

## New information on *Dianmeisaurus gracilis* Shang & Li, 2015 (postprint)

**Authors:** SHANG Qing-Hua, LI Chun, Wu Xiao-Chun, SHANG Qing-Hua

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### Abstract

*Dianmeisaurus gracilis* is restudied on the basis of a new specimen. It provides some new information, especially that on the skull roof, to the species. The most striking of those new characters include the snout (preorbital region) shorter than the orbit, the interorbital septum extremely narrow, the frontal with a sharp process at both ends, and the posterior margin of the skull roof deeply V-shaped. A phylogenetic analysis with new information confirms that *Dianmeisaurus* is the sister group of *Diandongosaurus* and that these two genera, together with those Chinese taxa (*Majiashanosaurus*, *Dianopachysaurus*, *Keichousaurus*, and *Dawazisaurus*), form a monophyletic clade which is more closely related to the *Nothosauroides* than to a clade formed by the European pachypleurosaurs.

A detailed restudy of *Dianmeisaurus gracilis* Shang & Li, 2015 was conducted based on a new specimen from the Middle Triassic Guanling Formation Member II of Luoping, Yunnan, in combination with the holotype from the same locality and horizon. The original holotype is exposed in ventral view, whereas the new specimen is exposed in dorsal view; the two complement each other to provide more complete and precise anatomical information for *Dianmeisaurus gracilis*. The new material reveals that this species possesses a very short snout, with the length of the preorbital region not only shorter than that of the postorbital region, but even shorter than the orbital length; the external naris is small and positioned anteriorly, meaning the length of the pre-narial region is shorter than the distance between the posterior margin of the naris and the anterior margin of the orbit; the interorbital septum formed by the two frontals is extremely narrow, with a width less than 1/3 of the parietal table width; the frontal bears sharply tapering processes at both anterior and posterior ends; the posterior portion of the parietal is not constricted, and the posterior margin of the parietal table is deeply V-shaped. A phylogenetic analysis supplemented with new information and including more taxa (e.g., *Dawazisaurus*) supports the previous

conclusion that *Dianmeisaurus* and *Diandongosaurus* are sister groups; simultaneously, together with *Majiashanosaurus*, *Dianopachysaurus*, *Keichousaurus*, and *Dawazisaurus*, they form a monophyletic clade composed exclusively of Chinese genera. Compared with the European pachypleurosaur group (*Dactylosaurus*, *Anarosaurus*, *Serpianosaurus*, and *Neusticosaurus*), this monophyletic clade is more closely related to the Nothosauroidae.

## Full Text

### Preamble

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**New Information on *Dianmeisaurus gracilis* Shang & Li, 2015**

Qing-Hua Shang<sup>1</sup>, Chun Li<sup>1</sup>, Xiao-Chun Wu<sup>2</sup>

(1 Key Laboratory of Vertebrate Evolution and Human Origins, Chinese Academy of Sciences, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China, shangqinghua@ivpp.ac.cn)

(2 Canadian Museum of Nature, Ottawa, ON K1P 6P4, Canada)

### Abstract

*Dianmeisaurus gracilis* is restudied on the basis of a new specimen, which provides novel information, particularly regarding the skull roof. The most striking new characters include a snout (preorbital region) shorter than the orbit, an extremely narrow interorbital septum, frontals with sharp processes at both ends, and a deeply V-shaped posterior margin of the skull roof. A phylogenetic analysis incorporating this new information confirms that *Dianmeisaurus* is the sister group of *Diandongosaurus*, and that these two genera, together with other Chinese taxa (*Majiashanosaurus*, *Dianopachysaurus*, *Keichousaurus*, and *Dawazisaurus*), form a monophyletic clade more closely related to Nothosauroidae than to a clade comprising European pachypleurosaurs.

