

# 湖南界岭邵东段小孢子及其地质时代

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## 内 容 提 要

湖南界岭邵东段小孢子化石的地方特性较明显,并含有较多见于俄罗斯地台晚泥盆世沉积地层的分子,也有少量原被视为欧美地区典型的石炭纪分子,因此具有浓厚的泥盆纪与石炭纪的双重时代色彩。但对 101 个已知小孢子种(可归入 42 属)的研究表明。邵东段归属晚泥盆世晚期更为合理。

**关键词** 小孢子 邵东段 晚泥盆世晚期 湖南界岭

## 一、前 言

邵东段由侯鸿飞于 1965 年创名,标准剖面位于湖南邵东界岭附近,岩性主要由薄层泥质灰岩与黄色砂岩组成,厚约 10 余米。它与下伏“岳麓砂岩”呈假整合接触,与上覆孟公坳段似呈整合接触。该剖面的确切位置已不可寻,惟界岭刘家塘(又称刘家冲)一带邵东段的露头仍多处可见。

60 年代至 80 年代初,以腕足类(侯鸿飞,1965)和珊瑚化石(吴望始等,1981)为依据,邵东段被划归早石炭世或早石炭世初期。80 年代以来以陆生小孢子为主的微体化石所得出的时代意见则倾向于晚泥盆世。但据不同门类化石所论及的泥盆系与石炭系界线,亦众说纷纭(侯静鹏,1982;谭正修等,1987;高联达,1990;方晓思等,1993;卢礼昌,1994;Wan Cheng-yuan and Willi Ziegler,1982)。

本文研究的材料取自界岭附近刘家塘东侧一露头剖面。剖面的顶底界线清楚、地层出露良好,岩性与当年侯鸿飞(1965)描述的邵东段标准剖面的主要岩性颇相似,主要由浅灰色(风化表面为土黄色)薄层泥灰岩、小型灰岩扁豆体、砂质泥岩、钙质页岩与黄色砂岩组成,厚约 30 余米(未实测)。由下至上共采集孢粉、疑源类样品 10 块,经化学浸解,其中 SD-1、SD-4、SD-5 和 SD-7 含有类型与数量不等的小孢子化石,其中,SD-4 与 SD-7,尤以 SD-4 的孢子类型最丰富,并见有少量的疑源类等海相微体化石。本文依其中 101 个已知小孢子种(可归入 42 属)和 2 属 2 种疑源类,初步揭晓了该地层所含小孢子的面貌与特征,这对进一步研讨华南地区晚泥盆世孢子组合乃至泥盆-石炭系界线的划分均具有一定的意义。

## 二、邵东段的小孢子化石及其主要特征与地质时代

湖南界岭邵东段的小孢子相当丰富,除少量的疑源类与虫牙(scolecodont)等海相微体

化石外,主要由陆地植物产生的小孢子组成,计 101 种(可归入 42 属),其中 7 新联合种,2 比较种,1 未定种,其余均为已知种(含单缝孢 1 属 1 种),现罗列如下(种名的创建人姓氏与年代,除首见于本文之外,其余从略): *Acanthotriletes denticulatus* Naumova 1953, *A. (Lophotriletes) fastuosus* (Naumova) comb. nov., *A. hirtus* Naumova 1953, *Anapiculatisporites hystricosus* Playford 1964, *Anaplanisporites globutus* (Butterworth et Williams) Streel et Butterworth 1967, *Ancyrospora* cf. *furcula* Owens 1971, *Aneurospora asthenolabrata* (Hou) Lu 1994, *A. spinulifer* Wen et Lu 1993, *Apiculiretusispora flexuosa* Hou 1982, *A. gannanensis* Wen et Lu 1993, *A. leberidos* McGregor et Camfield 1982, *A. plicata* (Allen) Streel 1967, *A. pseudozonalis* Lu 1980, *Apiculatisporis morbosus* Balme et Hassell 1962, *Auroraspora asperella* (Kedo) Van der Zwan 1980, *A. macra* Sullivan 1964, *Brochotriletes foveolatus* Naumova 1953, *Clivosispora verrucata* McGregor var. *verrucata* McGregor 1976, *Convolutispora ampla* Hoffmeister, Staplin et Malloy 1955, *C. balmei* Playford 1971, *C. crassa* Playford 1962, *C. major* (Kedo) Turnau 1978, *C. vermiformis* Hughes et Playford 1961, *Cordylosporites papillatus* (Naumova) Playford et Satterthwait 1985, *Crassispora imperfecta* Lu 1988, *Cristatisporites limitatus* Ouyang et Chen 1987, *Cyclogranisporites baoyingensis* Ouyang et Chen 1987, *C. pisticus* Playford 1978, *Cymbosporites cyathus* Allen 1965, *Densosporites capistratus* Hoffmeister, Staplin et Malloy 1955, *D. crassus* McGregor 1960, *D. secundus* Playford et Satterthwait 1988, *D. spinifer* Hoffmeister, Staplin et Malloy 1955, *D. variomarginatus* Playford 1963, *D. xinhuanensis* Hou 1982, *Diaphanospora depressa* (Balme et Hassell) Evans 1970, *D. (Hymenozonotriletes) submirabilis* (Jush.) comb. nov., *Dictyotriletes famenensis* Naumova 1953, *Discernisporites macromanifestus* (Hacquebard) Higgs, Clayton et Keegan 1988, *D. micromanifestus* (Hacquebard) Sabry et Nevens 1971, *D. papillatus* Lu 1993, *D. varius* Lu 1993, *Foveosporites insculptus* Playford 1962, *F. pellucidus* Playford et Helby 1968, *Geminosporea (Archaeozonotriletes) lasius* (Naumova) var. *minor* (Naumova) comb. nov., *G. spongiata* Higgs, Clayton et Keegan 1988, *Grandispora cornuta* Higgs 1975, *G. (Spelaeotriletes) cumula* (Higgs et Streel) comb. nov., *G. echinata* Hacquebard 1957, *G. (Hymenozonotriletes) eximia* (Naumova) comb. nov., *G. gracilis* (Kedo) Streel 1974, *G. saurota* (Higgs, Clayton et Keegan) Playford et McGregor 1993, *Granulatisporites (Spinizonotriletes) atratus* (Naumova) comb. nov., *G. humerus* Staplin 1960, *Hymenozonotriletes angulatus* Naumova 1953, *H. elegans* (Waltz) Naumova 1953, *H. granulatus* (Naumova) Jushen, in Kedo 1963, *H. spicatus* Lu 1994, *Knoxisporites dedaleus* (Naumova) Lu 1994, *Laevigatosporites vulgaris* (Ibrahim) Alpern et Doubinger 1973, *Leiotriletes crassus* Lu 1994, *L. macrothelis* Wen et Lu 1993, *L. microthelis* Wen et Lu 1993, *L. ornatus* Ischenko 1956, *L. pyramidatus* Sullivan 1964, *L. cf. subintertus* (Waltz) Ischenko var. *rotundatus* Waltz 1941, *L. velatus* (Caro-Monieg) Streel 1974, *Lophotriletes atratus* Naumova 1953, *L. magnus* (Naumova) Lanniger 1968, *Lophozonotriletes torosus* Naum. var. *famenensis* Naumova 1953, *Phyllothecotriletes rigidus* Playford 1962, *Planisporites magnus* (Naumova, in Kedo) Lu 1994, *Punctatisporites debilis* Hacquebard 1957, *P. irrasus* Hacque-

