

**A Short Report on the Occurrence of *Dilophosaurus*  
from Jinning County, Yunnan Province**

by

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## Introduction

In August of 1987 specimens of a nearly complete theropod, *Dilophosaurus*, and a prosauropod, *Yunnanosaurus*, were collected from the Lower Lufeng Fm. at Qinglongshan near the village of Muchulang, in the rural tribal district of Xiyangyi, Jinning County, Yunnan Province. This short report is warranted as it is the first record of the genus *Dilophosaurus* not only in China but on the entire Asian continent. The discovery of *Dilophosaurus* in the Early Jurassic Lufeng Saurischian Fauna is an additional rare element that provides evidence for research into Asian and American dinosaur evolution.

## Description

### Theropoda Marsh, 1881

### Halticosauridae Huene, 1948

### *Dilophosaurus* Welles, 1970

### *Dilophosaurus sinensis* sp. nov.

**Diagnosis:** A moderate sized theropod approximately 5.5 meters in length with a high, large, and robust skull ornamented with two fan-shaped crests that diverge obliquely and laterally in dorsal perspective. Nasal is oblique and long, and the dorsal process of the maxilla is split into antero- and posterodorsal branches. Dentition consists of 5 premaxillary, 13 maxillary, and 13 dentary teeth which are laterally compressed and possess small serrations anteriorly and posteriorly. Vertebrae are typically carnosaurian, consisting of 9 cervical, 15 dorsal, 4 sacral and 36 out of a possible 45 caudals prepreserved. The coracoid fenestra penetrates dorsally, scapula is narrow and long, ilium is low with an extended posterior lobe, pubis is longer than ischium, and sacrum is incompletely fused. Limbs are all pneumaticized, the humerus is half as long as the femur, and the tibia is also shorter than the femur. The femoral fourth trochanter lies medially at a point one third down the shaft. Metatarsals are parallel, and pes phalanges are robust with a formula of 2-3-4-5-1.

**Type:** Specimen KMV8701 is a nearly complete skeleton. Skull is completely preserved, vertebrae include nearly articulated cervical, dorsal, and a large portion of the caudal series, but anterior limbs are incomplete and left posterior phalanges are missing.

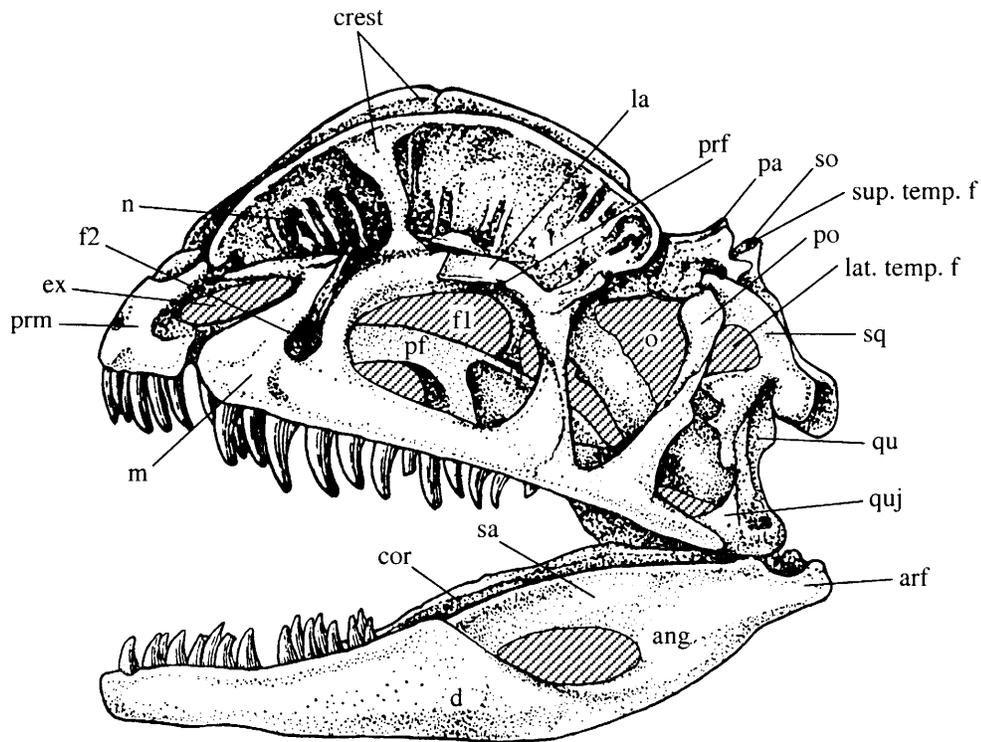
**Locality and stratigraphic position:** Early Jurassic, Lower Lufeng Fm. Qinglongshan at the village of Muchulang, in the rural tribal district of Xiyangyi, Jinning County, Yunnan Province.

