A Short Report on the Dinosaur Fauna from Dashanpu, Zigong, Sichuan

II Ornithopoda

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Introduction

The evolution of the suborder Ornithopoda in China began in the Late Triassic of Sichuan, where they are typically represented by the Heterodontosauridae. The earliest appearance of this family occurs in the South American Ischigualasto deposits of Argentina. Traditionally, the suborder Ornithopoda is regarded as originating on the Gondwana Continent; however, in 1965, Simmons reported on a small heterodontosaurid, *Tatisaurus*, from the Lufeng sediments of Yunnan, China. This was the first recorded occurrence of this group in the Northern Hemisphere, and was a discovery indeed significant toward research into the distribution and origin of the Ornithopoda.

Currently, there is a gap within the evolutionary systematics of the Ornithopoda that is represented by the lack of Early to Middle Jurassic taxa that lie between the Late Triassic Heterodontosauridae and Late Jurassic Hypsilophodontidae. In spite of deficient specimens, some extremely important ornithopod material has been discovered from the Middle Jurassic Dashanpu Sichuan Dinosaur Fauna that may fill this vacancy.

Description of Fossils

While sorting the dinosaur collections made from the 1979-1980 Dashanpu, Zigong field season* two small ornithopod specimens were recovered. However due to inadequate collecting techniques, the material was damaged and found incomplete. But one specimen, field No. Cr. 003, was relatively well preserved and selected as the type for this short report.

Ornithopoda Marsh 1871
Fabrosauridae Galton 1972
***Xiaosaurus* gen. nov**

Diagnosis: As for species

***X. dashanpensis* sp. nov.**
(Plate I)

Etymology: Xiao - Pinyin Romanization for dawn. Dashanpe - representing Pinyin Romanization for the locality from which the specimen was found.

Diagnosis: A small hypsilophodontid ornithopod. Body length of approximately one meter. Skull high with antorbital fenestra, premaxillary teeth, single alignment of dentition, tooth crowns flattened, lingual and labial sides symmetrical with a thin enamel layer present, but no conspicuous interlocking wear facets and lacking a central crest and enamel folds. Denticles are present on the anterior and posterior margins. Tooth roots are conically shaped, and enamel development between the crown and root is incipiently formed, or not well developed.

The vertebrae are hypsilophodontid-like in appearance, as is the anterior curvature of the femur. Femur:tibia ratio is 1:1.09. The third metatarsal is long, being 60 percent the

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*Participating in the 1979-1980 Dashanpu collections were Pixiao Zhong, Jian Zong, and Chunkang Shu from the Zigong Historical Museum of Salt Industry; Shiwu Zhou, and Wei Chen of the Chungking Museum; and Chuanyu Pan, Guobin Zhang and Dewang Chen from the Institute of Vertebrate Paleontology, Paleoanthropology.

length of the tibia. Toes are long and nearly symmetrical with straight unguals for digitigrade locomotion.

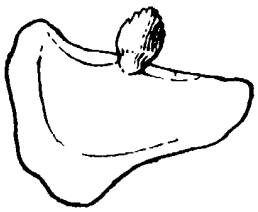

Figure 1. *Xiaosaurus dashanpensis* gen. et sp. nov. maxillary fragment with tooth (x1)

Type: A small damaged maxilla with the first tooth complete, two cervical vertebrae, four caudal vertebrae, a humerus, and a complete hind limb. Field number Cr. 003. IVPP specimen number V6730A.

Hypodigm: One complete right femur, one dorsal vertebra, two articulated sacral vertebrae, a phalanx, a rib, and two isolated teeth. IVPP specimen number V6730B.

Age and Locality: Middle Jurassic, Lower Shaximiao Formation, from Dashanpu, Zigong Municipality, Sichuan Province.

Description: A small piece of broken maxilla bearing a single slightly spatulately curved tooth. The tooth crown is slightly flat, labially convex and lingually concave. A thin enamel layer is present lingually. The tooth crown lacks both vertical enamel folds and a conspicuous central crest. Denticles are present on both anterior and posterior margins. Enamel at the base of the tooth is not well developed, and the teeth do not wear in an interlocking facet pattern. Tooth roots are round and conical. The dental morphology is unlike the vertically pleated form of *Hypsilophodon*, but more closely resembles that of *Nanosaurus*.

Vertebrae: Specimen V6730A preserves several isolated and incomplete vertebrae. It is possible to diagnose the position of the cervical vertebrae, but difficult to determine the precise position of the others.

