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广西南侗早石炭世牙形石生物地层研究新进展

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摘要:笔者等对广西南侗五指山组、巴平组下段所产丰富的牙形石进行了系统的检查和研究。经研究表明,南侗剖面巴平组下段 20~30 层牙形石系统演化特征与早石炭世杜内期牙形石快速演化类群的系统发生、谱系演化十分相似。且化石组合特征也颇为一致。依据它们在剖面上的垂向分布特征和牙形石带分子首现为标志,将巴平组下段划分为 10 个牙形石间隔带,自下而上依次为: *Siphonodella duplicate* sensu Hass, *S. cooperi* morphotype 1, *S. obosoleta*, *S. sandbergi*, *S. quadruplicata*, *S. lobata*, *S. crenulata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus*。其中, *Siphonodella duplicate* sensu Hass, *S. cooperi* morphotype 1, *S. obosoleta*, *S. quadruplicata*, *S. lobata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus* 为新建化石带。重要的是,进一步补充完善和确定了本区早石炭世早期牙形石 *S. sandbergi*, *S. crenulata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus* 带垂向分布特征和带分子首次出现位置等内容。这一划分方案为进一步精细地层对比提供了翔实资料。

关键词:早石炭世;巴平组下段;牙形石生物带;广西南侗

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New progress in the study of the early Early Carboniferous conodonts biostratigraphy from Nandong, Guangxi

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Abstract: Abundant conodonts fossils from the Late Devonian–early Early Carboniferous Wuzhishan Formation to the Early Carboniferous Baping Formation were examined and studied in this paper. The phylogenetic evolution of the conodonts fossils from 20th to 30th layer of the Baping Formation along the Nandong section is very similar to that of rapidly evolutionary taxa described by Sandberg & Ziegler et al. (1978). Due to the vertical distribution and FAD of the conodonts, ten conodont interval zones were recognized from the bottom upward, i.e., *Siphonodella duplicate* sensu Hass, *S. cooperi* morphotype 1, *S. obosoleta*, *S. sandbergi*, *S.*

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quadruplicata, *S. lobata*, *S. crenulata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus*, respectively. Among them, *Siphonodella duplicata* sensu Hass, *S. cooperi* morphotype 1, *S. obosoleta*, *S. quadruplicata*, *S. lobata*, *S. isosticha*, *Gnathodus delicatus*, and *Protognathus preadelicatus* interval zones are newly established in this paper. Furthermore, the vertical distribution and zone taxon FAD of the early Early Carboniferous *S. sandbergi*, *S. crenulata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus* interval zones in Nandong area of Guangxi were revised and confirmed. The results achieved by the authors supply more detail information for delicate stratigraphic correlation.

Key words: Early Carboniferous; lower part of Baping Formation; conodont zone; Nandong in Guangxi

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晚泥盆世晚期—早石炭世早期,牙形石主要以 *Palmatolepis*, *Siphonodella*, *Gnathodus* 三属的演化为主导。其中,牙形石 *Siphonodella* 一属在杜内阶底界的地层划分对比中起到至关重要的作用。该属已有 80 年的研究历程。其地理分布极广,演化十分迅速。实际上,该属 20 余种均为 P 分子,其他组合分子目前仍不清楚^[1]。目前,仍以形态型 (Morphotype) 来进行分类,而有别于其它地质时期大多数的牙形石器官分类。晚泥盆世法门期牙形刺的演化是以 *Palmatolepis*, *Siphonodella* 两属为主线,后者仅见于晚泥盆世晚期。对 *Palmatolepis* 属的谱系演化的研究已有大量深入细致的研究基础^[2-6], 早石炭世杜内早期的牙形石演化与上述时期牙形石的演化同样以牙形石系统发生和谱系演化为基础,生物带是以谱系带的概念而建立^[1]。主要由 *Siphonodella* 和 *Gnathodus* 两属为主导^[7-10]。特别是杜内早期的 *Siphonodella* 一属的谱系演化^[11,12], 为早石炭世杜内早期的牙形石生物地层划分和对比提供了高精度的划分标准。

此外,从牙形石生物相方面来讲,南边村剖面晚泥盆世—早石炭世界线附近牙形石生物相可以划分出 3 种不同沉积环境的牙形石序列^[7]。季强将晚泥盆世—早石炭世牙形石生物相类型归纳为 2 类^[11-12]: 深水相和浅水相。深水牙形石序列自下而上为: *Siphonodella praesulcata*, *Siphonodella sulcata*, *Siphonodella duplicata*, *S. cooperi*, *S. obosoleta*, *S. quadruplicata*, *S. sandbergi*, *S. crenulata*, *S. isosticha*。浅水牙形石序列自下而上为: *Siphonodella homosimplex*, *Siphonodella levis*, *Siphonodella simplex*, *Siphonodella dasaibaensis*,

Siphonodella eurylobata。上述研究为当前南桐剖面巴平组下段牙形石生物带的建立和开展生物相研究提供了重要的指导作用。

1993 年,笔者李志宏受广西壮族自治区第七地质队王瑞刚高级工程师委托,承担了广西南桐剖面共计 65 个牙形石样品的分析鉴定工作。除在晚泥盆世—早石炭世界线附近牙形石样品采集量较少外,早石炭世巴平组下段 *Siphonodella duplicata* 带上部至 *Siphonodella isosticha* 带地层间隔中,获得了十分丰富的牙形石标本。化石产出率为 93%,标本总数达 10320 余枚,计有 20 属、57 种、15 亚种、5 未定种、6 相似种、1 亲近种、1 新种、1 新未定种(其中修订 1 种)。其中 *Siphonodella* 属比例为: 58%~62%, *Polygnathus*, *Pseudopolygnathus* 和 *Spathognathodus* 等属占 25%~27%,复合型和单锥形牙形石占 11%~17%。主要显示深水相牙形石序列特征,而较浅水的台棚沉积环境牙形石比例相对较少。结合目前开展的湘黔桂油气资源调查项目^①,笔者深入研究了这批标本。特别是对剖面上牙形石垂向分布及组合特征进行了再研究。从中识别出 *Siphonodella duplicata*, *S. cooperi*, *S. obosoleta*, *S. sandbergi*, *S. quadruplicata*, *S. lobata*, *S. crenulata*, *S. eurylobata*, *S. isosticha*, *Gnathodus delicatus* 等重要的牙形石分子及其部分 *Siphonodella* 的形态型及其在剖面上垂向分布的准确位置。系统检查了 *S. isosticha*, *S. crenulata*, *S. obosoleta*, *S. quadruplicata*, *S. sandbergi*, *S. lobata*, *S. duplicata*, *S. cooperi* 等牙形石标本;发现一新种: *Siphonodella nandongensis* sp. nov. Li; 一新未定种: *Siphonodella* sp. nov. A; 且修订 *Siphonodella trirostrata* Druce (1969) 的含义(另文发

①广西壮族自治区地质矿产勘查开发局,王瑞刚等。1:5 万黄茂东幅区域地质调查报告。1993。

表)。此外,上述层位化石带中尚伴生较丰富的其他牙形石属:*Polygnathus*, *Protognathus*, *Pseudopolygnathus*, *Spathognathus*, *Ozarkodina*, *Elictognathus*等。

尤为重要的是:发现南桐剖面巴平组下段20~30层牙形石系统演化特征,与Sandberg & Ziegler称之为快速演化类群^[1]的系统发生、谱系演化十分相似,且化石组合特征也颇为一致。进一步分析研究*S. duplicata*, *S. cooperi*, *S. obsoleta*, *S. sandbergi*, *S. quadruplicata*, *S. lobata*, *S. crenulata*, *S. isosticha*等化石带内部牙形石垂向分布、演化特征等,并以上述牙形石带分子首现为标志,将巴平组下段划分为10个牙形石带,自下而上依次为:*Siphonodella duplicate* sensu Hass, *S. cooperi* morphotype 1, *S. obsoleta*, *S. quadruplicata*, *S. lobata*, *S. crenulata*, *S. sandbergi*, *S. eurylobata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathus preadelicatus*。另外,依据五指山组牙形石在剖面上的垂向分布特征,也进行了扼要的划分对比研究。

1 地质背景及研究概况

南桐剖面地处华南右江盆地与湘桂盆地结合部位,是华南重要的含油气资源盆地所在地;在构造古地理演化上属于一个具有特殊性的被动大陆边缘盆地。在岩相古地理位置上,处于台盆、台棚相交接地带,属台盆-台棚相^[9,10,13]。晚泥盆世一早石炭世其沉积特征是浅水台地与深水台间海槽间列、浅水碳酸盐台地与深水海盆沉积共存^[14]。因此,这一时期沉积类型复杂,距离短、相变快。相关研究包括岩石地层组合特征、沉积环境分析、层序地层分析和碳氧同位素地质等详细资料均有报道^[15-18]。

该剖面晚泥盆一早石炭世牙形石生物地层研究工作亦有较长研究历史。宁宗善、白顺良等^[19,20]曾在该剖面西侧(黄茂)开展过牙形石生物地层研究工作,初步建立5个牙形石带。嗣后, Bai Shunliang et al.^[21]在黄茂剖面五指山组上部、王佑组和黄茂组(相当于本文所指巴平组下段下部)进一步研究、建立6个牙形石带。同时,曾在南桐剖面五指山组和王佑组底部,建立10个牙形石带。重要的

是,不仅在晚泥盆世法门晚期地层中建立了详细的牙形石生物地层对比标志,且在五指山组与王佑组之间地层间隔中发现*S. preasulcata*, *S. sulcata*牙形石序列,为解决晚泥盆世与早石炭世界线划分对比提供了可靠资料。

关键的问题是,上述研究主要基于晚泥盆世与早石炭世界线、弗拉斯与法门阶界线附近生物地层和地质事件的研究,而本区牙形石*S. crenulata*带上部, *S. isosticha*带, *Gnathodus delicatus*带和*Protognathus preadelicatus*带内容的补充和完善正是本文所亟待解决的问题。

2 剖面描述

实测剖面临近白顺良等^[20]、Bai shunliang et al.^[21]黄茆剖面以东,起点位于广西壮族自治区武宣县二塘乡六峰林场南桐村附近,距武宣县约18.4 km。根据1:5万黄茆东幅区域地质报告(1993)岩石地层划分方案^①,将南桐剖面自下而上分为:东岗岭组、榴江组、五指山组、巴平组。需要说明的是:巴平组在南丹巴平建立^[22],原含义是:其下伏为鹿寨组、上覆为南丹组。但在南桐一带,鹿寨组硅质岩、页岩相变为碳酸盐岩,该组整体上代表下石炭统的沉积。本文所涉及地层层序自下而上划分为五指山组(顶部8.20 m地层间隔相当于王佑组^[19])和巴平组下段(该段下部相当于黄茆组^[19])。五指山组以台棚相和台盆相相间沉积类型为主。台棚相岩性为灰色薄层条带状团粒粉-泥晶灰岩夹灰色薄层一中层藻团粒泥-粉晶灰岩,发育瘤状构造。台盆相岩性则以灰色薄一中层含硅质、瘤状泥晶灰岩,或呈不等厚互层状。偶夹薄层泥岩和泥晶含砂屑生物碎屑灰岩为特征。厚221 m。巴平组下段沉积类型划分为两种:台盆相、台棚相。自下而上由台棚与台盆相相互叠置。台棚相岩性为:灰色中层夹薄层含生物碎屑粉-泥晶灰岩与中层藻屑灰岩互层,或灰色中层状粉晶-细晶海百合茎灰岩组成;台盆相岩性为:灰色中层生物泥晶灰岩夹灰黑色薄层炭质泥岩、硅质岩、硅质灰岩为主。水平层理发育。厚224 m。自上而下为:

上覆地层:巴平组上段,浅灰色中层状灰岩

①广西壮族自治区地质矿产勘查开发局,王瑞刚,等. 1:5万黄茆东幅区域地质调查报告. 1993.