bard 1957, *P. planus* Hacquebard 1957, *P. subtritus* Playford et Helby 1968, *Pustulatisporites distalis* Lu 1981, *Reticulatisporites* (*Azonotriletes*) *cancellothyris* (Waltz) comb. nov., *R. minor* (Naumova) Gao et Ye 1987, *Retispora cassicula* (Higgs) Higgs et Russell 1981, *R. lepidophyta* (Kedo) Playford 1976, *Retusotriletes avonensis* Playford 1963, *R. crassus* Clayton, in Clayton et al. 1980, *R. rotundus* (Streel) Lele et Streel 1969, *R. triangulatus* (Streel) Streel 1967, *Spelaeotriletes crenulatus* (Playford) Higgs, Clayton et Keegan 1988, *S. crustatus* Higgs 1975, *S. hunanensis* (Fang, Steemans et Streel) Lu 1994, *S. obtusus* Higgs 1975, *S. pretiosus* (Playford) Neves et Belt 1970, *S. resolutus* Higgs 1975, *S. setosus* (Kedo) Lu 1994, *S. triangulatus* Neves et Owens 1966, *Spelaeotriletes* sp. of Wen et Lu 1993, *Vellamispores irritatus* Playford 1978, *V. perinatus* Knox (Hughes et Playford) Playford 1971, *Verruciretusispora megaplatyverruca* Lu et Ouyang 1976, *Verrucosisporites mesogrummosus* (Kedo) Byvscheva 1985, *V. morulatus* (Knox) Potonie et Kremp 1954, *V. papulosus* Hacquebard 1957 与 ? *Videospora glabrimarginata* (Owens) Higgs et Russell 1981。此外, 尚有 2 属 2 种疑源类 *Veryhachium trispinosum* (Eisenack) Deunff 1954, *Micrhystridium stellatum* Deflandre 1954。上述小孢子系由占绝对优势的三缝孢与极少量的单缝孢组成。其中以 *Apiculiretusispora* (5 种), *Convolutispora* (5 种), *Densosporites* (6 种), *Discernisporites* (4 种), (*Grandispora* (6 种), *Hymenozonotriletes* (4 种), *Leiotriletes* (7 种), *Punctatisporites* (4 种), *Retusotriletes* (4 种) 与 *Spelaeotriletes* (9 种) 等 10 属 54 种占优势, 但最具有时代意义的是 *Retispora lepidophyta*, *R. cassicula* 与 *Spelaeotriletes hunanensis*。

上述小孢子化石中的一些已知种, 在我国云南、四川、赣南、江苏、浙江、西藏与新疆等也有发现。现将它们的地层分布列于表 1。

表内所列 38 个已知小孢子种的地层分布表明, 除见于(部分早于)吉维特期(Givetian)与弗拉斯期(Frasnian)的 6 种外, 剩余的 32 种是: (1)限于法门期(Famennian)的 14 种, 其中 *Retispora cassicula* 与 *R. lepidophyta* 是法门期最晚期的标志分子, 特别是后者, 它最终消失的顶界被视为泥盆纪沉积的结束, 并与标志石炭纪沉积开始的牙形刺 *Siphonodella sulcata* 的首次出现几乎在同一水平线上, 加之它在南、北半球均有分布, 所以 *R. lepidophyta* 也被视为全球性划分泥盆-石炭系界线的最重要的指示化石之一; 同时, *Spelaeotriletes hunanensis* 是华南地区晚泥盆世的特有分子, 它常与全球性晚泥盆世标准植物化石 *Leptophleum rhombicum* 同层或隔层产出(文子才、卢礼昌, 1993; 卢礼昌, 1994), 并且在晚泥盆世以外的沉积中尚无报道。(2)见于法门期与杜内期(Tournaisian)的 16 种。(3)限于杜内期的 3 种。

概括地说, 表内所列小孢子, 见于我国晚泥盆世晚期地层的为 30 种、早石炭世早期地层的 19 种, 具有泥盆纪与石炭纪双重时代色彩的 16 种。时代为法门期的占优势。再从地理分布来看, 分布于法门期小孢子的产地为 9 处, 杜内期的为 6 处, 即法门期小孢子的覆盖面大于杜内期的覆盖面, 前者为后者的 1.5 倍。表 1 中的已知小孢子种, 在我国的地层分布范畴是以泥盆系顶部最为集中, 占所列小孢子种数的 79%。因此, 邵东段的地质时代归属晚泥盆世晚期, 即法门期较适合。

表 I 湖南界岭邵东段小孢子种在中国的地层分布  
Stratigraphical distribution in China for selected miospore species  
from the Shaodong Member at Jieling, Hunan Province

小孢子种 Miospore species	中 国 China				著 者 Author(s)
	吉维特阶 Givetian	弗拉斯阶 Frasnian	法门阶 Famennian	杜内阶 Tournaisian	
<i>Apiculiretusispora pseudoxonalis</i> *	1				
<i>Crassispora imperfecta</i> *	2				1. 卢礼昌(1980)
<i>Cymbosporites cyathus</i>	1,2	3,4			2. 卢礼昌(1988)
<i>Densosporites crassus</i>		3			3. 卢礼昌(1981)
<i>Grandispora cornuta</i>		4			4. 高联达(1990)
<i>Apiculiretusispora plicata</i>			5		5. 侯静鹏(1982)
<i>Aneurospora spinulifer</i>			6		6. 文子才、卢礼昌
<i>Cristatisporites limitatus</i> *			9		(1993)
<i>Densosporites xinhuanensis</i> *			6		7. 高联达(1983)
<i>Diaphanospora depressa</i>			6		8. 卢礼昌(1994)
<i>Grandispora saurota</i>			6		9. 欧阳舒、陈永祥
<i>Leiotriletes microthelis</i> *			6		(1987a)
<i>Retispora cassicula</i>			4		10. 高联达(1980)
<i>Spelaeotriletes obtusus</i>			4		11. 何圣策、欧阳舒
<i>Grandispora gracilis</i>			6,7		(1993)
<i>Retusotriletes triangulatus</i>			5,9		12. 卢礼昌(1993)
<i>Retispora lepidophyta</i>			4,7,11		
<i>Retusotriletes crassus</i>			4,6,8		
<i>Spelaeotriletes hunanensis</i> *			4,5,6,8		
<i>Apiculiretusispora flexuosa</i>			5	8	
<i>Cyclogranisporites baoyingensis</i> *			8	8	
<i>Discernisporites papillatus</i> *			12	12	
<i>D. varius</i> *			12	12	
<i>Leiotriletes macrothelis</i> *			6	6	
<i>L. ornatus</i>			8	8	
<i>Spelaeotriletes crenulatus</i>			8	8	
<i>S. crustatus</i>			8	8	
<i>Laevigatosporites vulgaris</i>			6,7	4,8	
<i>Auroraspora macra</i>			4,6,7	4,8	
<i>Discernisporites micromanifestus</i>			4,6,7	4,6,8	
<i>Spelaeotriletes resolutus</i>			4,6,8	4,8	
<i>Grandispora echinata</i>			4,6,8	4,7,8	
<i>Aneurospora asthenolabrata</i> *			5,6,8	6	
<i>Acanthotriletes denticulatus</i>			6,7,8	6,8	
<i>Apiculiretusispora gannanensis</i> *			6,8,9,10	6,8	
<i>Knoxisporites dedaleus</i>				8	
<i>Spelaeotriletes pretiosus</i>				8	
<i>Cordylosporites papillatus</i>				8,11	