### Key words

Luoping, Yunnan, China; Anisian, Middle Triassic; small-sized eosauroptrygian, *Dianmeisaurus gracilis*

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## 1 Introduction

*Dianmeisaurus gracilis* is a small-sized eosauroptrygian (Shang and Li, 2015). The holotype was collected from Member II (Anisian) of the Guanling Formation in Luoping County, Yunnan Province, China. Previous work suggested

that *Dianmeisaurus* was closely related to *Diandongosaurus* from the same stratum in Luoping (Shang and Li, 2015). Together with *Dianopachysaurus dingi* (Liu et al., 2011), *Diandongosaurus acutidentatus* (Shang et al., 2011), and *Dawazisaurus brevis* (Cheng et al., 2016), four small-sized eosauroptrygians have been reported from Member II of the Guanling Formation in Luoping.

Unfortunately, the holotype of *Dianmeisaurus* preserves only the ventral side of the skeleton, leaving the dorsal side unknown. Here we report a new specimen of *Dianmeisaurus gracilis* from the type locality that is nearly complete and preserved in dorsal view, allowing observation of additional osteological features from the dorsal side. This new specimen enriches our knowledge of *Dianmeisaurus*, helps clarify its phylogeny, and tests existing hypotheses on relationships among European pachypleurosaurs (including *Neusticosaurus*, *Serpianosaurus*, *Dactylosaurus*, and *Anarosaurus*), Nothosauroida, and Chinese pachypleurosaur-like forms (sensu Cheng et al., 2016).

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## 2 Description

The new specimen (IVPP V 17054) is fully articulated and preserved in dorsal view [Figure 1: see original paper]. It is nearly complete, measuring 250 mm in length, slightly smaller than the 315 mm holotype. The following description of the dorsal side is based on the new specimen, with ventral features described from the holotype for comparison.

### Skull

The skull length (from snout tip to occipital condyle) is 18.5 mm in the new specimen [Figure 2: see original paper], slightly shorter than the 22 mm holotype. The snout (preorbital region) is remarkably short—shorter than the orbit—a condition comparable only to *Keichousaurus hui* among known eosauroptrygians (Holmes et al., 2008). The snout is rounded anteriorly and lacks rostral constriction.

The oval external naris is very small and positioned anteriorly, closer to the snout end than to the orbit. This contrasts with *Dianopachysaurus dingi* (Liu et al., 2011) and *Dawazisaurus brevis* (Cheng et al., 2016), where the opposite condition occurs. The orbit is large, slightly longer than wide, with its longitudinal length slightly less than twice that of the supratemporal fenestra. The supratemporal fenestra is elongated elliptical, as in *Dianopachysaurus* and *Dawazisaurus*, but differs from the oval shape in *Diandongosaurus* (Shang et al., 2011). The infratemporal fenestra is large and opens ventrally, as in the aforementioned taxa. The oval pineal foramen is positioned anteriorly, level with the anterior margin of the supratemporal fenestra.

As in *Dianopachysaurus* and *Dawazisaurus*, the preorbital region is shorter than the postorbital portion (to the posterolateral end of the squamosal). *Dian-*

*meisaurus* differs in having an extremely narrow interorbital septum, less than one-third the width of the interfenestral region of the skull table. The occipital edge of the skull roof is deeply concave, as in *Dawazisaurus*.

The large paired premaxillae form most of the snout, embracing the external naris and shaping its anterior and lateral margins. The maxillary process extends posteriorly to contact the maxilla and nasal posteromedially at a level behind the posterior naris margin. The nasal process is elongate, extending further posteriorly between the nasals to a level far behind the posterior naris margin. The palatal portion of the premaxilla is largely covered by the mandible in the holotype, but it clearly meets its counterpart along the ventral midline, forming the entire anterior margin of the internal choana. Posteriorly, the premaxilla contacts the maxilla laterally and the vomer medially. This condition matches European pachypleurosaurs and *Keichousaurus* (Sander, 1989; Carroll and Gaskill, 1985; Holmes et al., 2008), but differs from *Diandongosaurus* (Sato et al., 2014) and *Nothosaurus* (Rieppel, 2000: figs. 55B, 58B, 59B, 60B), where the premaxilla is excluded from the internal naris.

The nasals meet posteriorly along the midline. Anteriorly, they have a slender premaxillary process extending into the external naris, forming the medial margin against the nasal process of the premaxilla. Together, these form the internarial septum. Posteriorly, the nasals taper and end between the anterior processes of the frontals shortly behind the orbital anterior margin. Laterally, the nasal forms the posterior margin of the external naris and meets the maxillary process of the premaxilla, excluding the maxilla from the naris.

