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DESCRIPTION OF THE TYPE AND REFERRED MATERIAL OF *PHUWIANGOSAURUS SIRINDHORNAE* MARTIN, BUFFETAUT AND SUTEETHORN, 1994, A SAUROPOD FROM THE LOWER CRETACEOUS OF THAILAND

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Abstract : The type specimen of *P. sirindhornae* Martin, Buffetaut and Suteethorn, 1994 is an incomplete, partly articulated, skeleton discovered in the Phu Wiang area of northeastern Thailand). Most of the abundant sauropod material from the Sao Khua Formation (Early Cretaceous), collected on the Khorat Plateau, in northeastern Thailand, is referable to this species. *Phuwiangosaurus* is a middle-sized sauropod, which is clearly different from the Jurassic Chinese sauropods (Euhelopodidae). On the basis of a few jaw elements and teeth, *P. sirindhornae* may be considered as an early representative of the family Nemegtosauridae.

Key words : Sauropoda, Osteology, Early Cretaceous, Thailand

Description du type et du matériel rapporté de *Phuwiangosaurus sirindhornae* Martin, Buffetaut et Suteethorn, 1994, un sauropode du Crétacé inférieur de Thaïlande

Résumé : Le spécimen type de *Phuwiangosaurus sirindhornae* est un squelette incomplet, partiellement articulé, découvert dans la région de Phu Wiang (Nord-Est de la Thaïlande). *Phuwiangosaurus* est un sauropode de taille moyenne (15 à 20 m de longueur) très différent des sauropodes du Jurassique chinois. La majeure partie de l'abondant matériel de sauropodes, récolté sur le Plateau de Khorat (Formation Sao Khua, Crétacé inférieur), est rapportée à cette espèce. D'après les dents et les rares éléments crâniens découverts jusqu'à maintenant, *Phuwiangosaurus* pourrait appartenir à la famille des Nemegtosauridae.

Mots clés : Sauropoda, Ostéologie, Crétacé inférieur, Thaïlande

INTRODUCTION

Phuwiangosaurus sirindhornae Martin, Buffetaut and Suteethorn, 1994, is based on a partly articulated skeleton, discovered at Phu Pratu Teema (Phu Wiang, site 1) (Fig. 1, 2, 3). *Phuwiangosaurus* material was found in sediments of the Sao Khua Formation, which is Early Cretaceous in age (Racey *et al.*, 1994, 1996). Belonging to the very thick sedimentary deposits of the Khorat Group, the Sao Khua Formation consists of red clays, grey and red sandstones and conglomerates, indicating a wide floodplain environment with low energy meandering rivers, and a semi-arid climate with two distinct seasons (Mouret *et al.*, 1993).

The description of the type specimen of *Phuwiangosaurus sirindhornae* is followed by a description of the material from another site, in Kalasin Province, referred to this species. The juvenile material from Phu Wiang attributed to *Phuwiangosaurus sirindhornae*, which has already been described (Martin, 1994), and the numerous bones from the new locality at Wat Sakawan (Kalasin site 4 : Suteethorn *et al.,* 1995), which are still being prepared, are not described here.

The aim of the present paper is to provide a detailed description of the type material of *Phuwiangosaurus sirindhornae* and of some additional material which complements the information provided by the type.

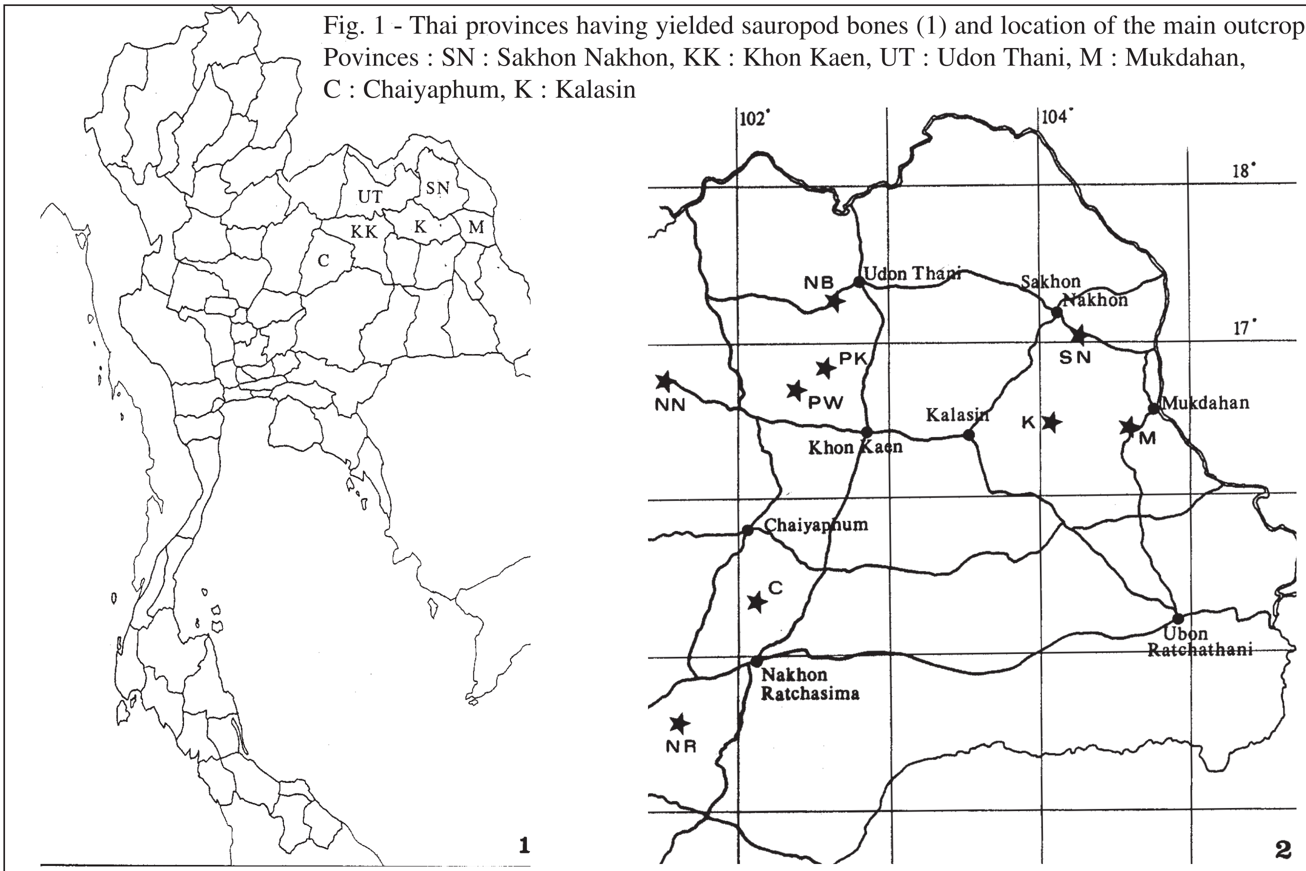


Fig. 1 - Thai provinces having yielded sauropod bones (1) and location of the main outcrops (2). Povinces : SN : Sakhon Nakhon, KK : Khon Kaen, UT : Udon Thani, M : Mukdahan, C : Chaiyaphum, K : Kalasin

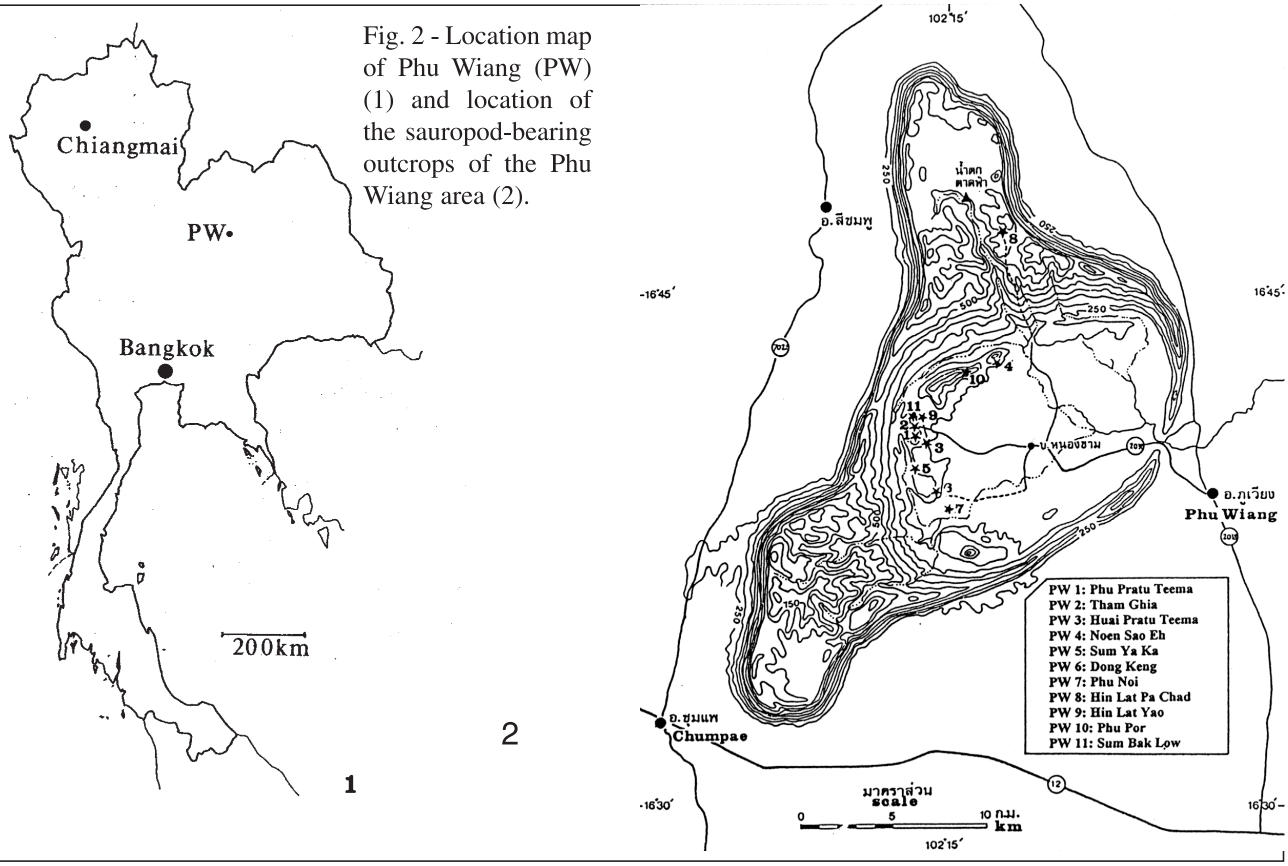


Fig. 2 - Location map of Phu Wiang (PW) (1) and location of the sauropod-bearing outcrops of the Phu Wiang area (2).

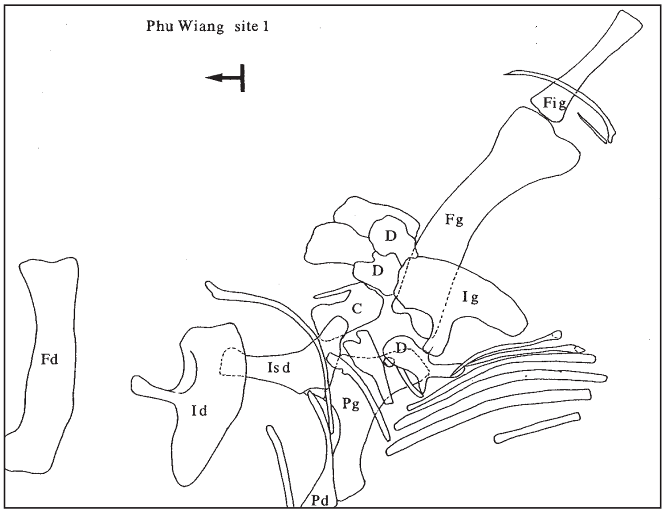


Fig. 3 - Map of some of the *Phuwiangosaurus* bones at site P.W.1 (after Varavudh Suteethorn).

Although *Phuwiangosaurus* has been included in recent cladograms of the Sauropoda (Upchurch, 1998), no attempt is made here to discuss its phylogenetic affinities at great length. This will be done later, when newly discovered material including skull elements from sites in Kalasin Province is described in detail. The teeth and cranial elements clearly suggest affinities with the Nemegtosauridae (Buffetaut & Suteethorn, 1999), and this will shed new light on the evolutionary history of the Cretaceous sauropods of Asia. Meanwhile, as the postcranial skeleton of the Nemegtosauridae was hitherto unknown, it seemed useful to provide a detailed description of the postcranial elements of what appears to be the earliest known representative of this family. Cranial elements will be described in detail in a later paper.

A SHORT HISTORY OF SAUROPOD DISCOVERIES IN THAILAND

The scientific study of Thai dinosaurs began in the 1970s. Dinosaurs have now become as popular there as elsewhere, and their bones exert a considerable fascination on the public and are sometimes surrounded with beliefs and superstitions. To touch a dinosaur bone is said to ensure a long life, or to help finding winning lottery numbers, for instance. Dinosaur bones are often brought by villagers to the local Buddhist temple, which commonly serves as a repository for all kinds of local curiosities, and monks are of great help in reporting and locating fossil sites.

