

Discovery of the Middle–Late Triassic elasmobranch ichthyoliths from the Guanling area, Guizhou, SW China

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摘要:应用Johns等(1997)的形态分类系统,对首次报道出现于贵州关岭地区中上三叠统的软骨鱼类的微体化石进行了初步研究,描述了其中的1个牙齿化石(可能属于弓鲛鲨科的)和7个鳞片类化石的形态属种,其中包括两个鳞片类化石的新属种,即*Lobatocorona* cf. *floriditurris*, *Sacrisubcorona* cf. *circabasis*, *Glabrisubcorona* cf. *arduidevexa*, *Parvicorona daerysulca* n. gen. et. n. sp. s. f., *Annulicorona pyramidalis* n. gen. et. n. sp. s. f., new (?) paragera A 和 new (?) paragera B。还初步探讨了软骨鱼类微体化石在三叠纪地层划分中的应用,以及中国西南部三叠纪软骨鱼类与北美相当地层中软骨鱼类的洲际对比。

关键词:法郎组;软骨鱼类;三叠纪;贵州关岭

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Abstract: Abundant Middle–Late Triassic (Ladinian–Carnian) elasmobranch ichthyoliths (microscopic shark dermal denticles and teeth) from the Zhuganpo and Xiaowa Formations in the Guanling area, Guizhou Province, south-western China, are described and illustrated. The fauna includes a single tooth possibly belonging to Hybodontidae and 7 paragera and paraspecies of dermal denticles, i.e.: *Lobatocorona* cf. *floriditurris*, *Sacrisubcorona* cf. *circabasis*, *Glabrisubcorona* cf. *arduidevexa*, *Parvicorona daerysulca* n. gen. n. sp. s. f., *Annulicorona pyramidalis* n. gen. n. sp. s. f., and new (?) paragera A and B. This is the first time that shark dermal denticles are reported from the *Metapolygnathus polygnathiformis*–*M. nodosus* conodont zones. The application of microfossils of chondrichthyes in the stratigraphic division of the Triassic and the intercontinental correlation of Triassic chondrichthyes in south-western China and those in equivalent strata in North America are also discussed.

Key words: Chondrichthyes; Elasmobranchii ichthyoliths; Triassic; Carnian, Guizhou

1 Introduction

The Middle–Upper Triassic is subdivided in ascending order into the Guanling Formation, Yangliujing Formation, Zhuganpo Formation, Xiaowa Formation and Laishike Formation (Table 1). Among them the Zhuganpo and Xiaowa Formation revised (Wang et al. 2002)^[1] are equivalent to the Falang Formation, located near Falang Village in the Huajiang District, Guanling County. The stratigraphy has been described by Wang et al.^[1], Yin^[4], Chen et al.^[5], and Yang^[6] (Table 1). The Zhuganpo Formation consists mainly of nodular limestones and has a thickness of 100 m. The lower part of Xiaowa Formation consists of alternating beds of limestones and shales 11 to 12 m thick., with the shales becoming more and more dominant up-

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wards. The shales, corresponding to an anoxic environment, have yielded a very rich fauna of excellently preserved marine reptiles, fishes, crinoids, ammonites, and bivalves known as the "Guanling biota"⁷¹. For the age of the Zhuganpo Formation and Xiaowa Formation, we have tentatively correlated the Zhuganpo Formation with the Lower Carnian *Metapolygnathus polygnathiformis* conodont Zone, except the uppermost part, which, together with the Xiaowa Formation, is correlated with the Middle Carnian *M. nodosus* conodont Zone.

Table 1 Different schemes of stratigraphic scheme proposed for southwestern Guizhou

Wang Yu et al. ¹⁾ (1963)		Yin Hongfu ⁴ (1962)		Chen Chuzheng et al. ¹⁵⁾ (1979)		Guizhou Bureau ¹¹⁾ (1987)		Yang Shouren et al. ¹⁴⁾ (1995)		This paper	
Banan F.		Banan F.		Banan F.		Banan F.		Banan F.		Bana F.	
Ladinian	Falang F.	Falang F.	Sixth M.	Falang F.	Laishike M.	Falang F.	Laishike F.	Carnian	Laishike F.	Ladinian	Laishike F.
	Zhuganpo Limestone		Fifth M. (Zhuganpo M.)		Zhuganpo M.		Wayao M.		Wayao F.		Xiaowa F.
							Zhuganpo M.		Zhuganpo F.		Zhuganpo F.
Anisian	Yangliujing Limestone	Guanling F.	Fourth M. (Yangliujing M.)	Guanling F.	Yanghujing M.		Yanghujing F.	Anisian	Yangliujing F.	Anisian	Yangliujing F.
	Guanling F.				Guanling M.	Guanling F.	Guanling F.		Guanling F.		

