DOI:10.19800/j.cnki.aps.1997.02.005
第 36 卷第 2 期 古 生 物 学 报 Vol.36,No.2
1997 年 4 月 ACTA PALAEONTOLOGICA SINICA Apr.,1997

湖南界岭邵东段微体植物群

卢礼昌
(中国科学院南京地质古生物研究所,南京 210008)

提 要 湖南界岭微体植物群由 56 属 145 种(含 13 新种)小孢子及很少量的疑源类与虫牙组成,并以 *Spelaeotriletes hunanensis* 的百分含量最高(26.8%)和同时含泥盆纪与石炭纪双重时代色彩的分子 *Retispora lepidophyta*, *R. crassicula* 与 *Cordylosporites papillatus*, *Spelaeotriletes protiosus* 为特征,但其地质时代属晚泥盆世晚期或晚法门期。

关键词 邵东段 微体植物群 晚泥盆世 界岭剖面 湖南

1 湖南界岭邵东段微体植物群

湖南界岭邵东段的地层剖面及其所含绝大部分小孢子已知种和它们的地质、地理分布卢礼昌(1995)已作了报道,在此不再重述。本文着重阐述邵东段微体植物群的特征,并将其与相关组合作对比。

1.1 微体植物群成分

邵东段微体植物群由 145 种*(可归入 56 属)小孢子、2 属 3 种疑源类与 1 属 1 种虫牙共同组成。

本文记载的有 13 新种:*Camptoriletes triangulatus* sp.nov., *Camptozonotriletes proximalis* sp.nov., *Cristatisporites digitatus* sp.nov., *Cymbosporites microgranulatus* sp.nov., *Discernisporites deminutus* sp.nov., *D. suspictus* sp.nov., *D. usitatus* sp.nov., *Geminospora multiramis* sp.nov., *Grandispora furcata* sp.nov., *Gulisporites hiatus* sp.nov., *Spelaeotriletes fanxiaensis* sp.nov.(=*Spelaeotriletes* sp. of Lu, 1995), *S. hetermorphus* sp.nov., *S. rarus* sp.nov.;3 个新联合种:*Microreticulatisporites distinctus*(Naumova, in Kedo) comb.nov., *Reticulatisporites amplectus* (Naum.) comb.nov., *Grandispora serena*(Kedo) comb.nov.;21 个已知种:? *Acanthotriletes impolitus*,? *Archaeozonotriletes aconthaceus*, *Baculatisporites fusticulus*, *B. villosus*, *Cirratriraditus veeversi*, *Convolutispora subtilis*, *Cristatisporites connexus*, *Densosporites rariabilis*, *D. rarispinosus*, *Geminospora lemurata*, *G. micropaxilla*, *G. venusta*, *Lycospora uber*, *Microreticulatisporites reticuloides*, *Punctatisporites cornatus*, *P. limbatus*, *Reticulatisporites ancoralis*, *Spelaeotriletes microgranulatus* var. *minor*, *S. microspinosus*(=*S. resolutus*,卢礼昌,1995),? *Stenozonotriletes extensus* var. *major*, *Tumulispora ordinarius*;2 个比较种:*Cymbosporites* cf. *formosus* 与 *Schopfites* cf. *claviger*;7 个未定种:*Leiotriletes* sp. of Lu(1994), *Cycloverrutriletes* sp., *Densosporites* sp., *Hymenospora* sp., *Raistrickia* sp., *Tumlispora* sp., *Velamisporites* sp.;以

*145 种小孢子是由本文的 46 种加卢礼昌(1995)报道的 101 个已知种,再减去 2 个共同种。

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及疑源类 *Veryhachium polyaster* 与虫牙 *Leogenys altilis* 各1种。

卢礼昌在1995年已报道的有三缝小孢子 *Acanthotriletes denticulatus*, *A. fastuosus*, *A. hirtus*, *Anapiculatisporites hystricosus*, *Anaplanisporites globutus*, *Ancyrospora* cf. *furcula*, *Aneurospora asthenolabrata*, *A. spinulifer*, *Apiculiretusispora flexuosa*, *A. gannanensis*, *A. leberidos*, *A. plicata*, *A. pseudozonalis*, *Apiculatisporites morbosus*, *Auroraspora asperella*, *A. macra*, *Brochotriletes foveotatus*, *Clivosispora verrucata* var. *verrucata*, *Convolutispora ampla*, *C. balmei*, *C. crassa*, *C. major*, *C. vermiformis*, *Cordylosporites papillatus*, *Crassispora imperfecta*, *Cristatisporites limitatus*, *Cyclogranisporites baoyingensis*, *C. pisticus*, *Cymbosporites cyathus*, *Densosporites capistratus*, *D. crassus*, *D. secundus*, *D. spinifer*, *D. vrariomarginatus*, *D. xinhaunensis*, *Diaphanospora depressa*, *D. submirabilis*, *Dictyotriletes famenensis*, *Discernisporites macromanifestus*, *D. micromanifestus*, *D. papillatus*, *D. varius*, *Foveosporites insculptus*, *F. pellucidus*, *Geminospora lasius* var. *minor*, *G. spongiata*, *Grandispora cornuta*, *G. cumula*, *G. echinata*, *G. eximia*, *G. gracilis*, *G. saurota*, *Granulatisporites atratus*, *G. humerus*, *Hymenozonotriletes angulatus*, *H. elegans*, *H. granulatus*, *H. spicatus*, *Knoxisporites dedaleus*, *Leiotriletes crassus*, *L. macrothelis*, *L. microthelis*, *L. ornatus*, *L. pyramidatus*, *L.* cf. *subintertus* var. *rotundatus*, *L. velatus*, *Lophotriletes atratus*, *L. magnus*, *Lophozonotriletes torosus* var. *famenesis*, *Phyllothecotriletes rigidus*, *Planisporites magnus*, *Punctatisporites debilis*, *P. irrasus*, *P. planus*, *P. subtritus*, *Pustulatisporites distalis*, *Reticulatisporites cancellothyris*, *R. minor*, *Retispora cassicula*, *R. lepidophyta*, *Retusotriletes avonensis*, *R. crassus*, *R. rotundus*, *R. triangulatus*, *Spelaeotriletes crenulatus*, *S. crustatus*, *S. hunanensis*, *S. obtusus*, *S. pretiosus*, *S. resolutus*, *S. setosus*, *S. triangulatus*, *Spelaeotriletes* sp. (of Wen et Lu, 1993), *Velamisporites irrugatus*, *V. perinatus*, *Verruciretusispora megaplatyverruca*, *Verrucosisporites mesogrumosus*, *V. morulatus*, *V. papulosus*, ? *Videospora glabrimarginata*; 单缝小孢子 *Laevigatosporites vulgaris*, 以及疑源类 *Veryhachium trispinosus* 与 *Michrhystridium stellatus*。

1.2 微体植物群特征

界岭剖面邵东段的微体植物群具有如下特征:

1)本微体植物群除占绝对优势的小孢子外,还含有极少量的疑源类与虫牙,前者产自陆生植物,后者标志海相建造。

2)在小孢子中,又以三缝孢类的属种占绝对优势,其中 *Spelaeotriletes* (13种, 36.4%)*, *Densosporites* (9种, 5.3%), *Leiotriletes* (8种, 3.6%), *Discernisporites* (7种, 4.7%), *Grandispora* (7种, 3.9%), *Geminopora* (6种, 4%), *Apiculiretusispora* (5种, 2.6%)以及 *Tumulispora ordinarius* (8.7%), *Camptozonotriletes proximus* sp. nov. (3.2%), *Cristatisporites digitatu*(2.6%)与 *Gulisporites hiatus*(2.1%),合计11属59种,占小孢子总含量的77.1%;单缝孢类仅 *Laevigatosporites vulgaris*1属1种(<1%),处于绝对劣势地位。

* 其百分比是在微体植物群中所占比例,下同。

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3) *Spelaeotriletes hunanensis* 是苏、皖、湘、赣等地区上泥盆统上部特有分子(卢礼昌，1994)，它在本微体植物群中含量最高，达 26.8%，表明本微体植物群浓厚的地方色彩。

4) *Retispora lepidophyta* 与 *R. cassicula* 是世界性晚泥盆世晚期的标志或重要分子；*Cordylosporites papillatus* 与 *Spelaeotriletes protiosus* 通常被视为欧美与南澳大利亚早石炭世的典型分子。这些分子在邵东段微体植物群中同时存在，表明本微体植物群具有泥盆、石炭纪双重时代色彩。