The first dinosaur bone from Thailand was found by a geologist from the Department of Mineral Resources (Bangkok), Mr Suthem Yaemniyom, while prospecting for uranium in the Phu Wiang area. The specimen, from the Sao Khua Formation, was identified as the distal end of a sauropod femur by Philippe Janvier (Centre National de la Recherche Scientifique, Paris) during a visit to the Department of Mineral Resources. This led to the first reports about Thai dinosaurs (Ingavat *et al.*, 1978; Ingavat & Taquet, 1978). Subsequent Thai-French expeditions found more isolated sauropod bones in the Sao Khua Formation. A major discovery occurred in 1982, when a partly articulated skeleton was found in fine-grained sandstone on Phu Pratu Teema hill (Phu Wiang, site 1A), which resulted in the lengthy excavation of what was to become the type of *Phuwiangosaurus sirindhornae*. The skeleton was associated with isolated theropod teeth, an association which was interpreted as evidence of scavenging of a sauropod carcass by theropods (Buffetaut & Suteethorn, 1989).

In 1989, seven cervical vertebrae of a sauropod were found in connection at Phu Wiang (site 2). An attempt was made to preserve them *in situ*, but unfortunately efficient protection proved impossible and the specimen was almost completely destroyed.

In 1990, numerous small bones were found in the forest near Phu Wiang (site 4) by schoolboys, and given to the Department of Mineral Resources by their teacher. These small bones were the first remains of juvenile sauropods to be found in Thailand.

In 1991, during prospection work in the Kalasin area, a large accumulation of bones was found by the driver of the expedition near a temple at Phu Pha Ngo. These huge bones, thought by the locals to be elephant bones, had been collected by the workers during the erection of the temple. More than one hundred incomplete sauropod bones were found, forty of them identifiable. An excavation at the site later yielded other bones belonging to at least three individuals.

In the course of prospecting around Phu Wiang in 1991 and 1992, more sauropod remains were discovered, including numerous bones of juveniles

(Phu Wiang, sites 5 and 5A).

A major discovery of sauropod remains occurred in November 1994 near the temple at Wat Sakawan (Sahat Sakhan, Kalasin Province). This new locality has yielded several partly articulated skeletons, including elements of the upper jaw and numerous teeth (Suteethorn *et al.*, 1995). More than 600 bones have been recovered from this site and are still being prepared. Since then, several other sauropod sites have been discovered in the Sao Khua Formation, mainly in Kalasin Province. Their scientific exploitation is still going on and they will be described later.

Class **REPTILIA**, Linné, 1758
Super-order **DINOSAURIA**, Owen, 1842
Order **SAURISCHIA**, Seeley, 1888
Sub-order **SAUROPODOMORPHA**, Huene, 1932
Infraorder **SAUROPODA**, Marsh, 1878
Family **NEMEGTOSAURIDAE**, Upchurch, 1995

PHUWIANGOSAURUS MARTIN, BUFFETAUT AND SUTEETHORN, 1994

Derivatio nominis : From the name of the type locality, Phu Wiang, and the Greek *sauros* (lizard).
Type species : *Phuwiangosaurus sirindhornae* Martin, Buffetaut and Suteethorn, 1994.
Diagnosis : same as the type species.

PHUWIANGOSAURUS SIRINDHORNAE MARTIN, BUFFETAUT AND SUTEETHORN, 1994

Type : A partly articulated skeleton (n° P.W.1-1 to P.W.1-21).
Locus typicus : Phu Pratu Teema (Phu Wiang site 1), Amphoe Phu Wiang, Khon Kaen Province, north-eastern Thailand.
Stratum typicum : Sao Khua Formation, Khorat group, Early Cretaceous.
Derivatio nominis : In honour of Her Royal Highness Princess Maha Chakri Sirindhorn, Princess of Thailand, who has repeatedly demonstrated her great interest for the palaeontological riches of her country.
Referred material : Most of the abundant sauropod bones found in the Phu Wiang and Kalasin areas, including the important juvenile material, are referable to *Phuwiangosaurus sirindhornae*. A detailed list of the material is provided in the Appendix 2.

Diagnosis : Middle sized sauropod (15 to 20 m long). Anterior cervical vertebrae with a very low and wide neural arch. Diapophyses and parapophyses very developed lateroventrally. Large zygapophyses situated low and far from each other, firmly diverging laterally from the centrum. Neural spine of the posterior cervical vertebrae widely bifurcated with no median spine. Cervical vertebrae with a well developed system of laminae and cavities. Centra of the dorsal vertebrae opisthocoelous with deep pleurocoels. Posterior dorsal vertebrae with unforked neural spine. Neural spine elongated craniocaudally. Long diapophyses directed more dorsally than laterally, nearly reaching the level of the spine. Hyposphene-hypantrum system present. Elongated scapula with lateral ridge of the proximal extremity at right angle with the shaft, and slight distal expansion. Humerus similarly expanded at both ends. Anterior blade of the ilium well developed. Pubic peduncle of the ilium straight, long and directed at right angle to the direction of the blade. Ischiatic peduncle of the ilium faintly marked. Pubis with very open angle between the axis of the shaft and the ischiatic border. Well marked curvature of the caudal border of the shaft of the ischium. Femur flattened anteroposteriorly with the head situated slightly above the level of the great trochanter. Fourth trochanter crest-shaped, located medially above the midlength of the shaft. Very large lateral epicondyle at the distal end of the femur. Slight lateral bending of the shaft of the fibula.

TYPE MATERIAL OF *PHUWIANGOSAURUS SIRINDHORNAE*

The type material, as well as the referred material, of *Phuwiangosaurus sirindhornae*, has been compared to most known sauropods (listed in appendix 3). Comparisons mainly refer to the best known, described and illustrated genera. All the sauropod families have been used, except the Titanosauridae. The Titanosauridae which are well represented in the

Late Cretaceous, show very peculiar characteristics distinguishing them from the other families. Among these characteristics are the peculiar procoelous caudal vertebrae, the backward directed neural spines of the dorsal vertebrae, the absence of hyposphene / hypantrum system on the dorsal vertebrae and the very elongated pubic peduncle of the ischium (Le Loeuff, 1993), which are altogether very different from what can be seen in *P. sirindhornae*. However, it should be noted that in cladograms published by Upchurch (1998), *Phuwiangosaurus* consistently clusters with titanosaurids, which has led Upchurch to place it within the Titanosauroidea, as a member of the family Andesauridae, together with *Andesaurus* and *Malawisaurus*. Clearly, further comparisons of *Phuwiangosaurus* with the titanosaurs will be needed, in conjunction with a reappraisal of the phylogenetic position of the Nemegtosauridae, once the cranial material of *Phuwiangosaurus* is described (for a discussion of the Nemegtosauridae, see Upchurch, 1999).

In the following comparative descriptions, presacral vertebrae were considered as the most useful post-cranial elements for comparisons, specialisations being more easily recognisable on vertebrae than on limbs and girdles.

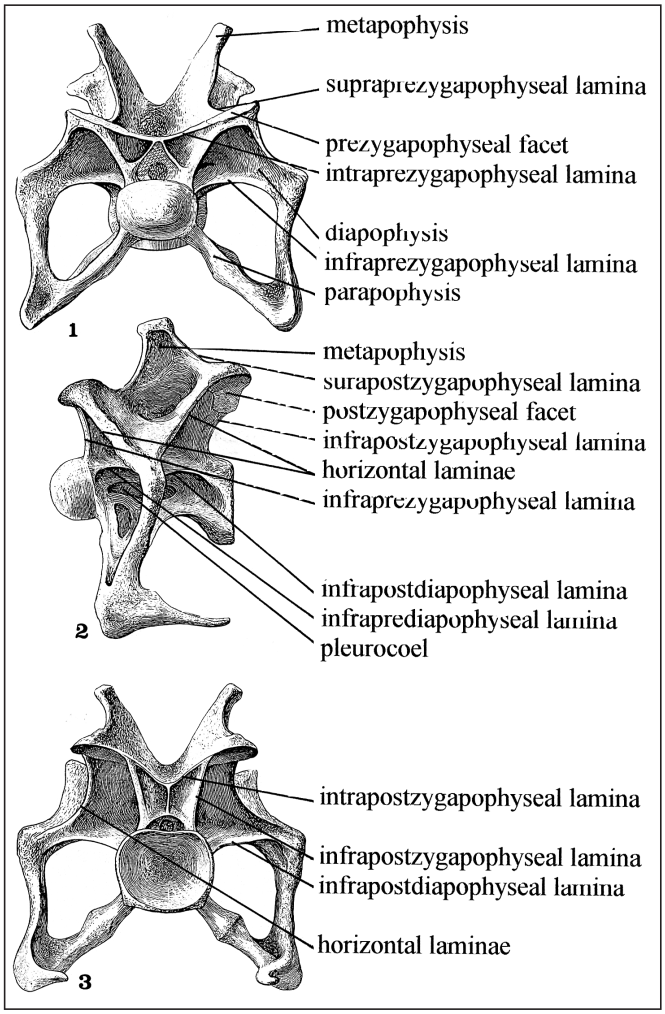


Fig. 4 - Nomenclature of the cervical vertebrae, cranial (1), lateral (2) and caudial (3) views (*Apatosaurus louisae* after Gilmore, 1936).

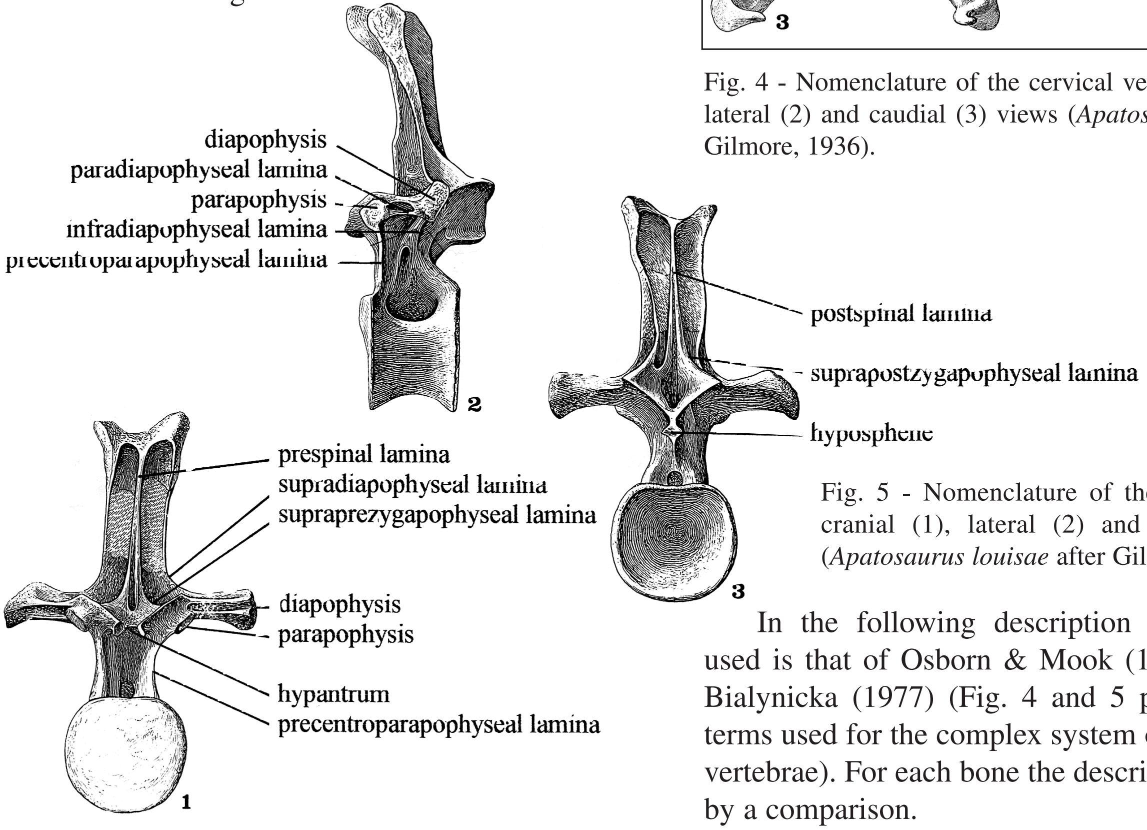


Fig. 5 - Nomenclature of the dorsal vertebrae, cranial (1), lateral (2) and caudal (3) views (*Apatosaurus louisae* after Gilmore, 1936).

In the following description the terminology used is that of Osborn & Mook (1921) or Borsuk-Bialynicka (1977) (Fig. 4 and 5 present the main terms used for the complex system of laminae of the vertebrae). For each bone the description is followed by a comparison.

CERVICAL VERTEBRAE

P.W. 1-1 (Fig. 6)

This cranial cervical vertebra is well preserved in its cranial part, but the neural arch is incomplete caudally.

Centrum : The strongly opisthocoelous centrum is very elongated. The cranial articular surface is strongly convex in ventral and lateral views. In cranial view this part is oval in shape (wider transversally). The caudal edge is straight in ventral view. In caudal view the outline is subrectangular, wider transversally than dorsoventrally. In lateral view the ventral edge of the centrum presents a sigmoid curvature, concave cranially and convex caudally. In lateral view, the ventral part of the caudal edge is more elongated caudally than the dorsal part of the caudal edge.

Their extension is lateral and slightly ventral. Cervical ribs are fused with the centrum. In ventral view the ventral surface is strongly constricted transversally, caudally to the parapophyses. A shallow depression can be observed on the ventral surface between the parapophyses, in the middle of the centrum and caudally, on each side of the ventral surface. The lateral borders of the ventral surface form a sharp ridge.

