First Record of Protorosaurid Reptile (Order Protorosauria) from the Middle Triassic of China

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Abstract A new genus and species of the family Tanystropheidae, *Dinocephalosaurus orientalis* gen. et sp. nov., is described based on a nearly complete skull. This is the first record of the order Protorosauria from China. It also represents the only known occurrence of Tanystropheidae outside Europe, the Middle East and North America. *Dinocephalosaurus* is quite similar to *Tanystropheus* from Monte San Giorgio, Switzerland. Primarily it is distinguished from *Tanystropheus* in the shape of the premaxilla, maxilla, jugal and parietal. Although the family Tanystropheidae is now referred to the order Protorosauria, the new material from China indicates that the archosauromorph affinities of tanystropheids need further investigation. The discovery of *Dinocephalosaurus* provides new clues for the study of the evolution and radiation of Protorosauria and Tanystropheidae. It is also important for the study of the eastern Tethyan Fauna and the paleobiogeographical relationship between Europe and southern China in the Triassic.

Key words: Protorosauria, Tanystropheidae, Middle Triassic, Guizhou, China

1 Introduction

The family Tanystropheidae from the Triassic is one of the most bizarre reptile groups in the vertebrate history. So far all fossil records of these monsters are known from the Triassic of Europe, North America and the Middle East (Rieppel, 2001). Currently the tanystropheid is considered as the most derived protorosaurs (prolacertiforms), which is an early member of the archosauromorph assemblage. It was once believed that the squamates were derived from protorosaurs fairly directly, but this idea has been abandoned (Evans, 1988). *Tanystropheus* from Europe, which is famous for its incredible long neck, was described in detail by Wild (1973) as related to Squamata. Both Bassani (1886) and Nopcsa (1923) had misidentified the extremely elongated cervical vertebrae of this animal as the phalangeal elements. As a consequence the reptile was reconstructed as a pterosaur, and the functional morphology of the animal is still a mystery (Kummer, 1975; Wild, 1973; Tschanz, 1988). During the last three years, some Triassic marine reptile fossils that were previously only known from the western Tethyan Fauna such as armored (cyamodontid) placodonts and *Lariosaurus* have been found in Guizhou Province, southern China (Li, 2000; Li and Rieppel, 2002; Li et al, 2002; Rieppel et al, 2003). During the fieldwork of 2002, a nearly complete skull with a few cervical vertebrae of *Tanystropheus*-like reptile was found in Panxian of Guizhou Province. This is the first record of Protorosauria from China, and it is the only occurrence of the family Tanystropheidae in the eastern Tethyan Fauna. The discovery of new material in China shows consanguineous relationship between the eastern and western Tethyan Fauna.

2 Geological Background

The fossil locality is in Xinmin at the southwestern edge of the South China block. Limestone and dolostone of the Lower (Yongningzhen Formation) and Middle (Guanling Formation) Triassic are widely exposed, producing abundant reptile fossils including Ichthyosauria (Wang et al., 2001), Nothosauroidea, Pistosauroidea, and Protorosauria. The recent analysis of the tuff from the Guanling Formation indicates that the mass decease of vertebrates could have been related to the volcanic event (Wan, 2002).

3 Systematic Paleontology

Class Reptilia Linnaeus, 1758
Order Protorosauria Huxley, 1871
Family Tanystropheidae Gervais, 1858
Genus *Dinocephalosaurus* gen. nov.

Etymology: Derived from the Latin words "din-", "cephalo-" and "saur", refers to the ghastful skull of this taxon.

Type species: *Dinocephalosaurus orientalis* gen. et sp. nov.

Diagnosis: As for the type and only known species.

Dinocephalosaurus orientalis gen. et sp. nov.

Etymology: Latin word, refers to the eastern Tethyan

distribution of the taxon.

Holotype: IVPP (Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences) V13767. A nearly complete skull with a few cervical vertebrae. Fig. 1 and Plate I.

Type locality and horizon: Xinmin, Panxian of Guizhou Province, southern China; Guanling Formation, Anisian of the Middle Triassic.

