贵州兴义烂滩剖面中—上三叠统之交鱼类微体化石和牙形石生物地层

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内容提要:贵州兴义烂滩剖面位于扬子地台西南缘,在该剖面第6层中发现3类辐鳍鱼牙齿化石,其伴生有介形类 *Cavellina jangyouensis*,在12层中发现软骨鱼类鱼鳞化石和2类辐鳍鱼牙齿化石,在第14发现大量的粗菊石 *Trachyceras* sp.。在该剖面上建立了2个牙形石带,自下而上分别为:*Paragondolella polygnathiformis* 和 *Paragondolella tadpole* 带。根据牙形石特征,把中晚三叠世拉丁和卡尼期的界线定于12层底部。该剖面为该区中上三叠统之交的地层提供了较好的生物地层格架,对地层时代划分及区域对比具有重要意义。

关键词:中—晚三叠世;竹杆坡组;鱼类微体化石;牙形石;贵州兴义

兴义地区位于云南和贵州的交界处,交通极为便利(图1)。该区中—晚三叠世地层海相碳酸盐岩地质记录良好,是研究中—晚三叠世生物地层的理想区域。拉丁末期和卡尼早期扬子地台西南缘沉积地层以竹杆坡组为代表。竹杆坡组最初由王钰等(1963)命名,现指整合于杨柳井组白云岩或垄头组块状亮晶灰岩之上,小凹组泥质灰岩之下的一套含双壳类、腕足类化石的灰色中厚层灰岩、白云质灰岩,时代为中三叠世拉丁期至晚三叠世卡尼早期(贵州省地质矿产局, 1997;曾雄伟等, 2014;李志广等,2016)。在竹杆坡组地层中含多层化石丰富的黑色岩系化石库,典型的剖面和化石点在贵州龙的发源地贵州省兴义市顶效绿荫村(杨瑞东, 1997),和贵州兴义市乌沙镇泥麦古村(马乐天等, 2013;邹晓东等, 2015),以保存属种丰富的海生爬行动物化石、产出大量胡氏贵州龙为特色,多门类脊椎动物和无脊椎动物共同繁盛的重要生物群落。

笔者在贵州兴义地区从事1:5万区域地质调查工作中(中国地质调查局成都地质调查中心[1]),发现一条地层连续、露头较好、顶底齐全的竹杆坡组剖面——贵州兴义烂滩剖面,在该剖面上发现大量的鱼类微体化石和牙形石,为研究中晚三叠世之交生物群落演化提供了非常好的基础资料。

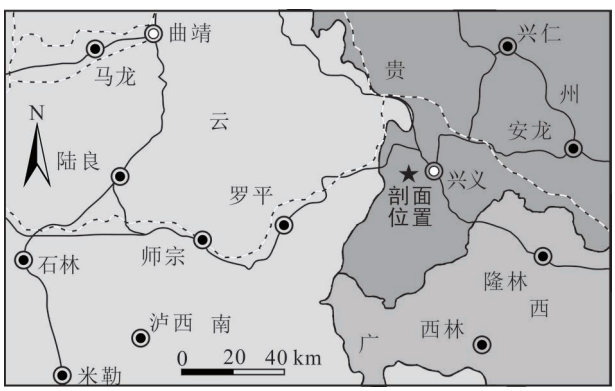


图1 贵州兴义烂滩剖面地理位置图
Fig. 1 Location map of the Lantan section in Xingyi, Guizhou Province

1 剖面描述

贵州兴义烂滩竹杆坡组剖面位于兴义市西侧岔米村烂滩附近,剖面起点地理坐标为25°04′07.5″N,104°47′52.2″E,终点地理坐标为25°04′13.6″N,104°48′10.2″E。剖面岩性及生物地层特征如图2所示。在地层分区上属于上扬子地层区下属的黔西南地层小区(贵州省地质矿产局, 1997),构造位置属于扬子陆块兴义隆起区(贵州省地质调查院, 2017)。岩性及厚度自上而下为:

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上三叠统小凹组

14 层:灰黑色中薄—中层状炭质泥岩夹薄层状深灰色泥灰岩。含牙形石:*Neogondolella* sp.;菊石:*Trachyceras* sp.;双壳:*Halobia* sp.。 45.29 m

——————整合——————

中—上三叠统竹杆坡组:314.33 m

13 层:深灰—灰黑色中—厚层状泥灰岩夹灰黑色炭质泥岩。 52.13 m

12 层:中—薄层状含生物碎屑泥质灰岩,风化面呈波丘状起伏。含牙形石:*Paragondolella polygnathiformis*、*P. tadpole*、*P. foliata inclinata*、*P. foliate foliata*、*Enantiognathus ziegleri*,鱼牙、鱼鳞。 39.83 m

11 层:灰—深灰色中薄层状泥晶灰岩夹炭质页岩,底部出露一层中层状含燧石结核泥晶灰岩,向上灰岩中的泥质成分逐渐增多。含鱼牙、鱼鳞。 7.41 m

10 层:浅灰—灰白色中薄状微晶灰岩,含生物碎屑,主要为海百合茎。向上岩石颜色逐渐变深。含牙形石:*Paragondolella polygnathiformis*、*P. foliata foliata*、*Enantiognathus ziegleri*,鱼牙、鱼鳞。 75.42 m

9 层:灰色中薄层状瘤状灰岩夹泥灰岩,风化面呈灰黄色。 6.67 m

8 层:灰—深灰色中厚层状含生物碎屑灰岩夹纹层状灰岩。 26.18 m

7 层:灰色中厚层状微晶白云岩夹中厚层状含生物碎屑灰岩。 3.40 m

6 层:灰—深灰色纹层状灰岩。含介形虫:*Cavellina jangyouensis* Xie,鱼牙。 16.36 m

5 层:灰—深灰色中厚层状含生物碎屑灰岩。 21.86 m

4 层:灰—浅灰色中厚层状砂屑灰岩夹纹层状白云质灰岩。 15.48 m

3 层:灰白—浅灰色中厚层状白云岩,夹纹层状白云岩。 9.55 m

2 层:灰—浅灰色中厚层状白云质灰岩,夹纹层状白云质灰岩。 40.04 m

——————整合——————

中三叠杨柳井组>13.59 m

1 层:灰白—浅灰色中厚层状粉—细晶白云岩。 13.59 m

未见底

2 鱼类微体化石的特征

在烂滩剖面上发现的鱼类微体化石包括了鱼鳞和鱼牙,形态多样,属于不同的类型。下面分类型介绍其特征。

鳞片类型 1:图 3i,大小 560 μm×410 μm。为软骨鱼类鳞片,由冠部、颈部和基部组成。鳞片冠部后倾,呈三尖状,冠后缘有三个冠尖,其中中部的冠尖略大,冠部上表面中央平台略突,向后收缩呈脊状,中央平台与冠部边缘之间为宽缓的鞍沟,下表面光滑无饰。颈部连接冠部和基部。基部较冠部大,呈近