2 Material and Method

The specimens described in this work have been collected from three localities (Fig. 1). The first one is near the village of Bamaolin, in a cliff in the lower part of the Xiaowa Formation near a small river; the second one along the road leading to the village of Xiaowa, approximately one kilometer to the village, also in the lower part of the Xiaowa Formation; the third one near the Wayao Village in the Zhuganpo Formation. All the localities are located in the Xinpu Township, Guanling County, Guizhou Province. All the specimens were recovered from limestones while the shales were barren of Chondrichthyan dermal denticles. However, the same shales have yielded many vertebrate fossils, mostly marine reptiles and some osteichthyan remains¹⁸⁻⁹. From the Bamaolin and Xiaowa localities, a sample of 500 g was collected from each bed in the studied section. In the Wayao locality, only eleven samples were collected from beds 25, 24, 23, 21, 19, 18, 15, 14, 6, 4 and 1. All the samples were processed in 8% acetic acid for 24 hours and then washed. The process was repeated 7 times. The samples were then screen-washed and sorted, primarily for conodonts recovery.

3 Systematic Paleontology

3.1 Tooth

Class Chondrichthyes

Subclass Elasmobranchii

Cohort Euselachii

Order ? Hybodontiformes

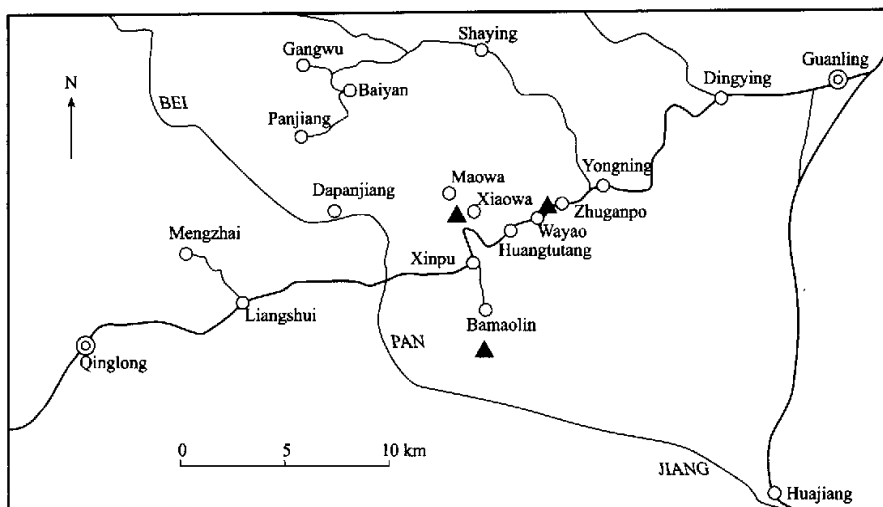


Fig. 1 Location of the investigated sections (Dark triangles: fossiliferous sites)

Family ? Hybodontidae

Genus and species indeterminate.

(Plate I, fig. 1)

Material. 1 posterior tooth.

Locality. Wayao Village, Zhuganpo Formation, Bed 22 (YTZC22).

Description. This tooth is a minute one, measuring only 0.76 mm mesio-distally and 0.20 mm labio-lingually. It has one main cusp bent distally and three pairs of lateral cusplets not very well preserved. The main cusp is 0.29 mm high. All the cusps show a convex surface while the lingual one is flat. The ornamentation on the labial side of the main cusp is made of one ridge originating from the apex and dividing itself in the upper third of the cusp, the resulting two ridges dividing again near the base of the crown, although the ornamentation has not been preserved in the mesial part of the main cusp. The labial and lingual sides of the lateral cusps, as well as the lingual side of the main cusp show a single ridge from the base to the apex. The crown is separated from the root on the labial side by a shallow furrow, the crown overhanging the root.

