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The Discovery of a Crinoid Community in the Late Triassic Zhuganpo Formation of Guizhou Province and Its Geological Significance

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Abstract Recently a rich and well-preserved crinoid community including *Traumatocrinus* and *Encrinus* has been found in the Late Triassic Zhuganpo Formation in Guanling and Xingyi, Guizhou province, China. Among the fossils *Traumatocrinus* is the richest, and most of it occurs as clusters, with each cluster containing 3–42 crinoid branches. Study of the stem and calyx of *Traumatocrinus* shows that the number of stem-joints (columnals) is equal to the total stem length × K (5.85 per cm × stem-diameter). There are about 376 first- and second-order columnals on the whole stem. This number seems to coincide with the number of days in a year at that time. According to the present study of the palaeoecological environment of the crinoid community, it is considered that the reproduction and preservation of the crinoid community were controlled by the Late Triassic regression and the restricted bay of an interior sea behind the S-shaped shoal zone.

Key words: crinoid, palaeoecological environment, Late Triassic, Guizhou province

Recently a rich and well-preserved crinoid community has been discovered in the Late Triassic Zhuganpo Formation at Guanling and Xingyi counties, Guizhou province, China. These crinoid fossils occurring on the surface of well-bedded argillaceous limestone are preserved so well that their "roots", stems and calices are intact. Most of them occur as clusters, with each cluster containing 3–42 crinoid branches. The crinoid commonly occurs together with the bivalve *Daonella*, the ammonite *Protrachyceras* and a few aquatic reptiles such as *Kueichousaurus* (Plate I-8).

1 Fossil Horizon

The crinoid community occurs at the base of the Late Triassic Zhuganpo Formation. Recently Late Triassic conodont elements (*Neogondolella polygnathiformis N. noantungensis* and *N. tadpola*) were found in the formation by Wang Liting (1997); so the age of the formation is assigned to Late Triassic. The section of the Late Triassic Zhuganpo Formation containing the crinoids was measured in Wayao village, Guanlin county, Guizhou province. It is described as follows.

Overlying strata: Late Triassic Wayao Formatiom (T_3w)

Grey and dark grey, medium–bedded bioclastic limestone and limestone, containing the bivalve *Halobia rugosoides* and *H. kui* and the ammonite *Protrachyceras* sp.

——————Conformity——————

Late Triassic Zhuganpo Formation (T_3z) Total thickness 97 m

8. Grey and dark grey moderately thick– to thin–bedded bioclastic and micritic limestone with a few chert nodules and well–developed argillaceous interlayers, containing the ammonite *Protrachyceras* sp.

27 m

7. Dark grey moderately thick– to thin–bedded bioclastic marl well–bedded, containing the ammonite *Protrachyceras* sp. and the bivalve *Daonella* cf. *indica*.

10 m

6. Grey and dark grey moderately thick–bedded bioclastic limestone with well–developed argillaceous stripes and a few chert nodules, containing the ammonite *Protrachyceras* sp.

17.5 m

5. Dark grey moderately thick–bedded bioclastic marl with rich organic material, containing the ammonite *Protrachyceras* sp. and the bivalve *Daonella* sp.

14 m

4. Dark grey argillaceous limestone with a few chert nodules along bedding.

12 m

3. Grey and dark grey moderately thick–bedded nodular micrite with a few chert nodules along bedding and some layers of calcareous claystone at the top, containing the bivalves *Daonella* sp., etc.

12 m

2. Grey and dark grey calcareous claystone with well–bedded argillaceous micrite, containing the crinoids *Traumatocrinus hsui* and *Encrinus liliformis* and the bivalve *Daonella* sp. occasionally; the ammonite *Protrachyceras* sp. is associated with the aquatic reptile *Kueichousauras* sp.

1.5 m

1. Grey and dark grey moderately thick–bedded micrite, heavily muddy.

3.0 m

——————Conformity——————

Underlying strata: Middle Triassic Yangliujing Formation (T_2y)
Grey and dark grey moderately thick–bedded dolomitic limestone.

2 Systematic Palaeontology

Traumatocrinus **Wöhrmann 1889 emend Mu 1949**

Diagnosis Crown large, wider in upper part and narrower in lower part. Calyx bowl–shaped, with 5 infrabasals, 5 basals, 5 radials, 10 brachials and one interbrachial, without anal plate. 20 fairly strong arms which are biserial, endotomous and pinnulate; with node or spine growing at bifurcation point. Tegmen composed of a large number of thecal plates with a ventral capsule; mouth under tegmen. Stem round, without cirri, but with " roots" . Columnal marked on its surface by a central round and small lumen and peripheral crenulae (ridges and grooves), giving rise to crenulate suture on stem surface. Many tiny holes along sutures.

Distribution and horizon: Asia and Europe; Middle–Upper Triassic.