The dorsal exposure of the prefrontal is broad. Its anterior process inserts between the nasal and maxilla, approaching the sutural joint of the premaxilla, nasal, and maxilla. Sutures with the nasal and maxilla are zig-zagged, and the prefrontal-frontal suture is deeply interdigitated.

The paired frontals form the dorsal margins of the orbits. The interorbital septum is extremely narrow, as shown in the holotype where a wide split along the ventral midline exposed the frontal ventral surface (see Shang and Li, 2015: fig. 2). The anterior end of the frontal tapers into a sharp process that, together with its counterpart, embraces the nasals anteriorly; laterally, this sharp process is forked to receive the prefrontal. Posteriorly, the frontal also tapers into a sharp process that, together with its counterpart, embraces the parietal and approaches the supratemporal fossa, as in many other Chinese pachypleurosaur-like forms such as *Dianopachysaurus* (Liu et al., 2011), *Diandongosaurus* (Shang et al., 2011), and *Dawazisaurus* (Cheng et al., 2016). The frontal-postfrontal suture is slightly convex laterally, while the frontal-parietal suture is deeply interdigitated.

As in *Dianopachysaurus*, *Dawazisaurus*, and *Diandongosaurus*, the postfrontal broadly lines the posteromedial orbital margin anterolaterally and enters the anteromedial margin of the supratemporal fenestra posterolaterally. Sutures with the parietal and postorbital are interdigitated.

The maxilla does not participate in the ventral margin of the external naris. It meets the premaxilla behind the posterior naris margin. The ascending process of the maxilla is not well-developed. Posteriorly, the maxilla forms the entire ventral orbital margin and is overlapped by the jugal at the posteroventral corner of the orbit.

The jugal is a small, lunate bone forming the posteroventral orbital margin, ending anteriorly just posterior to the midpoint of the ventral orbital margin. Posteriorly, the jugal forms the anterior margin of the infratemporal fenestra but is excluded from the upper temporal arch.

The postorbital is triradiate. Anteriorly, it defines the posterior border of the orbit. Its anteromedial ramus forms most of the orbital-supratemporal septum. Its posterior ramus extends caudally to a level slightly anterior to the midpoint of the supratemporal arch. Its suture with the jugal is linear, while its suture with the squamosal is deeply interdigitated.

The parietals are fully fused in the new specimen, though their anterior portions are sutured in ventral view in the larger holotype, suggesting possible variation within *Dianmeisaurus*. The parietal is extremely broad and flat between the supratemporal fenestrae and lacks the posterior constriction seen in *Dianopachysaurus*, *Dawazisaurus*, and *Keichousaurus*. Starting from the parietal foramen, the parietal narrows as a process inserting between the posterolateral frontal processes. It broadens posterolaterally to meet the squamosal in an oblique, linear suture, and its occipital margin is very concave, as in *Dawazisaurus*.

The squamosal is large and stout. Anteriorly, it forms the posterior half of the supratemporal arch and, medially, forms the posteromedial margin of the supratemporal fenestra together with the parietal. The occipital portion of the squamosal is flange-like, meeting the supraoccipital medially and the exoccipital-opisthotic complex ventrally. Laterally, the descending process extends downward to the quadrate condyle.

The presence of the quadratojugal is uncertain. The quadrate has limited exposure, with a concave posterior surface. The lateral portion of the condyle appears slightly larger than the medial portion.

The occiput is closed and plate-like, typical of eosauroptrygians (Rieppel, 2000). No distinct occipital crest is present. The supraoccipital surface is flat, without a medial ridge. No braincase sutures are clearly recognized due to poor preservation in the new specimen. Both the holotype and new specimen show the occipital condyle at the same level as the mandibular condyles of the quadrate.

The paired vomers are elongated and bar-like, forming the medial margins of the internal choanae anterolaterally and contacting the palatines posterolaterally. They extend posteriorly to suture with the pterygoids at a level nearly below the anterior orbital margins.