带 \* 号者为目前仅限于我国的分子。  
*Cordylosporites papillatus* 往上延伸的时代,因受表格的限制未能显示出来。

邵东段一些已知小孢子种在西欧、北美以及俄罗斯与澳大利亚等地的晚泥盆世和(或)早石炭世组合(或组合带)中也有数量不等的存在。例如,邵东段的 *Acanthotriletes denticulatus*, *A. hirtus*, *Brochotriletes foveolatus*, *Dictyotriletes famenensis*, *Granulatisporites* (*Archaeozonotriletes*) *atratus* (Naumova) comb. nov., *Grandispora* (*Hymenozonotriletes*) *eximia* (Naumova) comb. nov., *Hymenozonotriletes angulatus*, *H. elegans*, *Lophotriletes atratus*, *L. magnus*, *Lophozonotriletes torosus* var. *famenensis* 与 *Knoxisporites dedaleus* 等 12 种(可归入 9 属)也见于俄罗斯地台晚泥盆世沉积中(Naumova, 1953); 而 *Auroraspora asperella*, *A. macra*, *Convolutispora surmiformis*, *Discernisporites macromanifestus*, *D. micromanifestus*, *Geminispora spongiata*, *Grandispora cornuta*, *G. echinata*, *G. saurosa*, *Punctatisporites irrasus*, *P. planus*, *Retispora cassicula*, *R. lepidophyta*, *Retusotriletes crassus*, *R. triangulatus*, *Spelaeotriletes crenulatus* 与 *S. crustatus* 等, 则见于西欧泥盆-石炭系界线层中(Streel *et al.*, 1987; Higgs *et al.*, 1988)。这些小孢子种的绝大多数在欧洲、北美以及澳大利亚均具有类似的垂直分布范围。值得提及的是, 在西欧泥盆-石炭系界线层 8 个小孢子带(Higgs *et al.*, (1988) 的众多特征种, 如 *Knoxisporites literatus*, *Hymenozonotriletes* (*Indotriradites*) *explanatus*, *Verrucosisporites nitidus*, *Vallatisporites verrucosus*, *Retusotriletes* (*A-neurospora*) *incohatus*, *Umbonatisporites* (*Dibolisporites*) *distinctus* 与 *Schopfites claviger* 等, 在湖南界岭邵东段则完全缺失。这充分表明, 湖南界岭邵东段尚未达到泥盆系的顶界, 更不可能位于石炭系。然而, 界岭邵东段的小孢子中又确实含有少量的石炭纪分子, 例如 *Convolutispora balmei*, *C. crassa*, *Densosporites secundus*, *Punctatisporites subtritus*, *Velamisporites irrugatus* 与 *V. perinatus* 等, 它们主要见于澳大利亚早石炭世韦宪期(Playford, 1962, 1971, 1978; Playford and Helby, 1968; Playford and Satterthwait, 1985, 1986, 1988)。邵东段所产的 *Spelaeotriletes pretiosus* 与 *Cordylisporites papillatus*, 前者是北半球早石炭世杜内期晚期的典型小孢子种(南半球至今尚无记载), 后者是南、北半球石炭纪韦宪期(Visean)至纳缪尔期(Namurian)的重要标志分子(Playford, 1962, 1971; Byvscheva, 1963; Playford and Satterthwait, 1985); 该分子在我国首次见于南京地区五通组擂鼓台段上部(卢礼昌, 见蔡重阳等, 1987, 图版 3, 图 30、31)。概括地说, 上述 37 已知种在世界其它地区的垂直分布的范围, 大体可归入 3 个不同的“层段”, 即上泥盆统法门阶(12 种)、泥盆-石炭系界线层(17 种)以及以韦宪阶为主的韦宪-纳缪尔阶(8 种)。若依国外的这些资料, 似乎表明湖南界岭邵东段所产小孢子的泥盆-石炭纪色彩颇为浓厚。由于几乎是全球性分布的、时限仅限于泥盆系最顶部(Owens and Streel, 1967)的 *R. lepidophyta* 在邵东段的出现, 则强烈地表明邵东段不可能超越泥盆系的顶界, 即从孢粉学角度看, 该分子的最终消失才标志泥盆纪沉积的结束。因此, 湖南界岭邵东段小孢子化石所显示的时代与侯鸿飞(1965)用腕足类确定的时代颇接近, 但又有差别, 依腕足类得出的时代是“邵东段的时代应划归早石炭世”, 而且“泥盆、石炭系的界线应划在邵东段的底”, 而本文以小孢子化石为依据, 认为邵东段的地质时代应划归于晚泥盆世, 但不是晚泥盆世最晚期。该时代结论与 Wang Cheng-yuan 和 Willi Ziegler(1982)研究该段牙形刺化石确认的时代属晚泥盆世是一致的。

至于与世界性晚泥盆世晚期的指示分子 *R. lepidophyta* 共存(产自同一样品)的 8 种小孢子, 本文视之为“超前分子”。这种超前现象, 在我国中泥盆世的孢子组合(卢礼昌, 1980a,

1980b, 1988; 高联达, 1987; 高联达、叶晓荣, 1987) 中已有反映, 最为突出的例子是 *Archaeoperisaccus* 的代表分子。归入该单缝孢属的分子曾先后在欧洲 (Naumova, 1953; Pachkevich, 1964) 与北美 (Owens, 1971) 晚泥盆世早期 (弗拉斯期) 的沉积中被发现, 并被视为这些地区弗拉斯期的指示化石 (Owens and Richardson, 1972)。然而, 该属的孢子在我国中泥盆世晚期 (海相和非海相) 地层中的含量就已相当丰富。与此同时, 我国的大植物群也同样存在这种现象, 例如 “*Lepidodendropsis* 一属原被视为早石炭世初期植物群的代表分子, 但它在我国南方、新疆以及哈萨克斯坦中泥盆世晚期就开始繁盛” (李星学等, 1984)。上列情况表明, 相同的属种在不同的地区可以产自不同的层位。据李星学等 (1984, 122 页) 的研究, 导致这种结果的原因, “很可能这类石松类植物首先生长在亚洲地区, 然后才向其它地区迁移发育”。由此推论, 那些超前出现的小孢子的母体植物或植物群也有可能首先起源于中国, 然后才向其它地区发展。

综上所述, 湖南界岭邵东段小孢子化石的地方色彩较浓, 其时代色彩仍以晚泥盆世晚期的最为鲜明, 邵东段的地质时代应属法门期晚期, 但又确实含有某些见于国外石炭纪的属种或超前出现的分子。

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## 参 考 文 献

- 方晓思、司蒂曼斯、斯蒂尔, 1993: 湘中泥盆-石炭系界线划分的新进展。科学通报, 38(8): 732—736。
- 文子才、卢礼昌, 1993: 江西全南小慕泥盆-石炭系孢子组合及其地层意义。古生物学报, 32(3): 303—331。
- 卢礼昌, 1980a: 关于 *Archaeoperisaccus* 属在中国云南东部的发现。古生物学报, 17(1): 500—504。
- 卢礼昌, 1980b: 云南沾益龙华山泥盆纪小孢子及其地层意义。中国科学院南京地质古生物研究所集刊, 第 14 号, 1—45 页。科学出版社。
- 卢礼昌, 1981: 四川渡口大麦地一带晚泥盆世孢粉组合。中国科学院南京地质古生物研究所丛刊, 第 3 号, 91—130 页。江苏科学技术出版社。
- 卢礼昌, 1988: 云南沾益史家坡中泥盆统海口组微体植物群。中国科学院南京地质古生物研究所集刊, 第 24 号, 109—252 页。科学出版社。
- 卢礼昌, 1994: 南京龙潭地区五通组孢子组合及其地质时代。微体古生物学报, 11(2): 153—200。
- 李星学、蔡重阳、欧阳舒, 1984: 长江下游五通组研究的新进展。中国地质科学院院报, 第 9 号, 119—132 页。地质出版社。
- 侯鸿飞, 1965: 湘中界岭早石炭世孟公坳组腕足类化石兼论石炭系下界。地质部地质科学院论文集 乙种, 1 号, 111—146 页。地质出版社。
- 侯鸿飞、高联达、季 强, 1985: 国际泥盆—石炭系界线研究介绍。地质论评, 31(1): 87—93。
- 侯静鹏, 1982: 湘中锡矿山地区泥盆-石炭系过渡层的孢子组合。中国地质科学院地质研究所所刊, 5 号, 81—92 页。地质出版社。
- 欧阳舒、陈永祥, 1987: 江苏句容泥盆-石炭系孢子组合并讨论五通组的时代。中国科学院南京地质古生物研究所集刊, 第 23 号, 1—92 页。科学出版社。
- 高联达, 1980: 甘肃靖远下石炭统前黑山组孢子组合和它的时代。中国地质科学院院报地质研究所分刊, 1(1): 49—96。
- 高联达, 1983: 西藏聂拉木晚泥盆世孢子组合及其地层意义。青藏高原地质论文集(8), 183—218 页。地质出版社。
- 高联达, 1990: 湖南泥盆-石炭系界线层孢子组合及其地层意义。地质论评, 36(1): 58—68。