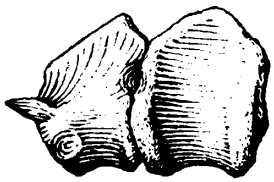

Figure 2 *Xiaosaurus dashanpensis* gen. et sp. nov. cervical vertebrae (x1).

Cervical vertebrae: Two articulated vertebrae are preserved. The neural spine and transverse process morphology determine them to be the axis and the third cervical.

Axis: Relatively well preserved and compares to the axis of *Hypsilophodon* (Galton 1972, Fig. 4). The centrum is short, broad and partially amphicoelus, or flat on one side and concave on the other. The neural arch is low, neural spine triangular and ridge-shaped, being inclined and expanded posteriorly. The posterior zygopophyses are spread open to exceed the centrum body. The anterior zygopophyses are situated at the base of the neural arch, are spatulate in shape and extend anteriorly to articulate with the neural arch of the atlas. The ventral margin is semi-projected and situated on the dorsal side of the centrum (Fig. 2).

The third cervical is articulated to the axis. The centrum is complete, but the neural arch broken. The centrum is acoelous and constricted in the center. There appears to be a trace of a ventral keel. A secondary transverse process is situated at the anterior end of the centrum.

Dorsal vertebrae: No dorsal vertebrae are preserved on specimen V6730A, but hypodigm specimen V6730B preserves one. The centrum is acoelous and slightly constricted at its center; a ventral keel is absent as is a lateral sulcus. The centrum-neural arch suture line is conspicuous. Most of the neural arch and neural spine is missing, but it may be determined from the impression in the matrix that the spine is low and plate shaped.

Sacral vertebrae: A strong sacrum is required of the ornithopods as a function of their bipedality. Specimen V6730B preserves two articulated sacral vertebrae; ScI and ScII are typical of the ornithopods. The transverse processes and costal nodes are fused to form sacral rib-transverse processes that lie between the sacral centra. ScI and ScII are fused, with ScII being the largest of the two. The first sacral rib-transverse process is robust and yoke shaped. This is structurally similar to both *Hypsilophodon* and *Psittacosaurus*.

The sacral centrum body is anteriorly concave, and although the centra are fused, the sacral spines are incompletely fused, and are plate-shaped and low. From the well-preserved condition of the fused centra it may be hypothesized that there were five sacral vertebrae.

Three caudal vertebrae are simple in structure and morphologically similar to the general condition of small ornithopods. The centra are acoelous with slightly reduced articular surfaces. As the caudals were tightly articulated, tail movement was restricted.

Appendages: Anterior limbs are short on primitive bipedal ornithopds. Only a single humerus is preserved on specimen V6730A, which is straight and lacks a well-developed deltoid crest. The humerus head is slightly convex, the cross-section of the shaft is round and hollow, and two distal condyles are nearly equivalent in size. The humerus morphology is similar to *Nanosaurus*. Its length is 8.7 cm (Fig. 3)

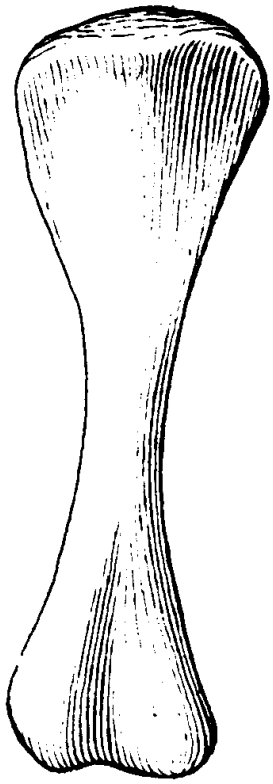

Figure 3 *Xiaosaurs dashanpensis* gen. et sp. nov.humerus (x2/3).

Hind limb: With the exception of some missing metatarsals and phalanges, a right posterior limb is basically complete.

Femur: A basically complete right femur and left femur lacking its proximal end are present (Plate I). The femur is curved anteriorly with an elliptical head lacking a neck. The greater trochanter lies upon the same plane as the femur head. The lesser trochanter is situated anteriorly as an ear-shaped process with a perpendicular or longitudinal groove that opens onto the shaft. The feature of the lesser trochanter situated lower than the greater trochanter corresponds to that of *Fabrosaurus*. The fourth trochanter projects as a well-developed fan-shaped crest that lies posteromedially one-third the distance from the proximal end of the femur. A shallow elliptical depression lies on the femoral shaft anterior to the fourth trochanter to accommodate the femoralis longus. The distal end of the femur is broad with condyles nearly equivalent in size. An anterior intercondylar groove is absent. The length of the femur is 11 cm, with its basic morphology consistent with *Hypsilophodon*.

