DOI:10.19800/j.cnki.aps.1964.03.010

A PRELIMINARY REPORT ON SPORAE DISPERSAE FROM THE LOWER SHIHHOTZE SERIES OF HOKÜ DISTRICT, NW SHANSI

OUYANG SHU

(Institute of Geology & Paleontology, Academia Sinica)

(Summary)

The literatures on the Permian Sporae dispersae are rather meagre and scattered as compared with those on the Carboniferous. The correlation of sediments of long geographical distance in this period is thus nearly impossible at this moment. As far as is known to the present writer, the contributors to the Permian microflora are Dalhunty (1945, 49), Balme (1952, 1955, 1956), Imgrund (1952, 1960), Klause (1953), Potonie & Klause (1954), Leschik (1956); Luber (1938), Kara-Murza (1952), Samoilovich (1953), Zoricheva & Sedova (1954), Andreeva (1956), Zauer (1960), Medvedeva (1960) and others.

A certain amount of work has been done on Sporae dispersae of the Palaeozoic coalfields in North China since 1954, under the direction of Prof. J. Hsü of the Geology Ministry, China. The results of these studies remain unpublished. In 1952 Imgrund published a paper dealing with the Permo-Carboniferous microfossils from the Kaiping Basin in Hopei province, China; this paper was republished in "Geologisches Jahrbuch" (B.77, 1960) after revision.

Imgrund (1960) described 68 species (36 as new) referred to 33 genera, the stratigraphical distribution of these elements being principally of the Lower Permian. His paper furnishes an early basis for the study of the Palaeozoic Sporae dispersae of China. Obviously much work is still to be done.

In the autumn of 1961, Prof. H. C. Sze prompted the writer to make a study of the microflora of the Hokü district, NW Shansi, the result of which was expected to serve as a supplement to our knowledge on the Palaeozoic flora of that region. Twenty-three plant-bearing rocks for maceration were selected from the collections which had been sent to Sze in 1954 by Mr. F. H. Chia and others. The plant beds lie upon the Ordovician limestone and is overlain by the Shihchienfeng Series. The beds belong to the following series: the Penchi Series, the Taiyuan Series, the Shansi Series and the Shihhotze Series.

Only six of the macerated samples, i.e. those from the lower part of the Shihhotze Series, have yielded a good result, which constitutes the essential part of this paper. They are preserved in gray and dark-gray shales or dary-gray and grayish-yellow silt-stones. The age of the Lower Shihhotze Series has long been considered as late Lower Permian by geologists and paleontologists.

Apart from a number of unidentifiable forms, the following 64 species (types) of Sporae dispersae belonging to 31 genera have been described in the sequence of classification proposed by Potonié and Kremp (1954, 55—56):

I. Super-division: Sporites H. Pot.
Division: Triletes (R.) Pot. & Kr.
Subdivision: Azonotriletes Luber
Series: Laevigati (B. & K.) R. Pot.

1. *Leiotriletes* cf. *adnatoides*
2. *Gulisporites*? sp.
3. *Punctatisporites* cf. *palmipedites*
4. *P. minutus*
5. *P. planus*
6. *P. obesus*
7. *P.* cf. *obesus*
8. *P. triangularis* sp. nov.
9. *P. parasolidus* sp. nov.
10. *P.* sp. a (sp. nov.)
11. *P.* sp. b (sp. nov.)
12. *P.* sp. c (sp. nov.)
13. *Calamospora* sp. (*C.* cf. *breviradiata*)
14. *Calamospora*? *cavumis* sp. nov.
15. *C.* sp.
16. *Retusotriletes* sp. (sp. nov.)

Series: Apiculati (B. & K.) R. Pot.

17. *Cyclogranisporites* sp. a
18. *Cyclogranisporites* sp. b
19. *Granulatisporites* cf. *granulatus*
20. *Converrucosisporites* sp. a
21. *Converrucosisporites* sp. b
22. *Verrucosisporites sinensis*
23. *V.* cf. *sinensis*
24. *V. verrucosus*
25. *V. reticuloides* sp. nov.
26. *V.* sp. a (sp. nov.)
27. *V.* sp. b (sp. nov.)
28. *Lophotriletes* sp. (sp. nov.)
29. *Planisporites* sp. a (sp. nov. ?)
30. *P.* sp. b
31. *P.* sp. c

Series: Murornati Pot. & Kr.