- 高联达、叶晓荣,1987: 西秦岭碌曲-迭部地区晚志留世至泥盆纪微体古植物。西秦岭碌曲、迭部地区晚志留世至泥盆纪地层古生物,下册,379—450页。南京大学出版社。
- 谭正修、李寿春、董振常、金玉龙、姜水根、杨云程,1985: 湖南晚泥盆世和早石炭世地层及生物群。地质出版社。
- 潘江、王士涛、高联达、侯静鹏,1978: 华南陆相泥盆系。华南泥盆系会议论文集,240—260页。地质出版社。
- 蔡重阳、卢礼昌、吴秀元、张国芳,1988: 下扬子准地台江苏地区泥盆纪生物地层。江苏下扬子准地台震旦纪—三叠纪生物地层,第169—217页。南京大学出版社。
- Higgs, K., Clayton, G. and Keegan, J. B., 1988: Stratigraphic and systematic Palynology of the Tournaisian rocks of Ireland. *Geol. Surv. Ire., Spec. Pap.*, **7**: 1—99.
- Higgs, K. and Streel, M., 1984: Spore stratigraphy at the Devonian-Carboniferous boundary in the northern "Rheinisches Schiefergebirge", Germany. *Cour. Forsch.-Inst. Senckenberg*, **67**: 157—179.
- Lu Li-chang and Wicander, R., 1988: Upper Devonian acritarchs and spores from the Hongguleleng Formation, Hefeng District in Xinjiang, China. *Revta. Esp. Micropaleont.*, **20**(1): 109—148.
- McGregor, D. C. and Playford, G., 1992: Canadian and Australian Devonian spores: zonation and correlation. *Geol. Surv. Can., Bulletin*, **438**: 1—125.
- Naumova, S. N., 1953: Spore-pollen complexes of the Upper Devonian of the Russian Platform and their stratigraphic significance. *Tr. Inst. Geol. Nauk Mosk.*, **143**(60): 1—204. (In Russian)
- Owens, B. and Streel, M., 1967: *Hymenozonotrites lepidophytus* Kedo, its distribution and significance in relation to the Devonian-Carboniferous boundary. *Rev. Palaeobot. Palynol.*, **1**: 141—150.
- Owens, B. and Richardson, J. B., 1972: Some recent advances in Devonian Palynology—a review, Report of C. I. M. P. Working Group No. 13B. C. R. 7<sup>e</sup> Congr. Int. Strat. Geol. Carb. Krefeld 1971.
- Playford, G., 1962: Lower Carboniferous microfloras of Spisbergen (Part one). *Palaeontology*, **5**(3): 550—618.
- Playford, G., 1971: Lower Carboniferous spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory. *Australia, Bur. Min. Resources. Bull.*, **115**: 1—105.
- Playford, G., 1978: Lower Carboniferous spores from the Ducabrock Formation, Drummond Basin, Queensland. *Palaeontographica, Abt. B*, **167**: 105—160.
- Playford, G. and Helby, R., 1968: Spores from a Carboniferous section in the Huter Valley, New South Wales. *J. Geol. Soc. Aust.*, **15**(1): 103—119.
- Playford, G. and Satterthwait, D. F., 1985: Lower Carboniferous (Visean) spores of the Bonaparts Gulf Basin, north-western Australia. Part 1. *Palaeontographica, Abt. B*, **195**: 129—152.
- Playford, G. and Satterthwait, D. F., 1986: Lower Carboniferous (Visean) spores of the Bonaparte Gulf Basin, north-western Australia. Part 2. *Palaeontographica, Abt. B*, **200**: 1—32.
- Playford, G. and Satterthwait, D. F., 1988: Lower Carboniferous (Visean) spores of the Bonaparte Gulf Basin, north-western Australia. Part 3. *Palaeontographica, Abt. B*, **208**: 1—26.
- Streel, M., Higgs, K., Loboziak, S., Riegel, W. and Steemans, P., 1987: Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenne-Rhenish regions. *Rev. Palaeobot. Palynol.*, **50**: 211—229.
- Wang Cheng-yuan and Willi Ziegler, 1982: On the Devonian-Carboniferous boundary in South China based on conodonts. *Geol. Palaeont.*, **7**: 151—162.

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# MIOSPORES FROM SHAODONG MEMBER AT JIELING SECTION OF HUNAN, CHINA AND THEIR GEOLOGICAL AGE

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**Key words** miospores, Late Devonian, Jieling Section, Hunan, China

## Summary

All the materials reported here are derived from the Shaodong Member at Jieling Section of the Shaodong County in Hunan, China. The Shaodong Member was established by Hou Hong-fei in 1965, with the type locality at Jieling from where came the investigative materials of the present paper. This member, approximately 30m thick, consists predominantly of light grey thin-bedded mud limestone, lenticular limestone, silty mudstone, or calcareous shale and sandstone. Probably it is conformably overlain by the Mengkungao Member, and is disconformably overlying the 'Yuelu' sandstone.

Among the 10 samples taken from the Shaodong Member, samples SD-1, SD-5 and SD-7, especially SD-4, yield rather abundant and best preserved miospores together with a small number of acritarchs and scolecodonts. In this paper the miospores, comprise 42 genera and 101 species (including 7 combined species, 91 known species, 2 comparable species and 1 indeterminate species), namely, *Acanthotriletes denticulatus* Naumova, *A. (Lophotriletes) fastuosus* (Naum.) comb. nov., *A. hirtus* Naum., *Anapiculatisporites hystricosus* Playford, *Anaplanisporites globatus* (Butt. et Will.) Streel et Butterworth, *Ancyrospora* cf. *furcula* Owens, *Aneurospora asthenolabrata* (Hou) Lu, *A. spinulifer* Wen et Lu, *Apiculiretusispora flexuosa* Hou, *A. gannanensis* Wen et Lu, *A. leberidos* McGregor et Camfield, *A. morbosus* Balme et Hassell, *A. plicata* (Allen) Streel, *A. pseudozonalis* Lu, *Auroraspora asperella* (Kedo) Van der Zwan, *A. macra* Sullivan, *Brochotriletes foveolatus* Naum., *Clivoispora verrucata* McGregor var. *verrucata* McGregor, *Convolutispora ampla* Hoffmeister, Staplin et Malloy, *C. balmei* Playford, *C. crassa* Playford, *C. major* (Kedo) Turnau, *C. vermiformis* Hughes et Playford, *Cordylosporites papillatus* (Naum.) Playford et Satterthwait, *Crassispora imperfecta* Lu, *Cristatisporites limitatus* Ouyang et Chen, *Cyclogranisporites baoyingensis* Ouyang et Chen, *C. pisticus* Playford, *Cymbosporites cyathus* Allen, *Densosporites capistratus* Hoffmeister et al., *D. crassus* McGregor, *D. secundus* Playford et Sat-