On the lateral surface of the centrum a median ridge originates in a cranial bulge. This ridge becomes fainter caudally. Ventrally to this ridge, in the cranial part, are two deep pleurocoels. The cranial pleurocoel is deeper, larger and more dorsally situated than the caudal one. The caudal part of the lateral surface of the centrum is nearly flat and not excavated. The lateral edges of the centrum are curved dorsally and ventrally to produce two parallel lateral laminae. The dorsal lamina originates more caudally than the ventral one.

In *Camarasaurus grandis* and *Haplocanthosaurus delfsi* the centrum is less elongated, but it is more elongated in *Omeisaurus tianfuensis* and *Omeisaurus junghsiensis*. The elongated centrum is close to *Brachiosaurus brancai*, but the lateral surfaces of *Brachiosaurus brancai* centra are more excavated. The cranial surface of the centrum of *Euhelopus zdanskyi* and *Camarasaurus grandis* is more rounded. No ventral keel is present, unlike the condition in *Omeisaurus tianfuensis*. The parapophyses are situated on the latero-ventral edge of the centrum, just posterior to the cranial convexity, as in *Euhelopus zdanskyi* or *Camarasaurus grandis*. In *Brachiosaurus brancai*, the parapophyses originate more caudally, not just after the cranial convexity. The bases of the parapophyses are wide in ventral view; they are less elongated in *Mamenchisaurus hochuanensis*. *Mamenchisaurus constructus* and *Omeisaurus changshouensis* have no marked pleurocoel. The pleurocoels of *Diplodocus carnegii* are larger and deeper.

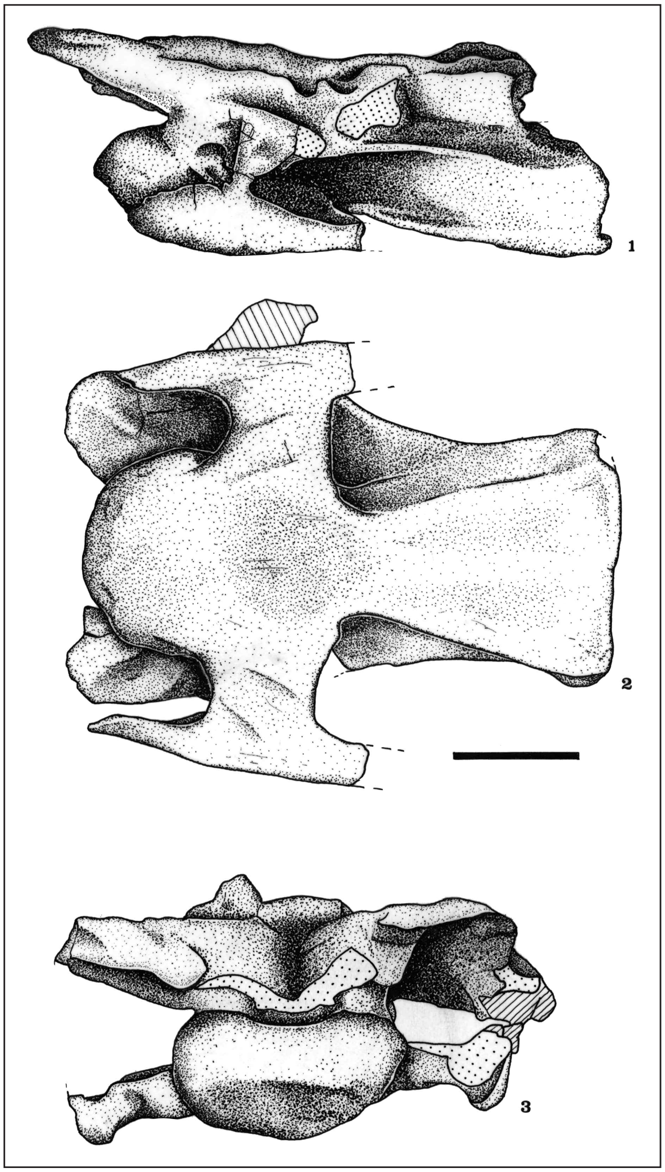


Fig. 6 - Anterior cervical vertebra P.W.1-1, lateral(1), ventral (2) and cranial (3) views. Scale bar: 10 cm

Neural canal : The oval neural canal is flattened dorsoventrally.

Neural arch : The very low neural arch is elongated, overhanging the cranial end of the centrum.

The neural arch is extending laterally as in *Barosaurus lentus*. The neural arches of the cranial cervical vertebrae of *Dicraeosaurus hansemanni* and *Haplocanthosaurus delfsi* are much more developed dorsally than in our specimen.

Neural spine : The very low, divided neural spine is situated above the caudal part of the centrum. The neural spine is thin cranially and becomes thicker caudally. The spine is laterally concave. Its end is blunted.

The straight pseudospinosus process of *Mamenchisaurus constructus* is more developed dorsally and uncurved. The pseudospinosus process of *Omeisaurus fuxiensis* is lower. The neural spine of the cranial cervicals of *Camarasaurus grandis* is higher.

Prezygapophyses : The wide flat prezygapophysial facets are nearly horizontal. In ventral view they are cranially rounded. They are situated low and far from each other, firmly diverging laterally from the centrum. The infraprezygapophyseal laminae support them ventrally.

The position of the prezygapophyses is as in *Barosaurus lentus*.

Diapophyses : The diapophysis is long craniocaudally and thin dorsoventrally. The diapophyses are directed lateroventrally. They are long and therefore the cervical ribs are situated far from the centrum. The diapophysis is supported cranially and caudally by the horizontal laminae and ventrally by the infrapostdiapophyseal lamina.

Cervical ribs : The cervical ribs are fused with the centrum and elongated in the same direction as the centrum. The cranial process is well developed and spoon-like in shape. Its medial surface is strongly concave and the lateral one is slightly convex. The ventral surface of the rib is slightly concave. The lateral surface of the rib becomes craniomedially curved. The rib presents a marked ridge lateroventrally.

In *Euhelopus zdanskyi*, *Apatosaurus excelsus* and *Apatosaurus louisae* the ribs are situated more ventrally.

This cervical vertebra is very elongated, as in *Brachiosaurus brancai*, but in the latter genus the centrum is more excavated than in our specimen. The parapophyses are situated just after the cranial condyle, as in *Euhelopus zdanskyi* or *Camarasaurus grandis*, unlike *Brachiosaurus brancai* where the parapophyses originate more caudally. The centrum presents two deep pleurocoels absent in *Mamenchisaurus constructus* and *Omeisaurus changshouensis*. In *Diplodocus carnegii* the pleurocoels are even deeper. The low elongated neural arch extends laterally (by means of the prezygapophyses and diapophyses) as in *Barosaurus lentus*. The ribs are situated less ventrally than in *Euhelopus zdanskyi*, *Apatosaurus excelsus* and *Apatosaurus louisae*. The cranial process is well marked.

The cervical vertebrae in *Euhelopus zdanskyi*, *Omeisaurus tianfuensis*, *Mamenchisaurus hochuanensis* and *Mamenchisaurus constructus* are very different from this one because they are strongly flattened transversally and not dorsoventrally. In this respect, this cervical vertebra is closer to the dorsoventrally flattened cervicals of *Camarasaurus supremus*.

Measurements (in cm) of the cervical vertebra n°P.W.1-1 of *P. sirindhornae*

Centrum length*	42,5
Centrum cran. height	9,5
Centrum caud. height	10,5
Centrum cran. width	16,8
Centrum caud. width	21
Width of diapophyses	20,5x2
Width of prezyga.	14,5x2
Width of postzyga.	-
Total height	20,4

* including the length of the cranial articular surface

P.W. 1-2 (Fig. 7)

This middle cervical vertebra is very well preserved, though a little twisted; the left side is incomplete. Some characteristics are similar to those of P.W.1-1.

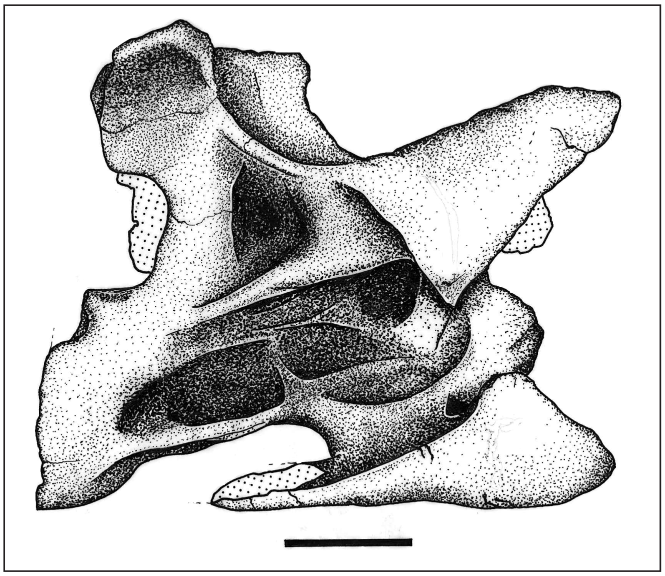


Fig. 7 - Middle cervical vertebra P.W.1-2, lateral view.
Scale bar: 10 cm

Centrum : The centrum is similar in shape to that of P.W.1-1, it is elongated and strongly opisthocoelous. The lateral and ventral surfaces are built in the same way. The ventral surface presents an additional deep depression, located in the cranial part of the ventral surface. The constriction after the parapophyses is less pronounced. The cranial articular surface is less prominent; in cranial view P.W.1-1 is oval in shape, this one is more spherical. The centrum is less flattened dorsoventrally. In lateral view the ventral surface presents two concavities; the cranial one is larger and the caudal one is less deep. The median ridge is cranially swollen and overhangs two elongated pleurocoels. The caudal pleurocoel extends farther caudally than in P.W.1-1.

Neural canal : The neural canal is more circular in outline than in P.W.1-1.

Neural spine : The neural spine is high and divided. It is located more in the middle of the centrum than in P.W.1-1. The neural spine is situated lower than the postzygapophyses.

Prezygapophyses : Although they are incomplete, we can observe their oblique direction, and that they are close to each other.

In *Omeisaurus tianfuensis* the prezygapophyses are less developed cranially.

Postzygapophyses : The large postzygapophyses are wide and oblique and their dorsal surfaces are swollen. The flat facet is subrectangular. The postzygapophysis is supported caudally by the infrapostzygapophyseal and intrapostzygapophyseal laminae. Between the two postzygapophyses there is a deep cavity.

Parapophyses : The parapophyses are situated less ventrally and more laterally than in P.W.1-1. They are wide, low and situated very cranially.

Diapophyses : They are similar to those of the preceding vertebra.

Cervical rib : The cranial process is very developed. The lateral surface of the cranial process is concave; this surface is slightly convex in the caudal part of the rib. The cranial process curves mediocranially.

This vertebra, as the preceding one presents no common character with the Euhelopodidae. The high and bifurcated spine and the great width of the vertebra are very different from the Euhelopodidae. The general pattern of this vertebra is more like that of the Camarasauridae or Brachiosauridae. In *Camarasaurus supremus* the outline of the neural spine and the development of the lamina system are similar. The bifurcation of the neural spine is also developed in the same way in *Camarasaurus supremus*. In *Brachiosaurus brancai* the general outline of the vertebra is comparable but the system of lamina is more complex than in P.W.1-2 and there is no evidence of bifurcation of the neural spine in this genus, unlike in P.W.1-2.

Measurements (in cm) of the cervical vertebra n°P.W.1-2 of *P. sirindhornae*

Centrum length*	39
Centrum cran. height	8,5
Centrum caud. height	16
Centrum cran. width	14
Centrum caud. width	15,6
Width of diapophyses	11,5x2
Width of prezyga.	9x2
Width of postzyga.	21
Total height	35

* including the length of the cranial articular surface

P.W.1-3 (Fig. 8)

This vertebra is slightly warped. It can be considered as a caudal cervical or a cranial dorsal.

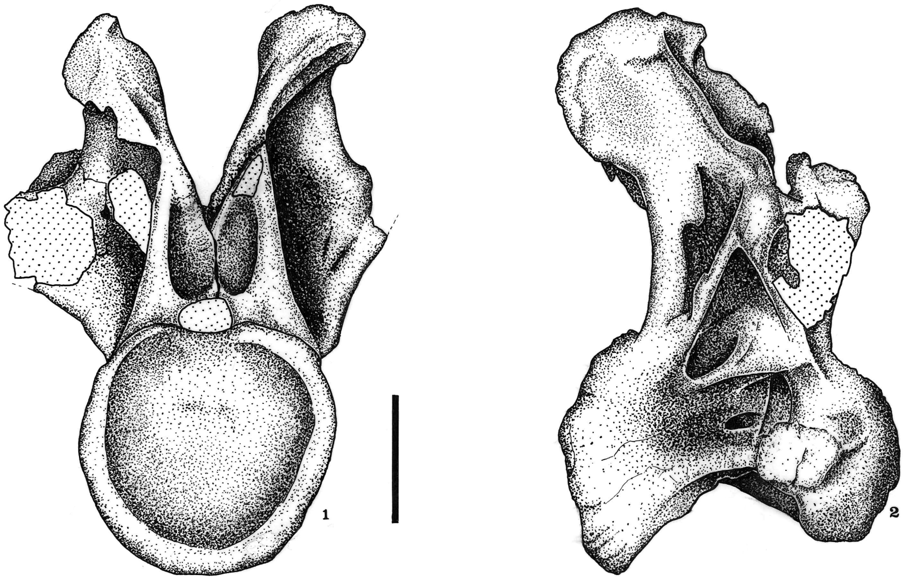


Fig. 8 - Posterior cervical vertebra P.W.1-3, caudal (1) and lateral (2) views. Scale bar: 10 cm

Centrum : The opisthocoelous centrum is shorter than in the preceding vertebrae. The cranial articular surface of the centrum is hemispherical. In caudal view, the centrum is circular in outline. In lateral view the middle of the centrum is strongly compressed dorsoventrally, leading to a deeply concave ventral surface. A slight and ventral median ridge originates at the cranial depression and merges caudally with the caudal ventral end of the centrum. Two shallow and elongated depressions occur on each side of this median ridge. In ventral view a marked constriction occurs behind the parapophyses. The parapophyses are situated cranially in the ventral half of the lateral surface of the centrum. A lamina originates caudally to the parapophysis. Above the parapophysis the centrum is excavated by two pleurocoels on the right side. The cranial one is larger, higher and triangular in shape. The caudal one is under the preceding one, smaller, and oval in shape. The lateral surface of the centrum is flat in its caudal part. On the left side there is a third small and deep pleurocoel.