32. *Convolutispora* sp. a (sp. nov.)
33. *C.* sp. b (sp. nov.?)
34. *Foveolatisporites* cf. *fenestratus*
35. *F. distinctus* sp. nov.
36. *F.* sp.
37. *Reticulatisporites* sp.
38. *Brocotriletes* sp.
39. *Knoxisporites*? sp.

Division: Zonales (B. & K.) R. Pot.
Subdivision: Auritotriletes Pot. & Kr.
Series: Auriculati (Schopf) Pot. & Kr.
40. *Triquitrites* sp.
Subdivision: *Zonotriletes* Waltz
41. *Lycospora* cf. *pellucida*
42. *Lycospora*? *levis* sp. nov.
43. *Anulatisporites* cf. *anulatus*
44. *Balteusispora textura* gen. & sp. nov.
Division: Monoletes Ibr.
Subdivision: Azonomoletes Luber
Series: Laevigatomonoleti Dyb. & Jach.
45. *Laevigatosporites vulgaris*
46. *L. desmoinesensis*
47. *L.* cf. *longilabris*
48. *Latosporites* cf. *latus*
49. *Punctatosporites* cf. *minutus*

II. Super-division: Pollenites R. Pot.
Division: Saccites Erdt.
Subdivision: Monosaccites (Chit.) Pot. & Kr.
Series: Aletesacciti Leschik
50. *Florinites* cf. *visendus*
51. *F.* sp. a
52. *F.* sp. b
53. *F.*? sp. c (sp. nov.)
54. *F.*? sp. d
55. *Archeoperisaccus* sp.
Subdivision: Disaccites Cook
Series: Disaccitrileti Leschik
56. *Limitisporites*? sp.
57. *Pityosporites* sp. a
58. *P.*? sp. b
59. *P.* sp. c
60. *P.* sp. d
61. *P.* sp. e
Series: Podocarpiditi R. Pot. et al.
62. *Platysaccus* sp.
Subdivision: Polysaccites Cook
63. *Polysaccites*-type (gen. & sp. nov. indet.)
Division: Plicates (Naum.) R. Pot.
Subdivision: Praecolpates Pot. & Kr.
64. *Schopfipollenites*? *shansiensis* sp. nov.

The majority of the forms can't be identified with any other species already known, but we establish no new species until over ten specimens have been observed and measured.

According to Sze's memoir entitled "Palaeozoic Plants from the Tsingshuiho region of Inner Mongolia and the Hokü district of NW Shansi" (manuscript), the flora of the Lower Permian of this tract is characterized by a distinctive dominance of plants belonging to Filicales and Pteridospermae, with Equisitales and Sphenophyllales occupying a subordinate position. In gymnospermae, the elements of Cordaitales are poorly represented; of the Ginkgoales-Cycadophyta, one type has been described respectively, only one form referred to Coniferales is discovered and the "material is too indistinct to permit of any definite conclusion"; *Walchia* which "forms a conspicuous feature of Lower Permian flora" has not been found.

These features are in general conformable to those reflected by the Sporae dispersae except that the members of Coniferales and Cordaitales appear to play a fairly important rôle, for many pollen grains of *Disaccites*- and *Monosaccites*-type at least partly belong to those groups. Some grains of *Florinites*-type may be derived from the important genus, *Walchia*. The complete absence of Ginkgoales-Cycadophyta is another noteworthy feature. The parent plants of the miospores classified under the new genus *Balteusispora* and the *Polysaccites*-type seem to hold a somewhat conspicuous place in the flora.

Description of New Genera and Species

Punctatisporites triangularis sp. nov.

(Pl. I, fig. 12)

Holotype: Pl. 1, fig. 12; Sl. 5015 (32).

Diagnosis: Roundly triangular in polar view, size 83 (94) 109 μ (on eleven specimens), holotype 83 μ; trilete mark distinct with sharp ends, *labra* thin, always open, between 1/2—2/3 the radius in length; exine 4 μ in thickness, levigate, *extrema lineamenta* smooth; yellow to brownish yellow.

Comparison: This form is similar to *P.* cf. *obesus* determined by Potonié (1955) and by Winslow (1959), but the size range of *P. obesus* is 100—150 μ, and the holotype of which is circular in outline. Hörst placed spores of 57—125 μ in *P.* cf. *obesus*; this range seems to be too broad for a species in the present case.