整合

巴平组下段:

厚 224 m

30. 灰色薄-中层状含生物碎屑粉晶灰岩、灰黑色薄层硅质条带灰岩夹浅灰色薄-中层状含团粒生物碎屑粉-泥晶灰岩,产牙形石:

距底 7.0 m(65)产牙形石: *Gnathodus delicatus* Lane et al.; *Ligonodina* sp.; *Hindeodella* sp.

距底 3 m(64)产牙形石: *Rhodalepis inornata* Druce, *Ligonodina* sp., *Hindeodella* sp., *Polygnathus* sp., *Protognathus kockeli* (Bischoff); *Protognathodus praedelicatus* Lane, Sanderberg et Ziegler, 及虫牙化石: *Scolocodont* sp.

19.91 m

29. 浅灰白色薄层状生物碎屑粉-泥晶灰岩与灰色薄-中层状含生屑粉晶灰岩不等厚互层状

9.5 m

28. 灰色薄层-中层状硅质条带粉-细晶白云质灰岩,距底 11m(63)产牙形石: *Hindeodella* sp.

21.9 m

27. 灰色中-厚层状粉晶砂屑含生屑灰岩,距底 3 m(62)产牙形石: *Pseudopolygnathus triangulus inaequalis* Voges, *Ozarkodina* cf. *homoarcuata* Helms, *Ligonodina* sp.; *Pseudopolygnathus primus* Branson & Mehl

8.73 m

26. 灰色中层含硅质条带粉-细晶生屑泥晶灰岩

31 m

距底 31 m(61)产牙形石: *Protognathus* sp., *Hindeodella* sp., *Neopanderodus* sp., *Siphonodella* cf. *isosticha* (Cooper), *Neoprioniodus postinversus* Helms, *Ligonodina* sp.;

距底 25 m (60) 产牙形石: *Siphonodella isosticha* (Cooper), *Gnathodus delicatus* Lane et al.; *Ozarkodina regularis* Branson & Mehl, *Neoprioniodus postinversus* Helms, *Pseudopolygnathus primus* Branson & Mehl, *Pseudopolygnathus* cf. *triangulus* Voges;

距底 15 m (59) 产牙形石: *Siphonodella isosticha* (Cooper), *Siphonodella obsoleta* Hass, *Gnathodus delicatus* Lane et al., *Hindeodella gemana* Homs, *Neoprioniodus barbatus* (Branson & Mehl), *Pseudopolygnathus primus* Branson & Mehl, *Pseudopolygnathus* cf. *triangulus* Voges, *Ozarkodina regularis* Branson & Mehl, *Neoprioniodus postinversus* Helms; *Polygnathus longiposticus* Wang & Wang;

距底 2 m (58) 产牙形石: *Siphonodella isosticha* (Cooper), *Pseudopolygnathus primus* Branson & Mehl, *Pseudopolygnathus* cf. *triangulus* Voges, *Ozarkodina regularis* Branson & Mehl, *Neoprioniodus postinversus* Helms, *Ligonodina* sp.; *Polygnathus delicatulus* Klapper

25. 掩盖(零星露头见灰色薄层含生屑泥晶灰岩) 50 m

24. 灰色薄层条带状含生屑泥-粉晶灰岩夹灰色中层状粉晶灰岩及少量浅灰色薄层状泥岩,偶夹中-厚层状粉晶砂屑含生屑灰岩

12.19 m

距底 2m(57)产牙形石: *Siphonodella isosticha* (Cooper), *Neopanderodus* sp., *Neoprioniodus* sp.

23. 灰色中层夹硅质条带含生屑、砂屑粉晶灰岩 46 m
距底 25 m (56) 产牙形石: *Siphonodella isosticha* (Cooper), *Polygnathus bischoffi* Rhodes, Austin & Druce, *Hindeodella* sp.; *Neoprioniodus barbatus* (Branson & Mehl), *Polygnathus longiposticus* Wang & Wang

距底 5 m(55)产牙形石: *Siphonodella crenulata* (Cooper), *Siphonodella eurylobata* Ji, *Siphonodella isosticha* (Cooper), *Siphonodella quadruplicata* (Branson & Mehl); *Polygnathus purus purus* Voges, *Neopanderodus* sp., *Tripodellus* sp., *Polygnathus* sp.

距底 2 m(54)产牙形石: *Siphonodella isosticha* (Cooper), *Ozarkodina* sp., *Hindeodella* sp.

22. 灰色中层生物泥晶灰岩夹灰黑色薄层炭质泥岩,水平层理发育

4.5 m

自上而下 15 个样品:

距底 4.5 m (53) 产牙形石: *Siphonodella sandbergi* Klapper, *Siphonodella crenulata* (Cooper), *Siphonodella eurylobata* Ji, *Siphonodella isosticha* (Cooper), *Elictognathus bialata* (Branson & Mehl), *Dinodus wilsoni* Druce; *Spathognathodus planicovexus* Wang et Ziegler, *Polygnathus purus purus* Voges;

距底 4.2 m (52) 产牙形石: *Siphonodella crenulata* (Cooper), *Siphonodella obsoleta* Hass, *Siphonodella eurylobata* Ji, *Neoprioniodus barbatus* (Branson et Mehl), *Polygnathus purus purus* Voges, *Hindeodella gemana* Homs, *Elictognathus bialata* (Branson & Mehl), *Ligonodina* sp.

距底 3.9 m (51) 产牙形石: *Siphonodella crenulata* (Cooper), *Siphonodella obsoleta* Hass, *Siphonodella eurylobata* Ji, *Siphonodella cooperi* Hass, *Siphonodella duplicata* (Branson & Mehl) *Morphotype 1*, *Polygnathus longiposticus* Wang et Wang, *Polygnathus* cf. *purus purus* Voges

距底 3.6 m (50) 产牙形石: *Siphonodella sandbergi* Klapper, *Siphonodella crenulata* (Cooper), *Siphonodella eurylobata* Ji, *Siphonodella obsoleta* Hass, *Siphonodella cooperi* Hass, *Siphonodella lobata* (Branson et Mehl), *Spathognathodus* sp.; *Spathognathodus planicovexus* Wang et Ziegler, *Polygnathus inornatus inornatus* E.R. Branson; *Pseudopolygnathus* cf. *triangularis triangularis* Voges, *Hindeodella gemana* Homs; *Polygnathus longiposticus* Wang et Wang, *Polygnathus purus purus* Voges, *Elictognathus bialata* (Branson et Mehl), *Ozarkodina plana* (Branson et Mehl), *Neoprioniodus barbatus* (Branson et Mehl), *Hibbardella* sp.

距底 3.3 m (49) 产牙形石: *Siphonodella crenulata* (Cooper), *Siphonodella sexplicata* (Branson et Mehl),

Siphonodella sandbergi Klapper, *Siphonodella tristrostrata* Druce, *Siphonodella eurylobata* Ji, *Siphonodella cooperi* Hass, *Elictognathus bialata* (Branson et Mehl), *Hindeodella gemana* Homs, *Polygnathus longiposticus* Wang et Wang, *Polygnathus purus purus* Voges

距底 3.0 m (48) 产牙形石: *Siphonodella crenulate* (Cooper), *Siphonodella obsoleta* Hass, *Dinodus wilsoni* Druce, *Elictognathus bialata* (Branson & Mehl), *Hibbardella* cf. *plana* Thomas, *Hindeodella gemana* Homs, *Ligonodina* sp.; *Neoprioniodus barbatus* (Branson et Mehl), *Ozarkodina plana* (Branson et Mehl), *Polygnathus longiposticus* Wang et Wang, *Polygnathus dialicatula* Ulrich et Bassler, *Pseudopolygnathus postimodosus* Rhodes, Austin et Druce, *Spathognathodus planiconvexus* Wang et Wang, *Spathognathodus* sp.

距底 2.7 m (47) 产牙形石: *Siphonodella* cf. *tristrostrata* Druce, *Siphonodella crenulate* (Cooper), *Siphonodella cooperi* Hass, *Siphonodella lobata* (Branson et Mehl), *Siphonodella obsoleta* Hass; *Polygnathus longiposticus* Wang et Wang, *Polygnathus purus purus* Voges, *Spathognathodus* sp., *Ozarkodina plana* (Branson et Mehl), *Neoprioniodus basbatus* (Branson et Mehl), *Dinodus wilsoni* Druce, *Elictognathus* sp.

距底 2.4 m (46) 产牙形石: *Siphonodella tristrostrata* Druce, *Siphonodella crenulate* (Cooper), *Siphonodella cooperi* Hass, *Spathognathodus* sp., *Dinodus* cf. *leptus* Cooper, *Hindeodella* sp., *Ozarkodina regularis* Branson et Mehl, *Polygnathus panatus*, *Polygnathus inornatus inornatus* E.R. Branson; *Pseudopolygnathus marginatus* (Branson et Mehl)

距底 2.1 m (45) 产牙形石: *Siphonodella cooperi* Hass Morphotype 2, *Siphonodella sexplicata* (Branson et Mehl), *Siphonodella eurylobata* Ji, *Siphonodella duplicata* sensu Hass, *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella crenulate* (Cooper) Morphotype 1, *S. obsoleta* Hass, *Siphonodella sandbergi* Klapper, *Dinodus fragosus* (Branson), *Tripodellus robustus* Bischoff, *Polygnathus distortus* Branson et Mehl, *Polygnathus lacinatus lacinatus* Huddle, *Polygnathus* sp., *Ozarkodina* sp., *Bispathodus aculeatus aculeatus* (Branson et Mehl), *Ligonodina* sp., *Pseudopolygnathus marginatus* (Branson et Mehl), *Pseudopolygnathus dentilinus* E.R. Branson, *Protognathodus meischneri* Ziegler

距底 1.8 m (44) 产牙形石: *Siphonodella* cf. *tristrostrata* Druce, *Siphonodella nandongensis* sp. nov. Li, *Siphonodella crenulate* (Cooper), *Siphonodella obsoleta* Hass, *Siphonodella duplicata* (Branson et Mehl) Morphotype 1, *Siphonodella eurylobata* Ji, *Elictognathus lacerata* (Branson et Mehl), *Polygnathus purus purus* Voges, *Polygnathus inornatus inornatus* E.R. Branson; *Pseudopolygnathus dentilinus* E.R.