The ventral surface is more deeply concave than in *Euhelopus zdanskyi*.

Neural canal : The neural canal is subcircular in outline.

Neural arch : The neural arch presents a well developed system of laminae and cavities. An oblique supracentral lamina is present at the level of the suture of the centrum with the neural arch. Above the supracentral lamina there is a deep oval depression filled in cranially. *Diplodocus carnegii* and *Brachiosaurus brancai* present a more complex and slender laminar system.

Neural spine : The high neural spine is deeply divided. The neural spine is slightly higher than the postzygapophyses and is situated at midlength of the centrum. The blade of the neural spine is very thin cranially and becomes thicker caudally. The dorsal end of the neural spine is blunt. The spines curve laterally, they are obliquely directed.

The neural spines of *Dicraeosaurus hansemanni* and *Dicraeosaurus sattleri* are much higher and even more deeply divided. The neural spines of *Haplocanthosaurus utterbacki* is higher but undivided. In *Euhelopus zdanskyi* the bifurcation is less pronounced, even at the base of the neck and in the region of the first dorsals, where this bifurcation is the deepest. There is no median spur, unlike the small one observable in *Diplodocus carnegii*. In lateral view *Diplodocus carnegii* presents a marked curvature between the prezygapophyses and the neural spine.

Postzygapophyses : The large and prominent postzygapophyses are situated more dorsally than the prezygapophyses. The postzygapophyses are oval in shape, higher than wide. They are obliquely directed. The articular facets are flat. Dorsally the postzygapophyses are linked with the ends of the neural spine. Cranially the accessory lamina joins the supradiapophyseal lamina. Ventrally the vertical infrapostzygapophyseal lamina supports the postzygapophysis, with the intrapostzygapophyseal lamina. Deep cavities are present between these laminae.

Parapophyses : The parapophysis is shorter on this vertebra, less wide but higher cranially.

Diapophyses : The incomplete diapophyses are dorsolaterally directed. They are situated more ventrally than the postzygapophyses.

This caudal cervical vertebra is characterised by its very tall neural spine and the deep bifurcation of this spine. The neural spine of this vertebra is taller than in *Brachiosaurus brancai* and *Camarasaurus supremus*. The deep bifurcation is less pronounced than in *Dicraeosaurus hansemanni* and *Dicraeosaurus sattleri*, but is much more developed than in *Euhelopus zdanskii* or *Mamenchisaurus hochuanensis*. There is no median spine unlike in *Euhelopus zdanskii* and *Diplodocus carnegii*. The system of laminae is very well developed and deep cavities separate the thin laminae.

These three cervical vertebrae of the same series can not be attributed to any known sauropod. Their main proper characteristics are the width of the cranial cervical vertebrae, and the high and deeply bifurcated neural spine in the caudal cervical vertebrae.

Measurements (in cm) of the cervical vertebra n°P.W.1-3 of *P. sirindhornae*

Centrum length*	28
Centrum cran. height	13,7
Centrum caud. height	18
Centrum cran. width	17,5
Centrum caud. width	19
Width of diapophyses	-
Width of postzyga.	13,5x2
Total height	44

* including the length of the cranial articular surface

DORSAL VERTEBRAE

Two well preserved middle dorsal vertebrae in connection (P.W.1-4), and two incomplete posterior ones (P.W.1-5, P.W.1-6), are present in that specimen. Among those in connection, the more caudal one is in better condition.

P.W. 1-4 (Fig. 9)
Centrum : The elongated centra are opisthocoelous. The cranial articular surface is prominent and regularly convex in ventral view. In cranial and caudal views the centrum is subcircular in outline. At mid length, the centrum is ventrally constricted dorsoventrally and

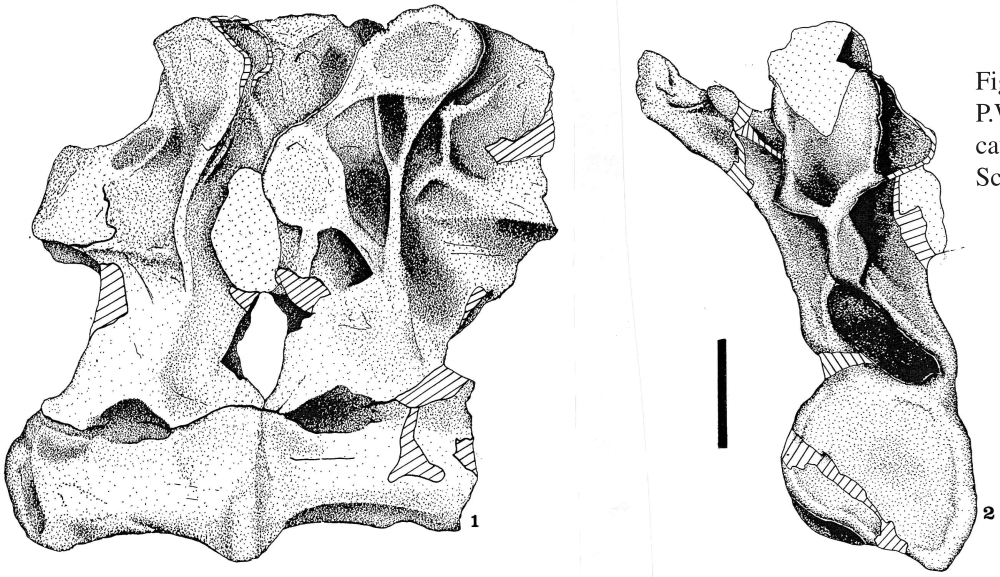


Fig. 9 - Dorsal vertebra P.W.1-4, lateral view (1), caudal view (2). Scale bar: 10 cm

transversally, leading to a concave ventral edge in lateral view, bearing a faint ventral keel. The lateral surfaces of the centrum are dorsoventrally convex, with a shallow depression just above the keel. The spindle-shaped pleurocoel is elongated, deep and situated just at the base of the neural arch.

The centrum is small compared to the well developed neural arch.

The ventral surface of the centrum of *Euhelopus zdanskyi* is less concave in lateral view. *Euhelopus zdanskyi* presents similar pleurocoels. The pleurocoels of *Apatosaurus excelsus*, *Dicraeosaurus hansemanni*, *Tienshanosaurus chitaiensis* and *Camarasaurus supremus* are smaller. *Diplodocus carnegii* presents deeper pleurocoels. The relative size of the centrum compared to the neural arch is even smaller in *Haplocanthosaurus priscus* and *Haplocanthosaurus delfsi*. In *Opisthocoelicaudia skarzynskii*, *Camarasaurus supremus* and *Barosaurus lentus*, the centrum is larger compared to the neural arch.

Neural canal : The neural canal is subcircular in outline. It is quite completely covered by the neural arch.

The neural canal of *Camarasaurus supremus* is smaller.

Neural arch : The neural arch is very developed, therefore the centrum appears very small compared to the height of the neural arch. The base of the neural arch is elongated craniocaudally along the whole length of the centrum. The lateral side of the neural arch is slightly convex dorsoventrally. A slight warp occurs on the neural arch and some laminae are distorted.

The base of the neural arch is more elongated than in *Haplocanthosaurus priscus* or *Apatosaurus excelsus*. The well developed lamina system of *Euhelopus zdanskyi* is very close to that specimen. The neural arch of *Diplodocus carnegii* and *Haplocanthosaurus priscus* is much more lightened than in this quite stout specimen. The lamina system of *Diplodocus carnegii* is made of blades of very thin bone, with numerous accessory blades. The lamina system of *Camarasaurus supremus* and *Apatosaurus excelsus* is less developed.

Neural spine : The spine is simple and unforked. The spine is thick, very short dorsoventrally and not much higher than the level of the diapophysis. The dorsal end of the spine is incomplete. The neural spine is cranially thin and becomes thicker caudally for the first dorsal spine. Cranially to the spine of the second dorsal a thick mass of bone gets thinner caudally; this mass, produced by the junction of two supraprezygapophyseal laminae, is probably broken on the first one. Laterally, a lamina system buttresses the spine.

The neural spines of *Diplodocus carnegii*, *Dicraeosaurus hansemanni*, *Dicraeosaurus sattleri* and *Brachiosaurus brancai* are more slender. As in *Euhelopus zdanskyi* the neural spine is very elongated craniocaudally, more so than in most sauropods.

Prezygapophyses : The small prezygapophyses are directed dorsomedially at a 45° angle to the direction of the spine. They are roughly square-shaped. The supra and infraprezygapophyseal laminae buttress them. The hypantrum is well developed and is limited by the closely placed prezygapophyses

Postzygapophyses : The small square-shaped postzygapophyses can be observed on the second dorsal. In caudal view their articular surface is slightly concave. They are more nearly perpendicular to the direction of the spine than the prezygapophyses. The hyposphene is diamond-shaped and very well marked.

Diapophyses : The very long diapophyses show a laterodorsal, mainly dorsal, direction. The end of the diapophysis is rounded. Dorsally the diapophysis is shallow and depressed. The horizontal laminae, the supradiapophyseal laminae and the infradiapophyseal laminae buttress the diapophysis. The infradiapophyseal lamina is divided into two laminae, the caudal one being more marked than the cranial one. These two laminae merge together at the level of the parapophysis.

The laterodorsal direction of the diapophyses is even more marked here than in *Haplocanthosaurus priscus* and *H. delfsi*. The diapophyses of *Omeisaurus junghsiensis* and *Brachiosaurus brancai* are directed mainly laterally. The diapophyses of *Apatosaurus* *louisae* are very different because they are directed laterally and are very short.

Parapophyses : The well developed parapophyses are wide and subcircular in outline. Situated well above the centrum, at mid-height on the neural arch, they indicate a middle position in the dorsal series. On the first of the two dorsals in this specimen, the parapophysis is in contact with the diapophysis by means of the infraprediapophyseal lamina. The parapophyses are supported by the horizontal lamina, the oblique lamina and the infraprezygapophyseal lamina.

These opisthocoelous dorsal vertebrae show a well developed system of laminae and deep elongated pleurocoels. The pleurocoels in *Apatosaurus excelsus*, *Dicraeosaurus hansemanni*, *Tienshanosaurus chitaiensis* and *Camarasaurus supremus* are smaller, and deeper in *Diplodocus carnegii*. The centrum is small compared to the size of the neural arch, less so than in *Haplocanthosaurus priscus* and *Dicraeosaurus hansemmanni* but more so than in *Opisthocoelicaudia skarzynskii*. The base of the neural arch is elongated craniocaudally and dorsoventrally. The system of laminae is well developed but less so than in *Diplodocus carnegii*. The neural spine is low and unforked on the posterior dorsal vertebrae. The hypantrum/hyposphene system is well developed. The diapophyses are long and dorsally directed. All together, these characteristics can not fit with any genera of sauropod. As far as the anatomy of the dorsal vertebra is concerned, the closer form is *Camarasaurus supremus*. But in *Camarasaurus supremus* the spine is more expanded transversally and the base of the neural arch is shorter dorsoventrally.

Measurements (in cm) of the dorsal vertebrae n°P.W.1-4 of *P. sirindhornae*

Centrum length	21	22
Centrum cran. height	13,8	14,2
Centrum caud. height	14,2	14,4
Centrum cran. width	14,1	16,9
Centrum caud. width	16,9	16,3
Width of diapophyses	16,7x2	17,5x2
Width of postzyga.	-	9,5
Width of prezyga.	12	-
Total height	49	50

P.W. 1-5

For this vertebra only the centrum and the base of the neural arch are preserved.

Centrum : This vertebra presents some similarities with the two preceding ones. The opisthocoelous centrum is constricted transversally and dorsoventrally. In lateral view the ventral edge is concave. The centrum is subcircular in cranial and caudal views. The centrum is shorter than in P.W.1-4. The cranial articular surface is convex, but less prominent. The caudal articular surface is deep. The lateral surface of the centrum is concave craniocaudally and convex dorsoventrally. The pleurocoel is very well developed and deep in the cranial part. Two rounded depressions are separated by a small oblique blade in the cranial part of the pleurocoel. The shape of the pleurocoel is more circular on the right side of the vertebra than on the left side. The ventral surface of the centrum is flat.

Neural canal : The same subcircular outline can be observed.

Neural arch : Just above the pleurocoel, the base of the neural arch starts swelling out.

Measurements (in cm) of the dorsal vertebra n°P.W.1-5 of *P. sirindhornae*

Centrum length	20
Centrum cran. height	14,2
Centrum caud. height	18,5
Centrum cran. width	16
Centrum caud. width	18,4

P.W. 1-6

A large part of the neural arch is missing.