Remarks: Potonié et al. (1955, 1959) expressed the view that "in *Leiotriletes* are placed triangular and subtriangular forms ··· even if the equator approaches very much a circle ··· and only those which are very circular are to be placed in *Punctatisporites*". (Potonié & Kele, 1959). In view of the fact that our new species through some transitional forms is much closer to the species determined here as *P.* cf. *obesus* shown in pl. II, figs. 1—3, we therefore assign it to *Punctatisporites*.

Punctatisporites parasolidus sp. nov.

(Pl. I, fig. 6)

Holotype: Pl. 1, fig. 6; Sl. 5019 (12).

Diagnosis: Spores circular in polar view, size 58 (69) 84 μ (on ten specimens), holotype 66 μ; trilete rays distinct, up to 1/2 the radius, sometimes unequal in length in the same specimen, *tecta*-ends usually indistinctly bifurcated, *labra* thin and slightly elevated; surface smooth due to sculptureless, exine 4—6 μ in thickness, consisting of an exoexine and a thinner intexine; brownish yellow in colour.

Comparison: Comparable species is *P. solidus* Hacq. (1957), but the size of which 50—64 μ, and the exine thinner, *tecta*-ends are not bifurcated. *P. obliquus* Kos. is smaller (31—46 μ), exine 1.5 μ in thickness.

As compared with the type of *Leschikisporites,* the difference is that the latter "mit asymmetrischer Dreistrahlmark. Ein Strahl kürzer als die beiden anderen, welche fast eine Gerade bilden können, ... so dass der dritte sehr viel kurzere Strahl beinahe senkrecht auf der Beruhrungstelle der beiden anderen steht." (Potonié, 1957, p. 16).

Calamospora? *cavumis* sp. nov.

(Pl. II, figs. 6—12)

Holotype: Pl. II, fig. 6; Sl. 5021(4).

Diagnosis: ±Circular in polar view, ±bean-shaped in lateral view; size 70 (88) 106 μ (on ten specimens), holotype 70 μ; trilete mark distinct, *apex* and *vertex* low, *labra* thin, 1/2—2/3 radius in length; exine fairly thick (3 μ), composed of an inner and an outer, the thinner intexine often more or less separated from the exoexine constituting a "mesospore"; exine sculptureless, surface showing many irregularly disposed folds with ±blunt ends, 3—5 μ broad in general; *extrema lineamenta* slightly wavy or smooth; brown or yellow to light-yellow.

Comparison and Discussion: All specimens discovered show a partial "separation" of intexine and exoexine except one in which other features are in quite agreement with those of the former. It is probably safe to assume that they all represent one species; and judging from the fact that the position of this "separation" is uncertain, we believe that these specimens are not comparable to those of some genera referred to Monosaccites. We therefore provisionally assign them to *Calamospora.*

Known species belonging to *Calamospora* and *Noeggerathiopsidozonotriletes* distinguish from ours in having no such "separation" of exine. A few specimens such as shown in pl. II, fig. 12 appear to be similar to *Calamospora microrugosa,* but after a close inspection the separated intexine can still be traced, thus they are not identical with that species.

Verrucosisporites reticuloides sp. nov.

(Pl. IV, figs. 1—6)

Holotype: Pl. IV, fig. 5; Sl. 5016 (32).

Diagnosis: Miospores with circular outline in polar view, lenticular in lateral view with strongly convex distal side; size 127 (141) 156 μ (on fifteen specimens), holotype 127 μ; trilete mark visible reaching near the equator of spore body, *apex* and *vertex* low, *labra* thin with slightly uneven edge; composed of spore body and enclosing perisporal membrane; spore body 100—120 μ, all over surface covered with closely spaced, coarse *grana* (3—4 μ in diameter) and/or *verrucae* or round-apex *coni,* having round or oval-round form, sometimes connecting each other forming a *verrucae-reticulum* ornamentation (pl. IV, fig. 1); exine thick, dark-brown, 5—7 (9) μ in thickness; perisporal membrane light yellow in colour varying from less 10 μ to more than 14 μ in breadth, wavy or deep crenate in circumference, whole of which may be desintegrated.

Comparison: The ornamentation of the present species shows some relationship

to both *Verrucosisiporites* and *Reticulatisporites*. In view of the fact that the reticuloide character is indistinct, they are placed in the former genus. It differs from other species of these two genera in having a larger size and a diagnostic sculpture.