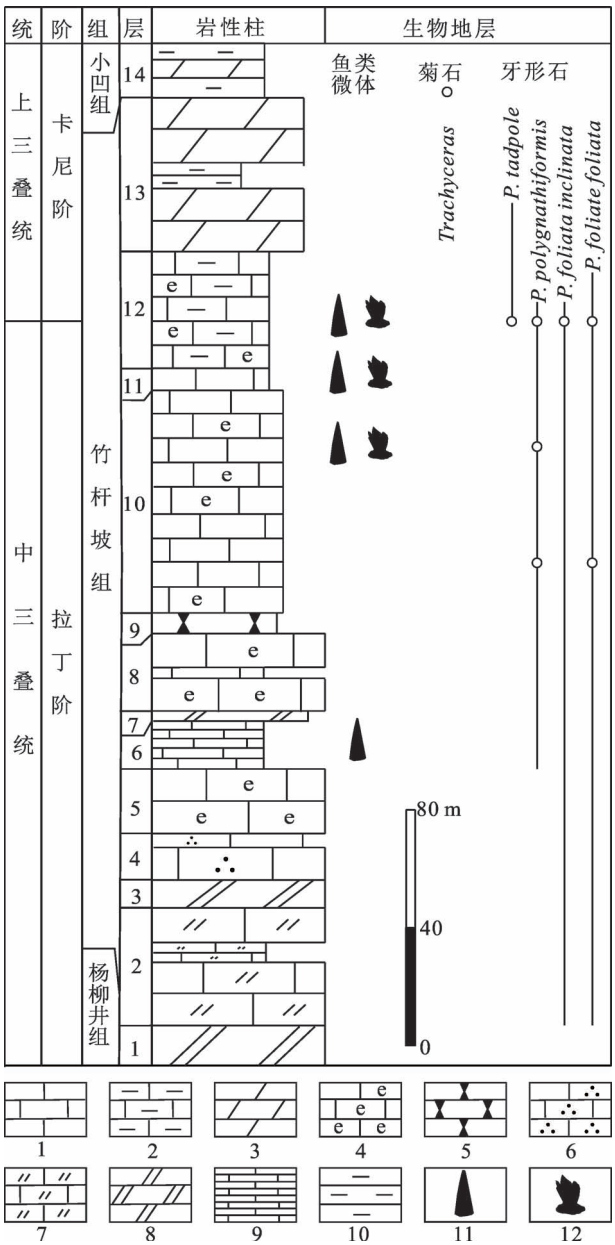


图 2 贵州兴义烂滩剖面岩性柱状图及主要化石分子

Fig. 2 Integrated stratigraphic column at the Lantan section in Xingyi, Guizhou, to show distribution of some index conodonts and fish microremains

1—泥晶灰岩;2—泥质灰岩;3—泥灰岩;4—生物碎屑灰岩;5—瘤状灰岩;6—砂屑灰岩;7—白云质灰岩;8—白云岩;9—纹层灰岩;10—泥岩;11—鱼牙;12—鱼鳞

1—micritic limestone; 2—muddy limestone; 3—marls; 4—bioclastic limestone; 5—nodular limestone; 6—sand limestone; 7—dolomitic limestone; 8—dolomite; 9—laminate limestone; 10—mudstone; 11—fish tooth; 12—fish scale