Diagnosis: Premaxilla extending dorsally to the posterior end of naris; maxilla relatively long and strong, entering the border of the external naris, extending from anterior part of naris to beyond the midline of the orbit; jugal without posterior process; lower margin of both premaxilla and maxilla convex, with "canine teeth" present on them; surface of parietal broad and flat; retroarticular process of the lower jaw small.

4 Description and Comparison

The material comprises a nearly complete skull with 3 cervical vertebrae. Both the right lateral and top surface of the skull are exposed. Many sutures are not legible as the fossil was preserved in pure limestone.

Premaxilla: The suture between the premaxilla and maxilla is very clear. It is located in the anterior part near the outer margin of the naris. The deltoid end of the premaxilla inserts the maxilla deeply. Five teeth are observed on the premaxilla. Among them the third one is distinctly enlarged. It is inserted in a convexity on the lower margin of the premaxilla. The dorsal part of the premaxilla appears to extend posteriorly to the end of the naris along the midline of the skull. The narial side of the premaxilla is sutured to the nasal.

Maxilla: Compared with *Tanystropheus longobardicus*, the maxilla of *Dinocephalosaurus orientalis* is very elongated. It extends posteriorly below the jugal and terminates behind the level of the middle of the orbit. Dorsally, this bone meets the nasal, the prefrontal and the lacrimal. Anteriorly, the maxilla contributes to the external naris. Anterior to its midpoint the ventral margin of the maxilla is obviously convex with 2 enlarged teeth implanted. Among them the anterior one is the largest in the specimen. There are a total of 12 teeth on the maxilla. The two enlarged teeth mentioned above are No. 4 and No. 5. Teeth No. 7 to No. 9 are very small, and they are obviously neonatal ones.

Nasal, frontal, prefrontal and parietal: The sutures among all these bones are indistinct except that the anterior tip of the nasal enters deeply between the premaxilla and the nares. The top surface of the parietal is broad and flat, and differs from that of *Tanystropheus longobardicus*, where there is a narrow triangular crest on the parietal. The parietal foreman is small but relatively elongated. Both the lateral and anterior margins of the parietal foramen are