根据上述特征，本文将界岭邵东段微体植物群称为 *Spelaeotriletes hunanensis*(Sh)微体植物群。

2　组合对比与时代讨论

2.1　与国内资料的比较与讨论

湘中锡矿山欧家冲泥盆－石炭系 *Spelaeotriletes lepidophytus-Granulatisporites hunanensis*(Ⅰ)组合带(侯静鹏，1982)产自欧家冲剖面的马牯脑段上部、欧家冲段与邵东段下部，“其地质时代大致相当于西欧的法门阶 Fa2d”。该组合带又按上述 3 个不同的地层层段相应地细分为 3 个亚带，共含小孢子 18 属 26 种(卢礼昌，1994，162 页)。它们的共同特点是，3 个亚带均含有数量不等的 *Spelaeotriletes lepidophytus*(本文改称 *Spel. hunanensis*，下同)的分子，其百分含量分别为 2%－10%、12%－26%与 2%－15%；而该分子在本文微体植物群中的百分含量最高，达 26.8%。除此以外，欧家冲Ⅰ组合带的 *Cristatisporites*，*Cyclogranisporites*，*Densosporites*，*Dictyotriletes*，*Hymenozonotriletes*，*Lophotriletes* 与 *Verrucosisporites* 以及 *Acanthotriletes* sp.(*Acanth. denticulatus*)，*Apiculiretusispora plicata*，*Cymbosporites parvibasilaris*(*Cymb. contatus*)，*Granulatisporites hunanensis*(*Apiculiretusispora gannanensis*)，*Leiotriletes ornatus*，*Punctatisporites debilis*，*P. planus*，*Punctatosporites* sp.(*Laevigatosporites vulgaris*)，*Retusosporites avonensis* 与 *Spelaeotriletes lepidophytus*(*Spel. hunanensis*)等，也见于邵东段微体植物群。上列情况表明，上述两组合虽然产于不尽相同的层位，但彼此关系仍显得颇为密切。

此外，欧家冲剖面尚有获自邵东段上部的 *Lophozonotriletes rarituberculatus-Vallatisporites batiambes*(Ⅱ)组合带(侯静鹏，1982)，由 20 属 36 种小孢子组成，其“层位大致可与杜内 Tnla 相当”。该组合带与本文微体植物群之间共同的种有 *Acanthotriletes* sp.(*Acanth. denticulatus*)，*Densosporites xinhuanensis*，*Discernisporites micromanifestus*，*Punctatisporites planus*，*Punctatosporites* sp.(*Laevigatosporites vulgaris*)与 *Retusotriletes asthenolabratus*(*Aneurospora asthenolabrata*)等；除上述各种所涉及的属外，共同的属还有 *Apiculiretusispora*，*Cyclogranisporites*，*Cymbosporites*，*Hymenozonotriletes*，*Knoxisporites*，*Leiotriletes*，*Lophozonotriletes*，*Lophotriletes* 与 *Verrucosisporites*。上列共同成分表明，欧家冲Ⅱ组合带与界岭微体植物群之间存在较密切的关系，差异仅是组合成分“富贫”较悬殊，前者的属(20)种(36)数量仅为后者属(46)种(145)数量的 35.1%与 24.8%；其次是 *Speleotriletes hunanensis* 在Ⅱ组合带缺失，而在本文微体植物群中是最丰富的(26.8%)；再次是海相微体化石，如疑源类与虫牙等，在Ⅱ组合带中无记载，但存在于本文微体植物群中。

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其实彼此均为海相沉积,岩性与层位也基本相同,这些差异很可能是人为因素导致的。

江西全南小慕三门滩组 *Acanthotriletes denticulatus-Apiculiretusispora rarissima*(DR)组合(文子才,卢礼昌,1993)含小孢子13属20种,时代属法门期。该组合成分虽然较贫乏,但与本文微体植物群共同的种仍有 *Acanthotriletes denticulatus*, *Apiculiretusispora gannanensis*,? *Retispora* cf. *lepidophyta* (*Spelaeoriletes hunanensis*), *Retusotriletes crassus*, *Spelaeotriletes resolutus*(*Spel. microspinosus*),与 *Spelaeotriletes* sp.(*Spel. fanxiaensis* sp. nov.),共同的属有 *Aneurospora*, *Auroraspora*, *Cymbosporites*, *Grandispora*, *Granulatisporites* 与 *Leiotriletes*。上述共同成分以归入 *Spelaeeotriletes* 的分子占多数,尤其是 *Spelaeotriletes hunanensis* 的存在,说明该两组合的关系很密切。据文子才、卢礼昌(1993)的研究结果表明,上述三门滩组DR组合与湘中锡矿山马牯脑段上部至邵东段下部Ⅰ组合带(侯静鹏,1982)的关系也甚为密切。而本文微体植物群与该Ⅰ组合带的关系也颇密切(见前述),因而进一步表明本文微体植物群与全南三门滩组DR组合非常接近。

江西全南小慕翻下组 *Leiotriletes macrothelis-Grandispora xiaomuensis*(MX)组合(文子才、卢礼昌,1993)含小孢子25属45种,其时代倾向地归属法门期,"但具体层位应略高于前述DR组合所在层位"。该MX组合与当前微体植物群之间具有较多的共同种,如 *Acanthotriletes denticulatus*, *Apiculiretusispora gannanensis*, *Auroraspora macra*, *Discernisporites micromanifestus*, *Densosporites rarispinosus*, *D. variabilis*, *Laevigatosporites vulgaris*, *Leiotriletes macrothelis*, *L. microthelis*, *Retusotriletes asthenolabratus*(*Aneurospora asthenolabrata*), *Spelaeotriletes* sp.(*Spel. fanxiaensis*)等11种,约占MX组合种数(45)的24.4%。其次,共同的属还有 *Aneurospora*, *Archaeozonotriletes*, *Bascaudaspora*, *Camptozonotriletes*, *Cyclogranisporites*, *Cymbosporites*, *Dictyotriletes*, *Foveosporites*, *Grandispora*, *Granulatisporites*, *Gulisporites*, *Microreticulatisporites*, *Punctatisporites* 与 *Tumulispora* 等14属,占MX组合属数(25)的56%。再次,彼此均属近岸海相沉积环境。除上述相似性外,两组合尚存的差异是:MX组合的成分相对较当前微体植物群的要贫乏,前者属(25)种(45)数量仅是后者(57属145种)的55.6%与31%; *Spelaeotriletes hunanensis* 仅见于本文微体植物群中,而在小慕MX组合中缺失(类似于湘中欧家冲邵东段上部Ⅱ组合带)。

南京龙潭地区五通组观山段 *Aneurospora asthenolabrata-Radiizonates longtanensis*(AL)组合(卢礼昌,1994*a*)具有17属25种小孢子,"地质时代属于晚泥盆世晚期(法门期),甚至很可能属法门期晚期"。该AL组合成分虽较贫乏,但与本文微体植物群共同的分子仍有 *Convolutispora*, *Cymbosporites*, *Granulatisporites*, *Hymenozonotriletes*, *Lophotriletes*, *Lycospora*, *Reticulatisporites*, *Retusotriletes*, *Velamisporites* 以及 *Acanthotriletes denticulatus*, *Aneurospora asthenolabrata*, *Apiculiretusispora gannanensis*, *Auroraspora macra*, *Cristatisporites connexus*, *Cycloganisporites baoyingensis*, *Densosporites rarispinosus*, *Discernisporites micromanifestus*, *Leiotriletes ornatus*, *Punctatisporites planus*, *Spelaeotriletes crenulatus*, *S. crustatus* 与 *S. setosus* 等9属12种,分别为AL组合属种数量的64.7%与32%。可见,上述两组合的关系仍相当密切。彼此组合成分贫与富的差异很可能是受沉积环境的控制,因为上述观山段是一套以石英砂岩为主的非海相建造。

南京龙潭地区五通组擂鼓台段中、下部 *Retusotriletes-Cymbosporites*(RC)组合(卢礼昌,

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1994)的“时代应属晚泥盆世晚期，甚至属法门期末”。RC 组合由 22 属 43 种小孢子组成，其中 *Acanthotriletes*，*denticulatus*，*Aneurospora asthenolabrata*，*Apiculiretusispora flexuosa*，*A. gannanensis*，*Discernisporites micromanifestus*，*Grandispora echinata*，*Leiotriletes ornatus*，*Punctatisporites planus*，? *Retispora* cf. *lepidophyta*(*Spelaeotriletes hunanensis*)，*Reticulatisporites papillatus*(*Cordylosporites papillatus*)，*Retusotriletes crassus* 与 *Velamisporites perinatus* 等 12 种也见于邵东段微体植物群。除上列诸种所涉及的属外，尚有 *Auroraspora*，*Camptosporites*，*Cymbosporites*，*Lophotriletes*，与 *Stenozonotriletes* 等属在邵东段微体植物群中出现。虽然该两组合的共同成分不很多，但若考虑到彼此组合的沉积环境各不相同(龙潭擂鼓台段中、下部为非海相沉积，界岭邵东段为海相沉积)，上述属种，特别是在我国颇具时代意义的 *Spelaeotriletes hunanensis* 以及在我国晚泥盆世超前出现的 *Cordylosporites papillatus* 的存在，似表明该两组合的关系非常亲近。

除上述相似性外，擂鼓台段的 DC 组合与邵东段微体植物群之间仍存在较明显的差异：龙潭擂鼓台段 RC 组合仅含三缝小孢子，而界岭邵东段微体植物群除含陆生植物小孢子外，尚有标志海相沉积环境的疑源类与虫牙；擂鼓台段 RC 组合的成分较邵东段微体植物群的贫乏，其种的数目(43)较邵东段微体植物群的属数(57)还少 24.6%，且孢子个体也略小；RC 组合以 *Cymbosporites* 的种数(7)最多及百分含量(26.8%)最高，而本微体植物群是以 *Spelaeotriletes* 的种数(13)与百分含量(36.4%)最高。存在上述差异的主要原因，很有可能是受沉积环境的控制。