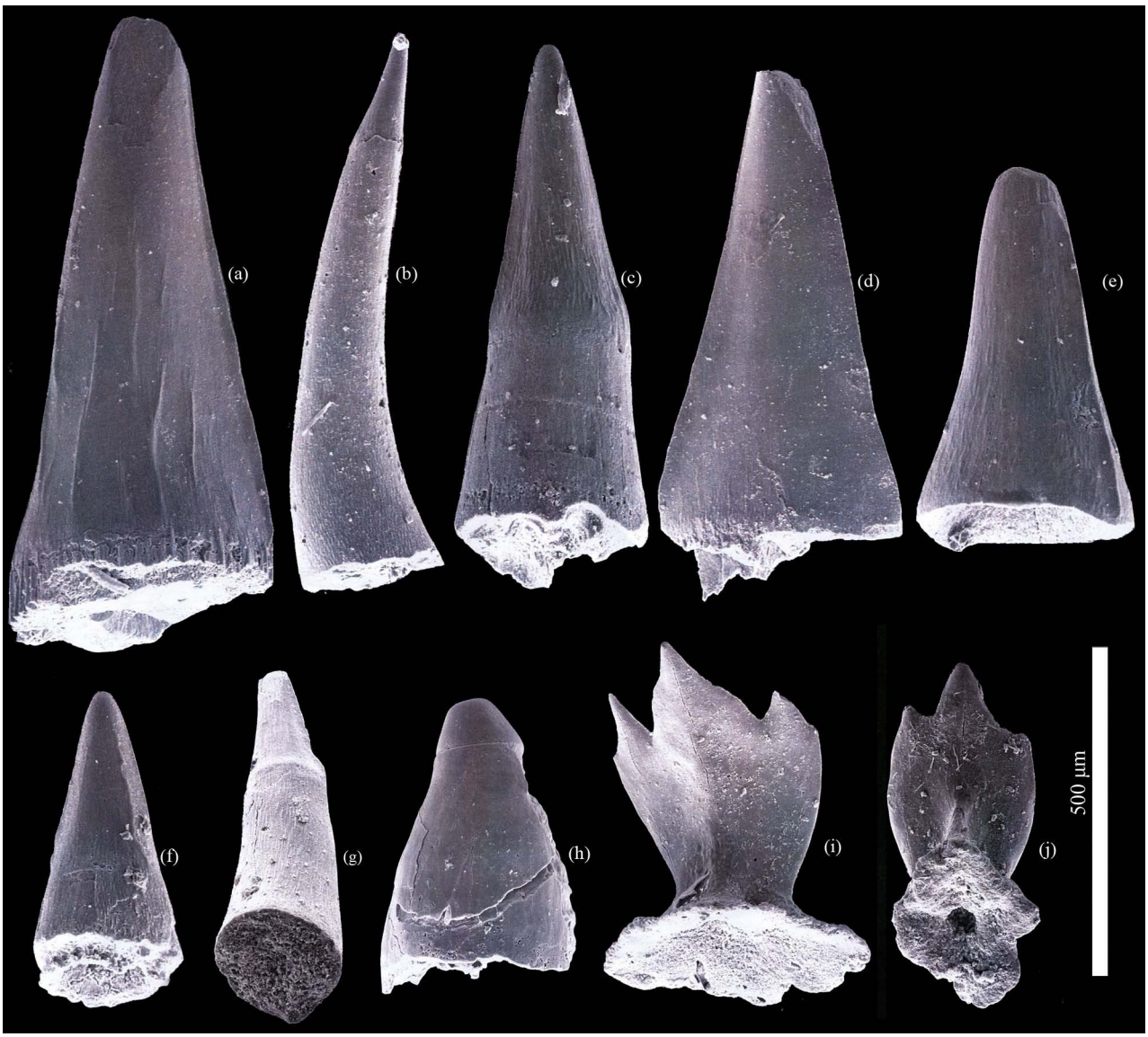


图 3 兴义烂滩剖面典型鱼类微体化石

Fig. 3 Illustrations of fish microremains from the Zhuganpo Formation in the Lantan section, Xingyi, Guizhou

(a)、(d)、(e)、(f)—鱼牙类型 1(辐鳍鱼类鱼牙),(a)、(d)剖面第 12 层,(e)、(f)剖面第 6 层;(b)—鱼牙类型 2(古鳕鱼类鱼牙),剖面第 12 层;(c)—鱼牙类型 3(比耶鱼类鱼牙),剖面第 6 层;(g)—鱼牙类型 4(辐鳍鱼类鱼牙),剖面第 11 层,(h)—鱼牙类型 5(辐鳍鱼类鱼牙),剖面第 6 层;(i)—鳞片类型 1(软骨鱼类鳞片),剖面第 12 层;(j)—鳞片类型 2(软骨鱼类鳞片),剖面第 11 层

(a), (d), (e), (f)—Tooth type 1 (Actinopterygian tooth), bed 12, bed 12, bed 6, bed 6; (b)—tooth type 2 (Palaeoniscoidea tooth), bed 12; (c)—tooth type 3 (Birgeria tooth), bed 6; (g)—tooth type 4 (Actinopterygian tooth), bed 11, (h)—tooth type 5 (Actinopterygian tooth), bed 6; (i)—scale type 1 (Chondrichthyes scale), bed 12; (j)—scale type 2 (Chondrichthyes scale), bed 11