The palatine is a broad plate extending substantially parallel to the dentary. Its

anterior part forms the posterior margin of the internal choana. Despite some cracks, its suture with the pterygoid is clear, being linear and oblique.

The ectopterygoid lies posterior to the palatine and points toward the infratemporal fenestra. It meets the anterolateral side of the transverse pterygoid process medially. The ectopterygoid is also present in *Diandongosaurus* (Sato et al., 2014) but absent in other Chinese pachypleurosaur-like forms such as *Dianopachysaurus* (Liu et al., 2011), *Dawazisaurus* (Cheng et al., 2016), and *Keichousaurus* (Holmes et al., 2008).

The pterygoids form most of the palate. Anteriorly, more than three-quarters of the pterygoids are widely spaced along the midline, but the posterior quarter meets at the midline with an unclear suture (Shang and Li, 2015: fig. 2). The anteriorly narrow pterygoid end meets the vomer. The quadrate ramus extends posterolaterally, broadly contacting the pterygoid ramus of the quadrate lateral to the occipital region.

Two hyobranchial elements are preserved on the ventral pterygoid surface. They are thin, stick-like, with the anterior portion slightly thicker than the posterior portion, as in some other eosauropterygians such as European pachypleurosaurs (Carroll and Gaskill, 1985; Sander, 1989), *Keichousaurus* (Holmes et al., 2008), and some nothosaurs (Li and Rieppel, 2004).

## Mandible

The mandibular symphysis is short, comparable to that of *Keichousaurus* (Lin and Rieppel, 1998; Holmes et al., 2008) and much shorter than in *Diandongosaurus* (Sato et al., 2014). The dentary extends posteriorly beyond halfway along the mandibular ramus. Posteroventrally, it overlaps the angular and tapers to a pointed end. Posterolaterally and posterodorsally, it meets the angular and surangular with interdigitated sutures.

Only the anterior splenial portion is exposed in the holotype, where it participates in forming the mandibular symphysis, as in *Diandongosaurus* (Sato et al., 2014).

The surangular forms the dorsal half of the posterior mandible and the dorso-lateral edge of the retroarticular process. The angular is longer than the surangular, forming the posteroventral half of the mandible and the ventrolateral edge of the retroarticular process. Anteromedial to the angular, a triangular prominence projecting dorsally indicates the coronoid process.

The anterior articular portion is broad, forming most of the articular fossa, which is divided into two parts matching the quadrate condyle divisions. The retroarticular process is well-developed, slightly longer than the supratemporal fenestra. Its dorsomedial surface is concave, and its posterior end is truncated.

## Dentition

There are five premaxillary teeth, of which the anterior four are enlarged and fang-like, though not as large as the king-sized premaxillary teeth of *Diandongosaurus* (Shang et al., 2011). The fifth tooth is possibly smaller, as in *Nothosaurus* (Rieppel, 2000).

The third maxillary tooth is fang-like and as large as the premaxillary teeth. The maxillary teeth anterior and posterior to this fang-like tooth are much smaller and similar in size. The maxillary tooth row extends posteriorly almost to the posterior orbital margin. The exact number of maxillary teeth is difficult to determine due to jaw occlusion, but based on preserved teeth and spaces in both specimens, the maxilla likely bears 15 teeth.

Four fang-like teeth are present within the mandibular symphyseal region. It is uncertain whether the fifth dentary tooth is also fang-like. An exact tooth count behind the symphyseal fangs cannot be established due to tight occlusion between the jaws.

All exposed teeth are sub-conical, curving medially and slightly posteriorly, with fine striations on the crown surface.

## Axial Skeleton

The last cervical or first dorsal vertebra cannot be determined due to poor rib preservation in the shoulder girdle region of the new specimen, though the count of 45 pre-caudal vertebrae matches the holotype (Shang and Li, 2015). Four sacral vertebrae were inferred in the holotype but can be confirmed in the new specimen. Thus, the new specimen likely had 23 cervical, 18 dorsal, and four sacral vertebrae, as in the holotype.