Traumatocrinus hsui **Mu 1949**

(Plate I–1–3 and 6–9)

Description Crown large, wide in upper part and narrower in lower part. Calyx bowl–shaped with 5 infrabasals, 5 basals, 5 radials, 10 rows of brachials and a row of intrabrachioles; without anal plate; 20 longer arms of biserial brachials which are endotomous and pinnulate; node and spine growing at bifurcation–point. Stem round, composed of a series of columnals, each of which is marked by a small central round lumen and numerous peripheral crenulae. 3rd– and 4th–order brachials near calyx; equal and thin brachials occurring towards arm extremities.

Discussion The fossil community occurs as clusters, each of which contains 3–42 crinoid branches. Stem 0.3–2.2 cm in diameter and 0.1–1.4 m long. According to our statistics on well–preserved specimens there are generally 376 columnals. In the central part of stem columnals × their diameter (in cm)= 5.85 (=K). Largest crown 38 cm in diameter plus 5 orders of pinnules— primary pinnules attach endotomously at the 3rd–order brachials, including 30 1st–order large pinnules, 60 2nd–order pinnules, 120 3rd–order, 240 4th–order and 480 5th–order pinnules; nodes and spines at bifurcation points. A few roots preserved, but generally shown as processes of 3–5 cm long.

Distribution and horizon Guanling and Xingren counties, Guizhou, China; Late Triassic Zhuganpo Formation.

Traumatocrinus hsui enormis **Mu 1949**

(Plate I–4)

Description This subspecies is almost same as first species in character, but differs in brachials and number and arrangement of interbrachials; these plates convex outside. Near calyx 2nd– and 3rd–order brachials are thin and sultural pores indistinct; 3rd–order brachials on middle and lower parts of calyx; brachials marked by longitudinal grooves, especially conspicuous on 2nd and 3rd brachials. Crown big.

Distribution and horizon Guanling and Xingren counties, Guizhou, China; Late Triassic Zhuganpo Formation.

Encrinus **Schutze 1756**

Diagnosis Crown liliform; calyx short, slightly concave dorsally; composed of 5 very small infrabasals, 5 large basals, and 5 largest radials; anal plate absent; 10 branches of brachials, starting uniserially for a short distance, then becoming biserial upwards; pinnulate stem round; columnal surface marked by radial grooves; cirri absent.

Distribution and horizon Asia and Europe; Middle–Upper Triassic.

Encrinus liliformis **Miller 1928**

(Plate I–5)

Diagnosis This species is similar largely to *T. hsui*; but it differs in lacking both the lumen and radial grooves on columnal surface.

Locality and horizon Guanling and Xingyi counties, Guizhou, China; Late Triassic Zhuganpo Formation.

3 Palaeoenvironment of the Crinoid Community

During the early Late Middle Triassic, the Guanling–Xingyi area in southwestern Guizhou, China, was located in a restricted bay of an interior sea behind an S–shaped platform margin belonging to the southern margin of the Yangtze platform. The waters there were relatively restricted and the hydrodynamic effect was weak, but during that time, the bay linked with an open sea to its south, and some small islands appeared in the S–shaped shoal zone. For example, mud cracks, foot prints of dinosaurs and impressions of plant have been found on Niuchang Island, Zhenfeng county (Wang Xuehua, 1989).

During the late Ladinian, it was due to the global regression that the S–shaped shoal zone in the southern Yangtze platform emerged from the water, forming a Loferite cyclothem—an atmospheric–freshwater sedimentary rock with cracks, gypsum moulds and pentrabeans (Wu et al., 1989). Then, afterwards in the early Late Triassic, a nearly enclosed bay was formed in the Xingyi–Guanling area, Guizhou, which linked with the Tethys in the south and north (Wu et al., 1989). The waters of such an environment were quiet and warm with a normal salinity (35‰), thus favouring the reproduction of organisms (Robert, 1970). Because the crinoid structure was mainly made up of plates and liable to be destroyed under the conditions of strong hydrodynamic effects, a good state of preservation of a crinoid community called for such a nearly enclosed bay with warm waters and normal salinity and a high rate of burial after their death. The Late Triassic crinoid community in Guizhou was well preserved just under such conditions. At that time, large numbers of organisms, such as reptiles, bivalves, ammonites, fishes and shrimps lived together with crinoids in the bay (Yang, 1972).

Afterwards, transgression occurred in the Xingyi–Guanling area, and then this almost completely enclosed bay again changed into a restricted sea, which was unfavourable to the growth and preservation of crinoids owing to strong hydrohynamic effects.

To sum up, the reproduction, flourishing and vanishing of the Late Triassic crinoid community in southwestern Guizhou were controlled by two requisite factors: the S–shaped shoal zone on the margin of the Late Triassic Upper Yangtze platform and the marine regression.