The crown also overhangs the root mesially and distally, resulting in a root shorter than the crown, measuring only 0.75 mm mesio-distally.

The root is very shallow (0.03 mm on the labial side) and projected lingually, at nearly 90° from the axis of the crown, but this projection is short, the maximum labio-lingual width being 0.27 mm. The vascularization of the root is made of numerous foramina of equal size distributed on the labial, basal, and lingual sides. They form a single irregular row on the labial and lingual side. On the lingual side, there is a larger, specialized foramen in a central position.

Comparison. The phylogenetic relationships of this tooth are rather difficult to decipher. The main cusp strongly bent distally and the minute size of the tooth indicates that it is a posterior tooth, which usually lacks diagnostic characters. The lingual projection of the root may suggest neoselachian affinities but it is shorter than the one seen in some early neoselachian like "*Hybodus*" *minor*^[10] or *Mucrovenator minimus*^[11]. Moreover, the vascularization is much similar to that of the Hybodontiformes. If this tooth belongs to a

hybodontiform shark, the well-developed main cusp on a posterior tooth suggests that it is a Hybodontidae. Only a study of the enameloid microstructure will permit a definitive answer, but the minute size of this tooth makes such a study technically very difficult. Pending the discovery of more material, we therefore tentatively consider that this tooth belongs to a Hybodontidae.

Range. Lower Carnian, *Metapolygnathus polygnathiformis* conodont Zone

3.2 Dermal denticles

The main lines of the utilitarian taxonomic system and hierarchy promoted by Johns^[12-14] have been used in this work, bearing in mind that this system, in the current state of our knowledge, does not allow the differentiation between neoselachian and hybodont dermal denticles. However, many of our specimens do not fit into the subgroups defined by Johns et al.^[14]. We think that the multiplication of subgroups is not warranted for the time being as it will result in possible confusion when more material will be described. Therefore, only the pedicle features have been taken into account for classification purposes.

3.2.1 Supergroup I: pedicle truncate

Group A: pedicle fluted truncate

Lobaticorona Johns, Barnes, and Orchard, 1997

Type species. *Lobaticorona floriditurris* s. f. Johns, Barnes, and Orchard, 1997

***Lobaticorona* cf. *floriditurris* Johns, Barnes, and Orchard, 1997**

(Plate I, fig. 4)

Material. 1 complete specimen.

Locality. Wayao Village in the lower part of the Xiaowa Formation, Bed 25B.

Description. The crown is erect, with an irregular outline in apical view. It is ornamented with very well developed, anastomosing ridges, but lacks developed lobes. There are two to three ridges on each side of the crown.

The pedicle is subcentral, with a base outline subcircular. The subpedicle is concave with a foramen in a central position.

Comparison. This species has narrower crown lobes than *Lobaticorona floriturris*^[14] and the pedicle is subcircular rather than multipetaloid. However, this could be the result of some wear. The crown morphology is also similar to that of *L. tumiditurris*^[14], but the latter shows a convex subpedicle. Pending the discovery of more material, our specimens are therefore cautiously referred to as *L. cf. floriditurris*.

Range. Middle Carnian, *Metapolygnathus nodosus* conodont Zone.

New Paragenus A

(Plate II, figs. 9-10)

Material. 1 complete specimen and one with the apical part of the crown broken.

Locality. Wayao Village in the lower part of the Xiaowa Formation, Bed 25B.

Description. The crown is deeply oblique with an acute lanceolate shape and possesses three apices. The mesial platform is narrow and prominent in the lower half of the crown. Basally, it is supported by a mesial keel on the pedicle. Distally, it forms a ridge reaching the main apex. There is no anterior longitudinal shoulder ridge. The lateral wings are approximately half the height of the main crown and are separated from it by a shallow furrow. The subcrown is without a medial ridge or a halo. The crown does not overhang the pedicle. The pedicle is anterior and is of a fluted truncate type. It is higher than the crown. The subpedicle is rhomboid in outline, slightly concave with a central canal opening.

Comparison. These specimens are characterized by a subcrown lacking ornamentation. This character is

found only in *Parviscapa*, but the latter is easily separated from the Chinese form by its supracentral pedicle. However, taking into account the small number of specimens currently available, we are reluctant to name a new paragenus and prefer, for the time being, to leave it in open nomenclature.