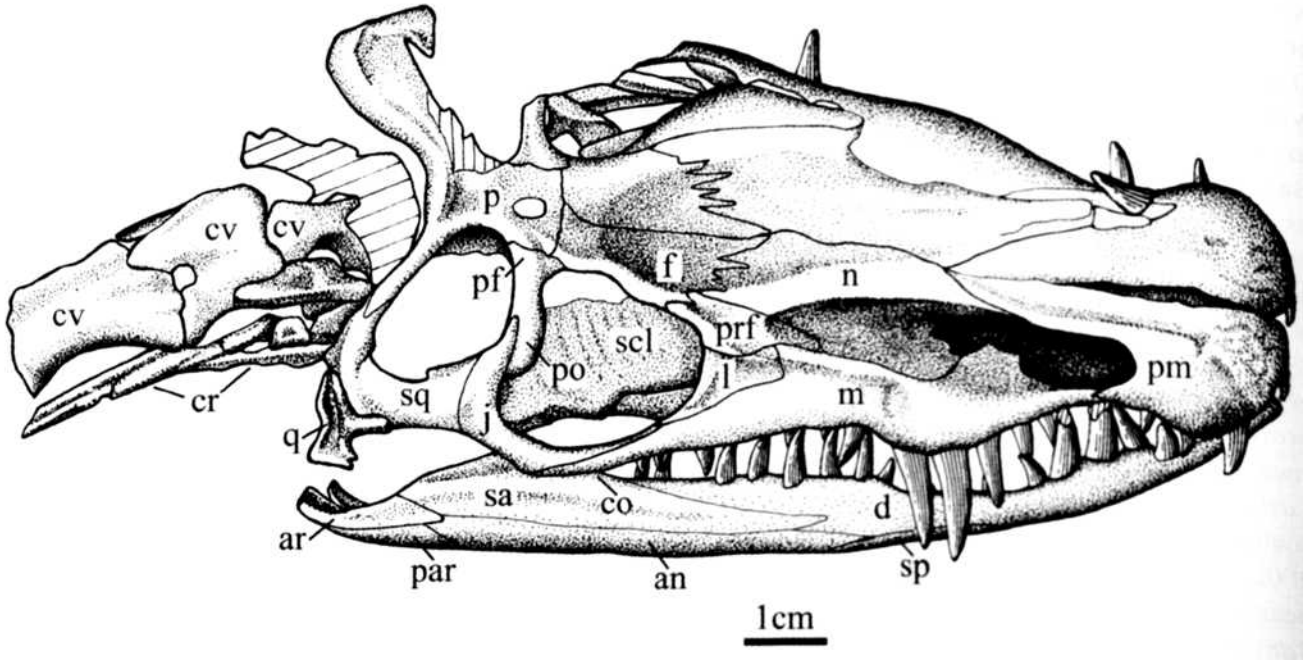

Fig. 1. *Dinocephalosaurus orientalis* gen. et sp. nov.
Abbreviations: an – angular; ar – articular; co – coronoid; cr – cervical rib; cv – cervical vertebra; d – dentary; f – frontal; j – jugal; l – lacrimal; m – maxilla; n – nasal; p – parietal; par – prearticular; pf – postfrontal; pm – premaxilla; po – postorbital; prf – prefrontal; q – quadrate; sa – surangular; scl – sclerotic plates; sp – splenial; sq – squamosal

Table 1 Triassic marine reptile fossils found in Guizhou Province

Stratum (Dong, 1997)		Age	Reptile fossils
Falang Formation	Laishike Member	Carnian	
	Wayao Member	Carnian	Ichthyosauria, Thalattosauria, Cyamodontoidea
	Zhuganpo Member	Carnian or Ladinian	Ichthyosauria, Thalattosauria, Cyamodontoidea, Eosauropterygia
Guanling Formation	Yangliujing Member	Ladinian	Sauropterygia
	Second Member	Anisian	Ichthyosauria, Protorosauria, Eusauropterygia
	First Member	Anisian	Eusauropterygia

straight, and the posterior margin is convex towards the occipital end. The naris is bordered by the premaxilla, maxilla and nasal. This opening is obviously elongated, and longer than the orbit.

Lacrimal: The lacrimal is sutured to the maxilla at its lower margin and contacts the jugal at its posteroventral end. The anterior and upper margins are sutured to the maxilla and the prefrontal along irregular seams. The posterior margin of the lacrimal forms the anterior border of the orbit.

Jugal: The lower border of the orbit is mainly formed by the jugal. It joins the lacrimal anteriorly and the squamosal posteriorly, but the suture with the latter is difficult to identify. Because of compression, the ascending process is lifted upward into the position between the postorbital and the temporal fossa. The jugal of *Dinocephalosaurus orientalis* is not trifurcate in shape as in most other reptiles. There is no posterior process in the specimen.

Squamosal: The squamosal occupies the posterior-most part of the skull. It meets the parietal in an irregular suture posteriorly. Its contact with the postorbital is covered by the ascending process of the jugal, which is dislocated from its natural position because of the compression of the specimen.

Quadrate: The quadrate is completely preserved with a well-developed mandibular condyle.

Orbit: Different from the oval-shaped orbit of *Tanystropheus* reconstructed by Wild (1973), the outline of the orbit in *Dinocephalosaurus* is peach-shaped with the narrow end anteriorly. The largest length and height of the orbit are both 4.2 cm. Most of the sclerotic plates are preserved but compressed.

Temporal fenestra: The upper temporal fenestra is bordered by the postfrontal, postorbital, squamosal, and parietal. All the sutures among these bones are indistinct