terthwait, *D. spinifer* Hoffmeister et al., *D. variomarginatus* Playford, *D. xinhuanensis* Hou, *Diaphanospora depressa* (Balme et Hassell) Evans, *D. (Hymenozonotriletes) submirabilis* (Jush.) comb. nov., *Dictyotriletes famenensis* Naum., *Discernisporites macromanifestus* (Hacquebard) Higgs, Clayton et Keegan, *D. micromanifestus* (Hacq.) Sabry et Neves, *D. papillatus* Lu, *D. varius* Lu, *Foveosporites insculptus* Playford, *F. pellucidus* Playford et Hebly, *Geminosporea (Archaeozonotriletes) lasius* (Naum.) var. *minor* (Naum.) comb. nov., *G. spongiata* Higgs et al., *Grandispora cornuta* Higgs et al., *G. (Spelaeotriletes?) cumula* (Higgs et Streel) comb. nov., *G. echinata* Hacquebard, *G. (Hymenozonotriletes) eximia* (Naum.) comb. nov., *G. gracilis* (Kedo) Streel, *G. saurota* (Higgs et al.) Playford et McGregor, *Granulatisporites (Spinozonotriletes) atratus* (Naum.) comb. nov., *G. humerus* Staplin, *Hymenozonotriletea angulatus* Naum., *H. elegans* (Waltz) Naum., *H. granulatus* (Naum.) Jushen, *H. spicatus* Lu, *Knoxisporites dedaleus* (Naum.) Lu, *Laevigatosporites vulgaris* (Ibrahim) Alpern et Doubinger, *Leiotriletes crassus* Lu, *L. macrothelis* Wen et Lu, *L. microthelis* Wen et Lu, *L. ornatus* Ischenko, *L. pyramidatus* Sullivan, *L. cf. subintertus* (Waltz) Isch. var. *rotundatus* Waltz, *L. velatus* (Caro-Monieg) Streel, *Lophotriletes atratus* Naum., *L. magnus* (Naum.) Lanniger, *Lophozonotriletes torosus* Naum. var. *famenensis* Naum., *Phyllothecotriletes rigidus* Playford, *Planisporites magnus* (Naum., in Kedo) Lu, *Punctatisporites debilis* Hacquebard, *P. irrasus* Hacquebard, *P. planus* Hacquebard, *P. subtritus* Playford, *Pustulatisporites distalis* Lu, *Reticulatisporites (Azonotriletes) cancellothyris* (Waltz) comb. nov., *R. minor* (Naum.) Gao et Ye, *Retispora cassicula* (Higgs) Higgs et Russell, *R. lepidophyta* (Kedo) Playford, *Retusotriletes avonensis* Playford, *R. crassus* Clayton, in Clayton et al., *R. rotundus* (Streel) Lele et Streel, *R. triangulatus* (Streel) Streel, *Spelaeotriletes crenulatus* (Playford) Higgs et al., *S. crustatus* Higgs, *S. hunanensis* (Fang, Steemans et Streel) Lu, *S. obtusus* Higgs, *S. pretiosus* (Playford) Neves et Belt, *S. resolutus* Higgs, *S. setosus* (Kedo) Lu, *S. triangulatus* Neves et Owens, *Spelaeotriletes* sp. of Wen et Lu, *Velamisporites irrugatus* Playford, *V. perinatus* (Hughes et Playford) Playford, *Verruciretusispora megaplatyverruca* Lu et Ouyang, *Verrucosisporites mesogrumosus* (Kedo) Byvscheva, *V. morulatus* (Knox) Potonie et Kremp, *V. papulosus* Hacquebard and ? *Videospora glabrimarginata* (Owens) Higgs et Russell. Among the dominant elements in these miospores are the representatives of *Apiculiretusispora* (5 species), *Convolutispora* (5 species), *Densosporites* (6 species), *Discernisporites* (4 species), *Grandispora* (6 species), *Hymenozonotriletes* (4 species), *Leiotriletes* (7 species), *Punctatisporites* (4 species), *Retusotriletes* (4 species) and *Spelaeotriletes* (9 species), all amounting to 10 genera and 54 species. These miospores are characterized by the presences of *Retispora lepidophyta* and *Spelaeotriletes hunanensis* (most abundant). In addition, there are 2 acritarch species, namely, *Veryhachium trispinosum* (Eisenack) Deunff and *Micrhytridium stellatum* Deflander.

Among the 38 selected species of miospores according to their vertical distribution in

China (see Table 1), totally 30 species occur in the Famennian, constituting an overwhelming majority, and indicating that the Shaodong Member should be attributed to the Famennian in age.

Among the miospores from the Shaodong Member, some species also occur in the Upper Devonian assemblages described by Naumova (1953) from the Russian Platform, such as *Acanthotriletes denticulatus* Naum., *A. hirtus* Naum., *Brochotriletes foveolatus* Naum., *Dictyotriletes famenensis* Naum., *Granulatisporites* (*Archaeozonotriletes*) *atratus* (Naum.) comb. nov., *Grandispora* (*Hymenozonotriletes*) *eximia* (Naum.) comb. nov., *Hymenozonotriletes angulatus* Naum., *H. elegans* (Waltz) Naum., *Lophotriletes atratus* Naum., *L. magnus* (Naum.) Lanniger, *Lophozonotriletes torosus* Naum. var. *famenensis* Naum. and *Knoxisporites dedaleus* (Naum.) Lu. Some species also occur in the Devonian—Carboniferous miospore assemblages in Ireland (Higgs *et al.*, 1988), such as *Auroraspora asperella* (Kedo) Van der Zwan, *A. macra* Sullivan, *Convolutispora surmiformis* Hughes et Playford, *Discernisporites macromanifestus* (Hacq.) Higgs *et al.*, *D. micromanifestus* (Hacq.) Sabry et Neves, *Geminispora spongiata* Higgs *et al.*, *Grandispora cornuta* Higgs *et al.*, *G. echinata* Hacquebard, *G. saurota* (Higgs *et al.*) Playford et McGregor, *Punctatisporites irrasus* Hacquebard, *P. planus* Hacquebard, *Retispora cassicula* (Higgs) Higgs et Russell, *R. lepidophyta* (Kedo) Playford, *Retusotriletes triangulatus* (Streel) Streel, *Spelaeotriletes crenulatus* (Playford) Higgs *et al.* and *S. crustatus* Higgs.

It is of interest to note that the Shaodong miospores contain some of the Carboniferous species, such as: *Convolutispora balmei* Playford, *C. crassa* Playford, *Cordylosporites papillatus* (Naum.) Playford, *Densosporites secundus* Playford et Satterthwait, *Punctatisporites subtritus* Playford, *Spelaeotriletes pretiosus* (Playford) Neves et Belt, *Velamisporites irrugatus* Playford and *V. perinatus* (Hughes et Playford) Playford. This might be one of the common characteristic features of the Middle to Upper Devonian assemblages from China. For instance, the representatives of *Archaeoperisaccus* are restricted to Frasnian deposits in Euramerica, but they have been found in the Givetian deposits of China (Lu Li-chang, 1980a, 1988; Gao Lian-da, 1989), i. e., the monolete genus *Archaeoperisaccus* discovered in China, is earlier in geological age than the Frasnian from “Timan in the western U. S. S. R. through the islands of the Arctic Archipelago of Canada to Alaska” (Owens and Richardson, 1972, p. 334). Secondly, the representatives of *Rotaspora* are found in the Early Carboniferous deposits from other parts of the world. They have, however, been reported from the Frasnian in Damaidi area of Dokou, Sichuan Province (Lu Li-chang, 1981), and some other places.

These miospores are present not only in microflora but also in macroflora from the Middle—Upper Devonian of China, such as the genus *Lepidodendropsis* which was extensively developed in the period ranging from Late Devonian to Early Carboniferous in Euramerica region, and had been most flourishing in the Middle Devonian time of South China

(Schweitzer and Cai Chongyang, 1987; Li Xing-xue *et al.*, 1993). However, the relationship between the advanced appearances of microflora and macroflora still remains unclear.

The following preliminary conclusions can be made from a thorough analysis on the geological and geographical distributions of 101 known miospore species obtained from the Shaodong Member at the Jieling Section:

1) These miospores have a distinct endemicity.

2) They contain more elements from the Upper Devonian of the Russian Platform than the contemporary ones from other regions of the world.

3) They contain a small number of Carboniferous elements occurring in the Euramerican region, and the similar advanced appearances have come out of the Middle to Upper Devonian assemblages in other regions of South China.