Centrum : The centrum is shorter than in the other dorsals of the specimen. The convex cranial part is more pronounced dorsally. It is also compressed dorsoventrally and transversally. The lateral surface is convex dorsoventrally and concave craniocaudally. In lateral view the ventral edge of the centrum is concave. This ventral surface bears a ventral keel and two shallow depressions laterally to this keel. The pleurocoel is more rounded. At the bottom of the depression, cranially and just at the base of the neural arch we can observe three depressions, one main one and two accessory ones cranially.

Neural canal : The circular neural canal is larger than on the preceding vertebrae.

Neural arch : The lateral surfaces of the neural arch are strongly swollen at their base.

Prezygapophyses : The prezygapophyses are well preserved, flat and horizontal. They are very close to each other. Although the intervening space is not completely prepared, some remains of the hypantrum can be seen. The prezygapophyses are concave and ventrally buttressed by laminae.

Parapophyses : At the same level as the prezygapophyses, the long parapophyses are supported by well marked infraprezygapophyseal laminae. The parapophyses are dorsoventrally elongated and craniocaudally constricted.

Diapophyses : The long diapophyses are thin craniocaudally and wide dorsoventrally. Their direction is more dorsal than lateral. The infradiapophyseal lamina ventrally supports the diapophysis.

Measurements (in cm) of the dorsal vertebra n°P.W.1-6 of *P. sirindhornae*

Centrum length	15
Centrum cran. height	17,5
Centrum caud. height	21,2
Centrum cran. width	20,7
Centrum caud. width	22
Width of diapophyses	19,5x2
Width of prezyga.	14
Width of postzyga.	-
Total height	-

CHEVRON BONE
P.W.1-20

The only preserved chevron is incomplete. The chevron is *Camarasaurus*-like, more than *Diplodocus*-like. The haemal canal is open and there is no cranial expansion of the distal end. The proximal end is enlarged craniocaudally and transversally. The distance between the two articular surfaces is wide. The blade is too poorly preserved to be described.

Measurements (in cm) of the chevron n°P.W.1-20 of *P. sirindhornae*

Length	-
Proximal transversal width	13,3
Depth of the bifurcation	10,5

SCAPULA
P.W.1-7, P.W.1-22 (Fig. 10)

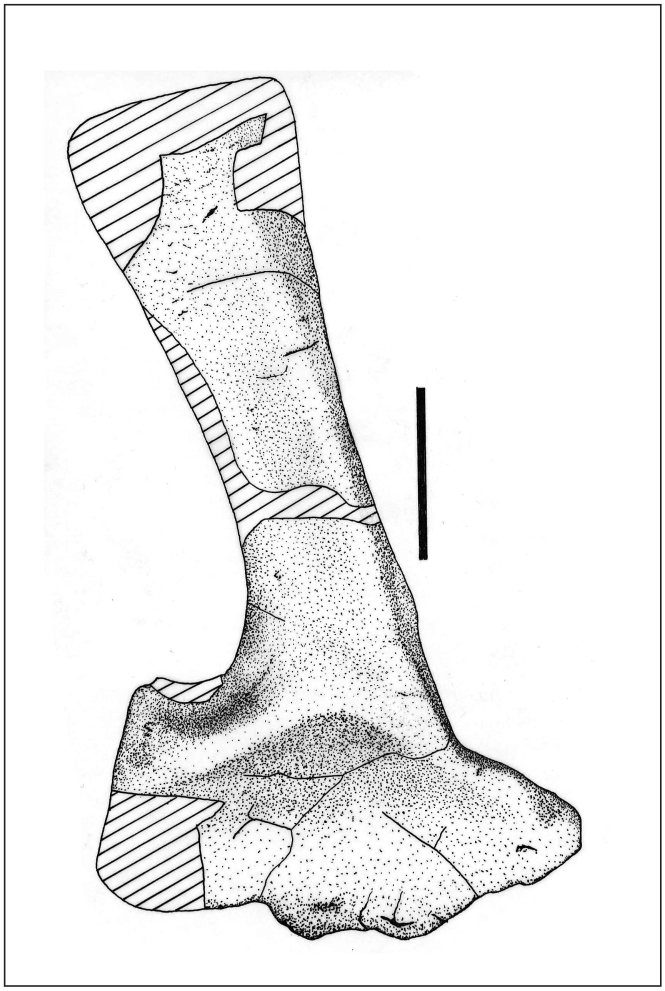


Fig. 10 - Left scapula P.W.1-7, lateral view. Scale bar: 20 cm

The left scapula n°P.W.1-7 is preserved but the dorsal edge of the proximal end and the distal end are missing. The distal end is preserved in the right scapula n°P.W.1-22.

This elongated bone, widely expanded proximally, is 1 m long.

The wide expansion of the proximal end is smaller than the total length of the scapular blade. The proximal expansion concerns the dorsal edge more than the ventral one. The smooth concave medial surface of the proximal end becomes convex close to the glenoid edge and flat ventrally.

The wide and massive glenoid surface is slightly deflected medially.

The strong lateral ridge is situated at right angle to the direction of the shaft.

An important constriction of the proximal plate is observed at the contact with the shaft. At this level the medial surface is very concave. In ventral view the shaft presents a strong curvature (lateral convexity). The dorsal and ventral edges of the shaft form sharp ridges. The ventral edge is thicker, flat and oblique. At the level of the constriction the ventral edge of the shaft presents a thickened rim which is elongated until the minimum breadth of the shaft. The ridge is medially situated distally and becomes more lateral proximally. In the middle of the shaft the section is triangular in shape. The lateral surface is dorsoventrally convex in the middle and becomes slightly concave toward its distal end.

The distal expansion of the blade is slightly marked.

The scapulae of *Camarasaurus supremus*, *Supersaurus vivianae*, *Diplodocus carnegii* and *Brachiosaurus brancai* are more massive and less elongated (Fig. 11). The scapular blade of *Apatosaurus excelsus* is more slender.

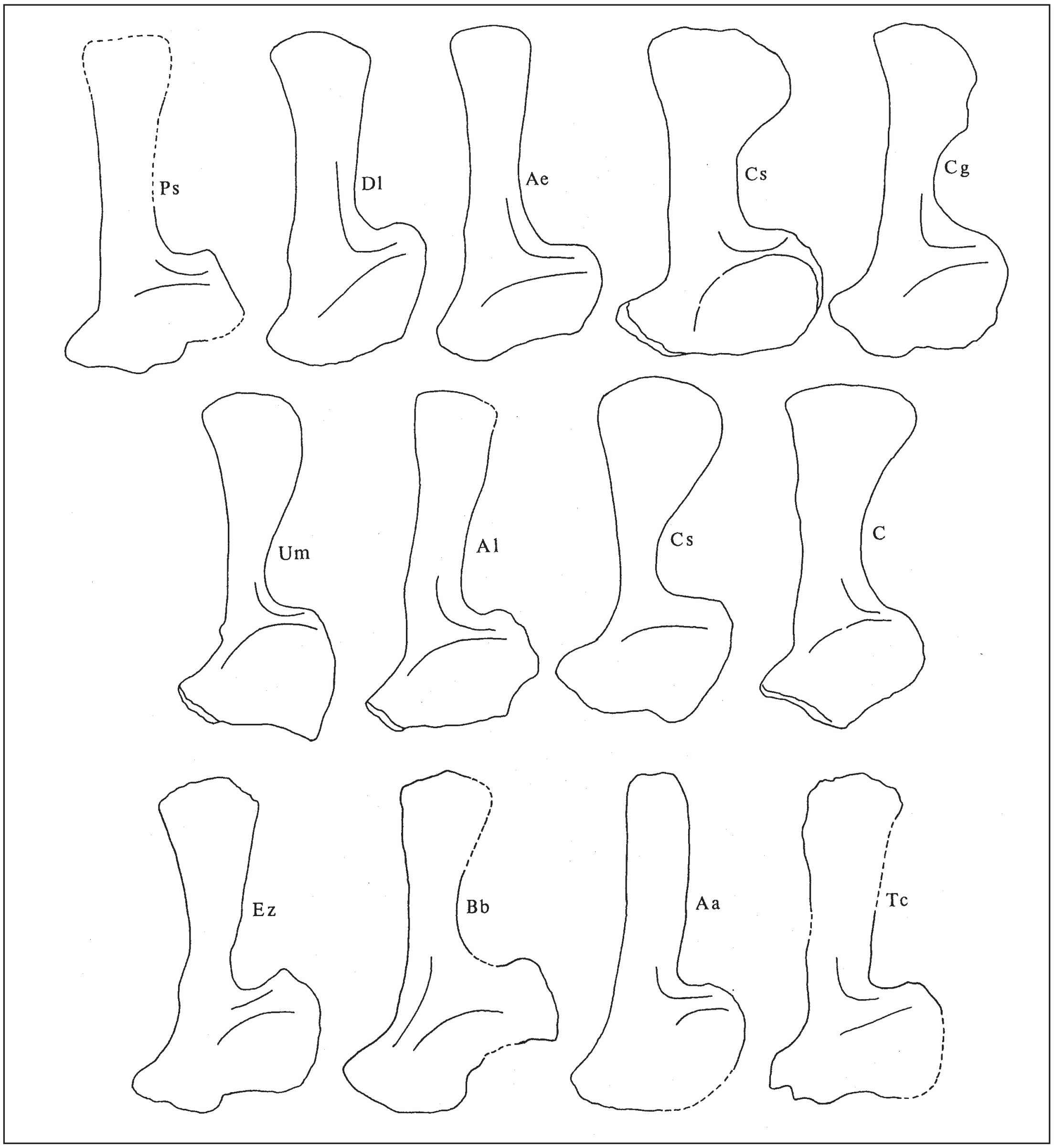


Fig. 11 - Scapulae, lateral views, Ps - *Phuwiangosaurus sirindhornae* Dl - *Diplodocus longus* (Osborn & Granger, 1901) Ae - *Apatosaurus excelsus* (Osborn & Granger, 1901) Cs - *Camarasaurus supremus* (Jensen, 1985) Cg - *Camarasaurus grandis* (Marsh, 1896) Um - *Ultrasaurus mcintoshi* (Jensen, 1985) Al - *Apatosaurus louisae* (Jensen, 1985) C - *Cetiosaurus* (Jensen, 1985) Ez - *Euhelopus zdanskyi* (Young, 1935) Bb - *Brachiosaurus brancai* (Riggs, 1903) Aa - *Apatosaurus ajax* (Marsh, 1896) Tc - *Tienshanosaurus chitaiensis* (Young, 1937). Drawings not to scale

The proximal expansion is more developed in *Brachiosaurus brancai*. The proximal end is more rounded in lateral view in *Camarasaurus alenquerensis*. The dorsal expansion is shorter in *Omeisaurus junghsiensis* but larger in *Brachiosaurus brancai*. The ventral expansion is shorter in *Dicraeosaurus sattleri* and longer in *Diplodocus carnegii*. The glenoid border of *Lapparentosaurus madagascariensis* is directed more dorsally. The strong lateral ridge has the same direction as in *Camarasaurus supremus* or *Brachiosaurus brancai*. In *Diplodocus longus*, *Diplodocus carnegii*, *Tienshanosaurus chitaiensis*, *Ultrasauros macintoshi* and *Barosaurus africanus* the angle between the ridge and the shaft is more acute.

The constriction of the proximal plate at the contact with the shaft is more marked in *Euhelopus zdanskyi*, *Camarasaurus alenquerensis* and *Ultrasauros macintoshi*. The strong lateral curvature of the shaft is more pronounced in *Supersaurus vivianae*. In lateral view, the concavity of the dorsal edge is more pronounced in *Euhelopus zdanskyi* and *Ultrasauros macintoshi*.

The distal ends of the scapulae of *Camarasaurus alenquerensis*, *Brachiosaurus brancai*, *Camarasaurus supremus* and *Supersaurus vivianae* are much more expanded.

The proximal end is broadly expanded, but less so than the length of the blade. The blade is distally slightly expanded. The distal expansion of the blade is much more marked in Camarasauridae and Brachiosauridae. The strong lateral ridge is situated at right angle to the direction of the shaft. The scapula is strongly constricted between the proximal end and the blade. The ventral edge of the shaft presents a marked rim near the proximal end. This scapula is very close to the scapula in *Tienshanosaurus chitaiensis* and in a lesser degree to *Apatosaurus excelsus*, *Apatosaurus louisae* and *Dicraeosaurus sattleri*.

Measurements (in cm) of the scapula n°P.W.1-7 of *P. sirindhornae*

Total length	100
Proximal breadth	54
Distal breadth	-
Minimum breadth of the shaft	14,9
Proximal thickness	12
Distal thickness	-

HUMERUS

P.W.1-8 (Fig. 12)

Only the left humerus is preserved. This elongated bone is 95 cm long. The proximal end is poorly preserved medially and the distal end is broken anteriorly.

Although incomplete proximally this bone seems to present a similar expansion at both ends.

The curve of the shaft seems to show that the proximo-medial edge is not much more developed than the preserved part.