For the tail, 36 caudal vertebrae are preserved in the holotype (Shang and Li, 2015), while 41 are preserved in the new specimen [Figure 1: see original paper]. The last preserved caudal vertebra in the holotype is less than 2 mm long, suggesting the missing tail tip contained only a few caudals. The last caudal vertebra of the complete tail in the new specimen is less than 1 mm.

The caudal vertebrae gradually decrease in size caudally. The caudal centra are cylindrical and constricted medially. Neural spines are low and strongly oblique posteriorly. The first five caudal vertebrae bear long, slender, laterally directed transverse processes that gradually shorten posteriorly, followed by four caudals with very short, triangle-shaped transverse processes.

Each gastral set consists of five elements, as in other eosauropterygians. The V-shaped angle of the median elements increases caudally. The lateral elements bear pointed distal ends, differing from the broadened ends in *Diandongosaurus* (Sato et al., 2014).

## Appendicular Skeleton

The pectoral girdle is fully exposed in the holotype [Figure 4A: see original paper]. The narrow medial clavicle portion meets its counterpart to exclude the interclavicle from the anterior pectoral girdle edge. The wide lateral clavicle portion develops a sharply triangular anterior process at its anterolateral corner, positioned as in *Diandongosaurus* but much stouter and blunter distally. This process was considered diagnostic for *Dianmeisaurus gracilis* by Shang and Li (2015) and is unequivocally present in the new specimen [Figure 4B: see original paper]. The posterolateral clavicle process overlaps the anteromedial dorsal scapula aspect, showing the typical sauropterygian pattern.

The interclavicle is rhomboidal and lacks a posterior process. The scapula has a constriction separating the ventral glenoidal portion from a posteriorly directed dorsal wing. The scapular dorsal process is rod-like, tapering to a blunt tip, with length equal to the glenoidal portion.

The coracoid shows a rounded proximal head and a strongly concave anterior margin opposing the less distinctly concave posterior margin. The coracoids of both sides meet ventrally in a well-defined suture.

Of the pelvic girdle, the ilium is not preserved in the holotype but is well-exposed in dorsal view in the new specimen [Figure 3B: see original paper]. It develops a short, tapering posterior process and a broadened ventral portion contributing to the acetabulum.

The two ischia and two pubes are preserved in articulation in the holotype (Shang and Li, 2015: fig. 3B), conforming to the general nothosaur pattern (Romer, 1956; Rieppel, 2000). The pubis shows weakly concave anterior and posterior margins. The obturator foramen is not closed, with an open slit at the ischial suture near the acetabular margin (see Shang and Li, 2015: fig. 3B). The ischium shows a narrow acetabular portion, weakly concave anterior margin, strongly concave posterior margin, and a widely expanded medial portion with a convex medial margin (see Shang and Li, 2015: fig. 3B).

No notable differences in limb morphology exist between the holotype and new specimen [FIGURES:5, 6]. The limbs are long and slender, with the forelimb slightly shorter than the hindlimb.

The humerus is shorter than the femur but relatively stouter, showing a concave medial (preaxial) margin, broadly expanded distal portion, and weakly sigmoidal appearance. The entepicondylar foramen is well set off from the distal articular facet, and a distinct ectepicondylar groove is present.

The ulna is as long as the radius but stouter. The ulna's proximal head is more expanded than its distal end, while the radius's proximal end is slightly wider than its distal end.

In the holotype, the carpus comprises three ossified rounded elements (intermedium, ulnare, and fourth distal carpal) in the right forelimb, but only two

elements (intermedium and ulnare) in the left forelimb, with the fourth distal carpal missing. The fourth distal carpal is not observed in either forelimb of the new specimen.

The first metacarpal is much shorter and slightly broader than the others. The third metacarpal is as long as the fourth in the holotype but is the longest in the new specimen, suggesting asymmetrical development given the size difference between specimens.

Phalangeal elements are completely preserved in digits 1-3 and 5, but the ungual is missing in the fourth digit of the right manus in the holotype. The complete fourth digit of the left manus in the new specimen bears five phalangeal elements, giving a forelimb phalangeal formula of 2-3-5-5-3 in *D. gracilis*. All preserved forelimb ungual phalanges show no distinct expansion, unlike *Diandongosaurus* (Shang et al., 2011).