4) The present author has much ground to believe that the Shaodong Member is referable to late Late Devonian in age.

## 图 版 说 明

除注明者外,其余图影均放大 500 倍,所有标本均未作任何修饰并全部保存于中国科学院南京地质古生物研究所。  
SD-12-28, SD-18-23 与 SEM4180 等均系标本编号。

### 图 版 I

1. *Leiotriletes ornatus* Ischenko 1956; 近极面观, SD-12-28。
2. *Leiotriletes pyramidatus* Sullivan 1964; 近极面观, SD-18-23。
3. *Retusotriletes avonensis* Playford 1963; 近极—赤道焦距, SD-16-18。
4. *Leiotriletes macrothelis* Wen et Lu 1993; 近极面观,  $\times 665$ , SD-2-4。
5. *Leiotriletes microthelis* Wen et Lu 1993; 近极面观, SD-18-11。
6. *Leiotriletes velatus* (Caro-Monie) Streel, in Becker *et al.* 1974; 近极面观,  $\times 665$ , SD-9-2。
7. *Punctatisporites irrasus* Hacquebard 1957; 近极面观, SD-12-16。
8. *Punctatisporites subtritus* Playford et Helby 1968; 近极—赤道焦距, SD-11-7。
9. *Punctatisporites planus* Hacquebard 1957; 近极面观, SD-12-5。
10. *Granulatisporites humerus* Staplin 1960; 近极面观, SD-6-11。
11. *Punctatisporites debilis* Hacquebard 1957; 近极面观, SD-6-8。
12. *Cyclogranisporites baoyingensis* Ouyang et Chen 1987; 近极面观, SD-11-12。
13. *Reticulatisporites (Azonotriletes) cancellathyris* (Waltz) comb. nov.; 极面观, SD-16-12。
14. *Granulatisporites (Archaeozonotriletes) atratus* (Naumova) comb. nov.; 近极面观, SD-14-29。
15. *Cyclogranisporites pisticus* Playford 1978; 偏近极面观, SD-39-8。
16. *Retusotriletes crassus* Clayton, in Clayton *et al.* 1980; 近极面观,  $\times 665$ , SD-2-16。
17. *Hymenozonotriletes elegans* (Waltz) Naumova 1953; 近极面观, SD-19-22。
18. *Leiotriletes cf. subintortus* (Waltz) Ischenko var. *rotundatus* Waltz 1941; 近极面观, SD-41-1。
19. *Retusotriletes triangulatus* (Streel) Streel 1967; 近极面观, SD-19-15。
20. *Retusotriletes rotundus* (Streel) Lele et Streel 1969; 近极面观, SD-39-6。
21. *Hymenozonotriletes granulatus* (Naum.) Jushko, in Kedo 1963; 近极面观, SD-9-4。
22. *Acanthotriletes (Lophotriletes) fastusus* (Naum.) comb. nov.; 远极面观, SD-9-14。

23. *Dictyotrilites famenensis* Naumova 1953; 近极面观, SD-18-23。
24. *Leiotrilites crassus* Lu 1994; 近极中央焦距, SD-16-14。
25. *Spelaeotrilites* sp. of Wen et Lu 1993; 极面观, SD-17-2。
26. *Cristatisporites limitatus* Ouyang et Chen 1987; 远极环面观, SD-10-3。
27. *Discernisporites varius* Lu 1994; 赤道焦距, SD-35-1。

## 图 版 I

1. *Apiculiretusispora gannanensis* Wen et Lu 1993; 近极面观, SD-6-14。
2. *Acanthotrilites denticulatus* Naumova 1953; 远极面观, SD-18-11。
3. *Spelaeotrilites setosus* (Kedo) Lu 1994; 偏近极面观, SD-2-3。
4. *Hymenozonotrilites angulatus* Naumova 1953; 近极面观, SD-16-29。
5. *Reticulatisporites minor* (Naum.) Wen et Lu 1993; 远极面观, SD-6-16。
6. *Verrucosisporites morulatus* (Knox) Pot. et Kr. 1955; 近极面观, SD-16-21。
7. *Anaplanisporites globulus* (Butt. et Will.) Smith et Butterworth 1967; 近极—赤道焦距, SD-18-14。
8. *Planisporites magnus* (Naum., in Kedo) Lu 1994; 近极面观, SD-19-6。
9. *Acanthotrilites hirtus* Naumova 1953; 赤道焦距, SD-17-11。
10. *Apiculiretusispora leberidos* McGregor et Camfield 1982; 偏极面观, SD-11-13。
11. *Verrucosisporites papulosus* Hacquebard 1957; 偏极面观, SD-18-11。
12. *Apiculiretusispora pseudozonates* Lu 1980; 近极面观, SD-7-4。
13. *Convolutispora ampla* Hoffmeister et al. 1955; 赤道焦距, SD-14-6。
14. *Anapiculatisporites hystricosus* Palyford 1964; 远极面观, SD-16-6。
15. *Lophotrilites atratus* Naumova 1953; 赤道焦距, SD-8-9。
16. *Foveosporites insculptus* Playford 1962; 近极面观, SD-9-11。
17. *Phyllotheotrilites rigidus* Playford 1962; 近赤道面观, SD-12-14。
18. *Convolutispora vermiformis* Hughes et Playford 1961; 赤道焦距, SD-16-4。
19. *Convolutispora major* (Kedo) Turnau 1978; 远极面观, SD-12-30。
20. *Cordylosporites papillatus* (Naum.) Playford et Satterthwait 1985; 远极面观, SD-6-2。
21. *Apiculatisporis morbosus* Balme et Hassell 1962; 赤道—远极面观, SD-14-20。
22. *Apiculiretusispora plicata* (Allen) Streel 1967; 远极面观, SD-8-2。
23. *Pustulatisporites distalis* Lu 1981; 赤道焦距, ca.  $\times 300$ , SD-19-24。
24. *Convolutispora balmei* Playford 1971; 偏极面观, SD-6-5。
25. *Lophotrilites magnus* (Naum.) Lanniger 1968; 近极面观, SD-36-6。
26. *Convolutispora crassa* Playford 1962; 近极中央焦距, SD-15-1。
27. *Crassispora imperfecta* Lu 1988; 近极面观, SD-15-20。
28. *Spelaeotrilites crenulatus* (Playford) Higge et al. 1988; 近极面观, SD-16-19。
29. *Brochotrilites ? foveolatus* Naumova 1953; 极面观, SD-18-28。