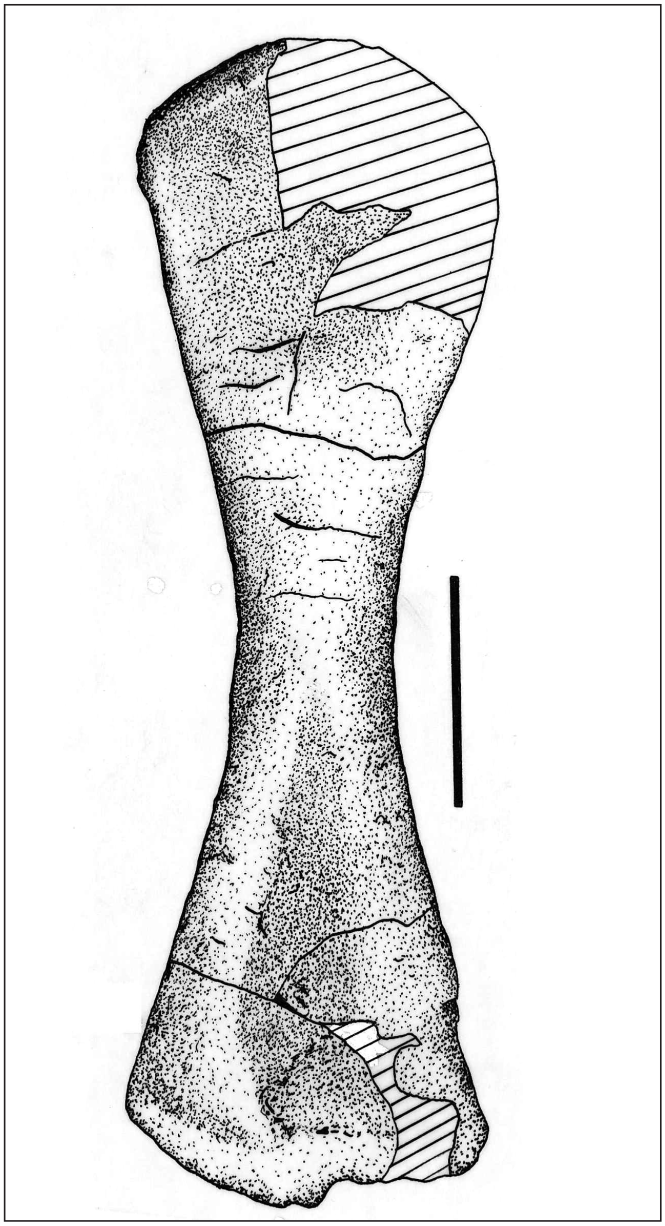


Fig. 12 - Left humerus P.W.1-8, posterior view
Scale bar: 20 cm

The proximal end of the humerus is anteroposteriorly flattened and presents a very well developed deltopectoral crest. This lateral crest merges with the shaft at the narrowest level of the shaft and on the lateral edge of the shaft. The posterior surface of the proximal end is flat, the anterior one is regularly concave.

Proximally, the straight shaft is deflected posteriorly. Dorsally a faint ridge originates in the middle of the proximal end and distally joins the shaft on its medial edge. The elliptical section of the shaft is flattened anteroposteriorly.

Toward the distal extremity, the posterior surface of the shaft shows a depression, the intercondylar groove. This depression gets deeper towards the distal end. In dorsal view the shape of the depression is triangular, with a maximum breadth at the distal end. The anterior surface is too incomplete to observe the distal condyles of the humerus.

The humeri of *Brachiosaurus brancai* and *Lapparentosaurus madagascariensis* are more elongated; *Apatosaurus excelsus*, *Camarasaurus grandis*, *Opisthocoelicaudia skarzynskii*, *Barosaurus africanus*, *Dicraeosaurus hansemanni* and *Tornieria robusta* have more massive and shorter humeri (Fig. 13).

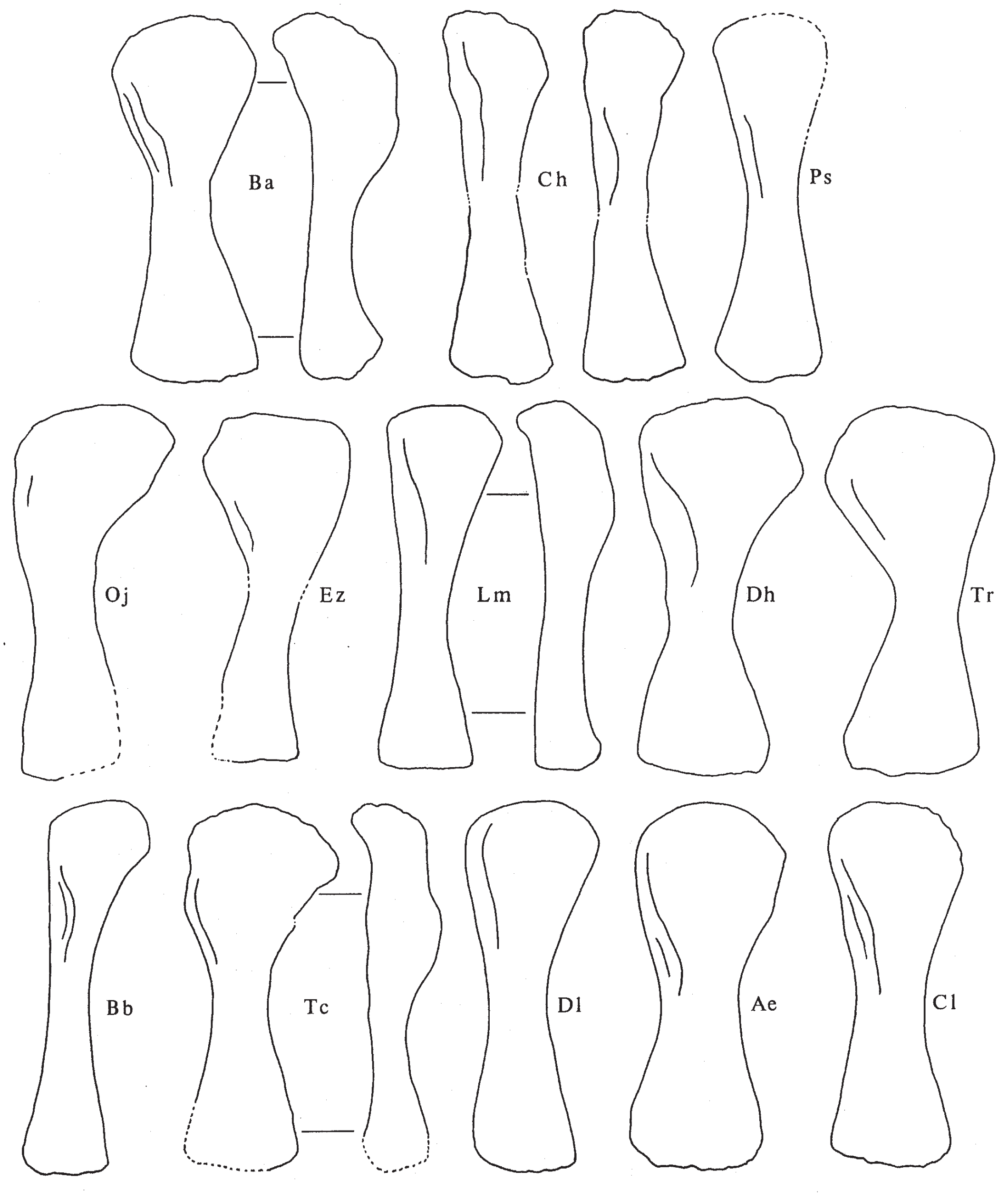


Fig. 13 - Humeri, anterior views, except a, b, c, medial views
Ba - *Barosaurus africanus* (Janensch, 1961) Ch - *Ceteosaurus humerocristatus* (Hulke, 1869)
Ps - *Phuwiangosaurus sirindhornae*
Oj - *Omeisaurus junghsiensis* (Young, 1937 Ez - *Euhelopus zdanskyi* (Young, 1935)
Lm - *Lapparentosaurus madagascariensis* (Ogier, 1975)
Dh - *Dicraeosaurus hansemanni* (Janensch, 1961)
Tr - *Torneria robusta* (Janensch, 1961)
Bb - *Brachiosaurus brancai* (Janensch, 1914)
Tc - *Tienshanosaurus chitaiensis* (Young, 1937)
Dl - *Diplodocus longus* (Osborn & Granger, 1901)
Ae - *Apatosaurus excelsus* (Osborn & Granger, 1901).
Drawings not to scale.

The proximal end of the humerus is more expanded medially in *Omeisaurus junghsiensis*. This extremity is less expanded in *Mamenchisaurus constructus* and *Lapparentosaurus madagascariensis*, but *Camarasaurus grandis, Barosaurus africanus, Tornieria robusta, Dicraeosaurus hansemanni* and *Euhelopus zdanskyi* show a broader proximal end.

In *Opisthocoelicaudia skarzynskii* the crest merges with the shaft in the middle of the width of the shaft. The deltopectoral crests of *Apatosaurus excelsus, Opisthocoelicaudia skarzynskii, Barosaurus africanus* and *Tienshanosaurus chitaiensis* are more developed in lateral view. The posterior deflection of the shaft is more marked in *Tienshanosaurus chitaiensis* and *Opisthocoelicaudia skarzynskii*. In anterior view, *Euhelopus zdanskyi* presents a shaft with a marked medial curvature. The shaft of *Mamenchisaurus constructus* is less constricted in the middle of its length.

The distal end in *Omeisaurus junghsiensis* is more expanded transversally and the distal ends in *Brachiosaurus brancai* and *Lapparentosaurus madagascariensis* are less expanded.

Because of its slenderness and the slightly expanded ends, this humerus is different from that of any other sauropod. It is more slender than the humeri in Camarasauridae, Diplodocidae and Euhelopodidae, but it is not as elongated as the humeri in Brachiosauridae. The lateral deltopectoral crest merges with the shaft on its lateral edge and at the level of the maximum constriction.

Measurements (in cm) of the humerus n°P.W.1-8 of *P. sirindhornae*

Total length	99
Distal breadth	29
Minimum breadth of the shaft	12
Proximal thickness	6
Distal thickness	15

ULNA

P.W.1-9 (Fig. 14)

The ulna is an elongated and slender bone. In this specimen the distal end is missing and the proximal end is broken on its medial surface.

The proximal end is triradiate and expanded craniocaudally and transversally. The olecranon is distinct but low. It is more developed craniocaudally than transversally. This olecranon overhangs the junction of the well developed lateral and medial expansions. The medial expansion is the less developed proximally and is below the level of the lateral expansion. The proximal surface of the lateral expansion is at right angle with the direction of the shaft, but for the medial expansion this direction forms a more acute angle. The lateral expansion is wider transversally than the medial one. The proximal surface of the lateral expansion is slightly concave and corresponds to the lateral condyle of the humerus.

The shaft tapers below the proximal end and becomes very slender. Its section is triangular. In the proximal half of the shaft the triangular cross-section presents concave sides. The anterior surface, where the radius fitted, is the more deeply concave.

The olecranon and the two expansions are continued distally by strong ridges, forming the angles of the triangular section of the shaft.

In lateral view the shaft presents a marked curvature (caudal concavity).

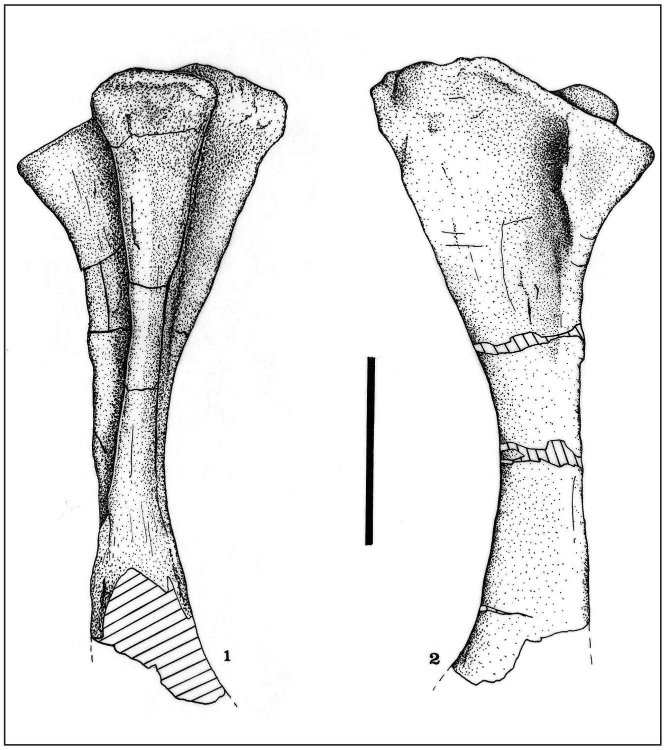


Fig. 14. Left ulna P.W.1-9, antero-lateral (1) and medial (2) views. Scale bar: 20 cm

The ulna is less elongated than in *Brachiosaurus brancai*. The olecranon is low, as in *Bothriospondylus madagascariensis* and *Opisthocoelicaudia skarzynskii*. The olecranon is as in *Tornieria robusta*. In *Camarasaurus grandis* the lateral and medial expansions are much shorter. The angle between the direction of the two expansions is more acute than in *Apatosaurus excelsus* where this angle is very widely open. In *Apatosaurus excelsus* the shaft is stouter. The curvature of the shaft is as in *Opisthocoelicaudia skarzynskii*. In *Diplodocus longus*, *Dicraeosaurus sattleri*, *Brachiosaurus brancai*, *Lapparentosaurus madagascariensis*, *Elosaurus parvus* and *Bothriospondylus madagascariensis* the ulna is straighter. In *Camarasaurus lentus* and *Camarasaurus grandis* the lateral view of the ulna presents a sigmoid curvature, convex proximally and concave distally.