西藏聂拉木波曲群上部 *Retispora lepidophyta-Vallatisporites pusillites*(LP)组合(高联达，1983)因含典型的 *R. lepidophyta*，其时代无疑为晚泥盆世晚期。本文邵东段微体植物群与该 LP 组合有许多方面比较相似：首先，彼此均由陆生植物的小孢子与标志海相沉积环境的疑源类与虫牙组成，并且成分均颇丰富。其次，共同具有(或可比较)的种有 *Aneurospora asperella*，*Apiculiretusispora plicata*，*Auroraspora macra*，*Cymbosporites formosus*，*Discernisporites micromanifestus*，*Geminospora lemulata*，*Grandispora cornuta*，*G. echinata*，*Laevigatosporites rarus*(*L. vulgaris*)，*Retispora lepidophyta*，*R. lepidophyta* var. *minor*(*Spelaeotriletes hunanensis*)；疑源类 *Veryhachium trispinosum*，*Michystridium stellatum*；虫牙：*Leogenys altilis*。再者，除这些(小孢子)共同种所涉及的属外，其他共有的属还有 *Acanthotriletes*，*Anapiculatisporites*，*Ancyrospora*，*Archaeozonotriletes*，*Cirratriradites*，*Convolutispora*，*Cyclogranisporites*，*Cristatisporites*，*Densosporites*，*Dictyotriletes*，*Granulatisporites*，*Hymenozonotriletes*，*Leiotriletes*，*Lophotriletes*，*Lophozonotriletes*，*Perotriletes*(*Velamisporites*)，*Punctatisporites*，*Retusotriletes*，*Stennozonotriletes*，*Verrucosisporites* 等。另外，它们皆为海相沉积环境。

除上述相似性外，两组合间也存在若干差异，即波曲群 LP 组合以典型的 *Retispora lepidophyta* 占优势，一般占孢子总含量的 50%－60%，而邵东段微体植物群是以颇具地方色彩的 *Spelaeotriletes hunanensis* 百分含量最高(达 26.8%)为特征。另外，常见于欧美，尤其是西欧泥盆系最顶部小孢子组合带的特征分子(除上述 *R. lepidophyta*) *Hymenozonotriletes explanatus* 与 *Vallatisporites pusillites* 仅见于波曲群组合，在邵东段微体植物群中则完全缺失。在孢子的大小方面，波曲群组合的一般较邵东段微体植物群的要大些。笔者曾指出(卢

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礼昌,1994*a*);波曲群组合的总体面貌似乎更接近"欧美型",而邵东段微体植物群则颇具地区性。这些差异的存在,是否反映了植物区系的不同,或是其他原因,目前尚难肯定;但层位的差异似乎可以肯定,即波曲群上部应略高于邵东段。

贵州睦化剖面Ⅲ格董关层孢子组合(高联达,见侯鸿飞,1985)以含 *Vallatisporites pusillites* 为特征,时代"应属泥盆纪,并与LN亚带对比"。由于该组合的孢子保存欠佳,故种的详细对比较困难,但该孢子组合中有 *Acanthotriletes*, *Aneurospora*, *Archaeozonotriletes*, *Cristatisporites*, *Cymbosporites*, *Dictyotriletes*, *Grandispora*, *Hymenozonotriletes*, *Lophotriletes*, *Lophozonotriletes*, *Pustulatisporites*, *Retispora*, *Reticulatisporites*, *Tumulispora*(部分相当本文的 *Lophozonotriletes*)与 *Verrucosisporites* 等属也见于邵东段的微体植物群。尽管如此,这两个组合的总体面貌不尽相似,这可能与格董关层略高于邵东段有关。

2.2 与国外资料的比较与讨论

鉴于我国现已报道的泥盆-石炭系孢子通常为泥盆-石炭系界线层的资料,因此本文与国外资料的对比是将该界线层附近各孢子组合或组合带视为一个整体组合而与之比较和讨论,并且着重与爱尔兰(西欧)、加拿大(北美)、俄罗斯(欧洲)及澳大利亚(南半球)的有关资料作比较讨论。

爱尔兰泥盆—石炭系小孢子序列含8个小孢子带*(Higgs *et al*., 1988),取材遍布爱尔兰各地80多个露头与钻孔的498块样品,共获得小孢子162种(可归入60属)。湖南界岭邵东段微体植物群与其共有的种(表Ⅰ)达21种,分别为爱尔兰与界岭组合的13%与14.5%。除共同种所涉及的属外,其他共有的属还有 *Acanthotriletes*, *Anaplanisporites*, *Apiculatisporis*, *Apiculiretusispora*, *Crassispora*, *Cristatisporites*, *Cyclogranisporites*, *Cymbosporites*, *Densosporites*, *Hymenozonotriletes*, *Knoxisporites*, *Latosporites* (= *Laevigatosporites*), *Leiotriletes*, *Lophozonotriletes*(部分相当于本文的 *Tumulispora*), *Microreticulatisporites*, *Raistrickia*, *Schopfites*, *Velamisporites* 与 *Verrucosisporites* 等,分别为两组合的35%与36.8%;彼此均不含大孢子(≥200 μm)。总的来说,两个组合的成分均很丰富,但湖南界岭邵东段Sh微体植物群较爱尔兰晚泥盆世3个(LL、LE与LN)组合带更丰富。

除上述相似点外,彼此组合间仍存在较明显的差异,爱尔兰(整体)的组合中所含泥盆-石炭系界线层各组合带的特征分子可谓应有尽有,而湖南界岭Sh微体植物群中则很少,这可能是前者的层位较后者(至少不含早石炭纪的沉积)要高有关。其次,爱尔兰各组合带,尤其是属于晚泥盆世的3个组合带不含海相化石(疑源类等),而邵东段Sh微体植物群则含有海相化石,因为前者产自"老红砂岩相"(Old Red Sandston Facies),纯属陆相沉积环境,而后者是属海相沉积环境。再者,爱尔兰各组合带孢子的大小较邵东段Sh微体植物群的分子一般要大些,这很可能表明彼此的古生态环境不尽相同。

加拿大东部Horton群孢子组合被认为属密西西比纪早期(Playford, 1964),但McGregor(1970)在新斯科舍省(Nova Scotia)暂归入"Horton群"的地层中发现了具晚泥盆世晚期的特征分子 *Retispora lepidophyta* 的孢子组合。笔者将Playford(1964)建立的Horton群的两个孢子组合合起来与本文Sh微体植物群作比较。它们之间共同的种有 *Anapiculatisporites*

* 晚泥盆世3个带,即LL,LE,LN带;早石炭世5个带,即VI,HD,BP,PC与CM带。

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属种名称(Miospore taxa)	爱尔兰(Ireland) (Higgs *et al*. 1988)								本　文 (This paper)
	LL	LE	LN	VI	HD	BP	PC	CM	*Sh*
Retispora cassicula	*	*							*
R. lepidophyta	*	*	*						*
? *Videospora glabrimarginata*	*	*	*						*
Grandispora cornuta	*	*	*	*	*	*	*		*
Retusotriletes triangulatus	*	*	*	*	*	*	*		*
Spelaeotriletes crustatus	*	*	*	*	*	*	*		*
Aneurospora asperella	*	*	*	*	*	*	*	*	*
Convolutispora vermiformis	*	*	*	*	*	*	*	*	*
Discernisporites macromanifestus	*	*	*	*	*	*	*	*	*
Disc. micromanifestus	*	*	*	*	*	*	*	*	*
Grandispora echinata	*	*	*	*	*	*	*	*	*
Punctatisporites irrasus	*	*	*	*	*	*	*	*	*
Spelaeotriletes crenulatus	*	*	*	*	*	*	*	*	*
Geminospora spongiata		*	*	*	*	*	*		*
Auroraspora macra		*	*	*	*	*	*	*	*
Pnuctatisporites planus		*	*	*	*	*	*	*	*
Retusotriletes crassus		*	*	*	*	*	*	*	*
Spelaeotriletes obtusus				*	*	*			*
Spel. resolutus				*	*	*	*		*
Spel. pretiosus							*	*	*
Anapiculatisporites hystricosus								*	*

hystricosus, *Convolutispora vermiformis*, *Endosporites* (*Discernisporites*) *macromanifestus*, *End.* (*Disc.*) *micromanifestus*, *Grandispora echinata*, *Perotriletes* (*Velamisporites*) *perinatus*, *Punctatisporites debilis*, *P. limbatus*, *P. irrasus*, *P. planus*, *Pustulatisporites* (*Spelaeotriletes*) *pretiosus*, *Retusotriletes avonensis* 与 *Stenozonotriletes extensus* var. *major* 等 13 种，约占彼此组合种数(分别为 53 种与 145 种)的24.5%与9.0%；除上述种所涉及的属外，其它共同的属还有 *Acanthotriletes*, *Camptotriletes*, *Cristatisporites*, *Dictyotriletes*, *Cyclogranisporites*, *Gulisporites*, *Leiortiletes*, *Lycospora* (*Cymbosporites*), *Microreticulatisporites*, *Pustulatisporites*, *Raistrickia*, *Reticulatisporites* 与 *Schopfites* 等 13 属，分别占各组合属数(28 与 56)的 46.4%与 23.2%。