The femur is slender and sigmoidal [Figure 6: see original paper]. The femoral shaft is straight and biconcave, with the proximal head expanded and slightly wider than the distal head. A very shallow intertrochanteric fossa appears present.

The fibula and tibia are approximately equal in length, though the tibia is wider. The fibula is slender and strongly curved, contrasting with the rather straight tibia.

In both specimens, two tarsal elements are ossified: the rounded astragalus and the smaller calcaneum, which lies between the fibula's distal end and metatarsal 5.

The first metatarsal is distinctly shorter and broader than the others, with a markedly expanded proximal head. The fourth metatarsal is the longest in the series. Phalangeal elements are cylindrical, slightly constricted at mid-shaft, and shorten toward digit tips. Ungual elements are well-developed in digits 1-4 of the new specimen, markedly expanded as in *Diandongosaurus* (Shang et al., 2011), and distinctly larger than preceding phalanges.

Phalangeal elements of the hindlimbs are completely preserved in the holotype except for the missing ungual in digit 4. With this ungual added, the hindlimb phalangeal formula is 2-3-4-5-5 in *D. gracilis*.

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### 3.1 Evidence Supporting Assignment of the New Specimen to *Dianmeisaurus gracilis*

Despite different preservational views, the skulls of both specimens are similar, sharing moderately developed fang-like teeth in the premaxilla, maxilla, and dentary, and a very anteriorly positioned naris. The distinctly narrow interorbital septum of the holotype is confirmed in the new specimen, which shows an even narrower septum—less than one-third the width of the intersupratemporal

region—unique among known Chinese pachypleurosaur-like forms. Both specimens also share a broad intersupratemporal region comparable to *Keichousaurus* but lacking posterior constriction.

Postcranial similarity is also evident. The new specimen has 41 presacral vertebrae (versus 39 in *Dianopachysaurus*, 38 in *Diandongosaurus*, and 36 in *Dawazisaurus*), non-pachyostotic ribs, elongate first five caudal ribs with blunt distal ends, and a clavicle with a stout anterolateral process (slender and sharper in *Diandongosaurus*). Limb characteristics shared with the holotype include long, slender proportions, presence of an entepicondylar foramen, expanded proximal ulna head, two ossified tarsals, rounded astragalus, and broadened first metatarsal. The only distinct difference is the number of ossified carpals: three in the holotype versus two in the new specimen. This likely reflects ontogenetic variation, as the smaller new specimen (65 mm shorter) may not have completed ossification of the fourth distal carpal. Therefore, this difference probably does not represent a true taxonomic distinction.

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### 3.2 Phylogenetic Position of *Dianmeisaurus*

The data matrix is derived from Shang and Li (2015), modified based on the new specimen and including *Dawazisaurus* (Cheng et al., 2016) (Appendix 1). The matrix contains 42 taxa and 139 characters. Analysis using PAUP\* (version 4.0b10; Swofford, 2002) treated multistate characters as unordered and equally weighted. A heuristic search of all 42 taxa yielded 207 most parsimonious trees (MPTs) with 750 steps (CI = 0.4840, RI = 0.6318). Unlike Sato et al. (2014) and Shang and Li (2015), the strict consensus of these 207 MPTs showed drastically changed branching patterns, with unresolved relationships among Chinese pachypleurosaur-like taxa, European pachypleurosaurs, and Nothosauroidae.

To test whether fragmentary taxa (*Kwangsisaurus*, *Chinchenia*, and *Sanchiaosaurus*) influenced the results, a second analysis excluded them. This heuristic search yielded 8 shortest trees with 706 steps (CI = 0.5142, RI = 0.6676), largely comparable to Shang and Li's (2015) second analysis and supporting a sister-taxon relationship between *Dianmeisaurus* and *Diandongosaurus* [Figure 7: see original paper]. The Chinese pachypleurosaur-like taxa (*Dianmeisaurus*, *Diandongosaurus*, *Majiashanosaurus*, *Dianopachysaurus*, *Keichousaurus*, and *Dawazisaurus*) form a monophyletic clade more closely related to Nothosauroidae than to European pachypleurosaurs. *Qianxisaurus*, *Wumengosaurus*, and *Hanosaurus* form successive sister-groups toward a clade containing European pachypleurosaurs, Nothosauroidae, and the six Chinese forms. Differences from Shang and Li (2015) include a more basal position for *Keichousaurus* than *Dianopachysaurus* within the Chinese clade, and *Hanosaurus* being more remotely related to Nothosauria than other Chinese pachypleurosaur-like forms.