Though incomplete the ulna is intermediate in shape between the Brachiosauridae and the Camarasauridae and seems to be closer to *Opisthocoelicaudia skarzynskii*.

Measurements (in cm) of the ulna n°P.W.1-9 of *P. sirindhornae*

Total length	66
Proximal breadth	24
Minimum breadth of the shaft	10
Proximal thickness	25

ILIUM

P.W.1-10, -11 (Fig. 15)

The complete right ilium P.W.1-11 is preserved, a large part of the dorsal blade is missing on the left one. The blade is 86 cm long craniocaudally and 52 cm high dorsoventrally.

The cranial blade is very well developed and orientated lateroventrally to mediodorsally and raised up dorsally on the dorsal edge. The cranial blade of the ilium is not flared into a horizontal plane. In lateral view the dorsal edge of the ilium is regularly convex (mainly on the caudal part; the cranial edge is less well preserved). In dorsal view, this dorsal edge presents a sigmoid curvature, with a lateral concavity cranially and a lateral convexity caudally. In ventral view the caudal part of the blade is slightly curved laterally. On the lateral surface, the deepest depression of the cranial blade is situated just cranially to the acetabulum. The change of curvature occurs at the level of the pubic peduncle. The border of the cranial blade is thickened cranially and very thin ventrally.

The medial surface of the iliac blade bears two triangular bulges, each continued ventrally by a ridge. But there is no indication of the precise number of sacral ribs. At the level of the acetabulum, the medial surface of the ilium is deeply depressed.

The pubic peduncle is very long, straight, thickened distally and well developed transversally. The direction of the pubic peduncle is at right angle with the blade. Its cranial surface is convex transversally

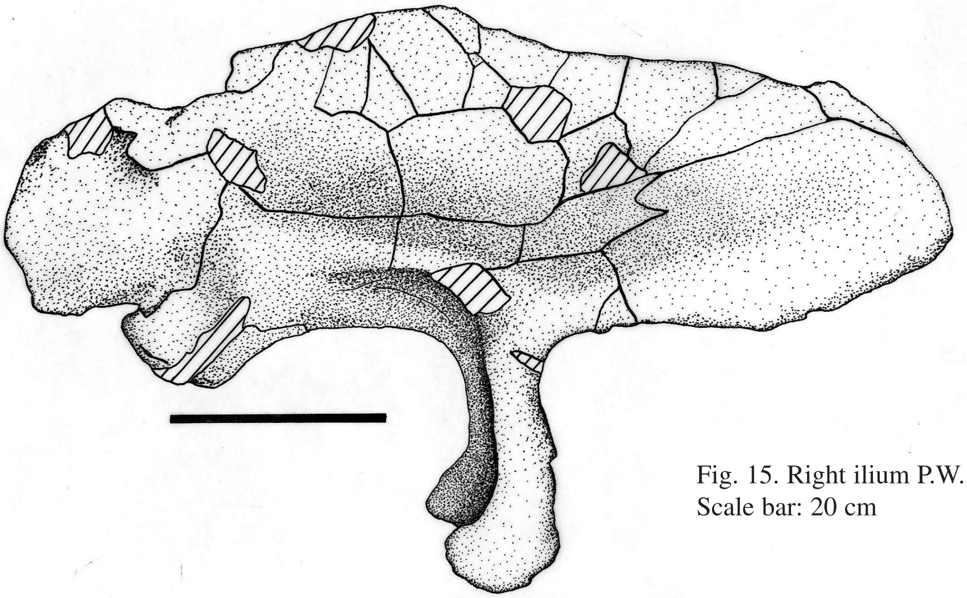


Fig. 15. Right ilium P.W.1-11, lateral view. Scale bar: 20 cm

and the caudal one is concave. Although thickened the distal end of the pubic peduncle is curved in the same way; it is comma shaped. Its very thin medial edge forms a sharp ridge which continues dorsally on the medial surface of the iliac blade. The lateral edge of the pubic peduncle is rounded. The very wide and smooth acetabular surface is inclined medioventrally and slightly tapers toward the ischiatic peduncle. A rim marks the dorsocranial limit of the acetabulum.

The ischiatic peduncle of the ilium is faintly marked and separated from the caudal blade by a notch. The ischiatic peduncle of *Brachiosaurus brancai* is more marked. In medial view the ischiatic peduncle shows a rugose bulging end.

The cranial orientation of the blade is very close to the one observed on *Euhelopus zdanskyi*. This cranial blade of the ilium is shorter in *Tienshanosaurus chitaiensis*, *Lapparentosaurus madagascariensis*, *Dicraeosaurus hansemanni*, *Camarasaurus supremus*, *Camarasaurus lentus*, *Omeisaurus tianfuensis* and *Brachiosaurus brancai* and thinner in *Euhelopus zdanskyi*. In *Haplocanthosaurus priscus* the ilium is more elongated craniocaudally than in our specimen. In lateral view the ventral edge of the cranial blade is more concave in *Omeisaurus tianfuensis*, *Euhelopus zdanskyi*, *Tienshanosaurus chitaiensis*, *Lapparentosaurus madagascariensis*, *Dicraeosaurus hansemanni* and *Camarasaurus supremus*. In ventral view the caudal part of the blade is slightly curved laterally, more than the straight caudal blade of *Camarasaurus supremus*. A shorter pubic peduncle is observed in *Omeisaurus junghsiensis* and *Dicraeosaurus hansemanni*; a larger one in *Brachiosaurus brancai*. The pubic peduncle of *Brachiosaurus brancai* is less expanded distally. The pubic peduncle of *Diplodocus longus*, and *Apatosaurus excelsus* is more cranially directed. In *Mamenchisaurus constructus* the acetabular surface is shorter craniocaudally. The acetabular surface of *Euhelopus zdanskyi* is laterodorsally edged with a faint rim.

This ilium is very similar to the ilium of *Euhelopus zdanskyi* and in a lesser degree to that of *Camarasaurus supremus*. The anterior blade is well developed in P.W.1-11 as in *Euhelopus zdanskyi*, the pubic peduncle presents the same direction from the blade and the ischiatic peduncle is slightly marked in the same way.

Measurements (in cm) of ilium n°P.W.1-11 of *P. sirindhornae*

Length	86
Maximum height with the pubic peduncle	52
Thickness of the distal end of the pubic peduncle	20,1
Maximum height above acetabulum	26
Length of the acetabulum	32

PUBIS

P.W.1-12, -13 (Fig. 16)

The complete left pubis P.W.1-12 is preserved; the proximal end of the right one is missing. The left pubis is 75 cm long and its maximal proximal breadth is 54 cm.

The pubis consists of a very broad proximal end, a short curved and flat shaft and a slightly widened distal end.

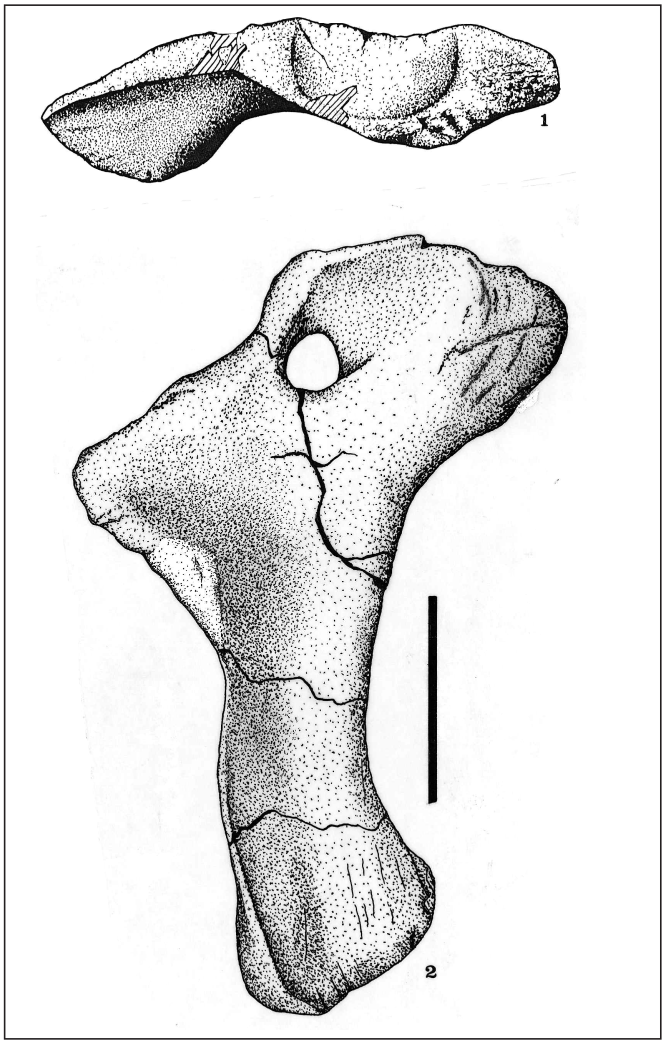


Fig. 16. Left pubis P.W.1-12, proximal (1) and medial (2) view. Scale bar: 20 cm

In lateral view, the proximal end of the pubis is broadly expanded in a large blade. This blade is cranially thick and becomes very thin caudally. The well marked and smooth acetabular surface is short craniocaudally and widened transversally. The short iliac surface is widened laterally.

The ischiatic surface is very elongated and tapers caudally. This surface forms an obtuse angle with the acetabular border. Concerning the angle formed by the direction of the shaft and the ischiatic border, it is more open in our specimen than in most sauropods. If we consider that the ischiatic edge is in a dorsoventral direction, this open angle leads to a pubis directed more cranially than in other sauropods.

The obturator foramen is completely enclosed in bone. Its ventral border is the thinnest. In dorsal view the dorsal edge of the caudal blade is concave medially. Distally to the obturator foramen this caudal blade twists and changes its concavity, the medial proximal concavity becomes lateral distally. The medial surface of the blade is completely smooth. This caudal blade joins the thin caudal border of the shaft at a slight angle.

The smooth and rounded cranial edge of the shaft is wider than the caudal one. In lateral view, the curvature of the cranial border of the shaft is deeply marked. The shaft is craniocaudally concave on its medial surface and convex on the lateral one.

At mid-length of the shaft the caudal ridge splits into two ridges running distally and forming a triangular distal end (in distal view). The surface limited by these two ridges is shaped like an elongated triangle and corresponds to the surface of contact between the two pubes. Distally the shaft becomes flat and expanded transversally; in lateral view the ventral border is rounded and rises up cranially and caudally.

The general shape of the pubis is very different from that of *Diplodocus carnegii* and *Dicraeosaurus sattleri*; the pubis of *Dicraeosaurus sattleri* shows no cranial curvature of the shaft in lateral view. The pubes of *Camarasaurus supremus* and *Brachiosaurus brancai* are more massive, the pubis of *Diplodocus carnegii* is more slender. The proximal end of the pubis of *Omeisaurus tianfuensis*, *Dicraeosaurus sattleri* and *Apatosaurus excelsus* is less developed craniocaudally. In *Brachiosaurus brancai* this acetabular surface is more elongated craniocaudally. The acetabular and iliac surfaces are shorter in *Omeisaurus tianfuensis*. The robust iliac border of *Euhelopus zdanskyi* is directed more craniomedially than in our specimen. The angle formed by the acetabular surface and the ischiatic border is less open in *Camarasaurus supremus* and much more so in *Brachiosaurus brancai*.

The curvature of the cranial border of the shaft is more pronounced in our specimen than in *Omeisaurus junghsiensis*, *Camarasaurus supremus* or *Apatosaurus excelsus*. The same craniocaudal expansion is kept all along the shaft unlike *Brachiosaurus brancai* which presents a marked constriction distally to the proximal blade.

The distal end of the pubis of *Apatosaurus excelsus* is more oval than triangular in shape. The surface of contact between the two pubes is more developed in *Camarasaurus supremus*. The craniodorsal curve of the cranial border of the distal end of the shaft is more pronounced in *Diplodocus carnegii*. The distal end is only slightly expanded craniocaudally as in *Omeisaurus tianfuensis* and *Barosaurus africanus*. In *Apatosaurus ajax* and *Dicraeosaurus sattleri* this expansion is larger.

This pubis is intermediate between the massive pubis of *Camarasaurus supremus* and *Brachiosaurus brancai* and the slender pubis of *Diplodocus carnegii*. The acetabular surface is short craniocaudally and widened transversally. The ischiatic surface is very elongated. The angle formed by the direction of the shaft and the ischiatic border is more open in our specimen than in most sauropods. The curvature of the cranial border of the shaft is pronounced. This pubis is different from any other and cannot be attributed to any sauropod family.

Measurements (in cm) of the pubis n°P.W.1-12 of *P. sirindhornae*

Total length	75
Proximal breadth	54
Distal breadth	23
Distal thickness	9,7
Minimum breadth of the shaft	15,7

ISCHIUM

P.W.1-14, -15 (Fig. 17)

Both ischia are preserved but the cranial edge of their shaft is incomplete. The bone is a thin elongated blade, craniocaudally expanded at its proximal end and slightly so at the distal one. The pubic process is well marked craniocaudally and very elongated dorsoventrally. In cranial view, this process is thickened dorsally and tapers ventrally, and it shows a laterally convex curvature.