加拿大 Horton 群组合的成分虽较丰富，但仍远不及当前微体植物群丰富多采，所以上述共同成分的存在表明本文 Sh 微体植物群与加拿大孢子组合较接近，其层位也大致相当。考虑到本微体植物群含有较典型的泥盆纪的分子，如 *Acanthotriletes denticulatus*, *Ancyrospora* cf. *furcula*, *Aneurospora asthenolabrata*, *Apiculiretusispora gannanensis*, *Cymbosporites cyathus*, *Retispora lepidophyta*, *R. cassicula* 与 *Spelaeotriletes hunanensis* 等未见于 Horton 群的组合中，所以当前微体植物群的地质时代应略早于后者(Horton 群)。

Playford(1976)将西澳大利亚 Canning 盆地 Fairfield 组的植物微体化石(plant microfossils)分为两个孢子组合，即 *Retispora lepidophyta* 组合与 *Grandispora spiculifera* 组合，地质时代分别属于晚泥盆世晚期与早石炭世早期。前一组合与当前微体植物群相比较，从总体来说，彼此均由小孢子与疑源类组成，并且均含有常见于泥盆纪的、具锚刺类型的分子(*An-*

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cyrospora 或 *Hystricosporites*)，以及晚泥盆世晚期的标志分子(即 *R. lepidophyta*)；同时，彼此还存在一定数量的共同成分，尤其是含有较多的共同属，如 *Brochotriletes*，*Camptotriletes*，*Cirratriradites*，*Convolutispora*，*Crassispora*，*Diaphanospora*，*Grandispora*，*Granulatisporites*，*Hymenozonotriletes*，*Lophozonotriletes*，*Raistrickia*，*Reticulatisporites*，*Retusotriletes* 与 *Stenozonotriletes*。此外，尚有 4 个共同种。存在的差异是 Fairfield 组的 *R. lepidophyta* 组合成分远不及邵东段 Sh 微体植物群的丰富多彩，前者的属(23)种(28)数量仅为后者属(56)种(145)数量的 4%与 19.3%；其次，*Spelaeotriletes* 与 *Densosporites* 的代表分子在 Sh 微体植物群中占优势，而在 *R. lepidophyta* 组合中则完全缺失；同时，*Spelaeotriletes pretiosus* 以及单缝孢子(*Laevigatosporites*)在该组合中也缺失。

Naumova(1953)报道的俄罗斯地台泥盆系小孢子达 265 种，但绝大多数产于上泥盆统，占其种数的 3/4 以上，其中 *Acanthotriletes*(*Archaeozonotriletes*) *acanthaceus*，*Acan. denticulatus*，*Acan. hirtus*，*Acan. impolitus*，*Archaeozonotriletes*(*Granulatisporites*) *atratus*，*Arch.*(*Knoxisporites*) *dedaleus*，*Arch.*(*Cymbosporites*) *formosus*，*Arch.*(*Geminospora*) *verustus*，*Brochotriletes foveolatus*，*Dictyotriletes*(*Microreticulatisporites*) *distinctus*，*Dict. famenensis*，*Hymenozonotriletes angulatus*，*Hym. eleganu*，*Lophotriletes atratus*，*Loph.*(*Acanthotriletes*) *fastuosus*，*Loph. magnus*，*Lophozonotriletes torosus* var. *famenensis* 与 *Stenozonotriletes extensus* var. *major* 等 18 种也见于界岭邵东段微体植物群。值得提及的是上述诸种在其他地区晚泥盆世或泥盆-石炭纪的组合中至今尚无记载。这似乎表明湘中地区与俄罗斯地台之间，在晚泥盆世的古植物群与古气候方面是较近似的。

综上所述，湖南界岭邵东段微体植物群的特征与国内各同期孢子组合的特征均较接近，尤其与湘中锡矿山欧家冲马牯脑段上部—邵东段下部Ⅰ组合带、江西全南小慕三门滩组 DR 组合、南京龙潭地区五通组擂鼓台段下、中部 RC 组合以及西藏聂拉木波曲群上部 LP 组合最为接近。与国外资料的对比表明，湖南界岭邵东段微体植物群与俄罗斯地台晚泥盆世小孢子化石(群)大致相似；与爱尔兰、加拿大泥盆—石炭系小孢子序列之间存在较多的共同成分，其主要特点是在西欧和北美地区少数早石炭世的典型分子超前出现在邵东段微体植物群中，显示邵东段具有泥盆-石炭纪过渡时代的色彩。

3 新种描述

冠脊孢属 Genus *Camptosporites* Naumova emend. Potonié et Kremp, 1954

三角形冠脊孢(新种) *Camptosporites triangulatus* sp. nov.

(图版Ⅱ，图 4)

特征 辐射对称、三缝小孢子；赤道轮廓近三角形，角部宽圆或钝凸，三边几乎直至微凸或内凹；大小(测 8 粒)56(62)71.8 μm，正模标本58.5 μm；三射线可见至清楚，窄而厚实(色暗)，表面接近光滑，具唇，宽 2.5—4.5 μm，顶部高略低于宽，朝末端逐渐或略微变低，约为孢子半径的 2/3—4/5，外壁厚约 1.5 μm(或不足)，具不规则点穴状结构，多褶皱；皱脊长短不一，末端钝，彼此不构成网状图案，或偶见个别“网穴”，长脊多折曲，常位于赤道或赤道附近，宽 1.5—2.2 μm，高略小于宽，近光面，平脊背，短脊分布不规则，宽度均匀或不等，形状

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多变，但无明显突起；黄棕或浅棕色。

比较　本新种以其明显的三角形和皱而无脊（顶部平）为特征而与该属的各已知种不同。新疆黑山头组产出的 *Camptotriletes bucculentus*（Loose）Pot·et Kr·和 *Camp·corrugatus*（Tbr·）Pot·et Kr·（卢礼昌，1993，52，53 页）的皱纹分别具似瘤状突起和明显突起，并且赤道轮廓均呈圆形。

皱纹具环孢属　Genus *Camptozonotriletes* Staplin，1960

近极皱纹具环孢（新种）　*Camptozonotriletes proximalis* sp·nov·

（图版Ⅱ，图 5—7）

特征　辐射对称、具环三缝小孢子；赤道轮廓宽圆三角形至近圆形，近极面低锥角形，远极中央区近半圆球形。大小（测 42 粒）50.5（57.8）71.8 μm，正模标本 57.5 μm。三射线可辨别至清楚，直或微弯曲、简单或具窄唇，单片唇宽 1.0—2.5 μm，等于或接近孢子半径长；赤道环宽 3.8—4.5 μm，表面光滑，同一标本上环的宽度与厚度基本一致；皱纹状纹饰限于近极面，在中央区最为集中；纹饰分子多呈宽“U”形，少数为不规则褶皱，但绝不构成网状图案；皱纹（或褶皱）表面光滑，基部宽 1.2—3.5 μm，顶部钝凸或宽圆，末端钝或微分叉；外壁表面光滑，细颗粒状结构较明显，在过度浸解的标本上表面微粗糙，甚者呈小刺-粒状；远极（中央区）外壁厚 2—3.2 μm，表面光滑无饰；赤道轮廓线圆滑；浅至深棕色。

比较　本文 *Camptozonotriletes proximalis* sp·nov·与西澳大利亚早石炭世韦宪期（Visean）的 *Camptozonotriletes robertsi* Playford 在形态特征与纹饰成分方面彼此颇相似，但后者的纹饰限于远极面（而非近极面），且较粗壮（宽 6—14 μm）。

注释　归入当前新种的某些标本（图版Ⅱ，图 5），其皱纹被一纵向窄“沟”一分为二，呈双轨型皱纹。

梳冠孢属　Genus *Cristatisporites* R·Potonié et Kremp emend·Butterworth，Jansonius，Smith et Staplin，1964

指状梳冠孢（新种）　*Cristatisporites digitatus* sp·nov·

（图版Ⅳ，图 13—18）

特征　辐射对称、具环三缝小孢子；赤道轮廓钝角、凸边三角形至近圆形。大小（测 32 粒）42.6（56.2）66.5 μm，正模标本 62.5 μm；三射线可见至清楚、简单或具窄唇（宽约 1.5—2.2 μm），至少伸达环内缘，顶部常具三小突起，基部宽 1.5—2.2 μm；外壁两层，彼此分离不明显，厚度难测量。纹饰限于远极面，以指状突起为主，并在环面上最发育，呈辐射状分布，基部彼此常不接触，宽 1—1.8 μm，长 3.8—5.5 μm，顶端钝凸，罕见超出赤道，次一级、稀散的小刺-粒状突起主要见于环面；带环内侧部分较外侧部分厚（暗）得多，但不如外侧部分宽，呈明显的双型环，总宽约为孢子半径的 1/3—1/2，内缘界线清楚，常超覆于内孢体（内层）边缘（极面观），外缘轮廓线微粗糙至平滑；孢子浅棕至深棕色。

比较　当前新种以其纹饰为指状突起而有别于本文记载和见于南京龙潭地区五通组（卢礼昌，1994 *a*）的 *Cristatisporites connexus* Pot·et Kr·（纹饰为粗壮的锥刺状突起）和新疆黑山头组的 *Cristatisporites bacutiformis* Lu（卢礼昌，1993）。新疆标本的纹饰形态呈棒刺状

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突起,与本新种的纹饰形态较近似,但其纹饰长度达 7.8—12.1 μm,孢体也较大,达 72.1(87.7)98.3 μm。

杯栎孢属 Genus *Cymbosporites* Allen,1965

细粒杯栎孢(新种) *Cymbosporites microgranulatus* sp·nov·

(图版Ⅲ,图 8—12)