Range. Middle Carnian, *Metapolygnathus nodosus* conodont Zone.

Group B. Pedicle plain truncate

***Parvicorona* n. gen. s. f.**

Etymology. *Parva* small and *corona* crown (Latin), referring to the small size of the crown, as compared with that of the pedicle.

Type species. *Parvicorona dacrysulca* s. f.

Diagnosis. Monospecific paragenus, see diagnosis for the type paraspecies.

Comparison. The crown of *Parvicorona* dermal denticles are quite similar to that found in the genus *Parviscapa*^[14] and both genera possess a supracentral pedicle. However, the shape of the mesial area is very different between the two genera, *Parvicorona* with a narrow tear-drop shape and plain truncate while *Parvicorona* with fluted truncate.

***Parvicorona dacrysulca* n. sp. s. f.**

(Plate II, figs. 1-8)

Material. 8 complete specimens, among which YTZC25B/TC0072 is designated the holotype.

Locality. 4 specimens from the upper part of the Zhuganpo Formation, near Wayao Village, Bed 25A (YTZC24A), 2, including the holotype, from the lower part of the Xiaowa Formation, near Wayao Village, Bed 25B (YTZC25B), and 2 from the lower part of the Xiaowa Formation, near Xiaowa Village, Bed 15 (XTZC15).

Etymology. *dacry*(tear in Latin), *sulca*(furrow in Latin), named for its narrow tear-drop-shaped mesial area.

Diagnosis. Crown erect to slightly oblique, outline lanceolate with a single acute apex and a prominent mesial area having a narrow tear-drop shape; subcrown surface ornamented with a prominent mesial ridge; pedicle anterior supracentral, plain truncate; subpedicle oval in outline and shallowly concave.

Description. The crown is erect or slightly oblique and its outline is lanceolate with an acute single apex. The mesial area of the crown is delineated by two ridges and those ends meet anteriorly and posteriorly, giving this area a narrow teardrop outline. Its surface is concave and protrudes from the surface of the crown. It does not attain the apex of the crown as the delineating ridges fuse together between 1/2 and 4/5 of the height of the crown to form a single ridge reaching the apex. The rest of the crown is not ornamented. The crown does not overhang the pedicle. The subcrown shows a prominent mesial ridge, extending from the base of the subcrown to its apex. The lateral sides of the subcrown are unornamented and shallowly concave, without a halo. The pedicle is plain truncate and supracentral. The subpedicle is oval in outline with a central canal opening. Its surface is slightly concave and is larger than that of the crown.

Remark. Two dermal denticles of *Parvicorona dacrysulca* have been found still attached together (Plate I, fig.8), which would suggest they were not shed but more probably belonged to a complete dead specimen.

Range. Lower-Middle Carnian. Plate II, figs. 1-3, 8, *Metapolygnathus polygnathiformis* conodont Zone; Plate II, figs. 4-7, *Metapolygnathus nodosus* conodont Zone.

3.2.2 **Supergroup II. Pedicle tetrahedroid**

Group A: pedicle simple or expanded tetrahedroid

***Annulicorona* n. gen. s. f.**

Etymology. From the Latin *annulus*, ring; *corona*, crown, referring to the ridge surrounding the base of the crown.

Type species. *Annulicorona pyramidalis* n. sp. s. f.

Diagnosis. Monospecific genus, see diagnosis for the type parasppecies.

***Annulicorona pyramidalis* n. sp. s. f.**

(Plate III, figs. 1–10)

Material. 10 complete specimens, among which YTZC15/TC0244 is designated the holotype.

Locality. 7 specimens from the lower part of the Xiaowa Formation near Wayao Village 5 of which from Bed 25B (YTZC25B), and 2 from Bed 25C (YTZC25C); 3 specimens, including the holotype, from near Xiaowa Village in the lower part of the Xiaowa Formation, Bed 15 (XTZC15).

Etymology. *Pyramidalis*, pyramid-shaped in latin, referring to the shape of the crown in apical view.

Diagnosis. Crown with a very prominent and narrow mesial platform, subcrown with a very prominent mesial ridge, giving a pyramidal shape to the entire crown; anterior longitudinal shoulder ridge connected with the subcrown halo, forming a ring around the base of the crown. Pedicle anterior and simple tetrahedroid type. Subpedicle flat and rhomboid in outline.