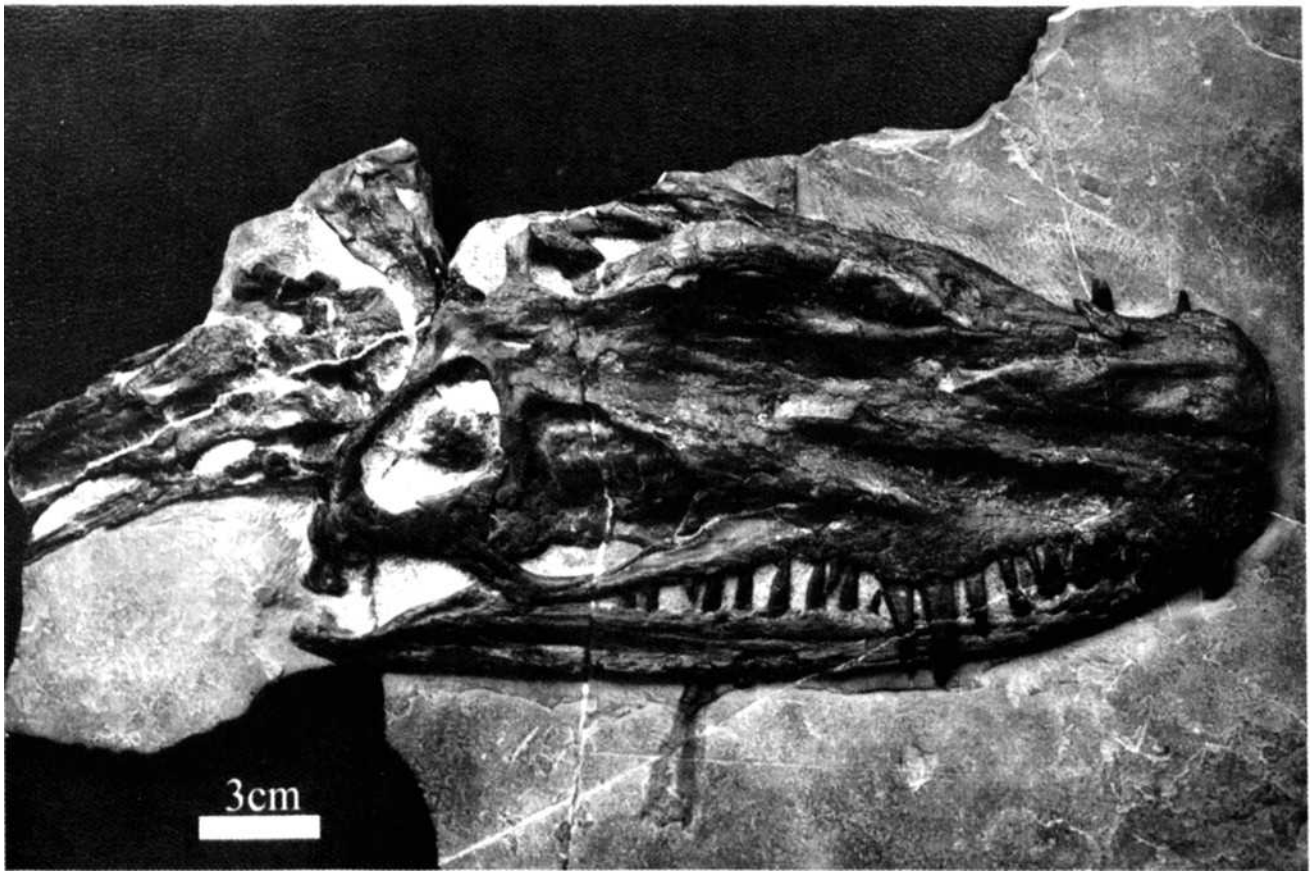

Plate I. Holotype of *Dinocephalosaurus orientalis* (IVPP V13767).

Table 2 Main differences between *Dinocephalosaurus* and *Tanystropheus* in the skull

	Dinocephalosaurus orientalis	*Tanystropheus longobardicus*
Maxilla	Elongated	Short
Jugal	Not trifurcate, without posterior process	Trifurcate
Parietal	Broad and flat, no crest on dorsal surface	Dorsal surface narrow and forming a triangular crest
Articular	Retroarticular process present	Retroarticular process absent
Orbit	Peach shaped	Oval

and the supertemporal is not observed.

Lower jaw: The lower jaw is slim and long. A convexity is present in the anterior upper margin of the dentary. This convexity matches the concavity between the two apophyses of the premaxilla and maxilla very well. The three teeth, especially the middle one, on this convexity, are the largest ones among the teeth on the lower jaw. 15 teeth are observed in the lower jaw. Similar to *Tanystropheus longobardicus*, there is a distinct coronoid process in the posterior part of the lower jaw. An important difference between the two genera is that *Dinocephalosaurus* has a small retroarticular process at the end of the jaw. Although many sutures between the elements of the lower jaw are indistinct, it is reasonable to reconstruct this part of *Dinocephalosaurus* as in *Tanystropheus*. The outline of the splenial is relatively clear.