**Description:** Skull length is 52.5 cm and height is 24 cm at the center of the first preorbital fenestra. Length to height ratio is 2.2:1. In lateral perspective the skull appears semicircular (Fig. 1).

The premaxilla bears five teeth, is short, high, and contacts the nasals with a blade-shaped and ridged suture line. The contact with the maxilla is high and precipitous. The left posterior process has broken off.

The maxilla is large and broad with a dorsal process that is antero- and posterodorsally split. The anterior branch is spoon-shaped, overlaps the basal margin of the nasal, and together they form the dorsal wall of the external nares. The posterodorsal branch is relatively broad, posteriorly bifurcated, is fused to the dorsal crest of the skull, and overlaps the prefrontal, lacrimal,

and nasal process. Also present on the maxilla are a maxillary recess, and preorbital fenestrae I, and II. Thirteen teeth are present along the linear dental margin, above which are nutrient foramen. Four teeth are missing on the right side of the skull.



**Figure 1.** Lateral view of the skull of *Dilophosaurus sinensis* sp. nov.

ang, angular; art, articular; cor, coronoid; cr, crest; ex, external nares; f, frontal; F1, first antorbital fenestra; f2, second antorbital fenestra; ju, jugal; la, lacrimal; lat. temp. f., lateral temporal fenestra; mx, maxilla; n, nasal; o, orbital; pa, parietal; pl, palatine; po, postorbital; prf, prefrontal; prm, premaxilla; ps, parasphenoid; qu, quadrate; quj, quadratojugal; sa, surangular; so, supraoccipital; sq, squamosal; sup. temp. f., supratemporal fenestra.

The straight medial suture line of the nasals forms a sharp edge. Anteriorly the nasals displace the anterodorsal process of the premaxilla to bifurcate the nares. Posteriorly they transform into the dorsal crest of the skull in combination with the antero- and posterodorsal process of the maxilla, lacrimal, and prefrontal. The posterodorsal termini of the nasals unite to form a robust tubercle and from this point the dorsal cranial crest initiates as two lobes.

The prefrontal is triangular in shape and overlaps the lacrimal and the medioventral nasal. Posteriorly it is ventrally inflated and contacts the anterior side of the frontal. Its dorsal margin composes a portion of the cranial crest.

From a dorsal perspective, the frontals are broad, large, and robustly swollen elements that lie between the two crests and contact the parietals with a greatly fissured suture line. Their posterior margins form a shelf.

The parietals are located particularly high on the skull and from dorsal perspective resemble an I-beam with a conspicuous medial suture. Anteriorly they are baton shaped, posteriorly they project to form wings, and together with the squamosal surround the supratemporal fenestra.

From ventral perspective the two anterior processes possess vertical laminae that contact the frontals.

The nasal process of the lacrimal overlaps the prefrontal and contacts the posterior branch of the posterodorsal maxillary process. The zygomatic process of the lacrimal contacts the jugal. Both processes intersect posteriorly and are inflated in a lateral projection. This element also composes a portion of the dorsal crest and constitutes the principal element of the posterior lobe of the crest.