4 Geological Significance of the Crinoid Community

1. The discovery of the crinoid community in the Late Triassic Zhuganpo Formation has the same stratigraphical and palaeontological significance as the discovery in the 1950s of the *Kueichousaurus* fauna in the same horizon at Dingxiao, Xingyi, Guizhou. First, it has enriched the fossil contents of the Tethys biota. Second, the crinoid fossils are so perfectly preserved that it is rare in the world and they provide very good specimens for the detailed study of crinoids.

2. After a detailed study of the stem *Traumatocrinus hsui*, it is found that the whole crinoid stems have 376 columnals (1st– and 2nd–orders) and that the number of columnals (in each centimetre) × stem diameter (in centimetre) is equal to the constant (K) = 5.85. Whether the number (376) coincides with that of the days in a year at that time as is the case with the annual growth–lines of the rugose coral *Helliophyllum* (Robert, 1970) remains to be further studied.

3. The crinoid fossils are of important economic value, since they may serve as rare, spectacular stones.

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Explanation of Plate

(Some fossil specimens in this study are stored in the Guizhou Institute of Geology, Guiyang, and the others are stored by fossil collectors.)

Figs. 1–3, 6–9. *Traumatocrinus hsui* Mu

1,2,9. Clustered crinoids, ×1 / 20.

3. Clustered crinoids, with pseudoroot, ×1 / 20.

6,7. Branchials and pinnules, ×1 / 4

A. branchial, B. pinnules, B1. first–order pinnule, B2. second–order pinnule, B3. third–order pinnule, B4. fourth–order pinnule.

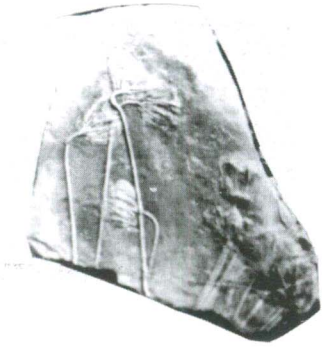
8. Croniods and *Kueichousaurus* sp., ×1 / 20.

Fig. 4. *Traumatocrinus hsui enormis* Mu, ×1 / 4. A.

Fig. 5. *Encrinus liliformis* Miller, ×1 / 10.

About the first author

Yang Ruidong Born in 1963; graduated from Southwest Petroleum College in 1984; awarded M.Sc at Chengdu College of Geology in 1989. He is now a Ph.D candidate at Department of Earth Sciences, Nanjing University, and engages in the study of stratigraphy and palaeontology and sedimentology.



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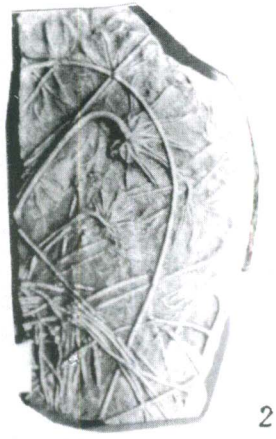

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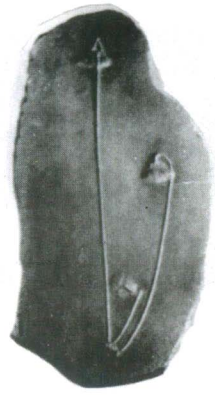

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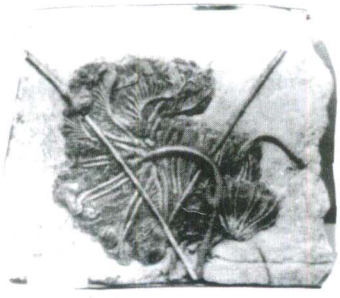

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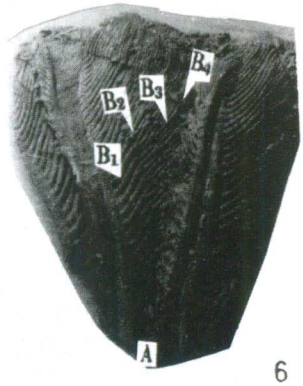

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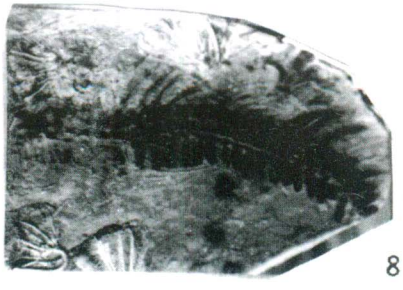

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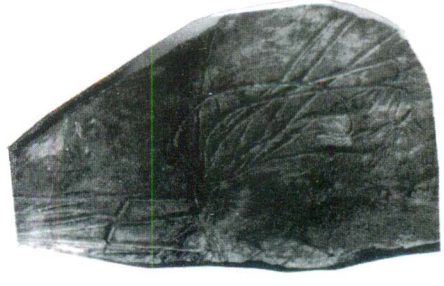

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