Tibia: The proximal end is anteroposteriorly broadened and the distal end lateromedially expanded. The cnemial crest is not well developed but is present as a flat, plate-like process that is separated from the lateral condyle by a longitudinal depression. There is very little difference between the size of the two condyles. The tibia shaft is triangular in cross-section with a transversely broadened distal end that is flattened medially and convex laterally. The poorly developed calcaneum process is a relatively primitive character. The tibia is 11.8 cm long.

Fibula: The shaft is straight with a transversely flattened proximal end. The shaft begins to become rounded one-third the distance from the proximal end. A flat surface is present medially for attachment to the tibia. It is a relatively robust tibia, 11.2 cm in length.

Metatarsals and phalanges: The ankle (astragalus-calcaneum) is missing, as are metatarsals I and II. Clear matrix impressions of metatarsals III and IV are present, and metatarsal V is lacking its proximal end. Number III metatarsal is the longest (Table I) with a flat and expanded proximal end. There is a longitudinally swollen fold on the dorsal side near the center that is the vestige of a compression facet with metatarsal IV on the lateral side. The metatarsal structure is similar to that of the hypsilophodontids. The length of metatarsal III is 7 cm.

The phalangeal formula is 2-3-4-5, typical of hypsilophodontids. Specimen 6730A preserves digits III and IV. The third digit is composed of three phalanges and an ungual. The phalanges are long and symmetrical with a symmetrical ligament sulcus. The claw is long and sharp, but not very recurved. The fourth digit preserves three phalanges and one claw. The measurements of the foot are given in Table I.

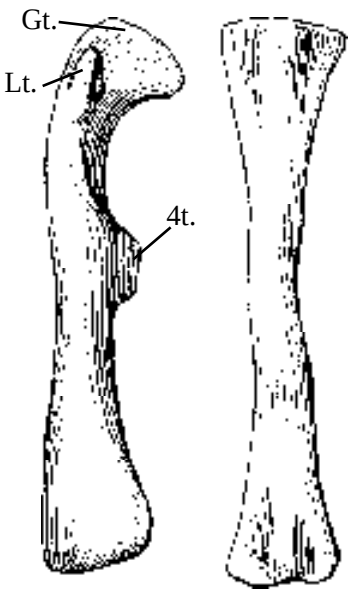

Figure 4 *Xiaosaurus dashanpensis* gen. et sp. nov. femur (left) and tibia (right). Gt. greater trochanter, Lt. lesser trochanter, 4t. fourth trochanter (x2/3)

Discussion and Comparison

The small dinosaur from the Sichuan Dashanpu fauna undoubtedly may be assigned to the order Ornithopoda based upon its hypsilophodontid-type femur and its spatulately recurved teeth.

Galton (1972) distinguished three families of small primitive ornithopods based upon mode of locomotion, differentiation of dentition, and degree of dental morphological development:

Table I. Pedal Measurements for *Xiaosaurus dashanpensis* (mm).

	Total Length	Proximal Breadth	Distal Breadth
Met. III.	70	9	6
Met. IV.	58	5	5
Met. V.	30(?)		4
Dig. III.	I(18). II(16). III(14). ungual(21)		
Dig. IV.	II(10?). III(9). IV(7). ungual(10)		

1. The Heterodontosauridae consist of several small primitive Triassic ornithopod taxa with caniniform teeth.

2. The Fabrosauridae are a small primitive ornithopod with a dentition erupting on the margins of the mandible and maxilla, a not very well developed cheek region, and enamel on the lingual side of the dentition.

The Hypsilophodontidae consist of several taxa of small and relatively specialized ornithopods with well-developed teeth and interlocking wear facets.

The dentition of the Dashanpu specimen may be excluded from the Heterodontosauridae as the teeth are lingual-labially asymmetrical and do not maintain a well-developed cingulum.