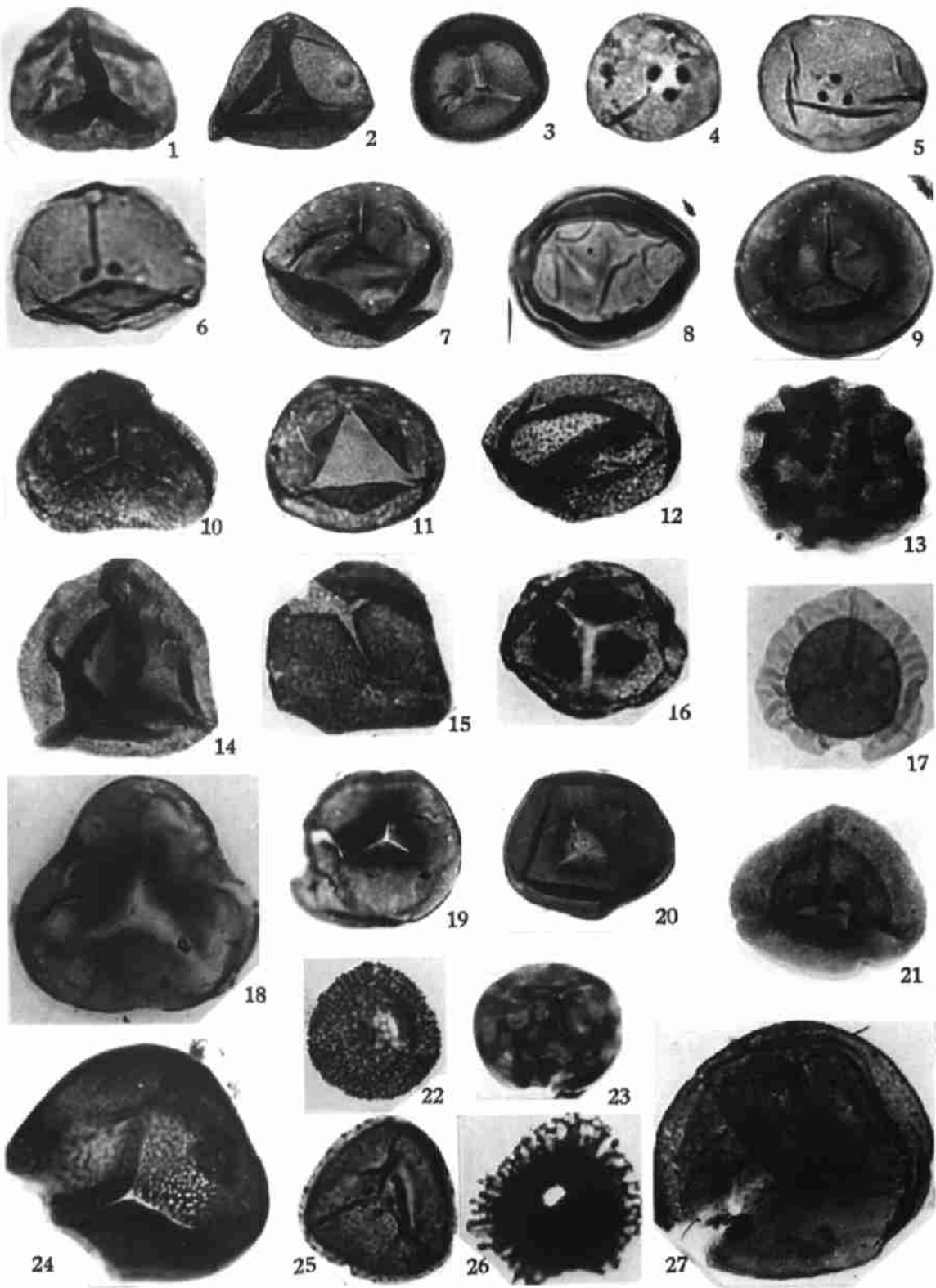
## 图 版 III

1. *Aneurospora spinulifer* Wen et Lu 1993; 近极面观, SD-1-24。
2. *Apiculiretusispora flexuosa* Hou 1982; 近极面观, SD-17-10。
3. *Knoxisporites dedaleus* (Naum.) Lu 1993; 远极面观, SD-9-5。
4. *Aneurospora asthenolabrata* (Hou) Lu 1994; 远极中央焦距, SD-18-18。
5. *Cymbosporites cyathus* Allen 1965; 远极面观, SD-18-32。
6. *Foveosporites pellucidus* Playford et Helby 1968; 近极面观, SD-19-20。
7. *Lophozonotrilites torosus* Naum. var. *famenensis* Naumova 1953; 赤道焦距, SD-16-17。

8. *Clivosispora verrucata* McGr. var. *verrucata* McGregor 1973; 赤道焦距, SD-11-19.
9. *Auroraspora macra* Sullivan 1964; 赤道焦距, SD-11-11.
10. *Grandispora saurota* (Higgs et al.) Playford et McGregor 1993; 赤道焦距,  $\times 665$ , SD-17-5.
11. *Spelaeotrilites resolutus* Higgs 1975; 近极面观, SD-7-2.
12. *Discernisporites micromanifestus* (Hacq.) Sabry et Neves 1971; 近极面观, SD-7-6.
13. *Auroraspora asperella* (Kedo) Van der Zwan 1980; 近极面观,  $\times 665$ , SD-17-5.
14. *Diaphanospora depressa* (Balme et Hassell) Evans 1970; 近极中央焦距, SD-14-16.
15. *Grandispora* (*Hymenozonotrilites*) *eximia* (Naum.) comb. nov.; 近极面观, SD-39-2.
16. *Diaphanospora* (*Hymenozonotrilites*) *submirabilis* (Luber) comb. nov.; 赤道焦距, SD-18-7.
17. *Grandispora gracilis* (Kedo) Streel 1974; 近极面观, SD-12-22.
18. *Hymenozonotrilites spicatus* Lu 1944; 带环焦距, SD-31-7.
19. *Spelaeotrilites pretiosus* (Playford) Neves et Belt 1970; 近极面观, SD-14-20.
20. *Spelaeotrilites obtusus* Higgs 1975; 赤道焦距, SD-12-17.
21. *Spelaeotrilites triangulatus* Neves et Owens 1966; 赤道焦距, SD-9-9.
22. *Grandispora* (*Spelaeotrilites*) *cumula* (Higgs et Streel) comb. nov.; 近极面观, SD-32-1.
23. *Spelaeotrilites crustatus* Higgs 1975; 近极面观, SD-10-2.
24. *Retispora cassicula* (Higgs) Higgs et Russell 1981; 偏极面观,  $\times 665$ , SD-5375.