Teeth: the teeth of *Dinocephalosaurus* are heterodont and thecodont. In the small tooth, the longitudinal shallow grooves extend from the tip to the base. In the large tooth, the grooves only occur in the upper part. All the teeth are nail-shaped.

Cervical vertebra: Only three anterior cervical vertebrae are preserved. They are poorly preserved. The neural arch is poorly developed and the centrum is rod-like. This is the typical character of the family Tanystropheidae. The cervical vertebra of *Dinocephalosaurus* is not elongated as much as that of *Tanystropheus*. The double-headed cervical rib inserts in the anterior tip of the centrum.

5 Discussion

In recent years a lot of Triassic marine reptiles have been found from Guizhou Province, southern China, including ichthyosaurs (Li, 1999; Li and You, 2002), thalattosaurs (Rieppel et al, 2000; Liu and Rieppel, 2002), armored placodonts (Li, 2000; Li and Rieppel, 2002), nothosaurs (Li et al, 2002) and the tanystropheid described in this paper. All known Triassic marine reptiles found in Guizhou (some of them have not been described yet) are listed in Table 1. Among these groups, *Dinocephalosaurus orientalis* is the first record of Protosauria from China. The structures around the temporal fenestra show clear protorosaurs affinities and the rod-like cervical vertebrae without neural arch means that the new taxon has a very close relationship to *Tanystropheus* from the Middle Triassic of Europe. Besides *Dinocephalosaurus* and *Tanystropheus*, a lot of groups of Thalattosauria, Cyamodontoidea and Nothosauroidea have been reported in recent years to share paleobiogeographic affinities between the western and eastern Tethyan Fauna. This phenomenon may be indicative of dispersal between the two faunas during the Triassic. On the other hand, there might have existed an earlier and more cosmopolitan fauna that was later isolated into two areas in the Triassic.

According to Romer (1956), a strong trend toward the elongation of the cervical vertebrae is the most prominent characteristic in the series Araeoscelidae (*Araeoscelis*)—Protorosauridae (*Protorosaurus*)—Tanystropheidae (*Tanystropheus*). Carroll (1988) gave a different arrangement of the order Protorosauria but the lengthening of the neck was still mentioned. In another specimen of *Dinocephalosaurus orientalis* that was collected together with the holotype the exaggerated elongation of the neck is obvious. In *Tanystropheus longobardicus*, known from relatively abundant material, the teeth differ markedly between small and large individuals. In the young individual they are tricuspid, whereas among the adults they are simple, sharp pegs. Based on this character it is clear that the V13767 is a full adult. The main differences between *Dinocephalosaurus orientalis* and *Tanystropheus longobardicus* in the skull are listed in Table 2.

The classification of the order Protorosauria was variable during the past, and its archosauromorph affinities had not been recognized until Gow (1975) re-described the Lower Triassic genus *Prolacerta* from southern Africa. Wild (1973) gave a full description on *Tanystropheus longobardicus* which he believed to be related to squamates. Although the Protorosauria affinity of tanystropheids has been testified by precise phylogenetic analysis (Evans, 1988), it is clear that a few non-Archosauromorph characters are observed in *Dinocephalosaurus*. The most obvious one is the maxilla, which is usually excluded from the nares in Archosauromorph. In V13767 this element broadly enters the elongated naris. Besides, the shape of the jugal in the specimen is non-trifurcate, and this form is usually observed in lizards and ichthyosaurs. All these skeletal features seem to point to a further investigation between tanystropheids and other Diapsidas.

Tanystropheus is a typical member of the western Tethyan Fauna. The earliest record of this genus (*T.*

antiquus) is from Buntsandstein of southern Germany, of the late Olenekian to early Anisian age. So far, most specimens of *Tanystropheus* are known from Europe and few scattered materials were reported from the Middle East (Rieppel, 2001). *Dinocephalosaurus orientalis* is the first record of the family Tanystropheidae from the eastern Tethyan province. It brings forward new materials for the study of the evolution and radiation of Tanystropheidae as well as Protorosauria. Moreover, it sheds new light on our understanding of the Triassic marine reptile fauna of China and its palaeobiogeography.