The supraoccipital is posteriorly warped, lies posterior to the parietal, dorsomedial to the occipital region, and has a lateral contact with the exoccipital. The right exoccipital is missing but the left is flat, lies parallel to the squamosal, and is extremely extended. The squamosal is shaped like the numeral 3, lies lateral to the parietal, has an anterior process that contacts the postorbital, a ventral process that contacts the quadrate, and a posterior process that is extremely extended. The ventral process projects anteriorly to form a triangular wing.

The quadrate is vertical with a dorsally curved and broadened shaft that holds a dorsoventrally oriented posterior groove. At the quadratojugal contact point it forms a vertical ridge. The quadratojugal is L shaped and contacts the quadrate on its posterior side.

The postorbital is laterally compressed and overlaps the dorsal process of the jugal on its lateral side. The frontal process of the postorbital constitutes a large and robust “brow ridge.” Its squamosal process is precipitous and short, while its jugal process is sharp and long. The anterior ascending process of the jugal overlaps the lacrimal and then extends with an anterior process that projects between the maxilla and lacrimal. Its posterior process, which is narrow and thin, overlaps the quadratojugal.

The palatine is broad, long, and slightly crescentic. Posteriorly it composes the posterior margin of the internal nares and is in contact with the hyoid. The shaft of the hyomandibular is smooth and glossy, yoke shaped, and has a distal end that lies distant from the posterior maxilla and mandible.

The dorsal crests consist of a thick bony base composed of the nasals, ascending process of the maxillae, lacrimals, and premaxillae. Numerous laminae are generated vertically as rounded bony spines aligned like a railing and subsequently compose a fan-like structure with broad and thick dorsal margins. The anterior lobes are an integral part of the lateral sides of the nasals, and at the point of the nasal tubercles the crests spread as two fans posterolaterally such that from dorsal perspective they resemble an inverted V. The crests are 31 cm in length and 11 cm high.

The mandible is narrow and long, 48.7 cm in length, and 10 cm deep. The dentary is thin anteriorly and deepens posteriorly. The dorsolateral margin inflates to form a ridge, but at the dorsal region of the ridge it becomes concave with a portion of it maintaining nutrient foramina. Posteriorly it angles ventrally to form a sharp process that overlaps the angular and surangular. The left dentary houses 13 teeth but the right preserves only six. The surface of the angular is smooth and glossy with a dorsal margin that composes the ventral margin of the mandibular fenestra. The surangular is shaped like a plough share with a dorsal margin that becomes scrolled. The mandibular fenestra is long, large, and oval in shape. The articular is long and the retroarticular process projects dorsally.

Nine distinct laterally concave cervical vertebrae are present with opisthocoelus centra. The pleurocoel is anteriorly positioned, the neural spine is beveled, and cervical ribs are long and gracile. Vertebrae lengthen from Cv5 to Cv9.

15 dorsal vertebrae are present with centra that transform from opisthocoelus to amphiplatyan. Neural spines transform from being columnar to quadratic plates. Transverse processes gradually descend to become horizontal. Centra are laterally concave while intertransverse foramina are no longer present.

Four amphiplatyan sacral vertebrae are present, the second and third of which are fused. Relatively well developed processes formed by the sacral ribs and transverse processes fuse to the ilia. Neural spines are square.

Thirty-six amphicoelus caudal vertebrae are preserved with neural spines that gradually alter from plate-shaped to linear. Many of the haemal arches are damaged, but those that are complete are baton-shaped and curved.

Both sides of the pectoral girdle is present. The clavicle is lanceolate although the proximal end is damaged. The coracoid is spaciouly broad and extremely thick at its contact with the scapula. The coracoid foramen is open dorsally but does not penetrate the element completely. The scapula is narrow and long with a deep and rounded glenoid.

The humerus is shallowly concave with a medial triangular depression upon it. It is slightly curved with an expanded proximal end and displays a medially curved deltopectoral crest. Its length does not attain half that of the femur. The radius is curved with expanded termini while the ulna is slightly longer than the radius and is relatively curved with a well developed olecranon process. A number of the metacarpals have been lost but among those preserved McIII is the longest.