Branson, *Polygnathus longiposticus* Wang et Wang, *Neoprioniodus barbatus* (Branson et Mehl), *Dinodus* sp.,

距底 1.5 m (43) 产牙形石: *Siphonodella obsoleta* Hass, *Siphonodella tristrostrata* Druce, *S. duplicata* (Branson et Mehl) Morphotype 1, *Siphonodella quadruplicata* (Branson et Mehl) Morphotype 2, *Siphonodella crenulate* (Cooper), *Spathognathodus planiconvexus* Wang et Ziegler, *Elictognathus bialata* (Branson et Mehl), *Elictognathus laceorata* (Branson et Mehl), *Polygnathus purus purus* Voges, *Polygnathus delicatula delicatula* Branson et Mehl, *Polygnathus longiposticus* Wang et Wang, *Neoprioniodus basbatus* (Branson et Mehl)

距底 1.2 m (42) 产牙形石: *Siphonodella lobata* (Branson & Mehl), *Siphonodella sandbergi* Klapper, *Siphonodella nandongensis* sp. nov. Li, *Siphonodella crenulate* (Cooper), *Siphonodella tristrostrata* Druce; *Pseudopolygnathus dentilinus* E.R. Branson, *Polygnathus panatus* Hinde, *Spathognathodus planiconvexus* Wang et Ziegler, *Elictognathus bialata* (Branson et Mehl), *Elictognathus laceorata* (Branson et Mehl)

距底 0.9 m (41) 产牙形石: *Siphonodella sandbergi* Klapper, *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella tristrostrata* Druce, *Siphonodella sexplicata* (Branson et Mehl), *Polygnathus longiposticus* Wang & Wang, *Pseudopolygnathus postimodosus* Rhodes, Austin et Druce; *Siphonodella* sp. nov. A

距底 0.6 m (40) 产牙形石: *Siphonodella sandbergi* Klapper, *Siphonodella tristrostrata* Druce

距底 0.3 m (39) 产牙形石: *Siphonodella quadruplicata* (Branson & Mehl), *S. obsoleta* Hass, *Siphonodella sandbergi* Klapper, *Siphonodella duplicate* sensu Hass, *Siphonodella crenulate* (Cooper) Morphotype 1, *Siphonodella sexplicata* (Branson et Mehl), *Siphonodella tristrostrata* Druce, *Siphonodella lobate* (Branson & Mehl), *Siphonodella* sp. nov. A, *Siphonodella nandongensis* sp. nov. Li, *Ligonodina* sp., *Polygnathus inornatus lobatus* Branson & Mehl, *Pseudopolygnathus postimodosus* Rhodes, Austin et Druce, *Dinodus fragosus* (Branson), *Elictognathodus lacerata* (Branson & Mehl)

21. 灰色中层夹薄层含生物碎屑粉-泥晶灰岩与中层藻屑灰岩不等厚互层 4.5 m

9个样品产牙形石:

距底 4.5 m (38) 产牙形石: *Siphonodella tristrostrata* Druce, *Siphonodella cooperi* Hass Morphotype 1, *Siphonodella lobate* (Branson & Mehl), *Pseudopolygnathus marginatus* (Branson & Mehl), *Pseudopolygnathus* sp., *Polygnathus inornatus*

inornatus E.R. Branson; *Polygnathus purus purus* Voges, *Polygnathus longiposticus* Wang & Wang, *Elictognathus bialata* (Branson & Mehl)

距底 4.0 m (37) 产牙形石: *Siphonodella lobata* (Branson & Mehl), *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella tironstrata* Druce, *Siphonodella eurylobata* Ji, *Siphonodella crenulata* (Cooper) Morphotype 1, *Siphonodella sanderbergi* Klapper, *Polygnathus distortus* Branson & Mehl, *Neoprioniodus postinversus* Helms, *Elictognathus laceorata* (Branson & Mehl), *Ozarkodina regularis* Branson & Mehl, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Polygnathus inornatus inornatus* E.R. Branson, *Hindeodina* sp., *Hibbardella* sp., *Hindeodella* sp.

距底 3.5 m (36) 产牙形石: *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella duplicata* (Branson & Mehl) Morphotype 1; *Siphonodella obsolete* Hass, *Siphonodella lobata* (Branson & Mehl), *Siphonodella eurylobata* Ji, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Pseudopolygnathus prima* Branson & Mehl, *Ozarkodina regularis* Branson et Mehl, *Hindeodina* sp.

距底 3.0 m (35) 产牙形石: *Elictognathus bialata* (Branson & Mehl), *Pseudopolygnathus prima* Branson et Mehl, *Pseudopolygnathus trigulus inaequalis* Voges, *Polygnathus lacinatus lacinatus* Hinde, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Siphonodella quadruplicatus* (Branson et Mehl), *Siphonodella sanderbergi* Klapper, *Siphonodella obsolete* Hass, *Siphonodella eurylobata* Ji, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1

距底 2.5 m (34) 产牙形石: *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella sanderbergi* Klapper, *Siphonodella obsolete* Hass, *Siphonodella eurylobata* Ji, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Ozarkodina regularis* Branson & Mehl, *Elictognathus lacerata* (Branson et Mehl)

距底 2.0 m (33) 产牙形石: *Elictognathus lacerata* (Branson et Mehl), *Elictognathus bialata* (Branson et Mehl), *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella duplicata* (Branson et Mehl) Morphotype 2, *Siphonodella sanderbergi* Klapper, *Siphonodella cooperi* Hass, *Siphonodella obsolete*, *Siphonodella eurylobata* Ji, *Siphonodella duplicata* (Branson et Mehl) Morphotype 1, *Pseudopolygnathus prima* Branson & Mehl, *Polygnathus panata* Hinde, *Polygnathus inornatus inornatus* E. R. Branson, *Polygnathus purus purus* Voges, *Spathognathodus* cf. *planiconvexus* Wang & Wang, *Pseudopolygnathus* sp., *Ozarkodina regularis* Branson & Mehl, *Neoprioniodus*

postinversus Helms, *Euprioniodus* sp., *Hindeodus* sp.

距底 1.5 m (32) 产牙形石: *Siphonodella duplicata* sensu Hass, *Siphonodella cooperi* Hass, *Siphonodella obsolete*, *Siphonodella sanderbergi* Klapper, *Spathognathodus strigosus* Tomas, *Ozarkodina regularis* Branson et Mehl, *Neoprioniodus postinversus* Helms, *Hindeodella* sp., *Hibbardella* sp., *Elictognathus lacerata* (Branson et Mehl), *Elictognathus bialata* (Branson et Mehl), *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Dinodus wilsoni* Druce, *Euprioniodus alternata*, *Polygnathus bischaff* Rhodes et al., *Pseudopolygnathus triangulus triangulus* Voges

距底 1.0 m (31) 产牙形石: *Siphonodella duplicata* sensu Hass, *Siphonodella cooperi* Hass, *Siphonodella eurylobata* Ji, *Spathognathodus strigosus* Tomas, *Elictognathus lacerata* (Branson et Mehl), *Ozarkodina regularis* Branson et Mehl, *Palmatolepis* sp., *Polygnathus inornatus inornatus* E. R. Branson, *Polygnathus bischaff* Rhodes et al., *Polygnathus purus purus* Voges, *Palmatolepis* sp.

距底 0.5 m (30) 产牙形石: *Pseudopolygnathus triangulus inaequalis* Voges, *Siphonodella duplicata* sensu Hass, *Siphonodella duplicata* (Branson et Mehl) Morphotype 1, *Polygnathus lacinatus lacinatus* Huddle, *Polygnathus* sp., *Ozarkodina* sp., *Hindeodella subtilis* Ulrich & Bassler, *Polygnathus communis communis* Hass, *Hindeodella* sp., *Falcodus* sp., *Polygnathus* cf. *distortus* Branson & Mehl

————— 整 合 —————

五指山组: 224.18 m

20. 灰色薄层条带状团粒粉-泥晶灰岩夹灰色薄层-中层藻团粒泥-粉晶灰岩, 瘤状构造发育。 7.33 m

距底 7.3 m (29) 产牙形石: *Siphonodella duplicata* (Branson & Mehl) Morphotype 2, *Siphonodella cooperi* Hass; *S. duplicata* (Branson & Mehl) Morphotype 1, *Polygnathus communis communis* Hass, *Polygnathus purus purus* Voges, *Polygnathus inornatus inornatus* E. R. Branson, *Bispathodus* sp.; *Neoprioniodus postinversus* Helms, *Ozarkodina regularis* Branson & Mehl, *Bispathodus* sp.; *Pseudopoly. multistriatus* Mehl et Thoms

距底 6.0 m (28) 产牙形石: *Siphonodella cooperi* Hass, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Pseudopolygnathus triangulus triangulus* Voges; *Polygnathus communis communis* Hass, *Polygnathus bischaff* Rhodes et al., *Polygnathus purus purus* Voges, *Neoprioniodus postinversus* Helms

距底 4.5 m (27) 产牙形石: *Siphonodella duplicata* sensu Hass, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Siphonodella cooperi* Hass Morphotype 1, *Polygnathus purus*

purus Voges, *Pseudopolygnathus* cf. *marginatus* (Branson & Mehl), *Pseudopolygnathus triangulus triangulus* Voges; *Polygnathus communis communis* Hass, *Polygnathus bischaff* Rhodes et al., *Polygnathus inornatus inornatus* E. R. Branson, *Neoprioniodus postinversus* Helms

距底 3.0 m (26) 产牙形石: *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Polygnathus communis communis* Hass, *Pseudopoly. multistriatus* Mehl et Thomas, *Pseudopolygnathus marginatus* (Branson & Mehl)

19. 浅灰色薄-中层瘤状泥晶灰岩, 局部层段含硅质, 或呈不等厚互层状。偶夹薄层泥岩和泥晶含砂屑生物碎屑灰岩。产牙形石:

距底 21 m (25) 产牙形石: *Palmatolepis gracilis sigmoidalis* Ziegler, *Protognathodus* sp., *Hindeodella* sp., *Apathognathus klapperi* Druce

距底 7 m (24) 产牙形石: *Pseudopolygnathus marburgensis trigonicus* Ziegler, *Protognathodus meischneri* Ziegler, *Hindeodella* sp., *Ozarkodina* sp.

距底 3 m (23) 产牙形石: *Polygnathus* sp., *Palmatolepis gracilis sigmoidalis* Ziegler, *Pseudopolygnathus marburgensis trigonicus* Ziegler, *Ozarkodina* sp., *Lonchodina arcuata* Ulrich et Bassler, *Drepanodina subcircularis* Wang, *Hindeodella* sp.

25.20 m

18. 灰色薄-中层瘤状泥晶灰岩夹硅质条带、硅质结核; 偶夹深灰色中层状粉-泥晶灰岩。产牙形石:

(24) *Palmatolepis marginifera marginifera* Helms, *Polygnathus communis communis* Hass, *Hindeodella subtilis* Ulrich & Bassler, *P. cf. foliacea* Youngquist; *Palmatolepis* cf. *glabra peclinata* Ziegler, *Polygnathus g. gracilis* Branson & Mehl, *Polygnathus g. sigmoidalis* Ziegler

(23) *Polygnathus purus purus* Voges, *Polygnathus inornatus lobata* Branson & Mehl; *Tripodellus* sp.; *Palmatolepis perllobata schindewolfi* Muller 18.10 m

17. 浅灰色中-厚层瘤状泥晶灰岩、粉晶灰岩夹少量黑灰色薄层泥岩。含牙形石:

(20) *Palmatolepis marginifera marginifera* Helms, *P. glabra lept*a Ziegler et Huddle, *P. glabra pectinata* Ziegler et Huddle, *Ozarkodina* sp., *Tripodellus robustus* Bischoff; *Palmatolepis marginifera marginifera* Helms, *P. glabra lept*a Ziegler et Huddle, *P. glabra pectinata* Ziegler et Huddle, *P. delicatula delicatula* Ulrich & Bassler 20 m

16. 浅灰-灰色薄-中层瘤状泥晶-粉晶灰岩, 局部偶夹厚层粉晶含砂屑层孔虫棘屑灰岩。含牙形石:

(19) *Palmatolepis marginifera marginifera* Helms, *P. glabra lept*a Ziegler et Huddle, *P. glabra pectinata* Ziegler et Huddle, *P. delicatula* Ulrich & Bassler, *Ozarkodina* sp.

Palmatolepis glabra prima Ziegler, *P. glabra pectinata*, *P. disprilis* Ziegler, *Drepanodus* sp. indet.

(18) 化石碎片, 属种不能鉴定 15.42 m

15. 灰色薄-中层瘤状夹硅质条带、硅质结核泥-粉晶含硅质、泥质灰岩。含牙形石:

(17) *P. delicatula delicatula*, *P. cf. minuta minuta* Branson et Mehl, *P. quadrantinodosa inflexa* Muller, *Hindeodella* sp.