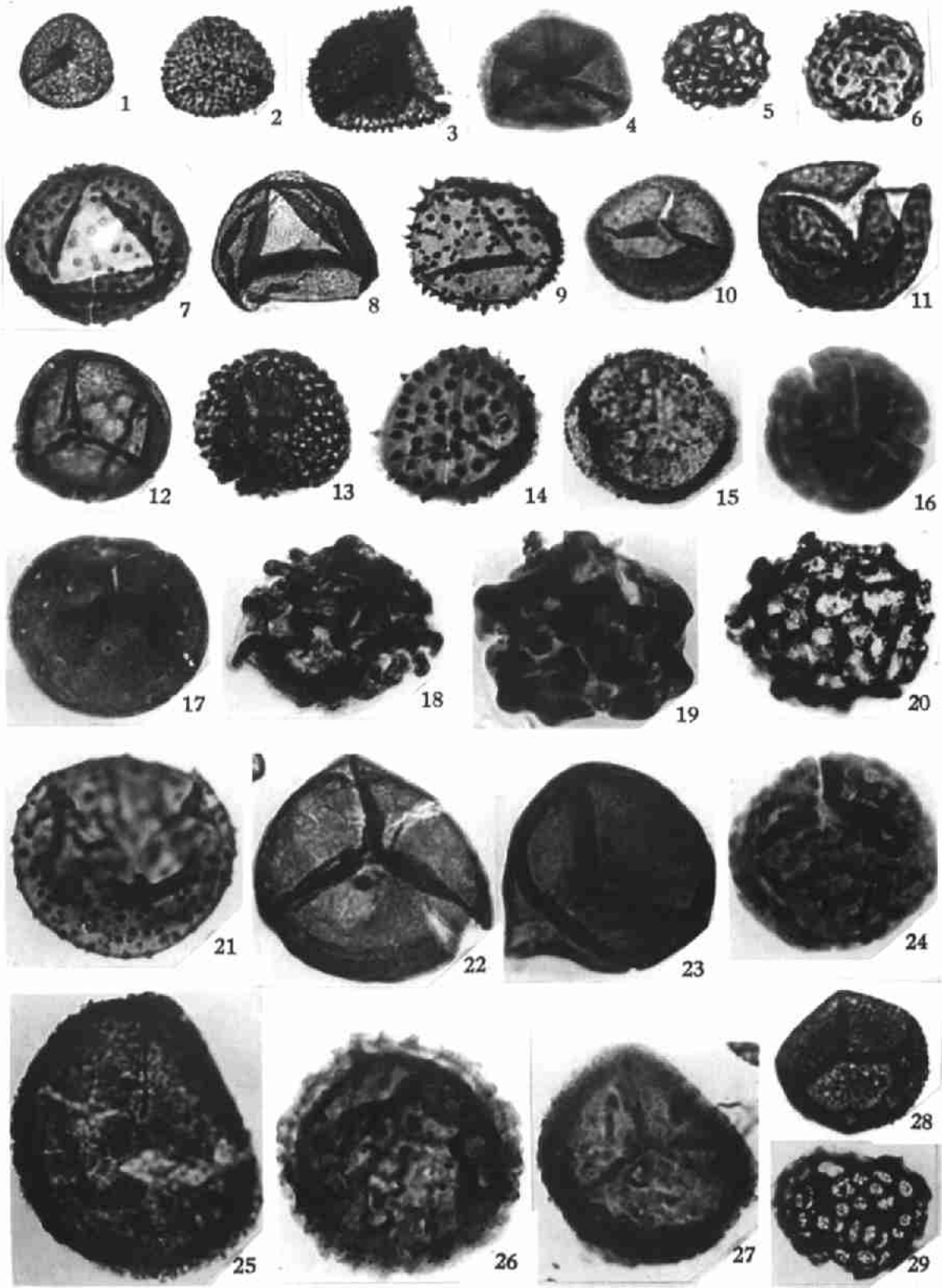
#### 图 版 IV

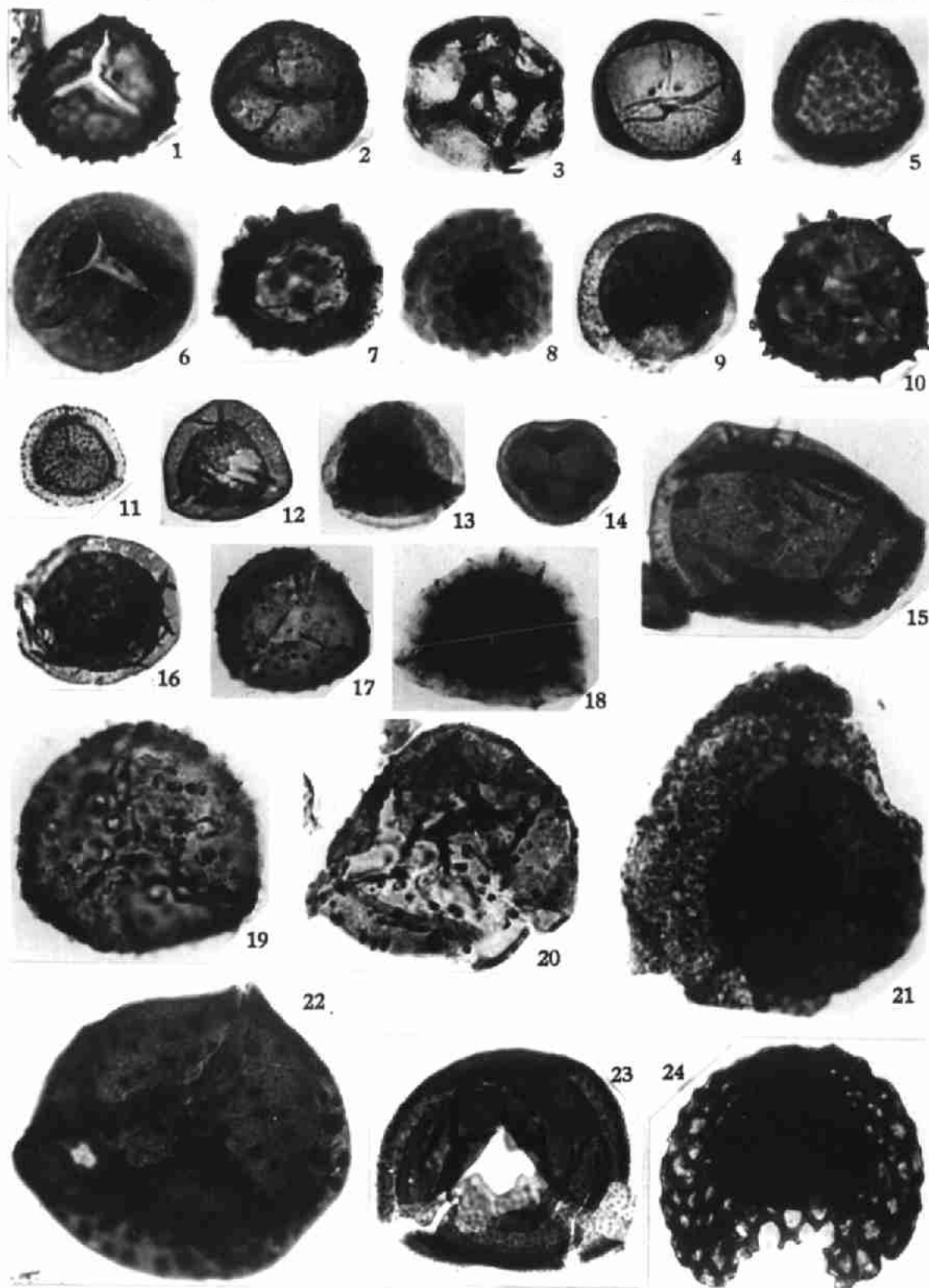
1. *Veryhachius trispinosum* (Eisenack) Deunff 1954; 疑源类,  $\times 665$ , SD-1-4.
2. *Micrhystridium stellatum* Deflandre 1954; 疑源类, SD-5-3.
3. *Densosporites spinifer* Hoffmeister et al. 1955; 赤道焦距, SD-14-36.
4. *Laevigatosporites vulgaris* (Ibr.) Alpern et Doubinger 1971; 近极面观, SD-33-6.
5. ? *Videospora glabrimarginata* (Owens) Higgs et Sussell 1981; 偏极面观, SD-39-1.
6. *Densosporites crassus* McGregor 1960; 偏近极面观, SD-6-3.
7. *Densosporites capistratus* Hoffmeister et al. 1955; 近极面观, SD-14-15.
8. *Verrucosporites mesogrumosus* (Kedo) Byvscheva 1985; 赤道焦距, SD-16-15.
9. *Densosporites xinhuanensis* Hou 1982; 远极面观, SD-14-18.
10. *Velamispores perinatus* (Hughes et Playford) Playford 1971; 偏极面观, SD-12-25.
11. *Velamispores irrugatus* Playford 1978; 极面观, SD-12-10.
12. *Densosporites secundus* Playford et Satterthwait 1988; 近极面观, SD-16-9.
13. *Geminispora* (*Archaeozonotrilites*) *lasius* (Naum.) var. *minor* (Naum.) comb. nov.; 近极面观, SD-14-19.
14. *Discernisporites papillatus* Lu 1994; 近极面观, SD-12-31.
15. *Geminispora spongiata* Higgs et al. 1988; 近极面观, SD-14-30.
16. *Grandispora echinata* Hacquebard 1957; 近极面观, SD-17-1.
17. *Discernisporites macromanifestus* (Hacq.) Higgs et al. 1988; 赤道焦距, SD-34-2.
18. *Ancyrospora* cf. *furcula* Owens 1971; 极面观, SD-31-2.
19. *Grandispora cornuta* Higgs 1975; 偏极面观, SD-35-3.
- 20, 21. *Spelaeotrilites hunanensis* (Fanf et al.) Lu 1994; 20, 近极面观, SD-5-10; 21, 远极面观, SD-11-16.
22. *Retispora lepidophyta* (Kedo) Playford 1976; 远极面观, SD-18-12.
23. *Verruciretusispora megaplatyverruca* Lu et Ouyang 1976; 极面观, ca.  $\times 300$ , SD-14-23.
24. *Densosporites variomarginatus* Playford 1963; 近极面观,  $\times 900$ , SEM4180.



Miospores from Shaodong Member at Jieling Section of Hunan, China and Their Geological Age

Plate I







Miospores from Shaodong Member at Jieling Section of Hunan, China and Their Geological Age

Plate IV