The sister-group relationship between *Dianmeisaurus* and *Diandongosaurus* is

supported by three unequivocal characters under ACCTRAN optimization: absence of pachyostosis in dorsal ribs [72(0)], presence of an anterolateral clavicular process [80(2)], and three carpal ossifications [137(1)].

The three fragmentary Chinese taxa (*Chinchenia*, *Kwangsisauros*, and *Sanchiaosaurus*) have different phylogenetic positions in previous studies (Riepel, 1999; Holmes et al., 2008; Sato et al., 2014; Shang and Li, 2015; Cheng et al., 2016). As tested in this study, these poorly preserved taxa again strongly influence internal branching patterns among European pachypleurosaurs, Nothosauroidae, and Chinese pachypleurosaurs-like forms.

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### 3.3 Morphological Comparisons of Small-Sized Eosauropterygians from the Luoping Fauna

Four small-sized eosauropterygian taxa have been described from the early Middle Triassic of Luoping: *Diandongosaurus*, *Dianopachysaurus*, *Dianmeisaurus*, and *Dawazisaurus*. All have adult body lengths under 50 cm and share: slender bodies with unspecialized limbs, skulls with large orbits and small supratemporal fenestrae, and relatively elongate necks and tails.

The *Dianopachysaurus dingi* holotype appears juvenile, indicated by unfinished limb bone ends and weak skull bone ossification. Its preserved snout-pelvis length is about 100 mm and skull length 23 mm (Liu et al., 2011), compared to 194 mm and 24 mm in *Diandongosaurus acutidentatus* (IVPP V 17761), 176 mm and 22 mm in *Dianmeisaurus gracilis* (V 18630), and 236 mm and 36 mm in *Dawazisaurus brevis* (Cheng et al., 2016). Despite its juvenile status, the *D. dingi* holotype is distinct, with a broad parietal showing weak posterior constriction and at least four carpal ossifications (Liu et al., 2011). The *D. gracilis* specimens are larger but have fewer ossified carpals, indicating they cannot be adult *Dianopachysaurus*. Additionally, *D. gracilis* lacks posterior constriction of the broad intersupratemporal region, has a relatively long snout, lacks a clavicular anterolateral process, and has non-pachyostotic ribs—further distinguishing it from *Dianopachysaurus*.

*Dawazisaurus brevis* (Cheng et al., 2016) has a short trunk (16 dorsal vertebrae), very small pre- and postzygapophyses, and five ossified distal carpals, clearly distinguishing it from *D. gracilis*.

Although *Dianmeisaurus* is phylogenetically close to *Diandongosaurus*, the latter has autapomorphies absent in the former: reduced nasals separated by premaxillae; large premaxillary nasal processes extending posteriorly to insert into the frontal; frontal excluded from the orbital dorsal margin by prefrontal-postfrontal contact; weakly constricted parietal skull table; mandibular articulation displaced distinctly behind the occipital condyle; premaxilla excluded from the internal choana margin; and reduced intertrochanteric fossa.

*Dianmeisaurus* differs from *Diandongosaurus* in these autapomorphies: paired frontals; distinct coronoid process; rounded cervical centra; four sacral ribs; simple overlapping clavicle-interclavicle contact; retracted external naris with longitudinal diameter distinctly less than half the orbital longitudinal diameter; non-king-sized premaxillary fangs; elongated elliptical supratemporal fenestra; extremely narrow interorbital septum; and much stouter clavicular anterolateral process.