Foveolatisporites distinctus sp. nov.

(Pl. V, fig. 3)

Holotype: Pl. V, fig. 3; Sl. 5015 (15).

Diagnosis: Circular in polar view, oval in lateral view; size 81 (101) 113 μ (on fifteen specimens), holotype 106 μ; trilete rays distinct, simple, faint, 1/3—2/3, often ca. 1/2 radius in length; surface covered with irregular imperfect *extrareticulum* enclosing circular or trigonal meshes (3—4 μ in diameter), in the center of each mesh a *foveola* traceable, *muri* 3—4 μ in height, 4—6 μ in breadth, base broader than top, 40—50 *muri* along the margin; *extrema lineamenta* toothed; exine ca. 4 μ (including the *muri*) in thickness; dark-brown in colour.

Comparison: Our species differs from the others referred to this genus in having larger, higher *muri* which are distinctly toothed at the margin.

Lycospora? *levis* sp. nov.

(Pl. V, fig. 14)

Holotype: Pl. V, fig. 14; Sl. 5019 (4).

Diagnosis: Triangular miospores with bluntly pointed angles; size 50 (56) 62 μ (on ten specimens), holotype 56 μ; equatorial *cingulum* narrow (5.5—7 μ broad); trilete mark distinct extending nearly to the equator of spore body, *apex* and *vertex* low, *labra* well-developed, 4—5 μ in breadth with truncate or slightly bifurcated ends and uneven edges; surface levigate; exine thin, brown or brownish yellow in colour.

Comparison: In size and shape, the present species bears a certain resemblance to the known species of *Lycospora,* but the latter is characterized by exine granulate and rays penetrating into the *cingulum* in general. *Cadiospora* is larger (60—100 μ or more) and shows distinctly bifurcated *tecta*-ends. *Stenozonotriletes* is circular or rounded triangular in outline. It is preferable to place our species in *Lycospora* provisionally.

Balteusispora gen. nov.

Genotype: *B. textura* gen. & sp. nov.

Diagnosis: ±Circular or subcircular in polar view; medium-sized miospores with a massive infrapunctate *cingulum* equatorially, more or less uniform in breadth, ca. 1/3—1/4 the radius; trilete mark distinct, faint but prominent, reaching the equator of the spore body or slightly penetrating into the *cingulum, apex* and *vertex* low, *labra* thin; spore body circular in outline, lighter in colour; in proximal surface exine-textures such as flexuose ridges visible, rest of surface sculptureless, exine thin, *extrema lineamenta* smooth.

Comparison: *Lycospora* (S.W. & B.) Pot. & Kr. distinguishes from our new genus in having a smaller size (less than 45 μ in general) and granulate ornamentation of exine; *Cadiospora* Kos. in having broad rays with bifurcated ends; *Gravispora* Bhard. is characterized by a "broad and elevated trilete apparatus" and "closely spaced, fine *grana*"; in

Patellisporites Ouyang[1], which was first recorded from upper Permian of S. China, the *cingulum* is wavy in outline, this feature and the indistinctly eccentric circular spore body distinguish *Patellisporites* from *Leiozonotriletes* Hacq. too; according to Prof.' Potonié's opinion (1960, p. 64), *Leiozonotriletes* Hacq.=*Archaeozonotriletes* (Naum.) Pot., and the latter "Zentralkörper subtriangulär, ... *cingulum* von ungleicher Breite, so dass der Zentralkörper exzentrisch in ihr lagert," it can therefore be separated from the present genus; in *Stenozonotriletes* (Naum.) Pot., as implied by its generic name, the *cingulum* is narrower (in most species less than 1/5 the radius), furthermore, it is to some extent doubtful whether a real *cingulum* is developed in the majority of species of this genus (cf. Hacquanbard, 1957, p. 313); *Asterocalamotriletes* (Luber) Pot. is defined as "*cingulum* relative schmaler, Y-mark breit mit dem *cingulum* verschmelzend" (Potonié, 1958, p. 25). In our new genus the *cingulum* is broad, trilete rays slender, accordingly these two genera are not comparable; and, it seems to the present writer that the genus *Asterocalamotriletes* emended was not established on solid basis: the original description of *A. bertschoguriensis*——an illustration (pl. 1, fig. 9) of which was selected by Prof. Potonié as generic type——given by Luber is as follows: "Spore subcircular in outline. Exine thick, relatively dark, yellow-brown in colour. Along the equatorial contour of spore body exine reveals darkened. Surface of exine levigate. Trilete. *Tecta* short, about ½ radius in length." (translated from Russian, Luber, 1955, p. 38). This description is correct at least judging from his pl. 1, fig. 8. However, the figure shown in pl. 1, fig. 9 is in some extent obscure, and cannot be solely served as a type of a genus.