特征 辐射对称,具栎三缝小孢子;赤道轮廓钝至宽圆三角形。大小(测 21 粒)44.8(52.5)58.5 μm,正模标本 47.5 μm,副模标本 44.8 μm。三射线常被粗壮的唇所掩盖,唇表面光滑,发育均匀,基部宽 2.6—5.5 μm,高近等于宽,顶部拱圆,伴随射线伸达赤道附近。赤道与远极外壁呈栎状加厚,并在赤道最厚,且呈环状,宽 3.3—6.2 μm,远极栎(外壁)厚 2.5—3.2 μm,表面具细圆珠状(或粒状)突起纹饰,分布致密,但基部彼此很少接结,小珠直径 0.7—1.2 μm,顶部近圆形或钝凸,表面近光滑,小珠间外壁具极小的孔穴(图版Ⅲ,图 12);接触区界线清楚,区内外壁较远极外壁薄得多(无法测量),表面微粗糙,并略下凹;近极环面光滑无饰;赤道轮廓线几乎光滑(透光图像)至细串珠状(扫描图像);罕见褶皱,黄棕至深棕色。

讨论 本新种以其珠状(或粒状)纹饰极为细小和分布致密为特征,以此区别于 *Cymbosporites* 的各已知种。Avchimovitch 等(1988)记载的 *Cymbosporites* sp·虽然其纹饰也为粒状,但粒径较大,且分布稀疏。Turnau 归入 *Aneurospora greggsii* (McGregor)Streel 种名下的标本(Turnau,1986,pl·IX,fig·9),其形态特征与大小均与当前标本颇为相似,应归入本新种。*Aneurospora* 属仅包含近极-赤道外壁不规则(不等厚、不等宽)加厚的分子,赤道外壁加厚的分子应排斥在外。

盘形孢属 Genus *Discernisporites* Neves emend·Neves et Owens,1966

缩小盘形孢(新种) *Discernisporites deminutus* sp·nov·

(图版Ⅱ,图 24,25)

特征 辐射对称、具腔三缝小孢子;赤道轮廓宽圆三角形。大小(量 12 粒)36.2(43.5)48 μm,正模标本 41.2 μm。三射线清楚,微弯曲,具窄唇(宽约 2 μm),伸达赤道,近顶部常具三小突起。外壁两层,内层界线清楚,厚不足 1 μm,表面无纹饰,极面观与外层多少分离,轮廓与孢子赤道近一致。赤道腔常连续但颇窄,仅为孢子半径的 1/6—1/5。外层较厚,赤道外层厚 1.5—2.2 μm,表面微粗糙至微颗粒状,粒近圆形,粒径约 0.5 μm,颇低矮,在赤道轮廓线上反映甚微;常具 1—3 条细条带状褶皱,彼此接近平行状分布;黄棕至棕色。

比较 当前新种以个体甚小与纹饰甚微为特征,以此区别于 *Discernisporites* 的已知种。新疆黑山头组的 *Discernisporites papillatus* Lu(卢礼昌,1993)虽然赤道腔也颇窄(仅为孢子半径的 1/15—1/8),且三射线顶部也具三小突起,但其孢体较大,达 58.8(65.2)72 μm,外层呈微弱的点穴状结构(而非表面粒状)。南京龙潭地区五通组(卢礼昌,1994a)与湖南界岭邵东段(卢礼昌,1995)产出的 *Discernisporites micromanifestus*(Hacquebard)Sabry et Neves 虽然其个体较欧美地区的同种标本小许多,但赤道腔较宽(一般不小于孢子半径的1/3),且射线顶部不具三小突起,同时外壁外层也不具纹饰。

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可疑盘形孢(新种)　***Discernisporites suspectus* sp·nov·**

(图版Ⅱ,图 15,16)

特征　辐射对称、具腔三缝小孢子;赤道轮廓宽圆三角形至近圆形。大小(量 7 粒)64.5(82.8)125 μm,正模标本 74.5 μm;三射线被唇覆盖,唇呈叶片状隆起,基部宽 2.2—3.8 μm,高 7.2—12.6 μm近末端略降低,脊部宽波状,伸达赤道。外壁两层,内层薄弱(厚<1 μm),界限可辨或清楚,极面观与外层分离,轮廓与孢子赤道基本一致。外层厚实,赤道外层厚 2.5—4.2 μm,具明显的点穴状结构,表面微粗糙或具极细小的粒状纹饰。赤道腔连续,宽约为孢子半径的 1/6—2/5。三射线两侧各具一行丘珍状纹饰或小圆瘤,每行 4—6 枚,每枚直径 5—7.5 μm,高约 0.5 μm,间距约是纹饰基部宽的 1—3 倍。常具褶皱,其宽窄、长短、方位与数量均多变。浅至深棕色。

比较　本新种以其三射线两侧各具一行丘珍状纹饰为特征。它与 *Discernisporites usitatus* sp·nov·及 *Dis· deminutus* sp·nov·的主要区别除具丘珍状纹饰外,同时孢体较大,外壁外层较厚,赤道腔也较宽。

平常盘形孢(新种)　***Discernisporites usitatus* sp·nov·**

(图版Ⅲ,图 13,14)

特征　辐射对称、具腔三缝小孢子;赤道轮廓宽圆三角形至近圆形。大小(量 17 粒)48.2(53.4)66.5 μm,正模标本 52.5 μm;三射线清楚,微弯曲,或具窄唇(宽 1.5—3.2 μm),等于或略小于孢子半径,三小突起依稀可辨。外壁两层,内层可见至清楚,厚 0.8—1.2 μm,极面观与外层不等距分离,轮廓与赤道近乎一致。外层厚 1.8—2.5 μm,具细颗粒状内结构,表面微粗糙。赤道腔窄,宽约 0.8—4.5 μm。褶皱不规则,长短不一,分布零乱,数量不等。孢子轮廓线圆滑,黄棕或浅棕色。

比较　本新种以具不规则褶皱为特征。它与 *Discernisporites deminutus* sp·nov·的主要区别在于外壁褶皱不规则,内外层分离不等距,孢体也较大。

厚壁具腔孢属　**Genus *Geminospora* Balme emend·Playford,1983**

多枝厚壁具腔孢(新种)　***Geminospora multiramis* sp·nov·**

(图版Ⅲ,图 1—4)

特征　辐射对称、具腔三缝小孢子;赤道轮廓近圆形。子午轮廓近极面低锥角形,远极面近半圆球形。大小(量 18 粒)42.6(50.3)66.5 μm,正模标本 61.2 μm,副模标本40.7 μm;三射线被唇掩盖,唇直、很少弯曲,粗壮,光滑,宽约 2.2—4.5 μm,等于或略小于孢子半径,末端两侧或与弓形脊连结。外壁两层,内层可见,轮廓与孢子赤道基本一致,极面观,与外层分离颇明显,外层近极面光滑,无饰,三接触小区常下陷,整个接触面几乎等于近极面。远极被一簇簇多分叉小突起所覆盖,每簇多分叉呈多枝珊瑚状或仙人掌状,基部分散或相互连结,基部窄长条形,宽约 1 μm,长 2.5—4.5 μm,突起高 1.5—3.2 μm,顶端小分叉高常不足 1 μm(图版Ⅲ,图 4);赤道腔明显、连续,宽约为孢子半径的 1/4—1/3;近极外层薄(不可量),远极外层、尤其赤道外层相当厚实,厚可达 3—4.5 μm,未见褶皱,浅棕至深棕色。

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比较 本新种以其纹饰呈多枝珊瑚状突起为特征，以此区别于 *Geminospora* 的已知种。它与同层位(邵东段)产出的 *Geminospora spongiata* Higgs *et al*.(卢礼昌，1995；图版Ⅳ，图15)形态特征颇相似，但后者纹饰为细颗粒与小锥刺(偶见)。当前新种与常见于中、晚泥盆世的 *G. lemurata* 相比，不同在于前者不含单缝和双缝孢子(Playford，1983)。

大腔孢属 Genus *Grandispora* Hoffmeister，Staplin et Malloy emend. Neves et Owens，1966

叉饰大腔孢(新种) *Grandispora furcata* sp. nov.

(图版Ⅰ，图15，16)

特征 辐射对称、具腔三缝小孢子；赤道轮廓宽圆三角形至近圆形。大小(量7粒)55.8(60.4)66.5 μm，正模标本58.5 μm。三射线可见至清楚，简单或具窄唇，(宽1.6—3.8 μm)，长度等于内孢体半径。外壁两层，内层清楚，厚1.2—1.8 μm，在赤道区与外层明显分离，但常不等距，轮廓与孢子赤道基本一致。外层厚2—3 μm，远极和赤道具稀散的棒状突起，末端常具两至三小分叉。纹饰基部宽一般为1.8—3.5 μm(少数稍宽)，往上逐渐或略微变窄，顶部分叉或钝凸，长3.5—5.2 μm，纹饰之间的间距常超过纹饰基宽的2—3倍。外壁内颗粒状结构明显，表面微粗糙或具次一级小突起，常沿一射线开裂，并延伸至远极面。近极表面无明显突起纹饰。赤道腔连续，但宽度不均匀，且颇窄，一般宽仅为孢子半径的1/7—1/5。赤道轮廓线呈不规则长齿状。罕见褶皱。棕至深棕色。

比较 本新种以其叉状纹饰为特征，有别于该属的其他种。爱尔兰晚泥盆世至早石炭世的 *Grandispora cornuta* Higgs(Higgs *et al*.，1988)的形态特征与本新种颇接近，但它的纹饰为角刺状突起，末端尖且不分叉。归入本新种的个别标本(图版Ⅰ，图16)的纹饰顶部无明显分叉，但形态特征尤其是内外层分离明显(即具赤道腔)，这一特征与该新种的其他标本颇为一致，为此也将这些标本归于本新种。

匙唇孢属 Genus *Gulisporites* Imgrund emend. Gupta，1969

开裂匙唇孢(新种) *Gulisporites hiatus* sp. nov.