圆形,基面微微内凹,中部的孔管系统开口较小。这与陈立德(2002)在贵州关岭小凹剖面瓦窑段下部发现的卡尼阶的 *Serratocorona halberdiforme* Ceng(戟状锯齿鳞)相似,不同在冠尖较少,仅三个,且基部较大,基下表面中部的孔管系统开口较小。与王念忠等(2007b)在浙江长兴县煤山剖面二叠/三叠系界线层上下软骨鱼类化石弓鲛科 Hybodontidae 鳞片不同在于颈部不发育。与张保民等(2012)在贵州贞丰竹杆坡组剖面中发现的拉丁阶的 *Fragilicorona wanlantricuspis* Zhang 不同在于基部更大,近圆形,颈部不发育。

鳞片类型 2:图 3j,大小 530 μm×230 μm。为软骨鱼类鳞片,由冠部、颈部和基部组成。鳞片冠部呈披针形,冠后缘有三个冠尖,其中中部的冠尖略大,

冠部上表面中央平台高突,中央平台前部为狭长的椭圆形,向后收缩呈脊状。冠部下表面光滑无饰。颈部连接冠部和基部。基部呈近菱形,基面内凹,有孔管系统,位于基部下表面中央,约占基部下表面的1/10。这与张保民等(2012)在贵州贞丰竹杆坡组剖面中发现的拉丁阶的 *Fragilicorona labritricuspi* Johns 相似,不同在于两翼冠尖略矮于中部最大冠尖,冠部上表面中央平台更为凸起。与陈立德(2002)在贵州关岭小凹剖面竹杆坡组上部、关岭瓦窑剖面竹杆坡组中部发现的拉丁阶—卡尼阶的 *Fragilicorona paralabritricuspis* Ceng(假横环单尖脆弱鳞)不同在两翼表面高凸不明显,冠前部没有显著的横向脊,基下表面中央孔管系统不大。

鱼牙类型1:图3a、d、e、f,呈扁尖锥状,长度480~965 μm,两侧具明显的侧棱,侧棱的一侧呈扁平状,另一侧略凸出,齿根具少数细的纵脊纹,略为粗大,断面呈椭圆状。为硬骨鱼纲辐鳍鱼类牙齿化石。与王念忠等(2007a)在浙江长兴煤山Z剖面长兴组上部发现的 *Baoqingichthys microdontus* Wang(小齿葆青鱼)相似,不同在于齿根更大,侧棱更为扁平。

鱼牙类型2:图3(b),呈纤长的单锥形,微微向后弯曲,长度850 μm,尖端质帽小,且表面光滑无饰,齿根表面具有细而密集大致平行排列且不连续的纵向细脊纹。为硬骨鱼纲古鳕鱼目牙齿化石。这与王念忠等(2007a)在浙江长兴煤山Z剖面长兴组顶部发现的 *Zhejiangichthys zhaoi* Wang(赵氏浙江鱼)和贵州紫云四大寨中二叠世晒瓦群第三段中发现的硬骨鱼类古鳕鱼牙化石(季强等, 2009)相似,不同在于齿根底部表面具有细小的纵向脊纹。

鱼牙类型3:图3c,呈短粗的单锥形,长度825 μm。齿帽表面具有细而密集大致平行排列且不连续的纵向细脊纹,向上明显收缩成齿尖。而齿根没见纵向细脊纹,齿根约与齿帽等长,略为粗大,呈筒状,断面近圆形。为硬骨鱼纲比耶鱼属牙齿化石。这与 Rieppel 等(1996)在美国内华达中三叠世的比耶鱼牙化石(Fig.5 c)相似在于齿帽具有密集的纵向脊纹,不同在于齿根纵向脊纹不发育。

鱼牙类型4:图3g,呈短粗的单锥形,微微向后弯曲,长度540 μm,尖端部分破损。整个牙齿表面具有细而密集大致平行排列且不连续的纵向细脊纹,齿根与齿帽间有一明显环形脊,齿根较为粗大,呈圆柱状,断面近圆形。为硬骨鱼纲辐鳍鱼类牙齿化石。