The pelvic girdle is complete with a low ilium that has an extended posterior lobe, a robust and quadratic pubic peduncle, and a short and small ischiac peduncle. The acetabulum is broad, perforated, and maintains a transversely expanded wall. An expanded trough lies on the posteroventral lobe of the ilium. The proximal end of the pubis is expanded and there is a well developed and fused lateral ridge. The obturator foramen is oval, the pubic shaft is long and curved, but a pubic boot is not very conspicuous. The proximal ischia are also well developed with gracile and straight shafts and that fuse distally with ischiac boots that are anteroposteriorly expanded. The pubis is longer than ischium with a 90° angle separating the two.

The head of the femur is perpendicular to the shaft, the lesser trochanter is separated by a deep groove and the fourth trochanter is a blade-shaped crest that is situated medially at a point one-third of the way along the shaft, which itself is slightly curved and triangular in cross-section. Distally, the trochlea is broad and deep. The femur is longer than the tibia with a 58.7 cm length. The proximal end of the tibia is well developed, its shaft is also triangular and attenuates distally. The cnemial crest is laterally expanded. The fibula is slightly shorter than the tibia with a posteriorly expanded proximal end, a gracile and curved shaft, and a slightly large and roundly inflated distal end. The astragalus is conspicuously concave and is L-shaped with its long arm extending into the tibio-astragalar recess. The calcaneum is a triangular wedge that is imbedded between the fibula, astragalus, and fourth metatarsal. There is an additional plate-shaped bone embedded between the calcaneum and fourth metatarsal, the function of which is unclear. Metatarsals are straight and pneumaticized. MtII, III, and IV are parallel and among them MtIII is the longest but does not attain half the length of the femur. MtV is present but rather reduced. Phalangeal shafts are broad and robust, ligament fossae are deep and rounded, and unguis are laterally compressed, recurved, and maintain a deep vertical groove.

**Comparison and discussion:** Specimen KMOV8701 from Jinning Co. is comparable to *Dilophosaurus* from the state of Arizona, USA, as both maintain a pair of high and inflated crests on top of the skull and the skull itself is proportionately larger than other taxa with an equivalently sized skeleton. Additional characters that assign it to the genus include a fissure that

separates the premaxilla and from the maxilla, and long, oblique, and anteriorly positioned nasals. Preorbital fenestra I is large and triangular, orbits are situated laterally, the quadrate is vertical, and the mandible is narrow and long with a well developed retroarticular process. Teeth are laterally compressed with small anterior and posterior serrations. Cervicals are short with distinctly laterally concave opisthocoelus centra. Dorsal vertebral sequence and morphology are identical. Scapula is anteroposteriorly extended and humerus is shorter than one-half femur length. Ilium is low with an extended posterior lobe and the fourth trochanter is situated on a point one-third down the femoral shaft. Tibia is shorter than femur, metatarsals II, III, and IV are parallel with III being the longest but with a length less than half that of the femur.

There are, however, several clear distinctions between KMV8701 and *Dilophosaurus wetherilli*: From dorsal perspective the anterior crests are in the configuration of a V while on the later taxon the crests are parallel with a posterior process. The premaxilla of the Chinese form is anteriorly high and broad, has a precipitous contact with the maxilla, and contains five teeth. On the latter specimen this element is oblique and sharp with a weak maxillary contact and bears four teeth. The Chinese specimen has a maxillary dental margin that is long and straight, dentition is broad, short and in tight alignment while the American form has a long and curved maxillary dental margin with a narrow and long dentition that is loosely spaced. Lateral temporal fenestrae also differ as the American form lacks antorbital fenestra II. On the Chinese specimen the coracoid foramen is dorsally open while on the American form this aperture is lateral. Obviously these specimens represent different species, and hence nomenclature for the Chinese form is erected as *Dilophosaurus sinensis* sp. nov.

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