The femur of the Dashanpu specimen is characteristic of the hypsilophodontids. In addition, the femur, tibia, and third metatarsal ratio of 1:1:6 falls within the parameters of the Hypsilophodontidae, but again this specimen may be excluded from this family by possessing a thin enamel layer lingually, teeth that are lingual-labially asymmetrical, non-interlocking wear facets, and the absence of enamel folds on the teeth. Consequently it appears more appropriate to assign the specimen to the family Fabrosauridae.

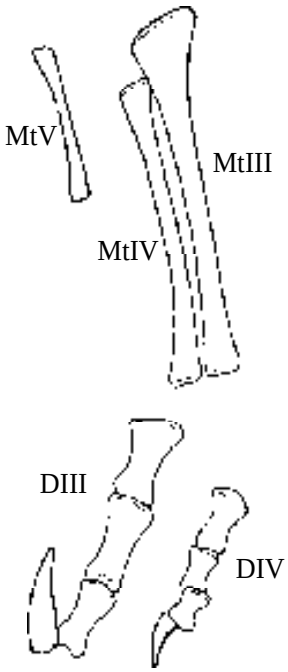

Figure 5 *Xiaosaurus dashanpensis* gen. et sp. nov. pes (x1). 3.

The Fabrosauridae currently encompass four genera:

Echinodon occurs in the Early Cretaceous Wealden Stage. At the time that Owen erected the genus in 1864, he included it within the Order Squamata. Heune and Steel later reassigned it to the Stegosauria. In 1972, after Galton studied the jaw, it was reassigned to the family Fabrosauridae. *Echinodon* is a small individual with tooth crowns unlike those of specimen V.6730A.*

In 1979 *Gongbusaurus* was erected on the basis of two isolated derived teeth, and was described as being a small ornithopod from the Late Jurassic of Rong County, Sichuan. It is distinguished from the Dashanpu material by maintaining a conically shaped premaxillary tooth, and lingual-labially symmetrical cheek teeth with a central ridge.

Scutellosaurus is a small North American armored ornithopod discovered in Arizona that differs from the Dashanpu specimen, and which E.H. Colbert assigned to the Fabrosauridae. It is known from the Triassic-Jurassic Kayenta Formation.

Fabrosaurus is a small ornithopod from the Triassic of South Africa. In 1964 Ginsbury erected the genus within the family Scelidosauridae. Later, Thulborn included it within the Hypsilophodontidae. In 1972 Galton elevated it to its own family level after careful consideration of the primitive nature of its cheek teeth and dental alignment. The family is diagnosed by its relatively pointed teeth, absence of a cingulum, and teeth that are basically symmetrical lingual and labially. These characters do not agree with the Dashanpu specimen.

After careful consideration of the comparisons above, in addition to the recognition of several derived features that the small Dashanpu ornithopod possesses, including the femur:tibia ratio of 1:1.09, the low position of the lesser trochanter, the undeveloped

* According to the text figures of Owen, the maxilla contained a canine. Cooper (1982) recognized *Fabrosaurus* as being derived from the *Massospondylus* Zone, with an age of Early Jurassic.

calcaneum process on the tibia, and its presence in the Middle Jurassic, the establishment of a new taxon is required: *Xiaosaurus dashanpensis* gen. et sp. nov.

Xiaosaurus is recognized as a small derived ornithopod. Its total length is estimated at 94-97 cm based upon the length of the posterior limb, and its proportional relationship to the torso. The derived features of the post crania indicate a relationship to *Hypsilophodon* and *Nannosaurus,* and suggest that within the evolutionary development of small ornithopods, post cranial variation is relatively conservative, but cranial variation occurs relatively liberally. This mosaic of evolutionary characters relates the small ornithopod hypsilophodontids and psittacosaurids to the the genus *Fabrosaurus* through symplesiomorphies of their post-crania.

Thulborn's 1972 discussion of the *Fabrosaurus* post cranial skeleton suggested that this genus shared many derived characters with the genus *Hypsilophodon*, illustrating the intimate relationship between the two, with the former being the predecessor of the latter. Despite the lack of good *Xiaosaurus* cranial material from Dashanpu,* the specimens at hand maintain a *Fabrosaurus*-style tooth and a primitive tibia, which imply this taxon may be the transitional form lying between *Fabrosaurus* and *Hysilophodon.* New material is required for supplemental and deeper studies to advance discussions on this topic.

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* Specimen V6730B is a second hypsilophodontid specimen. During manuscript preparation another small ornithopod recovered by the Sichuan excavation team was undergoing preparation. This caused specimen V6730 to be designated a hypodigm.