鱼牙类型5:图3h,长度450 μm,牙齿尖端质帽与齿根间有一明显的向内凹入的细环,整个牙齿表面光滑无任何饰纹。齿根略为粗大,呈筒状,断面近圆形。为硬骨鱼纲辐鳍鱼类牙齿化石。与王念忠等(2007a)在江西修水东岭剖面长兴组上段底部发现的辐鳍鱼类牙齿相似,不同在于牙齿破损,齿帽与齿根间的凹环不明显。与毛羽等(2013)在鄂西建始罗家坝剖面中二叠统孤峰组发现的辐鳍鱼类牙齿相似,不同在于齿根下部明显变粗。

3 牙形石生物地层

依据牙形石属种特征和地层分布情况,贵州兴义烂滩剖面可识别出2个牙形石带,自下而上为:*Paragondolella polygnathiformis* 和 *Paragondolella tadpole* 带。

Paragondolella polygnathiformis 带,烂滩剖面下部生物碎屑灰岩或白云岩未获取牙形石标本,不能判断是否为首现位置,顶界以 *P. tadpole* 的首现为标志。该带位于烂滩剖面11层(含)之下。此带以发现带分子 *P. polygnathiformis*(图4b)为特征,伴生分子有 *P. foliata foliata*(图4F)和 *Enantiognathus ziegleri*。*P. polygnathiformis* 最早由 Budurov 和 Stefanov(1965)命名,以其为带分子建立的化石带被认为是上三叠统卡尼阶最下部的一个牙形石带(Krystyn, 1983;Kozur, 1989;Balini et al., 2000;孙作玉等, 2005;Lehrmann et al., 2015)。在中国,*P. polygnathiformis* 多见于西南地区的法郎组、竹杆坡组、瓦窑组、边阳组和天井山组,如贵州关岭(杨守仁等, 1995;王红梅, 2000;陈立德和王成源, 2002;孙作玉等, 2005;Zhang Zaitian et al., 2017)、六枝(杨守仁等, 2002)、贞丰(杨守仁等, 1995;Sun Yadong et al., 2016)、罗甸(王红梅等, 2005;Lehrmann et al., 2015)、镇宁(王志浩和钟端, 1990)、兴义(王成源等, 1998),云南罗平(王志浩和钟端, 1990;Zhang Zaitian et al., 2018)、开远(王志浩和钟端, 1990),四川江油北川(王志浩和戴进业, 1981)等地。

Paragondolella tadpole 带,底界以带分子的首现为标志,未见顶。该带位于烂滩剖面12层(含)之上。此带以发现带分子 *P. tadpole* 为特征,*P. polygnathiformis*(图4c、d、e、g)继续延续本带,伴生分子有 *P. foliate inclinata*(图4a)、*P. foliata foliata*、*Enantiognathus ziegleri*。*P. tadpole* 最早发现于日本中部的 Adoyama 组(Hayashi, 1968),由其建立的化石带被认为是晚三叠统卡尼阶 Julian 亚阶下部的一



图 4 兴义烂滩剖面典型牙形石化石

Fig. 4 Illustrations of conodonts from the Zhuganpo Formation in the Lantan section, Xingyi

(a)—*Paragondolella foliata inclinata*,剖面第 12 层;(b)、(c)、(d)、(e)、(g)—*Paragondolella polygnathiformis*,(b) 剖面第 10 层、(c)、(d)、(e)、(g)剖面第 12 层.(f)—*Paragondolella foliata foliata*,剖面第 10 层

(a)—*Paragondolella foliata inclinata*, bed 12;;(b)、(c)、(d)、(e)、(g)—*Paragondolella polygnathiformis*, bed 10, bed 12, bed 12, bed 12, bed 12;(f)—*Paragondolella foliata foliata*,bed 10

