radius. Exine unevenly thick, the side $2\ \mu$ wide, the angle $3\ \mu$ wide, with verrucate processes; sexine foveolate, the pores $1 \times 2\ \mu$.

Type locality: Shihing Formation.

Type slide: ST1-3.

Taxonomic affinity: This species is closely related to *Trilobosporites trioreticulosus* Cookson and Dettmann 1938, and *Lygodium flocculosum* Martynava in Pokrovskay and Stelmak 1964. It may be related to the extant species of *Lycopodium*.

Note: The same palynomorph is also found in Kuantaoshan Sandstone Member (50-2R).

Genus 40. **TRIPLANOSPORITES** Pflug in Thomson & Pflug 1952.

Spores trilete; amb extremely concave, with a polar axis that is longer than the equatorial axis. Laesural arms indistinct. Exine smooth.

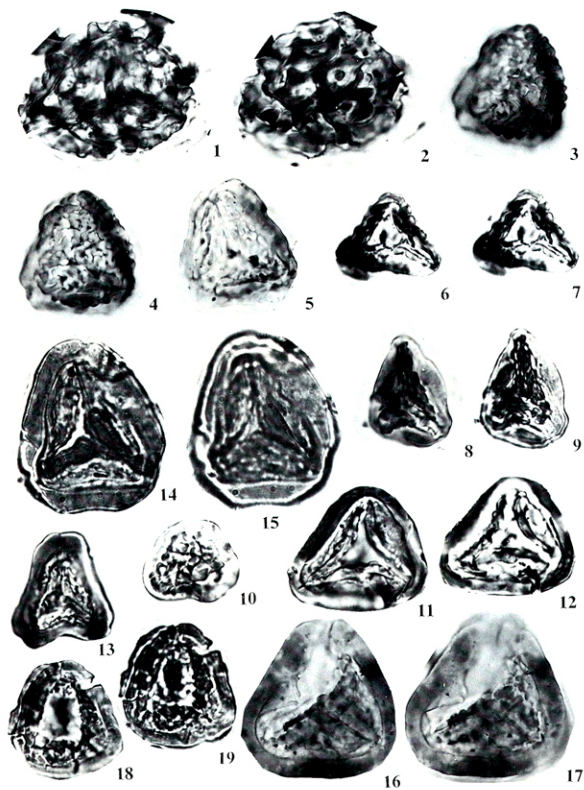


Plate 22

83. *Triplanosporites taiwanensis* Huang sp. nov.

Pl. 20, Figs. 8-9.

Spores trilete; 28-31 μ wide. Laesural arms indistinct. Exine 1 μ thick, psilate, smooth.

Type locality: Peliao Sandstone.

Type slide: 34-3R.

Taxonomic affinity: This species is related with the extant species of *Alsophila* of Cyathaceae.Genus 41. *VERRUCATITRILETES* Huang gen. nov.

Spores azonotrite; amb subtriangular. Exine with scabrate processes; sexine granulate and tuberculate together. Laesural arms studded by partially coalesced large tuberculae.

This genus is very similar to *Verrucatisporites* Nagy 1969, but the former is covered with the tuberculae and granules on whole surface of spores.84. *Verrucatisporites taiwanensis* Huang sp. nov.

Pl. 11, Figs. 12-15.

Spores trilete; amb subtriangular, the side slightly convex and concave, the angle acute or obtuse; 23-27 $\times$ 22-29 μ . Laesural arms 8-10 μ long, with tuberculae along laesural ridges. Exine 1 μ thick, with scabrate processes; sexine mixed with granulate and tuberculate together on whole surface of spore wall, the granules 1 μ wide, the tuberculae 2-3 μ wide.

Type locality: Kuanyinshan Sandstone.

Type slide: 35-3R.

Taxonomic affinity: This species is possibly related with the extant species of either *Lycopodium* or *Selaginella*.Genus 42. *VERRUCINGULATISPORITES* Kedves 1961.Spores azonotrite; amb rounded triangular, with zones 4-5 μ wide. Laesural arms simple. Exine thin, with thick cingulum, the cingulum with verrucate processes.85. *Verrucingulatisporites taiwanensis* Huang sp. nov.

Pl. 20, Figs. 10-11.

Spores trilete; amb subtriangular; 35-40 $\times$ 35-40 μ , the side straight, the angle acute. Laesural arms 12-13 μ long, folded one side. Exine 1 μ thick, with coarse irregular verrucate processes, the verrucae 4-5 μ thick; sexine extervermiculate.