Description. The crown shows an acute lanceolate shape with a single apex. The mesial platform is narrow and resembles the crown in outline. It protrudes from the surface and sometimes shows asymmetry. The platform reduces itself to a single ridge roughly at mid-height of the crown, this ridge always attaining the apex of the crown. There is a well-developed anterior longitudinal shoulder ridge, connected to a well-developed halo in the subcrown. As a result, a prominent ridge surrounds the base of the entire crown. The connection between the anterior longitudinal shoulder ridge and the halo is V-shaped, the extremity of the V joining the lateral sides of the crown (Pl. III, fig. 3b). There is also a V shape when the halo meets the mesial ridge (Pl. III, fig. 2b). The subcrown is also ornamented by a prominent mesial ridge reaching the apex. This ridge, together with the prominent mesial platform, gives a pyramidal shape to the crown in apical view. The pedicle is anterior and of a simple tetrahedroid type. The subpedicle base is rhomboid in outline, with a flat surface and a central canal opening. The pedicle is usually as high as the crown and often wider than the crown.

Comparison. The pyramidal shape of the crown and the basal ring are very unusual character among chondrichthyan dermal denticles, making the recognition of this paragenus and parasppecies quite easy.

Range. Middle Carnian. *Metapolygnathus nodosus* conodont Zone.

***Sacrisubcorona* Johns, Barnes, and Orchard, 1997**

Type species. *Sacrisubcorona circabasis* s. f. Johns, Barnes, and Orchard, 1997

***Sacrisubcorona* cf. *circabasis* Johns, Barnes, and Orchard, 1997**

(Plate I, fig. 2)

Material. 1 complete specimen.

Locality. Wayao Village, lower part of the Xiaowa Formation, Bed 25B (YTZC25B).

Description. The crown is rhomboid in outline with a single rounded apex. It is nearly horizontal and as wide as long. It is smooth, without ornamentation. The anterior margin is rounded, with an anterior longitudinal shoulder ridge. The subcrown shows a very well developed halo but no mesial ridge. The crown overhangs the pedicle. The pedicle is anteriorly situated and higher than the crown. The subpedicle outline is rhomboid with a flat surface and a central canal opening.

Comparison. The presence of a well-developed halo on the subcrown, the crown outline and the rhomboid outline of the subpedicle strongly suggests that our specimens belongs to the paragenus *Sacrisubcorona* ^[14].

But, the latter is also characterized by the presence of ridges in the anterior part of the crown. However, one of the specimens of *S. circabasis* figured by Johns et al. (1997, Pl. 29, Figs. 10–12) almost lacks such ridges. As we currently have only one specimen at our disposal, it is possible that its crown morphology corresponds to one extreme of the morphological variation observed in *S. circabasis*, and pending the discovery of more material, we therefore ascribed this dermal denticle to *S. cf. circabasis*.

The presence of a halo on the subcrown allows to easily differentiate this dermal denticle from those attributed to *Glabrisubcorona cf. arduidevexa* described below.

Range. Middle Carnian. *Metapolygnathus nodosus* conodont Zone.

***Glabrisubcorona* Johns, Barnes, and Orchard, 1997**

Type species. *Glabrisubcorona vadosidevexa* s. f. Johns, Barnes, and Orchard, 1997

***Glabrisubcorona cf. arduidevexa* Johns, Barnes, and Orchard, 1997**

(Plate I, fig. 3)

Material. 1 complete specimen.

Locality. Near Wayao Village, lower part of the Xiaowa Formation, Bed 25B (YTZC25B).

Description. The crown is lanceolate with a single rounded apex. It is oblique and longer than wide. There is no mesial platform and the crown shows one short lateral ridge on each side, attaining mid-height of the crown. The anterior margin of the crown is rounded with a not very well developed anterior longitudinal shoulder ridge. The subcrown is flat and unornamented. There is a minor overhang of the crown over the pedicle anteriorly.

The pedicle is anterior and of an expanded tetrahedroid type. It is almost as high as the crown. The subpedicle surface is flat and stretched rhomboid in outline, with a canal opening displaced posteriorly.