个牙形石带(Gallet et al., 1994; Orchard, 2007; Zhang Zaitian et al., 2017)。在中国,*P. tadpole* 见于西南地区的竹杆坡组中,如贵州关岭(杨守仁等, 1995;陈立德和王成源, 2002;孙作玉等, 2005; Zhang Zaitian et al., 2017)、贞丰(杨守仁等, 1995; Sun Yadong et al., 2016;Zhang Zaitian et al., 2017)、六枝(杨守仁等, 2002),云南罗平(Zhang Zaitian et al., 2018)等地。

4　讨论

海相拉丁阶—卡尼阶界线,以菊石 *Daxatina canadensis* 的首现位置标志卡尼阶的底界(Mietto et al., 2012),在我国目前没有发现定义该界线的标准菊石分子(童金南和殷鸿福, 2015)。作为第二辅助标准的牙形石 *P. polygnathiformis* 的首现位置作为卡尼阶的底界被大多数学者所认可(Krystyn, 1983; Kozur, 1989; Balini et al., 2000;孙作玉等, 2005; Lehrmann et al., 2015)。但 *P. polygnathiformis* 延限长,不同发育阶段形态多有不同(Koike et al., 1991; Hopkin, 2009;Chen Yanlong et al., 2017),且与标准菊石分子 *Daxatina canadensis* 不等时出现(Krystyn et al., 2004;Orchard, 2007;Mietto et al., 2012),甚至与拉丁期菊石混生出现(杨守仁等, 1995;Krystyn et al., 2004; Orchard, 2010; Zou Xiaodong et al., 2015)。因此,有学者提出以牙形石 *P. tadpole* 的首现作为卡尼阶的开始标志(孙作玉, 2006;郭文等, 2017),因为 *P. tadpole* 的首现点与菊石 *Daxatina* cf. *Canadensis* 的首现点最为接近(Krystyn et al., 2004)。据此,我们使用 *P. tadpole* 的首现作为卡尼阶的底部(表 1),在烂滩剖面竹杆坡组上部(12 层及以上)归入卡尼阶,竹杆坡组下部(11 层及以下)归入拉丁阶。

在扬子地台西南缘竹杆坡组中发现鱼类化石主要集中在贵州龙动物群层位,目前发现有 10 属 10 种(苏德造, 1959;刘冠邦等, 2003; Tintori et al., 2012;耿丙河等, 2012; Xu Guanghui et al., 2012,

表 1 滇东、黔西南地区拉丁—卡尼阶牙形石带对比表

Table 1 The correlation of the conodont zonations across the Ladinian—Carnian boundary in eastern Yunnan and southwestern Guizhou

阶	亚阶	菊石带 (Mietto et al.,2008)	牙形石带					
			本文	滇黔桂 (王志浩等, 1990)	黔西南 (杨守仁等, 1995)	贵州关岭/云南罗平 (孙作玉, 2006)	贵州罗甸 (Lehrmann et al.,2015)	贵州贞丰 (Zhang Zaitian et al.,2017)
卡尼阶	Cordevolian	*Trachyceras aon*		*P.polygnathiformis -Gladigondolella*	*P.polygnathiformis -P.tadpole*	*P.auriformis*		*P.*aff.*praelindae*
								P.tadpole
		Daxatina canadensis	*P.tadpole*		*P.polygnathiformis -P.maantangensis*	*P.tadpole*	*P.polygnathiformis*	*P.polygnathiformis*
拉丁阶	Longobardian	*Frankites regoledanus*	*P.polygnathiformis*	*mombergensis*		*P.polygnathiformis*	*P.inclinata*	*P.foliata*

2015)。在周边同时期发现有较多的鱼类微体化石,如张保民等(2012)在贵州贞丰挽澜剖面竹杆坡组地层中发现 4 属 6 种软骨鱼类鱼鳞化石;陈立德(2002)、Chen Lide and Cuny(2003)和 Chen Lide et al.(2007)在贵州关岭地区中晚三叠世法郎组中发现的软骨鱼类微体化石等,这些鱼类和鱼类微体化石(包括烂滩剖面发现的 2 种鳞片类型和 5 种鱼牙类型)与西特提斯同期的鱼群关系密切(金帆,2001, 2006),同时,可与该地区早、中三叠世的鱼类和鱼类微体化石进行对比,如早三叠世广西田东的软骨鱼类(王念忠等,2001)、中三叠世罗平生物群中的鱼类化石(张启跃等,2008;谢韬等,2019),这为二叠纪末生物大灭绝之后脊椎动物演化、复苏和辐射提供了材料。