(图版Ⅱ，图1—3)

特征 辐射对称、三缝小孢子；赤道轮廓近三角形，角部宽圆或钝凸，三边微凸。大小(量26粒)58.5(72.4)79.8 μm，正模标本69.2 μm。三射线清楚，唇颇薄并呈叶片状突起，高7.5—10 μm，光滑，半透明，几乎等高，等于或略小于孢子半径。外壁薄，厚约1 μm(或不足)，常沿三射线开裂，甚者可延伸至远极面，表面无滑，具内细颗粒状结构与窄条带状褶皱；射线顶部常具一小突起，基部宽达4—6.7 μm。棕黄色。

比较 本新种以其唇薄并呈叶片状突起为特征。四川大麦地晚泥盆世早期的 *Gulisporites intropunctus* Lu(卢礼昌，1981)的形态特征与本新种较相似，但该种孢子唇较发育，较厚实(暗)，且顶部较高(6—9 μm)，末端较低。同时，三射线顶部不具三小突起。河北开平二叠纪的 *Gulisporites cochlearium* Imgrund 唇突起颇低，高仅1.5 μm，远不如本新种的唇发育。

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空腔三缝孢属　Genus *Spelaeotriletes* Neves et Owens，1966

翻下空腔三缝孢(新种)　*Spelaeotriletes fanxiaensis* sp·nov·

(图版Ⅱ，图 17—19)

1993　*Spelaeotriletes* sp·，文子才、卢礼昌，图版Ⅳ，图 9—12(未描述)。

特征　辐射对称、具腔三缝小孢子；赤道轮廓钝角，凸边三角形。大小(量 18 粒)28.5(34.6)40 μm，正模标本 37.8 μm。三射线清楚，直或微弯曲，唇颇窄，宽仅 1.5—2.2 μm，伸达内孢体边缘，近顶部常具三小突起，基部宽 1.8—3.2 μm；外壁两层，内层清楚，厚约 1 μm(或稍厚)，极面观与外层分离不明显或仅局部分离。外层厚 1—1.5 μm，远极面具很小的锥刺，分布致密，但彼此基部罕见接触，且距间相通，呈负细网状结构，锥刺基部宽略大于突起高，约 0.5—0.8 μm，在赤道轮廓线上反映甚微弱。近极面，至少接触区表面无纹饰。赤道腔常不连续，且颇窄，宽仅为孢子半径的 1/10—1/8。外壁褶皱，并多呈条带状。浅棕色。

比较　当前新种以其纹饰甚弱小与赤道腔不明显为特征。本文记载的 *Spelaeotriletes microspinosus* Neves et Ioannides 的形态特征与当前新种颇近似，但纹饰成分不相同(为小刺)，且三射线常开裂，赤道腔也较明显。江西全南小慕翻下组的 *Spelaeotriletes* sp·在形态特征、纹饰成分，乃至大小等诸方面，均与本新种的极为相似，甚至相同，故将其归入本新种。

异形空腔三缝孢(新种)　*Spelaeotriletes heteromorphus* sp·nov·

(图版Ⅲ，图 15—17)

特征　辐射对称、具腔三缝小孢子；赤道轮廓宽圆三角形至近圆形，但常呈侧压标本保存，子午轮廓近极面略凹陷至低锥角形，远极面半圆球形或超半圆球形。赤道直径(量 8 粒)45.5(59.2)65 μm，极轴长 42.5(49.8)57.5 μm，正模标本 56.5 μm，极轴长 42.5 μm；副模标本 51.2 μm，极轴长 35.5 μm。三射线常被唇覆盖，唇宽 2.5—3.5 μm，顶部高略大于宽，末端较窄、较低，略小于至等于孢子半径，近顶部(内层)常具三小突起。外壁两层，内层清楚，侧面观，除三射线区域与外层紧贴外，其余部分，尤其远极半球与外层明显分离，并呈中孢体状，轮廓与赤道及远极半球轮廓基本一致。外层近极面光滑或凹凸不平，远极面具小棒、针刺和其他小突起纹饰，分布不规则，且易断落。纹饰粗细皆较均匀，一般宽为 0.5—1.0 μm，高可达宽的 1.5—3.5 倍。赤道腔较远极腔窄许多，前者仅为后者的 1/6—1/3。远极外层厚 1.2—2.6 μm，赤道外层略厚，罕见褶皱。浅至深棕色。

比较　当前新种以棒状纹饰为主和内外层在各部位分离程度不同为特征，以此有别于 *Spelaeotriletes* 各已知种。前述 *Spelaeotriletes fanxiaensis* sp·nov·与当前新种的主要区别是，前者的内外层分离不明显或仅局部分离，且纹饰为细小的锥刺。

稀少空腔三缝孢(新种)　*Spelaeotriletes rarus* sp·nov·

(图版Ⅲ，图 5—7)

特征　辐射对称、具腔三缝小孢子；赤道轮廓钝角，凸边三角形。大小(量 22 粒)50.6(53.8)61.2 μm，正模标本 54.7 μm，副模标本 58.5 μm；三射线常清楚，直或微弯曲，常具窄唇(宽约2 μm)，几乎伸达赤道。外壁两层，内层清楚，厚不足 1 μm，极面观，与外层分离明显，轮廓与孢子赤道近乎一致。外层厚 1.5—2.8 μm，远极和赤道具短棒-小锥瘤状纹饰，分

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布稀疏，但不均匀。纹饰坚实、光滑，基部轮廓圆形或近圆形，直径 1.2—2.0 μm，间距常为基宽的 1.5 至 3.5 倍，偶见局部接触，朝顶部略变窄，末端钝凸(罕见尖)，长 1.5—2.8 μm。近极面无明显凸起纹饰。赤道腔窄，仅为孢子半径的 1/7—1/4；赤道轮廓线呈低齿状凸起。常具 1—3 条窄而短的褶皱。浅棕至棕色。

比较 本新种以短棒-小锥瘤状纹饰为特征。*Grandispora furcatus* sp·nov·虽也具类似的棒状纹饰，但纹饰较粗(1.8—3.5 μm)、较长(3.5—5.2 μm)，而且末端常具小分叉。

参 考 文 献

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)：295—327。

方晓思、P·H·司蒂曼斯、M·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。

卢礼昌，1981： 四川渡口大麦地一带晚泥盆世孢子组合。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世海口组微体植物群。中国科学院南京地质古生物研究所集刊，第 24 号，1109—258 页。科学出版社。

卢礼昌，1994a： 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—199。

卢礼昌，1994b： 关于我国“*Retispora lepidophyta*”的再研究。微体古生物学报，**11**(4)：469—478。

卢礼昌，1995： 湖南界岭邵东段小孢子及其地质时代。古生物学报，**34**(1)：40—52。

何圣策、欧阳舒，1993： 浙西富阳西湖组泥盆—石炭系过渡层孢子组合。古生物学报，**32**(1)：31—48。

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群的时代问题。中国科学院南京地质古生研究所集刊，第 23 号，1—91 页。科学出版社。

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矿产研究所所刊，第 9 辑，81—92 页。地质出版社。

侯鸿飞、季 强、吴祥和等，1985： 贵州睦化泥盆-石炭系界线。孢子部分，40—43 页、50—85 页。地质出版社。

高联达，1983： 西藏聂拉木晚泥盆世孢子的发现及其地层意义。青藏高原地质论文集，8：183—218。

Higgs, K., 1975: Upper Devonian and Lower Carboniferous miospore assemblages from Hook Head, County Wexford, Ireland. Micropaleontology, **21**(4): 393—419.

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.

Naumova, S. N., 1953: Spore-pollen complexes of Upper Devonian of the Russian Platform and their stratigraphic significance. Tr. Inst. Geol. Nauk Mosk., **143**(60): 1—204. (In Russian)

Playford, G., 1964: Miospores from the Mississippian Horton Group, Eastern Canada. Bull. Geol. Surv. Can., **107**: 1—47.

Playford, G., 1976: Plant microfossils from the Upper Devonian and Lower Carboniferous of the Canning Basin, Western Australia. Palaeontographica Abt. B, **158**: 1—71.

Playford, G., 1983: The Devonian miospore genus *Geminospora* Balme 1962: a reappraisal based upon topotypic *G. lemurata* (type species). Mem. Ass. Australas., **1**: 311—325.

Playford, G. and Satterthwait, D. F., 1985: Lower Carboniferous (Visean) spores of the Bonaparte Gulf Basin northwestern Australia: Part One. Palaeontographica Abt. B, **195**: 129—152.