22.52 m

14. 浅灰色中层瘤状泥-粉晶灰岩夹含生物碎屑含泥质灰岩。含牙形石:

(16) *Palmatolepis glabra elongata* Holmes, *P. glabra lept*a Ziegler et Huddle, *Icriodus cornutus* Sannemann, *Hindeodella* sp., *Angulodus* sp., *Pelekysgnathus* sp.; *Palmatolepis margilifera* subsp. Sandberg, *Palmatolepis glabra lept*a Ziegler, *Pa. disprilis* Ziegler, *Pa. quadrantinodosa inflexa* Muller, *Pa. delicatula delicatula*, *Po. regularis* Cooper, *Po. vorus*, *Ozarkodina rugularis* Branson et Mehl, 15.80 m

13. 浅灰色薄-中层含燧石结核、硅质条带瘤状泥-粉晶灰岩。含牙形石:

(15) *Palmatolepis glabra elongata* Holmes, *Palmetolepis margilifera*, *Palmatolepis delicatula delicatula*, *Palmetolepis glabra prima* Ziegler, *P. quadrantinodosa inflexa* Muller, 1955; *Palmetolepis* sp. indet.; *Polygnathus glabra glabra*, *Falcodus variabilis* Sannenman, *Hindeodella* sp.; *Pa. cf. minuta minuta* Branson et Mehl, *Hindeodella* sp.

(14) 化石碎片, 属种不能鉴定 15.00 m

12. 灰-深灰色薄-中层瘤状含泥质、硅质泥-粉晶灰岩。含牙形石:

(13) *Palmatolepis* sp., *Ligonodina* sp. 6.73 m

11. 浅灰色薄层瘤状泥-粉晶灰岩夹泥质灰岩。含牙形石:

(12) 化石碎屑, 属种不能鉴定 14.55 m

10. 灰色薄-中层含硅质泥-粉晶灰岩夹深灰色薄层生物碎屑泥晶灰岩。偶夹薄层硅质岩。含牙形石:

(11) *Icriodus alternatus* Branson et Mehl, *Polygnathus* sp., *Palmatolepis minuta minuta* Branson et Mehl 11.15 m

9. 浅灰色薄-中层瘤状泥晶灰岩。含牙形石:

(10) *Palmatolepis minuta minuta* Branson et Mehl, *Palmatolepis delicatula delicatula* B. & M. 21.57 m

8. 灰色中层细粉晶灰岩夹少量深灰色、黑色薄层含竹节石、泥质硅质岩。含牙形石:

(9) *Angulodus walrathi* (Hinbbard), *Polygnathus glaber bilobatus* Ziegler, *Polygnathus glaber glaber* Ulrich, *Polygnathus* sp. indet.; *Palmatolepis triangularis* Sannemann, *Palmatolepis asymmetricus*, *Ligonodina* sp. indet.; *Avignathus?* sp. indet.; *Bellodella* cf. *resima* (Philip), *Hindeodella germana* Holms, *Neoprioniodus* sp. indet.

(8) *Palmatolepis subperlobata* Branson & Mehl, *Polygnathus* sp.及竹节石

(7)化石碎屑,属种不能鉴定

(6) *Palmatolepis subperlobata* Branson & Mehl, *Pa. triangularis* Sannenmann, *Palmatolepis provasal* Ziegler, 1958, *Pa. asymmetricus*, *Pa. punctata*, *Pa. minuta*, *Pa. cf. linguiformis*, *Pa. cf. triangularis* Sannenmann, *Pa. cf. glabra peclinata* Ziegler, *Pa. varus*, *Bryantodus* sp., *Avignathus* sp.; *Angulodus walrathi* (Hibbard), *Synprioniodina* sp., *Ligonodina* sp.; *Ozarkodina* sp. indet. 23.91 m

————— 整合 —————

榴江组: 厚 169.40 m

7. 深灰色薄层含竹节石,含炭质、钙质硅质岩,夹灰色薄-中层含硅质粉晶灰岩。含牙形刺:

(5) *Hindeodella* sp.及介形虫、海百合茎碎片

(4)介形虫、海百合茎碎片 59.87 m

6. 灰-深灰色薄层含竹节石硅质泥岩、硅质岩 1.58 m

5. 浮土掩盖 36.89 m

4. 浅紫灰色薄层含竹节石、炭质、泥质硅质岩 11.39 m

3. 深灰色薄层含竹节石硅质泥岩、硅质岩 9.67 m

————— 整合 —————

下伏地层:中泥盆统东岗岭组

2. 灰色薄-中层细晶白云岩夹薄层含竹节石泥晶灰岩,含少量竹节石,保存不好 10.70 m

1. 灰色薄-中层含竹节石泥晶灰岩,含牙形刺:

(1) *Neopanderodus transitans* Ziegler et Lindström, *Polygnathus* aff. *xylus* Stauff, *Neopanderodus* sp. > 2.00 m

3 牙形石生物地层及其对比

南桐剖面五指山组和巴平组下段共计划分14个牙形石带,其中五指山组可识别出4个牙形石带:*Palmatolepis triangularis*, *Palmatolepis minuta minuta*, *Palmatolepis marginifera marginifera*, *Palmatolepis gracilis sigmoidalis*带。巴平组下段建立10个牙形石带:*Siphonodella duplicate sensu* Hass, *S. cooperi*带, *S. obsoleta*带, *S. sandbergi*, *S. quadruplicata*, *S. lobata*, *S. crenulata*, *S. isosticha*, *Gnathodus delicatus*, *Protognathodus praedelicatus*带(图1)。上述牙形石间隔带均以带分子首次出现为标志,自上而下分别为:

(1) *Protognathodus praedelicatus*带(见图版 I)

位于剖面30层,距底3~7m地层间隔中(产于样品64和65),厚4.00 m。以*Protognathodus praedelicatus*首次出现为标志,除带分子*Protognathodus*

praedelicatus Lane, Sanderberg et Ziegler 外,其他重要分子有:*Protognathus kockeli* (Bischoff); *Gnathodus delicatus* Lane et al.; *Rhodalepis inornata* Druce, *Polygnathus* sp. 及少量复合型分子 *Ligonodina* sp., *Hindeodella* sp.。其中 *Protognathodus praedelicatus*, *Protognathus kockeli* 曾广泛见于华南地区同期沉积中。*Rhodalepis inornata* Druce 报道较少,主要见于澳大利亚同期^[23]沉积地层中。*Gnathodus delicatus* 可由下伏同名带延续上来,主要标志为 *Siphonodella* 类群绝灭、新生分子计有:*Protognathodus praedelicatus* Lane, Sanderberg et Ziegler, *Protognathus kockeli* (Bischoff); *Rhodalepis inornata* Druce 等。

本文建立 *Protognathodus praedelicatus* 带可与田树刚^[10]岩关阶中下部 *Gnathodus typicus*-*Gnathodus cuneiformis* 带上部直接对比。大致对应于云南施甸鱼洞剖面同名化石带的上部。当前所建化石带的生物群面貌较为单调,计有6个属 *Protognathus kockeli* (Bischoff); *Gnathodus delicatus* Lane et al.; *Rhodalepis inornata* Druce, *Polygnathus* sp., *Ligonodina* sp., *Hindeodella* sp.。未见 *Gnathodus typicus*, *Gnathodus cuneiformis* 分子;但均产有重要分子:*Protognathodus praedelicatus* Lane, Sanderberg et Ziegler, *Protognathus kockeli* (Bischoff); *Gnathodus delicatus* Lane et al.; 其中, *Gnathodus delicatus* Lane et al. 由下伏地层延续上来,新生分子由 *Protognathus kockeli* (Bischoff) 和 *Rhodalepis inornata* Druce 组成,大致相当于北美的 *Gnathodus typicus* 带上部^[9]。

(2) *Gnathodus delicatus* 带

位于剖面26层中部至30层下部地层间隔中(59~64),厚25.0 m。以 *Gnathodus delicatus* 首次出现为底界标志,以 *Protognathodus praedelicatus* 首次出现为顶界标志。该化石带以 *Siphonodella* cf. *isosticha* (Cooper), *Siphonodella isosticha* (Cooper), *Siphonodella obsoleta* Hass 的陆续绝灭和 *Gnathodus delicatus* 兴起为特色。下部主要分子计有:*Siphonodella isosticha* (Cooper), *Siphonodella obsoleta* Hass, *Gnathodus delicatus* Lane et al.; *Pseudopolygnathus primus* Branson & Mehl, *Pseudopolygnathus* cf. *triangulus* Voges, *Ozarkodina*