烂滩竹杆坡组剖面可与扬子地台西南缘周边竹杆坡组剖面进行对比,如贵州关岭永宁剖面(竹杆坡组层型剖面)(王钰等, 1963;贵州省地质矿产局, 1997;孙作玉等, 2005;曾雄伟等, 2013)、贵州贞丰龙场剖面(贵州省地质局❷, 1980;Sun Yadong et al., 2016)、贵州兴义乌沙泥麦古剖面(邹晓东等, 2015;Zou Xiaodong et al., 2015)、贵州义龙顶效剖面(陈宗富, 1985;胡智丹等, 2018)、贵州贞丰挽澜剖面(张保民等, 2012;王建坡等, 2013;曾雄伟等, 2013)、云南罗平板桥牛补歹剖面(云南省地质局❸, 1977;孙作玉, 2006;曾雄伟等, 2013)、云南罗平钟山菜子塘剖面(云南省地质局❸, 1977;Zhang Zaitian et al., 2018)等,进而为研究竹杆坡组的岩石、生物和年代地层提供基础,也为该区拉丁—卡尼期地层划分和对比提供材料。

5 结论

在贵州兴义烂滩竹杆坡组剖面第 6、11 和 12 层发现大量的鱼类微体化石,共分出 2 种鱼鳞类型和 5 种鱼牙类型。同时,建立了 2 个牙形石带,自下而上分别为: *Paragondolella polygnathiformis* 和 *Paragondolella tadpole* 带,以 *Paragondolella tadpole* 带底界(12 层底)作为中—上三叠统拉丁和卡尼阶的界线。该剖面可与扬子地台西南缘其他竹杆坡组剖面进行对比,对确定扬子地台西南缘中—晚三叠世地层层序、时代划分及区域对比具有重要的意义。

致谢:牙形石由云南省地质矿产勘查开发局区调队董致中老师鉴定,审稿专家提出了宝贵的修改意见,在此一并向他们表示诚挚的感谢。

注 释 / Notes

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❷ 贵州省地质局. 1980. 中华人民共和国 1∶20 万区域地质调查报告安龙幅.

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Fish microremains and conodont biostratigraphy across the Middle—Upper Triassic boundary at the Lantan section, Xingyi area, Guizhou Province

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Objectives: The Lantan section is located on the southwestern margin of the Yangtze platform. Because of its special paleogeographic position, the research of the Lantan section has great significance for the biostratigraphic subdivision and stratigraphic comparison on the southwestern margin of the Yangtze platform.

Methods: The main methods of this investigation are surveying section and conodont biostratigraphy in detail. At the same time, we study the characteristics of fish microremains at the Lantan section.

Results: Three types of Actinopterygii teeth and Ostracods *Cavellina jangyouensis* were discovered in the bed 6 of the Lantan section. Elasmobranchii scales and two types of Actinopterygii teeth were discovered in the bed 12. Abundant of *Trachyceras* sp. were discovered in the bed 14. Two conodont zones have been established from bottom

to top: *Paragondolella polygnathiformis* Zone and *Paragondolella tadpole* Zone.

Conclusions: There are two types of scales and five types of teeth at the Lantan section from the Zhuganpo Formation, Xingyi, Guizhou Province. According to the characteristics of conodont, the boundary between Ladinian and Carnian is defined at the bottom of the bed 12. It can help to build the biostratigraphica framework for the Middle—Upper Triassic boundary nearby.

Keywords: Middle—Late Triassic; Zhuganpo Formation; Fish microremains; conodont; Xingyi, Guizhou Province

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