Playford, G. and Satterthwait, D. F., 1986: Lower Carboniferous (Visean) spores of the Bonaparte Gulf Basin, northwestern Australia: Part Two. Palaeontographica Abt. B, **200**: 1—32.

Playford, G. and Satterthwait, D. F., 1988: Lower Carboniferous (Visean) Spores of the Bonaparte Gulf Basin, northwestern Australia: Part Three. Palaeontographica Pal. B, **208**: 1—26.

[1995 年 1 月 11 日收到，1996 年 11 月修改]

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MICROFLORA FROM SHAODONG MEMBER AT JIELING SECTION, HUNAN, CHINA

Lu Li-chang
(*Nanjing Institute of Geology and Palaeontology, Academia Sinica, Nanjing* 210008)

Key words microflora, Shaodong Member, Jieling Section, Hunan, China

Summary

The present paper is a continuation and complementary to the previous paper Microspores from Shaodong Member at Jieling Section of Hunan, China and their geological age (Lu Li-chang, 1995).

1 COMPOSITION OF THE PRESENT MICROFLORA

In the previous 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. fastuosus* (Naum.) Lu, *A. hirtus* Naumova, *Anapiculatisporites hystricosus* Playford, *Anaplanisporites globutus* (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 Campfield, *A. plicata* (Allen) Streel, *A. pseudozonolis* Lu, *Apiculatisporis morbosus* Balme et Hassell, *Auroraspora asperella* (Kedo) Van der Zwan, *A. macra* Sullivan, *Brochotriletes foveotatus* Naumova, *Clivosispora 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 Satterthwait, *D. spinifer* Hoffmeister *el al.*, *D. variomarginatus* Playford, *D. xinhaunensis* Hou, *Diaphanospora depressa* (Balme et Hassell) Evans, *D. submirabilis* (Jush.) Lu, *Dictyotriletes famenensis* Naumova, *Discernisporites macromanifestus* (Hacquebard) Higgs, Clayton et Keegan, *D. micromanifestus* (Hacquebard) Sabry et Neves, *D. papillatus* Lu, *D. varius* Lu, *Foveosporites inculptus* Playford, *F. pellucidus* Playford et Helby, *Geminospora lasius* (Naum.) var. *minor* (Naum.) Lu, *G. spingiata* Higgs *et al.*, *Grandispora cornutus* Higgs, *G. cumula* (Higgs et Streel) Lu, *G. echinata* Hacquebard, *G. eximia* (Naum.) Lu. *G. gracilis* (Kedo) Streel, *G. saurota* (Higgs *et al.*) Playford et McGregor, *Granulatisporites atratus* (Naum.) Lu, *G. humerus* Staplin, *Hymenozonotriletes angulatus* Naumo-

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va, *H. elegans* (Waltz) Naumova, *H. granulatus* (Naum.) Jushen, (in Kedo), *H. spicatus* Lu, *Knoxisporites dedaleus* (Naum.) Lu, *Laevigatosporites valgaris* (Ibr.) 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* (Walt) Ischenko, var. *rotundatus* Waltz, *L. velatus* (Caro-Monieg) Streel, *Lophotriletes atratus* Naumova, *L. magnus* (Naum.) Lanninger, *Lophozonotriletes torosus* Naumova var. *famenensis* Naumova, *Phyllothecotriletes rigidus* Playford, *Planisporites magnus* (Naumova, in Kedo) Lu, *Punctatisporites debilis* Hacquebard, *P. irrasus* Hacquebard, *P. planus* Hacquebard, *P. subtritus* Playford et Helby, *Pustulatisporites distalis* Lu, *Reticulatisporites cancellothyris* (Waltz) Lu, *R. minor* (Naum.) Gao et Ye, *Retispora casscicula* (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*, *Spelaeotriletes crenulatus* (Playford) Neves et Belt, *S. crustatus* Higgs, *S. hunanensis* (Fang, Steemana et Streel) Lu, *S. obtusus* Higgs, *S. pretiosus* (Playford) Neves et Belt, *S. resolutus* Higgs, (= *S. microspinosus* Neves et Ioannides in the present paper), *S. setosus* (Kedo) Lu, *S. triangulatus* Neves et Owens. *Spelaeotriletes* sp. of Wen et Lu (= *S. fanxiaensis* sp. nov. in the present paper), *Velamisporites irrugatus* Playford, *V. perinatus* (Hughes et Playford) Playford, *Verruciretusispora megaplatyverrca* Lu et Ouyang, *Verrucosisporites mesogrumosus* (Kedo) Bycscheva, *V. morulatus* (Konx) Potonié et Kremp, *V. papulosus* Hacquebard, and ? *Videospora glabrimarginata* Owens 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 most abundant *Retispora lepidophyta* and *Spelaeotriletes hunanensis*. In addition, there are 2 acritarch species, *Veryhschium trispinosum* (Eisenack) Deunff and *Micrhytridium stellatum* Deflander.

In the present paper the miospores eomprise 27 genera and 46 species (including 13 new species, 3 combined species, 21 known specie, 2 comparable species and 7 indeterminate specis), namely, *Camptotriletes triangulatus* sp. nov., *Gamptozonotriletes proximalis* sp. nov., *Cristatisporites** *digitatus* sp. nov., *Cymbosporites** *microgranulatus* sp. nov., *Discernisporites** *minutus* sp. nov., *D. pustulatus* sp. nov., *D. rugulosus* sp. nov., *Geminospora** *multiramis* sp. nov., *Grandispora** *furcata* sp. nov., *Gulisporites hiatus* sp. nov., *Spelaeotriletes** *fanxiaensis* sp. nov., *S. hetermorphus* sp. nov., *S. rarus* sp. nov.; *Microreticulatisporites* (*Dictyotriletes*) *distinctus* (Naumova, in Kedo) comb. nov., *Reticulatisporites** (*Periplecotriletes*) *amplectus* (Naumova) comb. nov., *Grandispora* (*Archaeozonotriletes*) *serena* (Kedo) comb. nov.; ? *Acanthotriletes** *impolitus* Naumona,

* Genera with asterisks also appear in the previous paper.

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Archaeozonotriletes aconthaceus (Naum.) Kedo, *Baculatisporites fusticulus* Sullivan, *B. villosus* Higgs et Russell, *Cirratriraditus veeversi* Playford, *Convolutispora** *subtilis* Owens, *Cristatisporites connexus* Potonié et Kremp, *Densosporites** *rariabilis* (Waltz) Potonié et Kremp, *D. rarispinosus* Playford, *Geminospora lemurata* (Balme) Playford, *G. micropaxilla* (Owens) McGregor et Camfield, *G. venusta*? (Naum.) McGregor et Camfield, *Lycospora uber* (Hoffmeister *et al.*) Staplin, *Microreticulatisporites reticuloides* (Kosanke) Potonié et Kremp, *Punctatisporites** *cornatus* Butterworth et Williams, *P. limbatus* Hacquebard, *Reticulatisporites ancoralis* Balme et Hassell, *Spelaeotriletes microgranulatus* Byvscheva var. *minor* Byvscheva, *S. microspinosus* Neves et Ioannides, ? *Stenozonotriletes extensus* Naumova var. *major* Naumova, *Tumulispora ordinarius* Staplin et Jansonius, cf. *Cymbosporites formosus* (Naum.) Gao, *Schopfites* cf. *claviger* Sullivan, *Leiotriletes** sp. of Lu, *Cycloverrutriletes* sp., *Densosporites* sp., *Hymenospora* sp., *Raistrickia* sp., *Tumulispora* sp. and *Velamisporites** sp. In addition, there are 1 acritarch species, *Veryhachium polyaster* Staplin and 1 scolecodont species, *Leogenys altilis* (Eller) Taugoudean. Therefore, here the microflora from Shaodong Member is generally composed of the predominant miospores together with a small number of acritarchs and scolecodonts in both papers. That is to say, this microflora is made up of 56 genera and 145 species of miospores, except 13 common genera (with asterisks) and 2 common species, together with 3 acritarch species which are assigned variously to 2 form genera and 1 scolecodont species.

Among the dominant elements in this microflora are the representatives of *Spelaeotriletes* (13 species, 36.4%), *Densosporites* (9 species, 5.3%), *Leiotriletes* (8 species, 3.6%), *Discernisporites* (7 species, 4.7%), *Grandispora* (7 species, 3.9%), *Geminospora* (6 species, 4.0%), *Apiculiretusispora* (5 species, 2.6%), together with *Tumulispora ordinarius* (8.7%), *Camptozonotriletes proximus* sp. nov. (3.2%), *Cristatisporites digitatus* sp. nov. (2.6%), and *Gulisporites hiatus* sp. nov. (2.1%), accounting for 77.1% of the total miospore content. This microflora is characterized by the presence of *Retispora lepidophyta* and the great abundance of *Spelaeotriletes hunanensis* (26.8%) and *Tumulispora ordinarius* (8.7%) which comprise about 35.5% of the total miospores.

2　COMPARISON WITH OTHER MIOSPORE ASSEMBLAGES

1) Comparison of the present microflora with those contemporaneous assemblages in this country

The microflora from the Shaodong Member described here is similar to Assemblage Zone I described by He Jingpeng in 1982 in many aspects: (1) The species *Spelaeotriletes hunanensis* (= *Spelaeotriletes lepidophytus* in He's assemblage) is most abundant, accounting for 26.8% and 12%—26% of their respective total miospore contents; (2) There are 10 common species and six common genera and (3) none of the spore species are greater than 200 μm.