***Balteusispora textura* gen. et sp. nov.**

(Pl. V, figs. 12—13)

Holotype: Pl. V, fig. 12; Sl. 5015 (36).

Diagnosis: Circular or subcircular in polar view, lenticular in lateral view; size 61 (71) 87 μ (on thirty specimens), holotype 75 μ; infrapunctate *cingulum* more or less uniform in breadth, brown in colour; trilete mark faint but distinct, slightly elevated and flexuose, reaching the equator of the spore body, with sharp or blunt ends connecting arcuate ridges in some case, *area contaginois* apparent; spore body light in colour, in the area some slightly flexuose textures radiating from near the apex to the equator; exine thin, levigate, *extrema lineamenta* smooth.

***Polysaccites*-type (gen. et sp. nov.) (indet.)**

(Pl. VIII, figs. 1—4, ?8)

Description: Miospores are composed of four "bladders"(?). Spores are subcircular or ±rectangular in transverse plane (Pl. VIII, fig. 2), *extrema lineameneta* may be slightly concave; size 149—106 μ × 138—116 μ (on ten specimens); "bladders" are ± crescent, semicircular or oval in outline, size 120—86 × 58—37 μ, infra-reticulate to infra-granulate structure distinct, faint or rough; sometimes more developed along the margin of the bladder; the four "bladders" cross each other perpendicularly in the central

1) Writer's note: This generic name, which has been published in an earlier paper (Acta Palaeont. Sinica, vol. 10, No. 1, 1962) as *Pataelisporites* Ou, 1961 (gen. nov.), *Pettalisporites* or *Patallisporites*, should be corrected into *Patellisporites*, gen. nov. (Ouyang).

part (transverse plane), only a ± rectangular blank space remains; no central body and germinal apparatus have been observed; yellow in colour. The construction of the present specimens, compressed laterally, is hard to explain for the present.

Comparison: The present form differs from all others described previously. The only genus *Alatisporites* under the Series *Polysaccites* is characterized by three bladders and subtriangular central body with trilete rays. As the construction of our specimens is uncertain yet, we assign them temporarily to *Polysaccites*-type.

***Schopfipollenites*? *shansiensis* sp. nov.**

(Pl. VIII, figs. 5—6)

Holotype: Pl. VIII, fig. 5; Sl. 5019 (24).

Diagnosis: Oval to broad oval in polar view, size 240—133 (116) × 189—106 (82) μ, average 173 × 126 μ (on eleven specimens), holotype 212 × 153 μ; with a well-developed, medially deflected monolete suture(?) in proximal surface, more than 4/5 the length of the major axis, the ends of which somewhat blunt or slightly sharp, *labra* prominent, suture open in some specimens; on both sides of distal surface, more or less parallel to this suture two folds traceable (pl. VIII, fig. 5), ± 1/2 the major axis; exine thick, 5—8(11) μ in thickness, in which a faint "interpalisade" structure visible in optical section, *extrema lineamenta* smooth or rough due to the secondary factors.

Comparison: In some respects such as in form, size, especially the medially deflected suture, our species is more or less comparable to those of *Schopfipollenites*, but the diversity is that in our species, instead of distal "grooves" only two secondary(?) folds may be traced, it is therefore to some extent doubtful to place it in this genus. Besides, the known species referred to *Schopfipollenites*, i.e. *S. ellipsoides* and *S. ovatus*, distinguish from ours in having large size (200—500 μ) and in absence of "interpalisade" structure, and older geological range (Westfal C—D).

It is noteworthy that the present specimens are much alike to the prepollen grains isolated from *Codonotheca caduca* by Schopf (1946, p. 716). As for the morphological feature he pointed out that "...*Codonotheca* spores lack any discernible vestige of distal apparatus" (grooves). In China two species of *Codonospermum* have been recorded from the Chaokochuang Formation of Kaiping Basin.