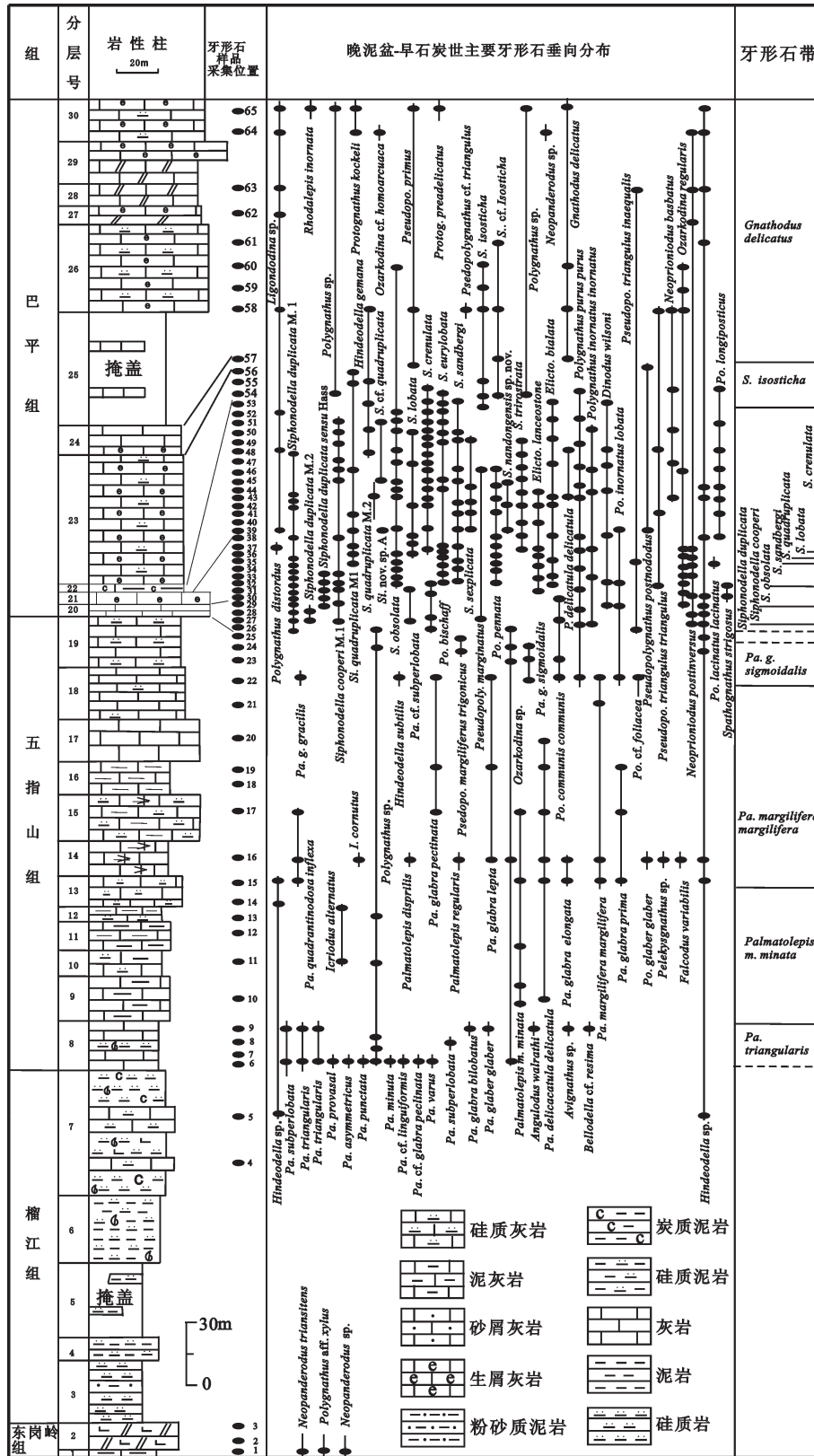
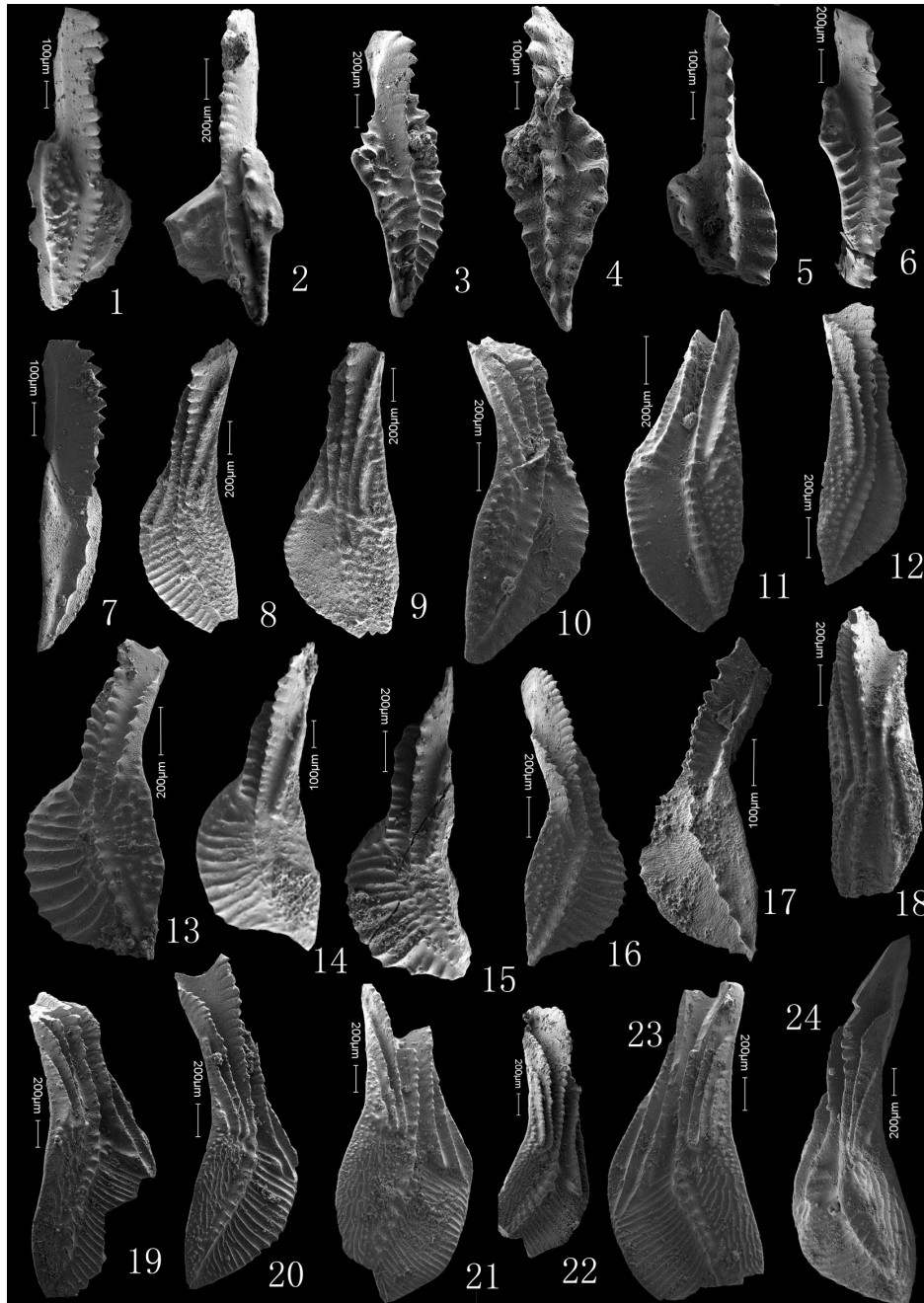


图1 广西南桐晚泥盆世—早石炭世早期五指山组—早石炭世巴平组下段牙形石分带和属种分布
 Fig. 1 Vertical distribution of conodont species and conodont zones along the Nandong section (Late Devonian—early Early Carboniferous Wuzhishan Formation and lower part of Early Carboniferous Baping Formation), Guangxi



图版 I (Plate I)

图版说明(Explanation of Plates)所有图示标本均采自广西武宣县二塘乡六峰林场南侗站下石炭统巴平组下段剖面,标本保存在中国地质调查局武汉地质调查中心资料室,斜线上为野外采集号,斜线下为标本登记号。牙形石标本规格大小见图版线条

- 比例尺。1. *Protognathodus praeliticus* Lane, S.&Z., 1980 口视, 64/2014-1; 产地层位: 广西武宣南侗下石炭统巴平组下段。2. *Gnathodus delicatus* Lane, S.&Z., 1980 口视, 59/2014-2; 产地层位: 广西武宣南侗下石炭统巴平组下段。3, 6. *Pseudopolygnathus primus* Branson et Mehl, 1934. 口视, 59/2014-3; 6. 口视, 59/2014-6; 产地层位均为: 广西武宣南侗下石炭统巴平组下段。4, 5. *Pseudopolygnathus* sp. 4. 口视, 62/2014-4; 5. 口视, 62/2014-5; 产地层位均为: 广西武宣南侗下石炭统巴平组下段。7. *Rhodalepis inornata* Druce, 1969 侧视, 64/2014-7; 产地层位: 广西武宣南侗下石炭统巴平组下段。8. *Siphonodella quadruplicata* (Branson et Mehl, 1934) 口视, 55/2014-8; 产地层位: 广西武宣南侗下石炭统巴平组下段。9-12. *Siphonodella obsoleta* Hass, 1959 9. 口视, 55/2014-9; 10. 口视, 60/2014-10; 11. 口视, 61/2014-11; 12. 口视, 52/2014-12; 产地层位均为: 广西武宣南侗下石炭统巴平组下段。13-16. *Siphonodella crenulata* (Cooper, 1939), Morphotype 113. 口视, 51/2014-13; 14. 口视, 51/2014-14; 15. 口视, 44/2014-15; 16. 口视, 44/2014-16; 产地层位均为: 广西武宣南侗下石炭统巴平组下段。17. *Siphonodella eurylobata* Ji, 1985 口视, 45/2014-17; 产地层位: 广西武宣南侗下石炭统巴平组下段。18. *Siphonodella sandbergi* Klapper, 1966 口视, 42/2014-18; 产地层位: 广西武宣南侗下石炭统巴平组下段。19-23. *Siphonodella nandongensis* sp. nov. Li (另文发表) 均为口视, 19. 44/2014-19, 副模; 20. 44/2014-20, 正模; 21. 43/2014-21, 副模; 22. 44/2014-22, 副模; 23. 44/2014-23, 副模。产地层位均为: 广西武宣南侗下石炭统巴平组下段。24. *Siphonodella* sp. nov. A 口视, 44/2014-24; 产地层位: 广西武宣南侗下石炭统巴平组下段。

regularis Branson & Mehl, *Neoprioniodus barbatus* (Branson & Mehl), *Neoprioniodus postinversus* Helms; *Hindeodella gemana* Homs, *Polygnathus longiposticus* Wang & Wang.

上部 *Pseudopolygnathus*, *Ozarkodina*, *Neopanderodus*, *Ligonodina*, *Gnathodus Hindeodella* 等属均可由下部化石带延续上来,但 *Siphonodella* cf. *isosticha* (Cooper), *Siphonodella isosticha* (Cooper), *Siphonodella obsoleta* Hass 均绝灭。

本文建立 *Gnathodus delicatus* 带可与田树刚^[10]岩关阶中下部 *Gnathodus typicus*-*Gnathodus cuneiformis* 带下部直接对比。大致对应于云南施甸鱼洞剖面同名化石带的下部。当前所建化石带的生物群面貌较为丰富,计有9属11种,4相似种。其中,均产有 *Gnathodus*, *Siphonodella*, *Pseudopolygnathus*, *Polygnathus* 属,所不同的是:*Gnathodus typicus*-*Gnathodus cuneiformis* 带下部产浅水相的复合型分子比例多。

此外,该带大多数牙形石分子由下伏地层延续上来,新生分子主要由 *Gnathodus delicatus* 和 *Neopanderodus* 分子组成。大致相当于北美的 *Gnathodus typicus* 带下部^[9]。

(3) *Siphonodella isosticha* 带

位于22层顶部至26层下部地层间隔中(53~58),厚约33.0 m。以 *Siphonodella isosticha* 首次出现为底界标志,以 *Gnathodus delicatus* 首次出现为顶界标志。主要分子计有:*Siphonodella isosticha*, *Siphonodella crenulata*, *Siphonodella eurylobata* Ji, *Siphonodella quadruplicata*, *Siphonodella sandbergi*, *Pseudopolygnathus primus*, *Pseudopolygnathus* cf. *triangulus*, *Spathognathodus planicovexus*, *Elictognathus bialata*, *Ozarkodina regularis*, *Neoprioniodus postinversus*, *Elictognathus bialata* (Branson & Mehl), *Dinodus wilsoni*, *Polygnathus delicatulus*, *Polygnathus bischoffi*, *Polygnathus purus* 及复合型分子:*Hindeodella* sp., *Dinodus wilsoni* Druce 和 *Ligonodina* sp. 等。其中, *Siphonodella sandbergi*, *Siphonodella crenulata*, *Siphonodella eurylobata* Ji, *Siphonodella quadruplicata* 绝灭于该带中下部。

本文建立 *Siphonodella isosticha* 间隔带,生物群

面貌与季强^[11-12]同名化石带一致,可直接对比。与王成源^[7]、Sandberg et Ziegler et al.^[1] *isosticha*-*crenulata* 组合带上部对比。此外,依据所产牙形石 *Siphonodella eurylobata*, 也大致对应于华南地区浅水相 *Siphonodella eurylobata* 化石带的层位相当^[12],地质时代为早石炭世早期。

(4) *Siphonodella crenulata* 带

位于21层上部至22层上部地层间隔中(37~52),厚5.00 m。以 *Siphonodella crenulata* 首次出现为底界标志,以 *Siphonodella isosticha* 首次出现为顶界标志。

主要分子计有:*Siphonodella crenulata*, *Siphonodella obsoleta*, *Siphonodella eurylobata*, *Siphonodella cooperi*, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Siphonodella sandbergi*, *Siphonodella lobata*, *Siphonodella sexplicata*; *Siphonodella quadruplicata*, *Siphonodella duplicata* sensu Hass, *Siphonodella crenulata* (Cooper) Morphotype 1, *Siphonodella cooperi*, *Siphonodella cooperi* Hass Morphotype 2。