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## 4 Systematic Paleontology

**Sauropterygia** Owen, 1860

**Eosauropterygia** Rieppel, 1994a [sensu Rieppel, 2000]

**Dianmeisaurus** Shang & Li, 2015

**Dianmeisaurus gracilis** Shang & Li, 2015 [FIGURES:1-6]

### **Holotype**

IVPP (Institute of Vertebrate Paleontology and Paleoanthropology) V 18630, a nearly complete skeleton with articulated skull preserved in ventral view.

### **Referred specimen**

IVPP V 17054, a nearly complete skeleton with articulated skull preserved in dorsal view.

### **Locality and horizon**

Da' aози Village, Luoping County, Yunnan Province, China. Upper Member of the Guanling Formation, conodont *Nicoraella kockeli* Zone; Pelsonian, middle Anisian, Middle Triassic (Zhang et al., 2009).

### **Emended diagnosis**

A small eosauropterygian under 50 cm total length, differing from others in the combination of: snout (preorbital region) shorter than postorbital region and orbit; rostrum without constriction; external naris closer to rostrum anterior end than to orbit; supratemporal fenestra elliptic and much smaller than orbit; interorbital septum extremely narrow; intersupratemporal septum about three times the interorbital septum width; pineal foramen anteriorly positioned; posterior skull roof margin deeply V-shaped; premaxillary and anterior dentary teeth fang-like but not king-sized; maxilla with one fang-like tooth behind one or two smaller conical teeth; vertebral column of 23 cervical, 18 dorsal, four sacral, and 41 caudal vertebrae; anterior caudal ribs 1-5 elongate with blunt distal ends; clavicle with stout anterolateral process; entepicondylar foramen present; three ossified carpals; two ossified tarsals; first metatarsal broadened; pes ungual phalanx extremely expanded; manual phalangeal formula 2-3-5-5-3; pes phalangeal formula 2-3-4-5-5.

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## Appendix 1

### Data matrix for *Dianmeisaurus*

The principle phylogenetic analysis described in the text used the data matrix of Sato et al. (2014) with the addition of *Majiashanosaurus* (Jiang et al., 2014) and *Dawazisaurus* (Cheng et al., 2016). Listed below are the 139 character codings for *Dianmeisaurus*:

```
11000120?? 2?0?1011?? ?0?00?110 000010011? 1101?00?0? 11?1121110  
0000?00000 00200?10?
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### New Material of *Dianmeisaurus gracilis* Shang & Li, 2015

Qing-Hua Shang<sup>1</sup>, Chun Li<sup>1</sup>, Xiao-Chun Wu<sup>2</sup>

(1 Key Laboratory of Vertebrate Evolution and Human Origins, Chinese Academy of Sciences, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China)

(2 Canadian Museum of Nature, Ottawa, ON K1P 6P4, Canada)

**Abstract:** Based on a new specimen from Member II of the Guanling Formation (Anisian) in Luoping, Yunnan, combined with the type specimen from the same locality and horizon, *Dianmeisaurus gracilis* Shang & Li, 2015 is restudied in detail. The original type specimen exposes its ventral side, while the new specimen exposes its dorsal side, providing complementary and more complete anatomical information. The new material reveals an extremely short snout where the preorbital region is not only shorter than the postorbital region but even shorter than the orbit itself. The external naris is small and anteriorly positioned, with the pre-narial region shorter than the distance between the posterior naris margin and anterior orbital margin. The interorbital septum formed by the frontals is extremely narrow, less than one-third the width of the parietal table. The frontal bears tapered processes at both anterior and posterior ends. The posterior parietal region is unconstricted, with the posterior skull roof margin deeply V-shaped. Phylogenetic analysis incorporating new information and additional taxa (e.g., *Dawazisaurus*) supports the previous

conclusion that *Dianmeisaurus* and *Diandongosaurus* are sister taxa. Together with *Majiashanosaurus*, *Dianopachysaurus*, *Keichousaurus*, and *Dawazisaurus*, they form a monophyletic clade comprising only Chinese genera, more closely related to Nothosauroida than to European pachypleurosaur clades (*Dactylosaurus*, *Anarosaurus*, *Serpianosaurus*, and *Neusticosaurus*).

**Keywords:** Yunnan Luoping; Middle Triassic; Anisian; Eosauropterygia; *Dianmeisaurus gracilis*

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