Comparison. The lanceolate shape of the oblique crown, the presence of short lateral parallel ridges, the unornamented subcrown and the rhomboid subpedicle outline indicate that these dermal denticles belong to the paragenus *Glabrisubcorona*. The minor overhang of the crown is reminiscent of the species *G. arduidevexa*, but the crown longer than wide would indicate *G. vadosidevexa*. However, the small size of our sample does not allow a proper understanding of the intraspecific variation and we consider here the absence of a strong overhang of the crown more diagnostic than the crown shape. Our specimen is therefore referred to as *G. cf. arduidevexa*.

Range. Middle Carnian. *Metapolygnathus nodosus* conodont Zone.

New paragenus B

(Plate I, figs. 5–6)

Material. 2 complete specimens.

Locality. Near Wayao Village, one from the lower part of the Xiaowa Formation, Bed 25B (YTZC25B), and the other from the uppermost part of the Zhuganpo Formation, Bed 25A (YTZC25A).

Description. The crown outline is lanceolate with a single apex. It is horizontal or steeply oblique. The crown surface shows a prominent narrow mesial platform that extends from the anterior shoulder to the posterior apex. This platform fades away in one specimen (Pl. I, fig. 6a) before to reach the apex. The anterior longitudinal shoulder ridge is prominent and reaches approximately half height of the crown on the lateral sides. The subcrown surface shows a well-developed mesial ridge, but no halo.

subpedicle surface is flat with a canal opening slightly displaced posteriorly. The anterior side of the pedicle is very high, almost as high as the crown, and displays a strong anterior keel that connects with the crown mesial platform. The crown does not overhang the pedicle.

Comparison. The shape of the crown, lanceolate with a strong mesial platform, is somewhat reminiscent of the paragenus *Ornatilabrilancea*^[1]. However, the specimens described above differ from the latter genus by the lack of lateral ridge on each side of the mesial platform and the crown not overhanging the pedicle. The high pedicle, which is not overhung by the crown, together with the crown ornamentation appears quite distinctive and these specimens probably represent a new paragenus. However, pending the discovery of more material, we prefer to leave them in open nomenclature for the time being.

Range. Lower-Middle Carnian. Plate I, fig. 6, *Metapolygnathus nodosus* conodont Zone; Plate I, fig. 5, *M. polygnathiformis* conodont Zone.

4 Discussion

Among the dermal denticles described in this work, *Lobaticorona* cf. *floriditurris*, the new paragenus A, *Annulicorona pyramidalis*, *Sacrisubcorona* cf. *circabasis*, and *Glabrisubcorona* cf. *arduidevexa* are restricted to the *Metapolygnathus nodosus* Zone (Middle Carnian) while *Parvicorona lacrysulca* and the new paragenus B are found both in the *M. polygnathiformis* (Lower Carnian) and the *M. nodosus* conodont Zones. This is the first record of dermal denticles from the *M. polygnathiformis* Zone. Although they represent new paraspecies, none are specific to this zone as their stratigraphic distribution extends into the *M. nodosus* conodont Zone. In the current state of our knowledge, the *M. polygnathiformis* conodont Zone cannot thus be characterized by its shark dermal denticles assemblage.

The results extend the stratigraphic distribution of *Glabrisubcorona* into the Carnian. So far, Johns et al.^[14] recorded this paragenus from the Norian only. Interestingly, most of the dermal denticles recovered so far from the Carnian of China show a concave subpedicle surface, while according to Johns et al.^[14], this subpedicle morphology is typical of Norian forms. However, only three paragenera out of a total of seven are found both in Canada and China; thus the comparison between the two realms is difficult. It is likely that these different patterns indicate some provincialism among shark faunas during the Carnian. These results are still preliminary and more sampling has been undertaken in Guanling County, which will hopefully lead to a better understanding of the stratigraphic and palaeogeographic distribution of shark dermal denticles. The recovery of teeth, which will allow a better identification of these Chinese sharks, is also expected.

5 Conclusions

Diverse Late Triassic elasmobranch ichthyoliths (microscope shark teeth and dermal denticles) were recovered from the *Metapolygnathus polygnathiformis* and *M. nodosus* conodont Zones in the Guanling area, Guizhou Province, China. This is the first time that dermal denticles are described from the *M. polygnathiformis* conodont Zone in China. The discovery completes the biostratigraphic scheme developed by Johns et al.^[14] in Canada, and indicates that dermal denticles with a concave subpedicle surface were more widespread in China than in Canada by Carnian time.