However, there are also differences in both assemblages. This assemllage is made up of 46

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genera and 145 species of miospores, whereas He′s Assemblage Zone I is made up of only 18 genera and 26 species of miospores.

The present microflora is also similar to Assemblage Zone Ⅱ described by He Jingpeng in 1982. The representatives of *Tumulispora*(=*Lophozonotriletes* in He′s assemblage)are rather abundant, accounting for about 9% and 14%—27% of both assemblages respectively. However, the species *Spelaeotriletes hunanensis* and acritarchs together with scolecodonts are only present in this microflora, but completely absent in He′s Assemblage Zone Ⅱ.

This microflora is similar to the DR assemblage described by Wen Zi-cai and Lu Li-chang in 1993, in the six genera and six species which are common to both assemblages, showing the very close relation of the present microflora to Wen and Lu′s assemblage.

This micrflora is comparable to the AL Assemblage described by Lu Li-chang in 1994a, with 13 miospore species and 9 genera common or comparable in both assemblages. However, there are also some differences, such as the elements of *Spelaeotriletes hunanensis*, which occur only in the former, are absent in the latter. In addition, the components are rather abundant (145 miospore species) in the former but very poor (25 miospore species) in the latter. These differences are probable a reflection of the different sedimentary environments between both regions.

This microflora is closely similar to the RC Assemblage described by Lu Li-chang in 1994a in the 14 common species and 5 common genera, but in the latter, the dominant element is *Cymbosporites*(26.8%), and the components are rather poor (only 43 miospore species, about 29.7% of this microflora). These differences may result from restricted sedimentary environments—the former from nonmarine sedments, and the latter from marine sedments.

The present microflora is closely similar to the *R. lepidophta-V. pusillites* Assemblage described by Gao Lianda in 1983, in the dominant miospores and a small number of acritarchs, together with scolecodonts, the occurrence of *R. lepidophyta* and the 11 common genera and 20 common species of miospores. However, there are also differences between both assemblages. For example, the species *R. lepidophyta* is very abundant (50%—60%) in the latter, but rather poor (less than 1%) in the former; the species *Hymenozonotriletes explanatus* and *Valatisporites pusillites* occur only in the latter, but are absent in the former.

2) Comparison of the present microflora with synchronous miospore assemblages in other parts of the world

This paper only gives a prelimanary comparison of the present microflora with those abroad, placing stress on those data available in Ireland, eastern Canada and western Australia.

The Shaodong microflora is very similar to the 8 miospore zonations, i.e., LL—CM Biozones (which are taken as a "single" assemblage here) from the late Late Devonian to early Early Carboniferous of Ireland described by Higgs *et al.* (1988) in many aspects: (1) the 21 common species (see Table Ⅰ); (2) the 19 common genera—*Acanthotriletes*, *Anaplanisporites*, *Apiculatisporites*, *Apiculiretusispora*, *Crassispora*, *Cristatisporites*, *Cyclogranisporites*, *Cymbosporites*, *Densosporites*, *Hymenozonotriletes*, *Knoxisporites*, *Latosporites* (= *Laevi-*

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gatosporites), *Leiotriletes*, *Lophozonotriletes* (partly = *Tumulispora*,) *Microreticulatisporites*, *Raistrickia*, *Schopfites*, *Velamisporites* and *Verrucosisporites*); (3) the abundance in components and the complete absence of megaspores ($\geqslant 200$ μm). But in the latter, (1) there are certain characteristic elements in the Devonian - Carboniferous boundary beds, such as *Knoxisporites literatus*, *Hymenozonotriletes explanatus*, *Verrucosisporites nitidus*, *Vallatisporites verrucosus*, *Kraeuselisporites hibernicus* and *Umbonatisporites* (*Dibolisperites*) *distinctus*, which are absent from the present microflora, probably reflecting the slightly higher horizon of the 8 miospore zonations from Ireland than that of the Shaodong microflora; (2) no acritarchs nor scolecodonts have been reported from Ireland and (3) the miospores are commonly larger in size than those from Hunan.

The present microflora is also somewhat similar to the two miospore assemblages from the Mississippian Horton Group in eastern Canada descriled by Playford (1964). Both of them, though poor in components (with only 53 miospore species), still share 13 species: *Anapiculatispores hystricosus*, *Convolutispora vermiformis*, *Endosporites* (*Discernisporites*) *macromanifestus*, *End.* (*Disc.*) *micromanifestus*, *Grandispora echinata*, *Perotriletes* (*Velamisporites*) *perinatus*, *Pnuctatisporites debilis*, *P. limbatus*, *P. irrasus*, *P. planus*, *Pustulatisporites* (*Spelaeotriletes*) *pretiosus*, *Retusotriletes avonensis* and *Stenozonotriletes extensus* var. *major*, in addition to 13 common genera: *Acanthotriletes*, *Camptotriletes*, *Cristatisporites*, *Dictyotriletes*, *Cyclogranisporites*, *Gulisporites*, *Leiotriletes*, *Lycospora* (*Cymbosporites*), *Microreticulatisporites*, *Pustulatisporites*, *Raistrickia*, *Reticulatisporites* and *Schopfites*. But in the former, some species occur in Devonian sediments, such as *Acanthotriletes denticulatus*, *Ancyrospora furcula*, *Aneurospora asthenolabrata*, *Apiculiretusispora gannanensis*, *Cymbosporites cyathus*, *Retispora lepidophyta*, *R. cassicula and Spelaeotriletes hunanensis*, which are absent in the latter. On the contrary, some species occur in the Devonian—Carboniferous boundary beds of the latter, such as *Vallatisporites vallatus*, *V. verrucosus* and *Verrucosisporites nitidus*, which are absent in the former. All these suggest the slightly higher horizon of the latter than that of the former.

This microflora is greatly similar to the *Retispora lepidophyta* Assemblage from the Fairfield Formation in the Canning Basin of western Australia (Playford, 1976). Both of them share the predominant miospores (*Retispora lepidophyta*) and a small number of acritarchs, with a broad similarity at generic level, involving such genera as *Brochotriletes*, *Camptotriletes*, *Cirratriradites*, *Convolutispora*, *Crassispora*, *Diaphanospora*, *Grandispora*, *Granulatisporites*, *Hymenozonotriletes*, *Lophozonotriletes*, *Raistrickia*, *Reticulatisporites*, *Retusotriletes* and *Stenozonotriletes*. All these suggest the very close relation of this microflora to the one described by Playford (1976). But in the former, the components are rather abundant, with 145 miospore species while in the latter, they are greatly poor, with only 28 miospore species accounting for about 19.3% of the species in the former. In addition, the former contains the representatives of *Laevigatosporites*, *Densosporites* and *Spelaeotriletes* (the elements of the last two genera being

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especially abundant), which are completely absent in the latter.

3. CONCLUSIONS

A thorough analysis of the Shaodong microflora leads to the following conclusions:

1)The Shaodong Member contains a diverse microflora showing a distinct endemicity, and a few acritarchs which suggest a marine sedimentary environment.

2)This microflora compares closely to the assemblage zone from top of Magunao to Lower Shaodong Member at Oujiachong section; the miospore assemblage from the Fanxia Formation at Xiaomu section; the RC Assemblage from the lower—middle Leigutai Member of Wutung Formation at Longtan and the assemblage from the upper Poqu Group in Nyalam. However, the last assemblage contains some elements in Devonian—Carboniferous boundary beds, which are absent in this microflora, such as *Aneurospora* (*Retusotriletes*) *incohata*, *Hymenozonotriletes explanatus* and some species of *Vallatisporites*.

3)This microflora compares roughly to the Russian Platform miospore assemblage (Naumova, 1953).

4)A broad similarity at both generic and species level exists between the present microflora from China, and the Devonian—Carboniferous miospore zones from Ireland (Higgs, 1975; Higgs *et al*., 1988) and Canada (Playford, 1964). However, the species *Cordylosporites papillatus* and *Spelaeotriletes pretiosus*, which have been found from late Late Devonian of China, are so far restricted to the Early Carboniferous in Euramerica. In addtion, the present microflora is more abundant than any Euramerican assemblage from Devonian—Carboniferous.

5)A broad similarity at generic level also exists between the present microflora and the *R. lepidophyta* Assemblage from western Australia. However, the representatives of *Laevigatosporites*, *Densosporites* and *Spelaeotriletes*, which frequently occurred in Late Devonian of China, are absent in the Australian assemblage of late Famennian.

6)Based on stratigraphic ranges of the miospores recovered, and compared with assemblages from other regions, the present microflora is considered as of Late Devonian (late Famennian) in age. However, the present microflora is characterized by elements with a double colour of Devonian and Carboniferous.

4 DESCRIPTION OF NEW SPECIES

Genus *Camptotriletes* Naumova emend. Potonie et Kremp, 1955

Camptotriletes triangulatus sp. nov.

(Pl. Ⅱ, fig. 3)

Diagnosis Miospores radial, trilete; amb broadly rounded-triangular with almost straight to slightly convex or concave sides. Laesurae perceptible to distinct, often straight or slightly sinuous, ca. 2/3—4/5 of spore radius in length, frequently accompanied by thickened lips totally 2.5—4.5 μm in width and 2—3.8 μm in height at proximal pole, becoming lower towards

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