Type locality: Peliao Sandstone.

Type slide: 26-3R.

Taxonomic affinity: This species is possibly related with the extant Pteridaceae.

Genus 43. *VERRUCOSISPORITES* Ibrahim 1933.

Spores trilete; sexine covered with warts or wrinkles (verrucate processes).

86. *Verrucosisporites taiwanensis* Huang in Bot. Bull. Academia Sinica 19: 24. pl. 5, figs. 2-4.

Pl. 23, Figs. 2-4.

KEY TO THE VARIETIES

1. Spores 54-68
- $\times$
- 50-64
- μ
- ; exine with verrucate processes; tuberculae 3
- $\times$
- 4
- μ
-

Plate 22. *Polypodiaceisporites* (PTERIDACEAE), $\times$ 1000.

- 1-2,
- P. intragiantibalticus*
- Huang (37-6R); 3-5,
- P. semipinnatus*
- Huang (49-2L); 6-7,
- P. microconcavus*
- Krutzsch (52-1L); 8-9,
- P. microconvexus*
- Huang (37-2R); 10,
- P. microformis*
- Huang (37-2R); 11-12,
- P. setuloso-costulatus*
- Huang (51-4R); 13,
- P. taiwanensis*
- Huang (35-1R); 14-15,
- P. dactylinus*
- Huang (46-1L); 16-17,
- P. venustus*
- Huang (49-3R); 18-19,
- P. wallichianus*
- Huang (37-2R).

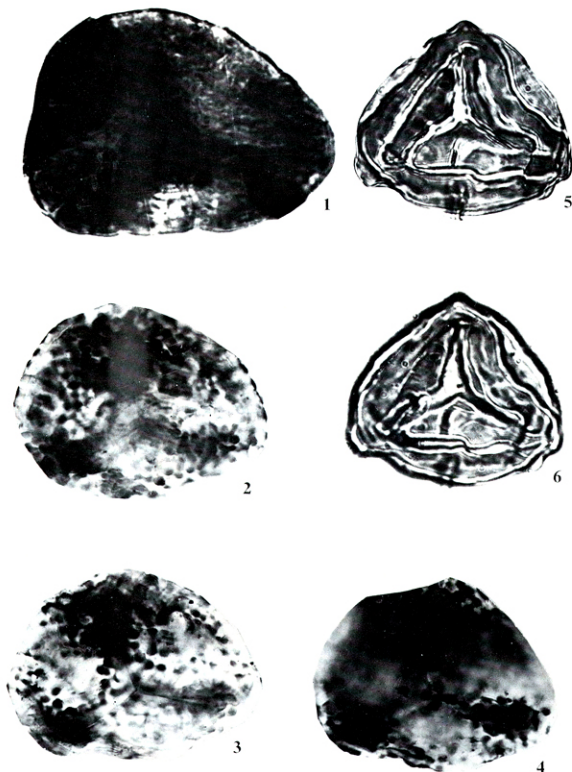


Plate 23. SCHIZAEACEAE, $\times 1000$.

1. *Toroisporis taiwanensis* Huang (1-2L); 2-4, *Verrucosisporites taiwanensis* Huang (50-1R); 5-6, *Plicatella taiwaniana* Huang (46-1L).

- 84a. *V. taiwanensis taiwanensis*.
 1. Spores $45-50 \times 45-50 \mu$; exine with scabrate processes; granules $1 \times 1 \mu$
 84b. *V. taiwanensis scabriformis*

86a. *Verrucosiporites taiwanensis*.

86b. *Verrucosiporites taiwanensis* var. *scabriformis* Huang var. nov.

Pl. 14, Fig. 7.

Spores trilete; rounded triangular; $45-50 \times 45-50 \mu$; Laesural arms $15-20 \mu$ long, with line-like or flange-like margo, the margo $2-3 \mu$ wide. Exine 3μ thick, with scabrate processes; sexine granulate, the granules $1 \times 1 \mu$.

Type locality: Kuanyinshan Sandstone.

Type slide: 35-2L.

Taxonomic affinity: *Lygodium japonicum* (Thunb.) Sw.

Note: This species differs from the typical variety by its smaller size of spores and granules, and with scabrate processes. The same sporomorphs are also found in Chuhuankeng Formation (19-20R), Peliao Sandstone (21-7L), and Talu Shale (10-31R).

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