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Explanation of Plates

All specimens are housed in the Yichang Institute of Geology and Mineral Resources. Specimens from YTZC and XTZC were collected from Wayao Village and the Xiaowa Village respectively; all the specimens are from the upper part of the Zhuganpo Member except otherwise mentioned. All specimens $\times 180$, except otherwise mentioned.

Plate I

1. ? hyodont tooth. a- Labial view; b- apical view; c- baso-lingual view. YTZC22 / TC0217.
2. *Sacrisubcorona* cf. *circobis* Johns et al., 1997. a- Anterior view; b- subpedicle view, $\times 120$. YTC25B / TC0190.
3. *Glabrisubcorona* cf. *arduidetesa* Johns et al., 1997. a- Anterior view. b- subpedicle view. YTC25B / TC0073.
4. *Lobaticorona* cf. *tumiditurris* Johns et al., 1997. a- Lateral view; b- apical view, YTZC25B / TC0199.
- 5-6. New Paragenus B. 5a- Anterior view; 5b- subpedicle view, $\times 120$. YTZC24A / TC0174. 6a- Anterior view; 6b- subpedicle view, $\times 120$. YTZC25B / TC0189.

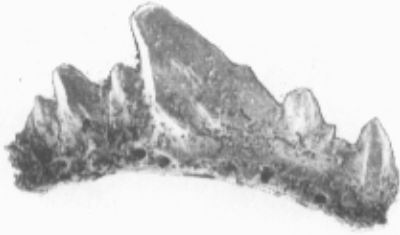
Plate II

- 1-8. *Purviscorona daerysulea* paragen. et sp. n
1. Apical view. YTZC24A / TC0182. 2. a- Subpedicle view; b- apical view, $\times 120$. YTZC24A / TC0177.
3. Anterior view, $\times 120$. YTZC24A / TC0181. 4. a- Anterior view; b- apical view, $\times 120$. XTZC15 / TC0225.
5. Apical view. YTZC25B / TC0192. 6.a- Lateral view; b- apical view. XTZC15 / TC0241.
7. Holotype. Apical view, $\times 220$. YTZC25B / TC0072. 8. Anterior view, $\times 180$. YTZC24A / TC0187.
- 9-10. New Paragenus A
9. a- Subcrown view; b- apical view. YTZC25B / TC0192. 10. Apical view. YTZC25B / TC0197.

Plate III

- 1-10. *Annulicorona pyramidalis* paragen. et sp. n
1. a- Apical view; b- subpedicle view($\times 120$). YTC25B / TC0195. 2. a- Apical view; b- subcrown view. YTZC25B / TC0193.
3. Holotype. a- Apical view; b- lateral view. XTZC15 / TC0244. 4. a- Apical view; b- lateral view. YTC25C / TC0099.
5. Anterior view. $\times 220$. YTC25B / TC0069. 6. Subpedicle view. YTC25B / TC0194.
7. Anterior view. XTZC15 / TC0230. 8. Anterior view. YTC25B / TC0197.
9. a- Apical view; b- lateral view. $\times 180$. YTC25C / TC0204. 10. a- Apical view; b- lateral view, $\times 100$. XTZC15 / TC0185.

Plate I



1a



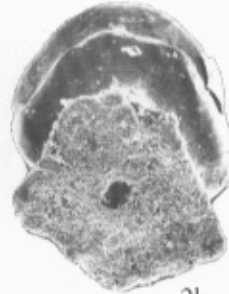
2a



3a



1b



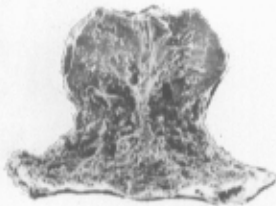
2b



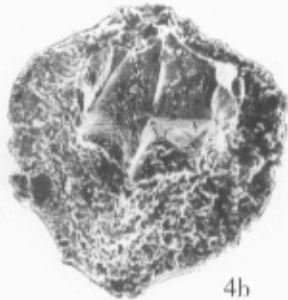
1c



3b



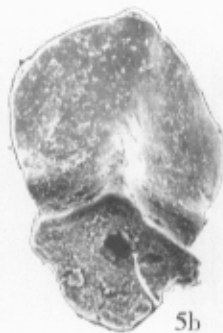
4a



4b



5a



5b



6a



6b