值得提及的是,仅 *Siphonodella* 属的新生分子大量出现:计有 *Siphonodella* sp. nov. A, *Siphonodella tirostrata* Druce, *Siphonodella sexplicata* (Branson et Mehl), *Siphonodella nandongensis* sp. nov. Li; 其中, *Siphonodella* sp. nov. A, *Siphonodella nandongensis* sp. nov. Li; 均为南桐剖面首次发现新种和新未定种。该带中下部见及发育5~6条吻脊的 *Siphonodella sexplicata* (Branson et Mehl)。重要的是:本文修订了 *Siphonodella tirostrata* Druce 一种的含义,该种为 Druce^[23]命名。曾见于澳大利亚,后者的图版7为王成源^[7]厘定为 *S. quadruplicata*; 而图版8的特征是:齿体狭长,不对称。自由齿片为齿台的三分之一长,前缘高,由20多个愈合的细齿组成。吻部发育3~4条细齿发育的吻脊。内齿台2条,外齿台2条;最显著的特征是:外齿台近齿脊的一条吻脊与齿台后部吻脊交错排列(分布有微弱的横脊)。内齿台外侧吻脊可由连续的瘤齿呈脊状组成。其边缘分布瘤齿。从当前标本和 Druce^[23] Pl. 41, fig. 8 观察,该种发育4条吻脊;外齿台后边发育的吻脊有微弱的横脊与齿台上齿脊光滑无饰,或有微弱皮革状纹饰。与 *Siphonodella obsoleta* 特征一致;但前者外齿台两条

吻脊是分离的,不同于 *Siphonodella obsoleta* 外齿台靠近齿脊的吻脊,且从吻部一直延伸至齿台后缘^[24]。上述内容的出现和灭绝均发生在该化石带的中部。

该化石带的其它属主要分子为: *Polygnathus distortus* Branson & Mehl, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Polygnathus inornatus inornatus* E.R. Branson, *Polygnathus longiposticus* Wang & Wang, *Polygnathus inornatus lobatus* Branson & Mehl, *Polygnathus delicatula delicatula* Branson et Mehl, *Neoprioniodus postinversus* Helms, *Neoprioniodus barbatus* (Branson et Mehl), *Elictognathus bialata* (Branson & Mehl), *Elictognathus laceorata* (Branson & Mehl), *Ozarkodina regularis* Branson & Mehl, *Ozarkodina plana* (Branson et Mehl), *Pseudopolygnathus marginatus* (Branson & Mehl), *Pseudopolygnathus postimodosus* Rhodes, Austin et Druce; *Pseudopolygnathus dentilineatus* E. R. Branson, *Spathognathodus planiconvexus* Wang & Ziegler, *Dinodus fragosus* (Branson), *Dinodus wilsoni* Druce, *Protognathodus meischneri* Ziegler, *Tripodellus robustus* Bischoff, *Bispathodus aculeatus aculeatus* (Branson et Mehl), 及复合型分子: *Hindeodina* sp., *Hibbardella* sp., *Ligondodina* sp. 等。该带自下而上主要变化是中部的 *Polygnathus* 属,即由下部的3种、3亚种向上增加为3种6亚种。与该层位 *Siphonodella* 属的生物多样性的比值一致。

本文建立 *Siphonodella crenulata* 带可与王成源^[25] 贵州陆化下石炭统王佑组顶部至未命名组的同名化石带和季强^[11,12] 同名化石带生物群面貌一致,地质时代相当,可直接对比。同时,也可直接与宁宗善、白顺良等^[19] 和白顺良等^[20] 下石炭统黄茆组 *Siphonodella crenulata* 带或相当层位进行对比;所不同的是:当前 *Siphonodella crenulata* 带内不仅化石多样性十分丰富,而且化石标本数量多。重要的是在该带中下部新发现 *Siphonodella nandongensis* sp. nov. Li; *Siphonodella* sp. nov. A, 及发育5~6条吻脊的 *Siphonodella sexplicata* (Branson et Mehl); 和 *Siphonodella trirostrata* Druce. 为进一步开展生物多样性研究提供了新的材料。

本带相当于 Sandberg and Ziegler et al.^[1] Lower

Siphonodella crenulata 带,以 *Siphonodella crenulata* 首次出现为底界标志,生物群面貌大致相当(图1)。

(5) *Siphonodella lobata* 带

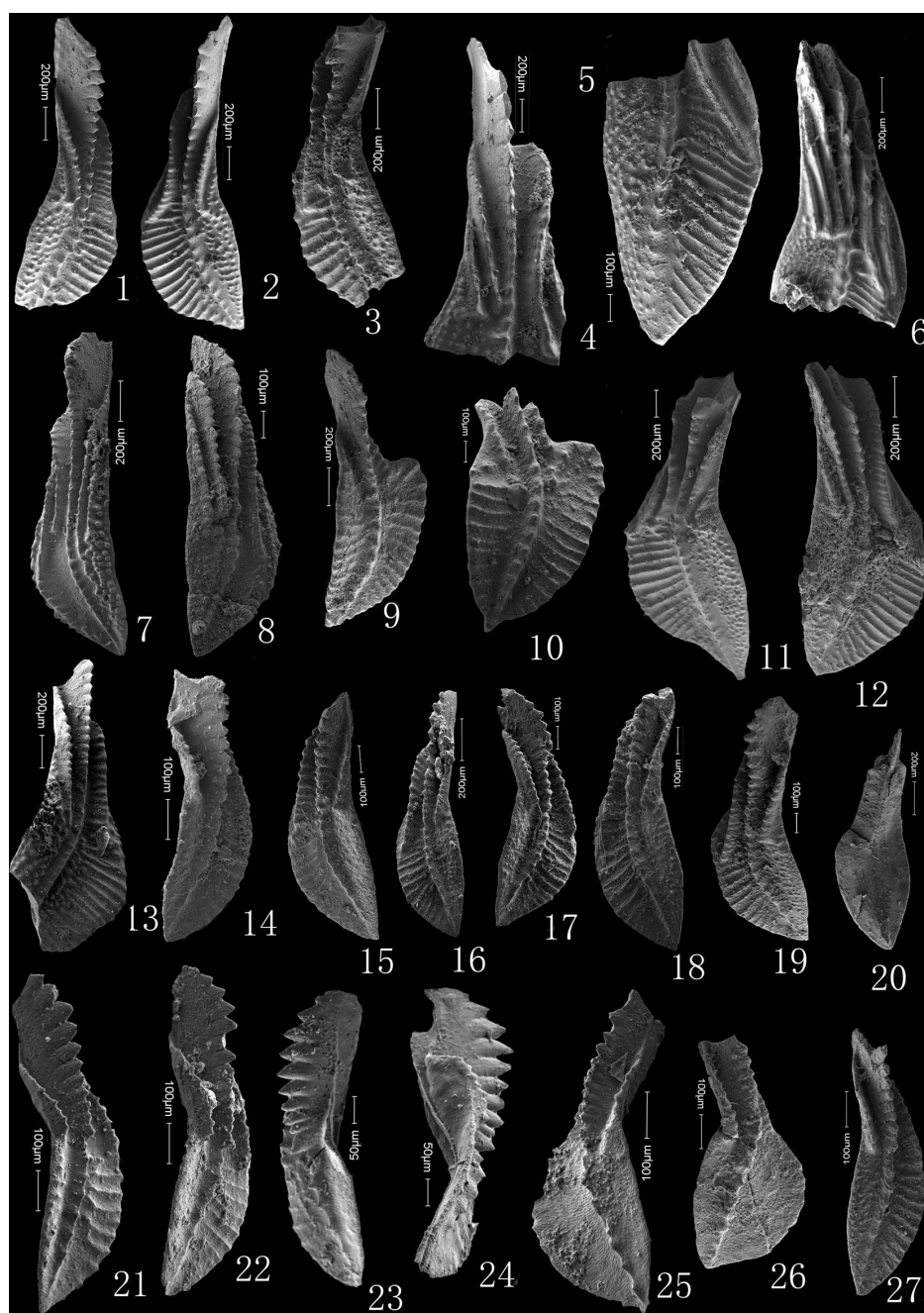
位于21层上部地层间隔中(36~37底部),厚约0.50 m。以 *Siphonodella lobata* 首次出现为底界标志,以 *Siphonodella crenulata* 首次出现为顶界标志。主要分子计有: *Siphonodella lobata* (Branson & Mehl), *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella duplicata* (Branson & Mehl) Morphotype 1; *Siphonodella eurylobata* Ji, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Pseudopolygnathus prima* Branson & Mehl, *Ozarkodina regularis* Branson et Mehl, *Hindeodina* sp. 等。其中 *Siphonodella lobata* 可由该带延至上覆 *Siphonodella crenulata* 带中部。

本文建立 *Siphonodella lobata* 带可与 Sandberg and Ziegler et al. *Siphonodella sanderbergi* 带^[1] 上部直接对比。资料显示: *Siphonodella lobata* 首次出现层位接近 *Siphonodella sanderbergi* 带顶部。

需要说明的是: Sandberg and Ziegler et al. 所建 *Siphonodella sanderbergi* 带的底界是由 *Siphonodella sanderbergi* 的首现限定^[1]; 顶界以 *Siphonodella crenulata* 首现限定。而当前本文建立 *Siphonodella lobata* 带实际上是该带的顶部层位。恰好 *Siphonodella lobata* 的首现层位又是在 *Siphonodella sanderbergi* 的顶部。同时, *Siphonodella lobata* 特征非常明显,不仅发育两条短的吻脊,最为突出的是:在外齿台前部发育了一个齿叶(本文图3中牙形石照片9和10),反口面有次级龙脊。从华南的资料看,季强^[11] 认为该种可由 *hassi* 带延至 *punctatus* 带。但从季强的资料^[12] 来看,该种首现于上 *duplicata* 带上部至 *Siphonodella crenulata* 带下部。与贵州陆化剖面^[25] 的结论基本一致。结合本剖面临近的黄茆剖面^[19] 上, *Siphonodella lobata* 主要见于牙形石 *Siphonodella sanderbergi* 带至 *Siphonodella crenulata* 带下部。

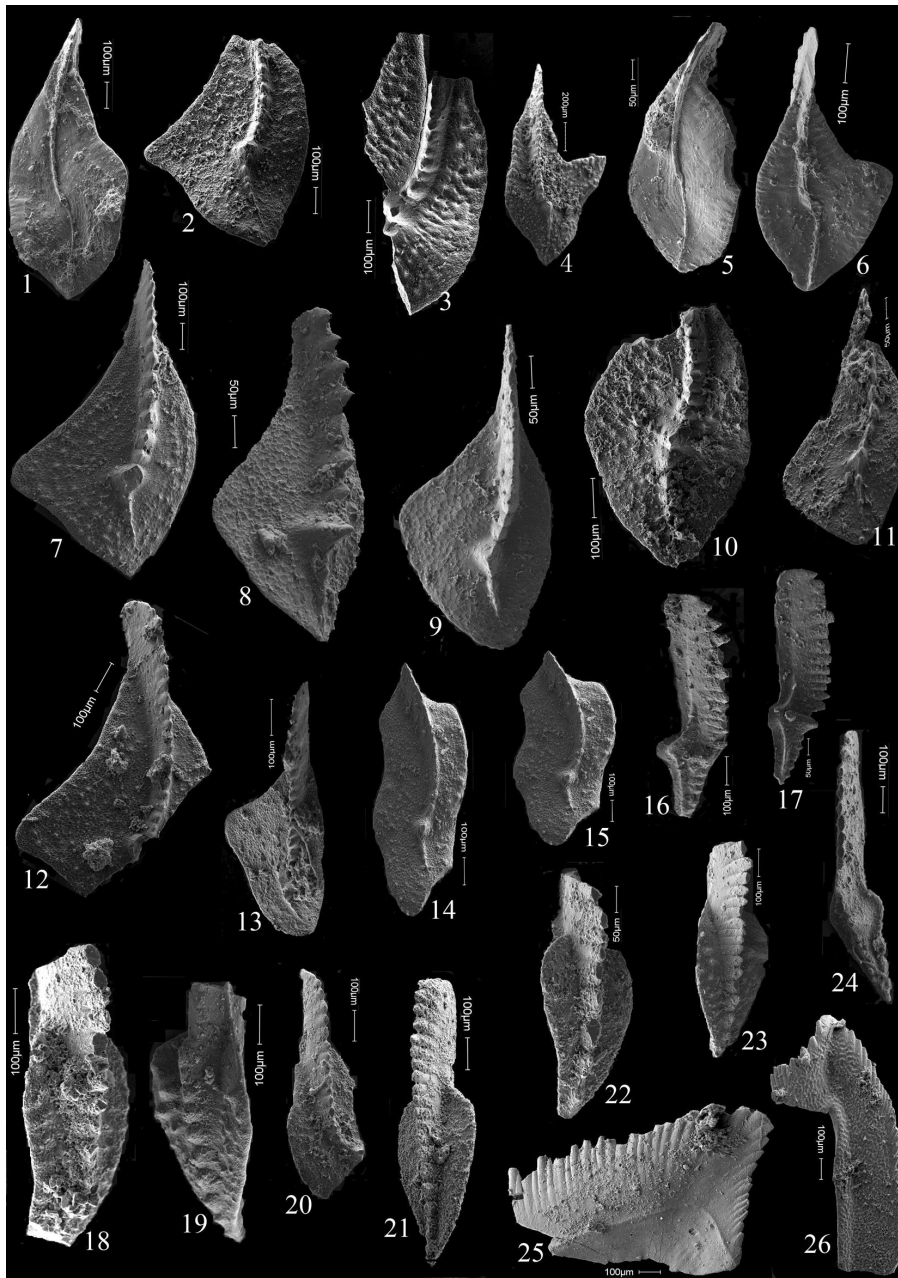
本文保留 *Siphonodella lobata* 作为建带分子,主要基于该种具有特征明显,分布广泛的特征。但也不排除该种属于浅水相生态类型,时限范围受控于岩相变化。