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References

Bassani, F., 1886. Sui fossili e sull'età degli schisti bituminosi triasici di Besano in Lombardia. *Atti Soc. Ital. Sci. Nat., Milano*, 29: 15–72,

Carroll, R. L., 1988. *Vertebrate Paleontnlogy and Evolution*. New York: W H Freeman and Company, 698.

Dong Weiping, 1997. *Stratigraphy (Lithostratic) of Guizhou Province*. Wuhan: China University of Geosciences Press, 306.

Evans, S. E., 1988. The early history and relationships of the Diapsida. In: Benton, M. J. (eds.), *The phylogeny and Classification of the Tetrapods*, Vol. 1: Amphibians, Reptiles, Birds. Oxford: Clarendon Press, 221–260.

Gow, C. E., 1975. The morphology and relationships of *Youngina capensis* Broom and *Prolacerta broomi* Parrington. *Palaeontographia Arficana*, 18: 89–131.

Kummer, B., 1975, Biomechanik fossiler und rezenter Wirbeltiere. *Natur Mus*, 105: 156–167.

Li Chun, 1999. Ichthyosaur from Guizhou, China. *Chinese Science Bulletin*, 44 (14): 1329–1333.

Li Chun, 2000. Placodont (Reptilia: Placodontia) from Upper Triassic of Guizhou, southwest China. *Vertebrata PalAsiatica*, 38(4): 314–317.

Li Chun and Rieppel, O., 2002. A new cyamodontoid placodont from Triassic of Guizhou, China. *Chinese Science Bulletin*, 47 (5): 403–407.

Li Chun and You Hai-Lu., 2002. *Cymbospondylus* from the Upper Triassic of Guizhou, China. *Vertebrata PalAsiatica*, 40(1): 9–16.

Li Jin-Ling, Liu Jun and Rieppel, O., 2002. A new species of *Lariosaurus* (Sauropterygia: Nothosauridae) from Triassic of Guizhou, southwest China. *Vertebrata PalAsiatica*, 40(2): 114–126.

Liu Jun and Rieppel, O., 2001. The second thalattosaur from the Triassic of Guizhou, China. *Vertebrata PalAsiatica*, 39(2): 77–87.

Nopcsa, F. V., 1923. Neubeschreibung des Trias-Pterosauriers Tribelesodon. *Paläont. Z., Berlin*, 5:161–181.

Rieppel, O., 2001. A new species of *Tanystropheus* (reptilia: Protorosauria) from the Middle Triassic of Makhtesh Ramon, Israel. *Neuse Jahrbuch für Geologie und Paläontologie, Abhandlungen*, 221: 271–287.

Rieppel, O., Liu Jun and Bucher, H., 2000. The first record of a Thalattosaur reptile from the late Triassic of Southern China (Guizhou Province, P R C). *Journal of Vertebrate Paleontology*, 20(3): 507–514.

Rieppel, O., Li Jin-Ling and Liu Jun, 2003. *Lariosaurus xingyiensis* (Reptilia: Sauropterygia) from the Triassic of China. *Canadian Journal of Earth Sciences*, 40: 621–634.

Romer, A. S., 1956. *Osteology of the Reptiles*. Chicago and London: The University of Chicago Press, 772.

Tschanz, K., 1988. Allometry and heterochrony in the growth of the neck of Triassic prolacertiform reptiles. *Palaeontology*, 31 (4): 997–1011.

Wan Daxue, 2002. Discovery on the tuff of the Middle Anisian stage in the Yangjian Area, Panxian, Guizhou and its significance. *Guizhou Geology*, 19(2): 77–81.

Wang Liting, Li Jinling, Wang Xinjin, Li Chun, Wu Tianzhuang and Liu Jun, 2001. Biostratigraphy of Triassic marine reptiles in southwest Guizhou and its adjacent area. *Acta Geologica Sinica* (English edition), 75 (4): 349–353.

Wild, R., 1973. *Tanystropheus longobardicus* (Bassani) (Eeue Ergebnisse). In: E. Kuhn-Schnyder und B. Peyer, *Die Triasfauna der Tessiner Kalkalpen*, XXIII. Schweiz. Paläont. Abh., 95: 1–162.