(6) *Siphonodella quadruplicata* 带(见图版II)



图版 II (Plate II)

1, 4-6, 11, 12. *Siphonodella quadruplicata* (Branson et Mehl, 1934) 1. 口视, 46/2014-25. 4. 口视, 43/2014-28. 5. 口视, 45/2014-31. 6. 口视, 44/2014-32; 11. 口视, 43/2014-29. 12. 口视, 43/2014-30. 产地层位均为: 广西武宣南垌下石炭统巴平组下段。2, 3. *Siphonodella cooperi* Hass, 1959. 口视, 45/2014-26. 3. 口视, 45/2014-27; 产地层位均为: 广西武宣南垌下石炭统巴平组下段。7, 8. *Siphonodella trirostrata* Durce, 1969. 口视, 44/2014-33. 8. 口视, 52/2014-34; 产地层位均为: 广西武宣南垌下石炭统巴平组下段。9, 10. *Siphonodella lobata* (Branson et Mehl, 1934) 9. 口视, 44/2014-35. 10. 口视, 45/2014-36; 产地层位均为: 广西武宣南垌下石炭统巴平组下段。13. *Siphonodella duplicata* sensu Hass, 1959 口方斜视, 44/2014-37, 产地层位: 广西武宣南垌下石炭统巴平组下段。14. *Siphonodella duplicata* (Branson et Mehl, 1934), Morphotype 2 口方斜视, 44/2014-38, 产地层位: 广西武宣南垌下石炭统巴平组下段。15-20, 27. *Siphonodella duplicata* (Branson et Mehl, 1934), Morphotype 415. 口视, 41/2014-39. 16. 口视, 28/2014-40; 17. 口视, 29/2014-41. 18. 口视, 28/2014-42. 19. 口视, 28/2014-43; 20. 侧视, 28/2014-44. 27. 口视, 30/2014-45. 产地层位均为: 广西武宣南垌下石炭统巴平组下段。21-24. *Siphonodella crenulata* (Cooper, 1934), Morphotype 221. 侧视, 45/2014-46; 22. 侧视, 45/2014-47; 23. 侧视, 45/2014-48; 24. 侧视, 45/2014-49, 产地层位均为: 广西武宣南垌下石炭统巴平组下段。25, 26. *Siphonodella eurylobata* Ji, 1985 25. 口视, 46/2014-50. 26. 口视, 41/2014-51. 产地层位: 广西武宣南垌下石炭统巴平组下段。



图版 III (Plate III)

- 1、5. *Palmatolepis linguiformis* Müller & Youngquist, 1947. 1. 反口视, 6/2014-52; 5. 反口视, 6/2014-56. 产地层位: 广西武宣南侗上泥盆统-下石炭统五指山组下部。2、7、12. *Palmatolepis* cf. *triangularis* Sannemann, 1955. 2. 口视, 6/2014-53. 7. 口视, 6/2014-58. 12. 口视, 6/2014-63. 产地层位: 广西武宣南侗上泥盆统一下石炭统五指山组下部。3、4. *Palmatolepis proversa* Ziegler, 1958. 3. 口视, 6/2014-54. 4. 口视, 6/2014-55. 产地层位均为: 广西武宣南侗上泥盆统-下石炭统五指山组下部。6. *Palmatolepis preatrigularis* Sandberg & Ziegler, 1988. 反口视, 6/2014-57. 产地层位: 广西武宣南侗上泥盆统一下石炭统五指山组下部。9. *Palmatolepis* cf. *minuta minuta* Branson & Mehl, 1934. 口视, 6/2014-59. 产地层位: 广西武宣南侗上泥盆统一下石炭统五指山组下部。9. *Palmatolepis minuta minuta* Branson & Mehl, 1934. 9. 口视, 6/2014-60. 产地层位: 广西武宣南侗上泥盆统一下石炭统五指山组下部。10、11、20. *Palmatolepis* sp. 10. 口视, 6/2014-61. 11. 口视, 6/2014-62. 20. 口视, 22/2014-71. 产地层位均为: 广西武宣南侗上泥盆统一下石炭统五指山组下部。13. *Palmatolepis delicatula delicatula* Branson & Mehl, 1934. 口视, 6/2014-64. 产地层位: 广西武宣南侗上泥盆统一下石炭统五指山组下部。14、15. *Palmatolepis glabra* subsp. nov. 14. 口视, 22/2014-65. 15. 口视, 22/2014-66. 产地层位均为: 广西武宣南侗下石炭统巴平组下部。16、17. *Palmatolepis gracilis sigmoides* Ziegler, 1962. 16. 侧视, 6/2014-67. 17. 侧视, 22/2014-68. 产地层位均为: 广西武宣南侗下石炭统巴平组下部。18、19. *Polygnathus marginatus* subsp. Sandberg & Ziegler, 1973. 18. 口视, 27/2014-69. 19. 口视, 22/2014-70. 产地层位均为: 广西武宣南侗下石炭统巴平组下部。21、22、23. *Polygnathus purus purus* Voges, 1959. 21. 口视, 28/2014-72. 22. 口视, 22/2014-73. 23. 口视, 22/2014-74. 产地层位均为: 广西武宣南侗下石炭统巴平组下部。24. *Palmatolepis gracilis gracilis* Branson & Mehl, 1934. 口视, 6/2014-65. 产地层位: 广西武宣南侗上泥盆统-下石炭统五指山组下部。25. *Dinodus* sp. A. 侧视, 26/2014-76. 产地层位: 广西武宣南侗下石炭统巴平组下部。26. *Dinodus* sp. B. 侧视, 26/2014-77. 产地层位: 广西武宣南侗下石炭统巴平组下部。

位于21层中部(33~36底部),厚1.50 m。以 *Siphonodella quadruplicata* 首次出现为底界标志,以 *Siphonodella lobata* 首次出现为顶界标志。

主要分子计有: *Siphonodella quadruplicata* (Branson et Mehl), *Siphonodella sandbergi* Klapper, *Siphonodella obsoleta* Hass, *Siphonodella eurylobata* Ji, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Siphonodella duplicata* (Branson et Mehl) Morphotype 2, *Siphonodella cooperi* Hass 其他主要分子: *Polygnathus lacinatus lacinatus* Hindle, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Pseudopolygnathus prima* Branson et Mehl, *Pseudopolygnathus trigulus inaequalis* Voges, *Elictognathus bialata* (Branson & Mehl), *Elictognathus lacerata* (Branson et Mehl); *Ozarkodina regularis* Branson & Mehl, *Spathognathodus cf. planiconvexus* Wang & Wang, *Ozarkodina regularis* Branson & Mehl, *Neoprioniodus postinversus* Helms, *Euprioniodus* sp., *Hindeodus* sp.等。

本文建立 *Siphonodella quadruplicata* 带可与季强同名化石带^[11]下部直接对比。*Siphonodella quadruplicata* 带的含义是:以 *Siphonodella quadruplicata* 首次出现为底界标志,以 *Siphonodella crenulata* 首次出现为顶界标志。当前该带的底界标志与上述化石带含义一致^[11],但顶界标志则是以 *Siphonodella lobata* 首次出现为顶界标志。仅相当于季强^[11] *Siphonodella quadruplicata* 带的下部。生物群面貌一致,地质时代相当。

(7) *Siphonodella sandbergi* 带

位于21层中下部地层间隔(32~33底部),厚约1.00 m。以 *Siphonodella sandbergi* 首次出现为底界标志,以 *Siphonodella quadruplicata* 首次出现为顶界标志。

主要分子计有: *Siphonodella sandbergi* Klapper, *Siphonodella duplicata* sensu Hass, *Siphonodella cooperi* Hass, *Siphonodella obsoleta*, *Polygnathus purus purus* Voges, *Polygnathus panata* Hinde, *Polygnathus bischaff* Rhodes et al., *Pseudopolygnathus triangulus triangulus* Voges, *Spathognathodus strigosus* Tomas, *Ozarkodina*

regularis Branson et Mehl, *Neoprioniodus postinversus* Helms, *Hibbardella* sp., *Elictognathus lacerata* (Branson et Mehl), *Elictognathus bialata* (Branson et Mehl), *Dinodus wilsoni* Druce, *Euprioniodus alternata*, *Hindeodella* sp.等。

本文所建立 *Siphonodella sandbergi* 带可与 Sandberg et Ziegler et al. 同名化石带^[1]下部直接对比。也对应于王成源^[7,25], 季强^[12] *Siphonodella sandbergi* 带下部。生物群面貌相似,地质时代相当。所不同的是,本文所建 *Siphonodella sandbergi* 带顶界标志是以 *Siphonodella quadruplicata* 首次出现限定。另外,在黄茆剖面上,从初始研究者的图示分析,未见说明;所建该化石带并不是以 *Siphonodella sandbergi* 首次出现为底界标志^[19]。

(8) *Siphonodella obsoleta* 带

位于五指山组上部20层至巴平组下段下部21层地层间隔(29~32底部),厚约1.80 m。以 *Siphonodella obsoleta* 首次出现为底界标志,以 *Siphonodella sandbergi* 首次出现为顶界标志。

主要分子计有: *Siphonodella obsoleta*, *Siphonodella duplicata* sensu Hass, *Siphonodella cooperi* Hass, *Siphonodella eurylobata* Ji, *Siphonodella duplicata* (Branson et Mehl) Morphotype 1, *Siphonodella duplicata* (Branson et Mehl) Morphotype 2; 其他主要分子有: *Spathognathodus strigosus* Tomas, *Polygnathus communis communis* Hass, *Polygnathus communis communis* Hass, *Polygnathus purus purus* Voges, *Polygnathus inornatus inornatus* E. R. Branson, *Polygnathus cf. distortus* Branson & Mehl, *Polygnathus bischaff* Rhodes et al., *Polygnathus lacinatus lacinatus* Huddle, *Pseudopolygnathus triangulus inaequalis* Voges, *Hindeodella subtilis* Ulrich & Bassler, *Elictognathus lacerata* (Branson et Mehl), *Bispathodus* sp.; *Pseudopoly. multistriatus* Mehl et Thoms, *Neoprioniodus postinversus* Helms, *Ozarkodina regularis* Branson & Mehl, *Falcodus* sp.等。

本文建立 *Siphonodella obsoleta* 带可与 Sandberg and Ziegler et al.^[1] Upper *duplicata* 带上部直接对比。大致对应于季强晚^[12] *duplicata* 上部。重要的是,可依据其指出 *Siphonodella obsoleta* 首见

于同名化石带的上部,与当前建立化石带可直接对比。

本文建立 *Siphonodella obsoleta* 带主要基于该种由 *Siphonodella duplicata sensu Hass* 演化而来,在北美、欧洲及华南等地区均有广泛的分布,层位稳定,特征突出。特别是 *Siphonodella obsoleta* 外齿台靠近齿脊的吻脊从吻部一直延伸至齿台后缘^[24]的特征易于同其他种区别。

(9) *Siphonodella cooperi* 带

位于20层下部,距底3.0~4.50 m地层间隔中(27~28),厚1.50m。以 *Siphonodella cooperi* 首次出现为底界标志,以 *Siphonodella obsoleta* 首次出现为顶界标志。

主要分子计有: *Siphonodella cooperi* Hass Morphotype 1, *Siphonodella duplicata sensu Hass*, *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, 其他重要分子有: *Pseudopolygnathus triangulus triangulus* Voges; *Pseudopolygnathus cf. marginatus* (Branson & Mehl), *Polygnathus communis communis* Hass, *Polygnathus bischaff* Rhodes et al., *Polygnathus purus purus* Voges, *Polygnathus inornatus inornatus* E. R. Branson, *Neoprioniodus postinversus* Helms 等。

本文建立 *Siphonodella cooperi* 带可与 Sandberg and Ziegler et al.^[1] *Upper duplicata* 带直接对比。其含义是以 *Siphonodella cooperi* 首次出现为底界标志。

笔者认为 *Siphonodella cooperi* 特征明显,层位稳定,而且有广泛的地理分布;与 *duplicata sensu Hass* 有着相似的形态特征呈连续过渡关系。故以该种的首现作为底界标志。

(10) *Siphonodella duplicata* 带上部

位于20层底部,距底3 m地层间隔(26),厚约1.50 m。以 *Siphonodella duplicata* (Branson & Mehl) Morphotype 1 带分子出现及伴生 *Polygnathus communis communis* Hass, *Pseudopolygnathus multistriatus* Mehl et Thomas, *Pseudopolygnathus marginatus* (Branson & Mehl) 为特征,可大致与白顺良等^[20,21]同名化石带对比。

主要分子计有: *Siphonodella duplicata* (Branson & Mehl) Morphotype 1, *Polygnathus communis communis* Hass, *Pseudopolygnathus multistriatus* Mehl et Thomas, *Pseudopolygnathus*

marginatus (Branson & Mehl) 等。并依据上覆地层 *Siphonodella cooperi* 首次出现,该层位仅相当于 *Lower duplicata* 带顶部层位^[7,12]。

值得说明的是:20层底部3m地层间隔和19层上部5.20m地层间隔未获牙形石。上述8.20m厚灰岩应大致可与白顺良等^[20,21] *Siphonodella praesulcata*, *Siphonodella sulcata*, *S. duplicata* 带下部对比。

(11) *Palmatolepis gracilis sigmoidalis* 带(见图版Ⅲ)

位于19层,距底3.00~20.0m地层间隔(22~25),厚约17m。以 *Palmatolepis gracilis sigmoidalis* 首次出现和消失为底、顶界标志。主要分子计有: *Palmatolepis gracilis sigmoidalis* Ziegler, *Pseudopolygnathus marburgensis trigonicus* Ziegler, *Protognathodus meischneri* Ziegler, *Protognathodus* sp., 及复合型分子: *Apathognathus klapperi* Druce, *Hindeodella* sp., *Lonchodina arcuata* Ulrich et Bassler, *Ozarkodina* sp., *Drepanodina subcircularis* Wang, *Polygnathus* sp. 等。

本文建立 *Palmatolepis gracilis sigmoidalis* 带,生物群面貌较为单调,但带分子比较丰富,可与华南地区晚泥盆世晚期同名化石带对比^[26],生物群面貌基本相似,可直接对比。亦大致相当于 *trachytera*, *postera*, *expensa* 和 *triangularis* 带的时限范围^[21]。

(12) *Palmatolepis marginifera marginifera* 带

位于13上部至18层下部,距底4.50~6.00 m地层间隔中(15~21),厚约60.0 m。以 *Palmatolepis marginifera marginifera* 首次出现为底界标志,以 *Palmatolepis gracilis sigmoidalis* 首次出现为顶界标志。主要分子计有: *Palmatolepis marginifera marginifera* Helms, *Palmatolepis cf. glabra peclinata* Ziegler, *Palmatolepis perlobata schindewolfi* Muller; *Polygnathus communis communis* Hass, *Polygnathus g. gracilis* Branson & Mehl, *Polygnathus purus purus* Voges, *Polygnathus inornatus lobata* Branson & Mehl; *Hindeodella subtilis* Ulrich & Bassler, *Tripodellus* sp. 等。

本文建立 *Palmatolepis marginifera marginifera* 带可与贵州睦化、广西南边村等剖面同名化石带^[7,25]

表 1 广西南桐上泥盆统法门阶一下石炭统杜内阶牙形石带与其他地区相同层位牙形石带对比
Table 1 Congnodont zones of the Upper Devonian Famenian and Lower Carboniferous Tournainian along the Nandong section, Guangxi, in comparison with those employed in some other regions

年代地层	广西南桐 (本文)		宁宗善等 ^[19] 白顺良等 ^[20,21]	王成源 ^[6,7,25]	季强 ^[12] , Liu Yong-qing et al. ^[8]	Sandberg et Ziegler ^[11]		
下石炭统	杜内阶	巴平组	<i>P. praedelicatus</i>	<i>S. crenulata</i>	<i>G. semiglaber</i>	<i>G. typicus</i>		
			<i>G. delicatus</i>					
			<i>S. isosticha</i>		<i>S. isosticha-</i> <i>u. crenulata</i>		<i>S. isosticha-</i> Late <i>S. crenulata</i>	<i>isosticha-</i> <i>U. crenulata</i>
			<i>S. crenulata</i>		<i>l. crenulata</i>		Early <i>crenulata</i>	
			<i>S. lobata</i>		<i>S. sanderbergi</i>		<i>S. sanderbergi</i>	<i>sanderbergi</i>
		<i>S. quadruplicata</i>						
		<i>S. sanderbergi</i>						
		五指山组	<i>S. obsoleta</i>	<i>u. duplicata</i>	<i>u. duplicata</i>	Late <i>duplicata</i>	<i>U. duplicata</i>	
			<i>S. cooperi</i>	<i>S. sulcata</i>	<i>l. duplicata</i>	Early <i>duplicata</i>	<i>L. duplicata</i>	
			<i>S. duplicata</i>		<i>S. sulcata</i>	<i>S. sulcata</i>	<i>S. sulcata</i>	
上泥盆统	法门阶			<i>S. preasulcata</i>	<i>u. preasulcata</i> <i>m. preasulcata</i> <i>l. preasulcata</i>	<i>u. preasulcata</i> <i>m. preasulcata</i> <i>l. preasulcata</i>	<i>S. preasulcata</i>	
		<i>Pa. g. Sigmoidalis</i>	<i>trachytera postera</i>	<i>u. expansa</i> <i>m. expansa</i> <i>l. expansa</i> <i>u. postera</i> <i>l. postera</i>				
		<i>Pa. m. marjilifera</i>	<i>trachytera marjilifera</i>	<i>u. trachytera</i> <i>l. trachytera</i> <i>u. marjilifera</i>				
		<i>Pa. m. minuta</i>	<i>rhomboidea crepida</i>					
		<i>Pa. triangularis</i>	<i>trianguliformis</i> <i>linguiformis</i> <i>rhenana</i>					

直接对比。但从华南的资料看,当前所建化石带的生物群面貌较为单调,大致可进行对比。亦相当于 *maginifera* 同名化石带^[25]。

(13) *Palmatolepis minuta minuta* 带

位于9~13层下部(10~14),厚约50.0 m。以 *Palmatolepis minuta minuta* 首次出现为底界标志,以 *Palmatolepis marginifera maginifera* 首次出现为顶界标志。

主要分子计有: *Palmatolepis minuta minuta* Branson et Mehl, *Palmatolepis delicatula delicatula* B. & M., *Icriodus alternatus* Branson et Mehl, *Polygnathus* sp., Branson et Mehl;

相当于 Bai Shunliang et al.^[21] *Palmatolepis crepida*, *Palmatolepis rhomboidea* 带。

(14) *Palmatolepis triangularis* 带

位于8层(6~9),厚约23.91m。以 *Palmatolepis triangularis* 首次出现为底界标志,以 *Palmatolepis minuta minuta* 首次出现为顶界标志。

主要分子计有: *Angulodus walrathi* (Hinbbard, 1927), *Polygnathus glaber bilobatus* Ziegler, *Polygnathus glaber glaber* Ulrich, *Polygnathus* sp. Indet.; *Palmatolepis triangularis* Sannemann, *Palmatolepis asymmetricus*, *Ligonodina* sp. indet.; *Avignathus* ? sp. indet.; *Bellodella* cf. *resima* (Philip, 1965), *Hindeodella germana* Holms, *Neoprioniodus* sp. indet., *Palmatolepis subperlobata* Branson & Mehl, *Polygnathus* sp., *Palmatolepis subperlobata* Branson & Mehl, *Pa. triangularis* Sannenmann, *Palmatolepis provasal* Ziegler, 1958, *Pa. asymmetricus*, *Pa. punctata*, *Pa. minuta*, *Pa.* cf. *linguiformis*, *Pa.* cf. *triangularis* Sannenmann, *Pa.* cf. *glabra peclinata* Ziegler, *Pa. varus*; *Bryantodus* sp., *Avignathus* sp.; *Angulodus walrathi* (Hinbbard), *Synprioniodina* sp., *Ligonodina* sp.; *Ozarkodina* sp. indet. 及竹节石。相当于 *renana*, *linguiformis*, *Palmatolepis triangularis* 带的时限范围^[21,26],可资对比。

4 结 论

精细生物地层对比研究表明,晚泥盆世至早石炭世早期南侗剖面所建立牙形石生物带与华南贵州陆化大坡上、广西桂林南边村乃至欧洲、北美、澳大利亚等地同期地层牙形石带可直接对比,其牙形石组合特征、生物群面貌较为相似。尤为重要的是:南侗剖面巴平组下段20~30层牙形刺系统演化特征,与Sandberg & Ziegler^[1]牙形石快速演化类群的系统发生、谱系演化十分相似。且化石组合特征也颇为相近。为同期地层划分提供了良好的对比标志。特别是本区巴平组下段上部牙形刺 *S. crenulata* 带上部和 *S. isosticha* 带, *Gnathodus delicatus* 带和 *Protognathus preadelicatus* 带等内容的补充和完善及南侗剖面 *S. crenulata* 带时限范围内发现的 *S. nandongensis* 和 *S. sp. nov. A*, *S. sexplicata*, *S. trirostrata* 等牙形石新材料,为进行洲际间不同生物地理分区的精细地层划分对比提供了详实的资料。

需要说明的是:五指山组20层底部3m地层间隔和19层上部5.20m地层间隔未获牙形石。上述8.20m厚灰岩应大致可与白顺良等^[20,21] *Siphonodella praesulcata*, *Siphonodella sulcata*, 下 *S. duplicata* 带下部对比。泥盆纪—石炭纪界线从中间通过。

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