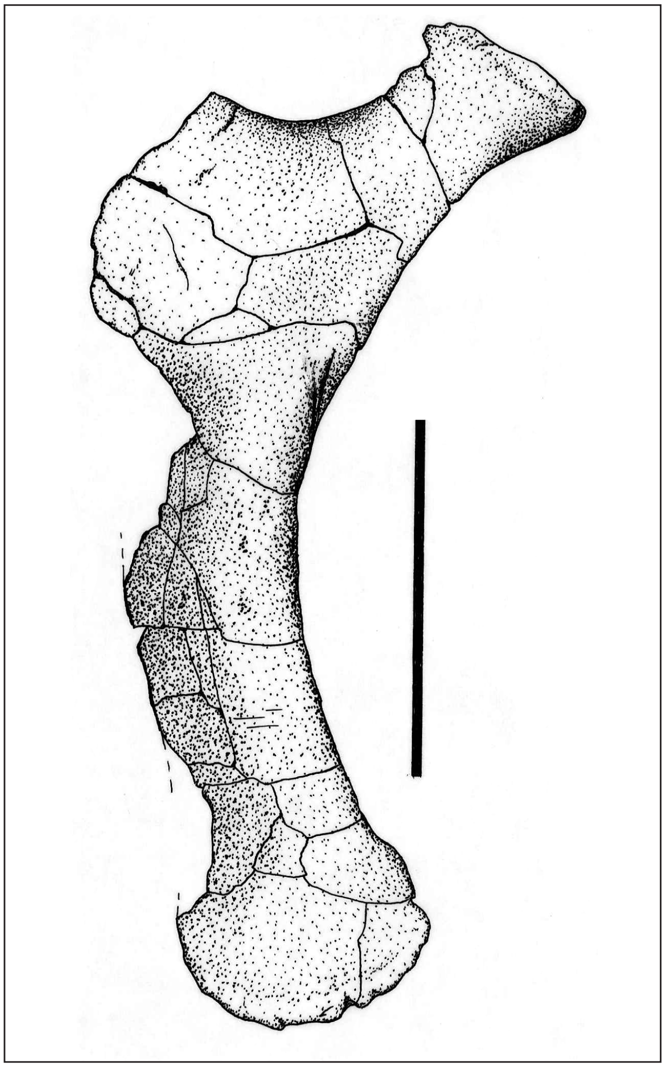


Fig. 17. Left ischium P.W.1-14, lateral view.
Scale bar: 20 cm

The long and smooth acetabular surface is shallow. Its lateral edge is rounded and its medial edge shows a faint ridge.

In proximal view the iliac peduncle is transversally expanded and triangular in shape; the widest caudal side tapers cranially to the acetabular surface. This rugose end of the peduncle is rounded.

In caudal view the shaft of the ischium is twisted. The cranial edge of the shaft is laterally curved. The caudal edge of the shaft is proximomedially curved and then laterally. In lateral view the cranial edge of the shaft is straight and the caudal edge is regularly concave. The caudal edge is thin under the iliac peduncle, and becomes thicker and forms a ridge merging with the shaft at mid-length. Another ridge originates laterally to the ridge on the caudal edge of the shaft and before it merges with the shaft. This second ridge continues until the distal end of the ischium, forming its thin caudal edge. The section of the shaft is triangular in shape distally to the pubic peduncle and becomes very flat distally.

The shaft is steeply expanded craniocaudally to its distal end and slightly broadened laterally. The distal end is slightly concave medially and flat laterally.

The ischia of *Diplodocus carnegii*, *Brachiosaurus brancai*, *Camarasaurus supremus*, *Apatosaurus excelsus*, *Haplocanthosaurus delfsi*, *Tienshanosaurus chitaiensis* and *Lapparentosaurus madagascariensis* are more slender in lateral view. The pubic peduncles of *Barosaurus africanus* and *Camarasaurus supremus* are shorter. The pubic peduncle of *Brachiosaurus brancai* is more elongated dorsoventrally. The acetabular surface of *Tienshanosaurus chitaiensis* is less concave. The acetabular surface of *Euhelopus zdanskyi* is very similar. The iliac peduncles of *Euhelopus zdanskyi*, *Barosaurus africanus*, *Tienshanosaurus chitaiensis* and *Camarasaurus supremus* are less developed. The curvature of the caudal edge of the shaft is similar in *Euhelopus zdanskyi* and less pronounced in *Apatosaurus excelsus*, *Lapparentosaurus madagascariensis*, *Omeisaurus junghsiensis*, *Mamenchisaurus constructus*, *Camarasaurus supremus* or *Diplodocus carnegii.*

Dicraeosaurus hansemanni and *Apatosaurus excelsus* show a marked constriction of the shaft under the proximal end. In *Camarasaurus supremus* the shaft is rod-like more than blade-like. The distal expansion is more marked in *Diplodocus carnegii*.

This ischium presents an elongated pubic peduncle and a well developed iliac peduncle. The acetabular surface is similar to the one in *Euhelopus zdanskyi*. The curvature of the caudal edge is well pronounced. The distal end is blade-like and not expanded transversally.

Measurements (in cm) of the ischium n°P.W.1-14 of *P. sirindhornae*

Total length	57
Distal breadth	17,2
Length of the iliac surface	13
Thickness of the iliac surface	8,5

FEMUR
P.W.1-16, -17 (Fig. 18)

Both femora are preserved in that specimen; the left one is complete and the right one is slightly flattened.

The femur of this specimen is a massive bone. The left femur is 1,25 m long. The minimum shaft diameter is 22 cm transversally and 8,5 cm craniocaudally.

The well developed head is situated above the level of the greater trochanter. The head is slightly directed forward the surface of the shaft in lateral view. The great trochanter is not markedly separated from the head; the proximal end forms a continuous rugose and puckered surface. This rugose surface is posteriorly limited by a rounded ridge of sigmoid outline. The head is buttressed on the posterior face.

The shaft of the femur is flattened anteroposteriorly. The well developed fourth trochanter is situated on the medial edge of the posterior surface, with a medioposterior direction. Its shape is a proximodistally elongated crest. The medial surface of the fourth trochanter shows a depression.

The shaft is widened anteroposteriorly and transversally at the level of the fourth trochanter. The anterior surface of the shaft is flat. The medial edge of the shaft shows a shallow curvature (medial concavity) except at the level of the fourth trochanter. The lateral edge of the bone is slightly curved with a lateral convexity interrupted before the distal end. The lateral deflection on the proximal third is well marked.

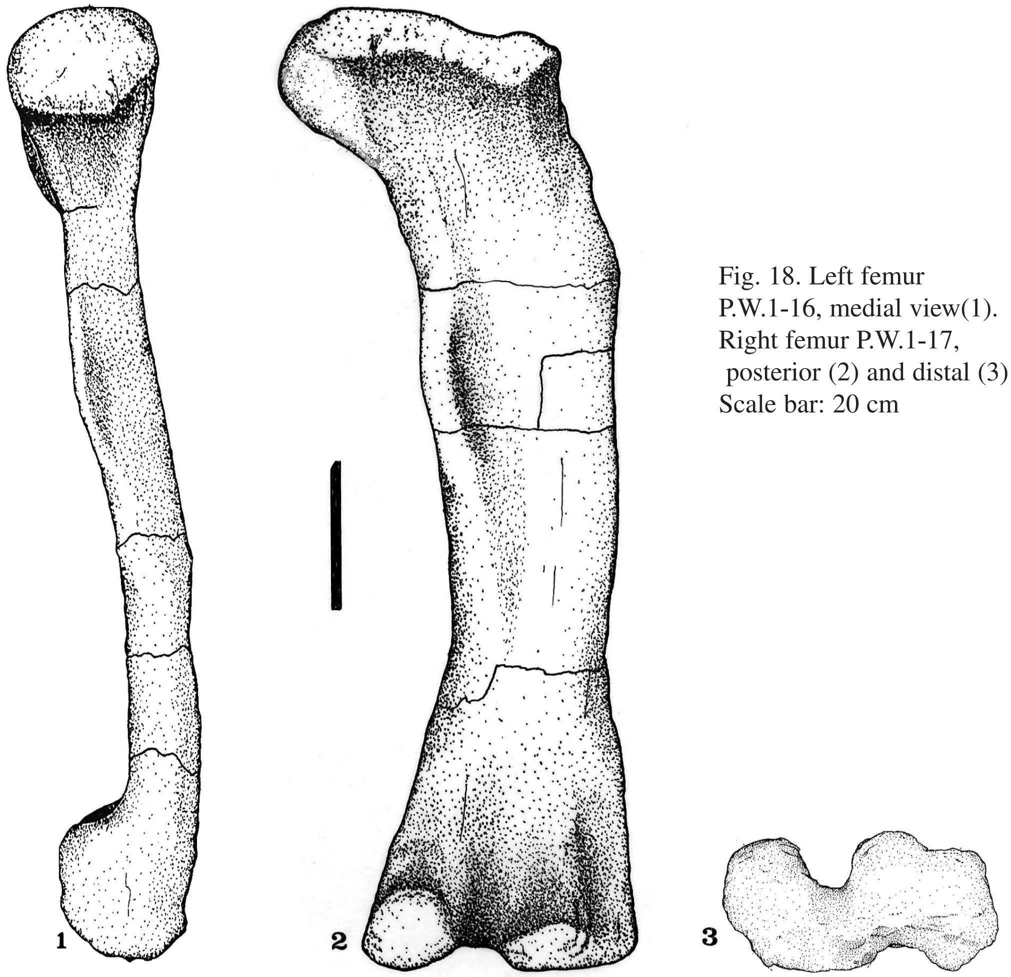


Fig. 18. Left femur P.W.1-16, medial view(1). Right femur P.W.1-17, posterior (2) and distal (3) views. Scale bar: 20 cm

In lateral view the shaft is slightly curved with a posterior concavity; except at the proximal end of the anterior surface.

The broadened distal end shows two very well developed condyles separated by a wide groove. The medial condyle is larger (anteroposteriorly and transversally) than the lateral one and is very prominent posteriorly. The lateral surface of the epicondyle is flat.

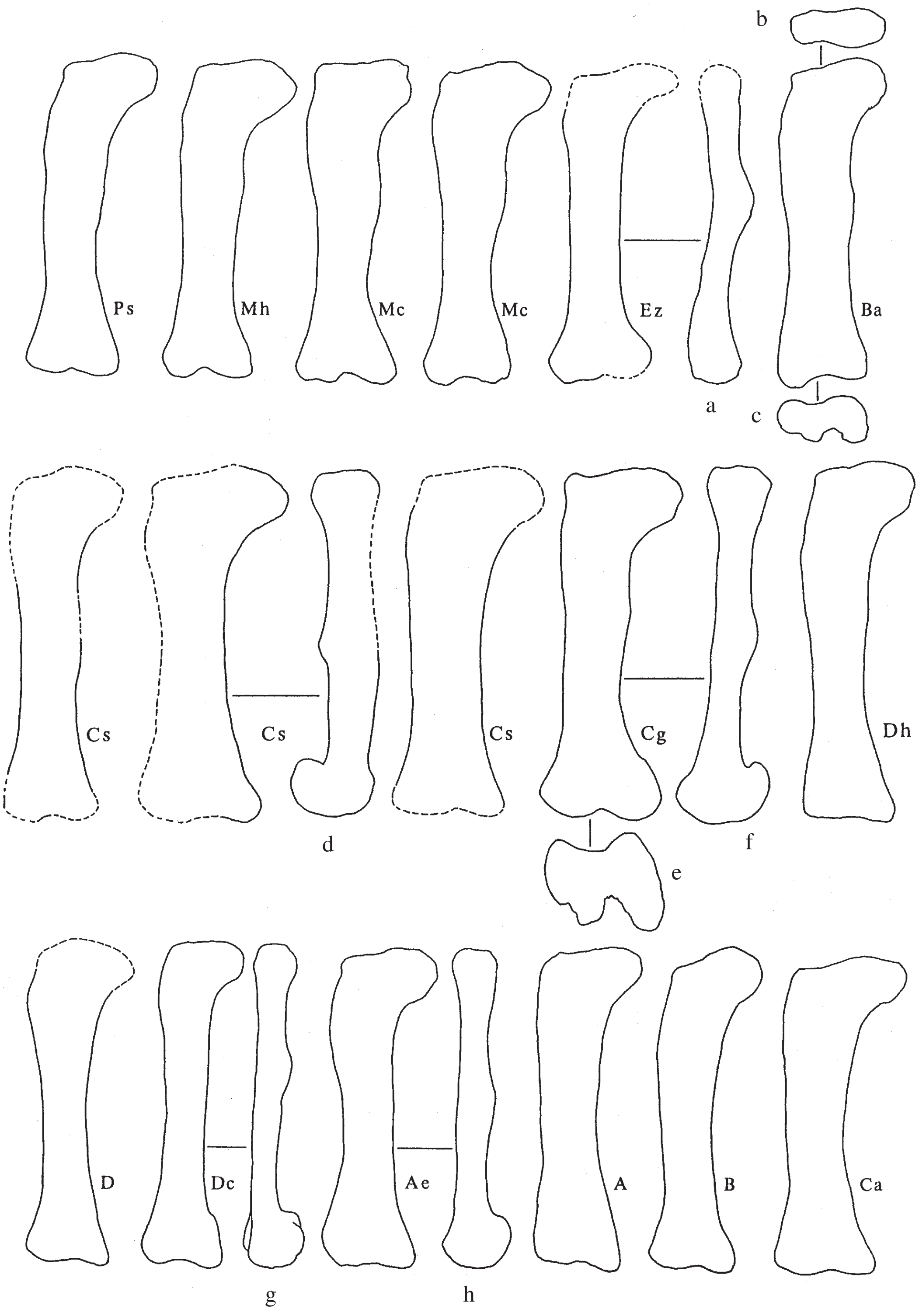


Fig. 19 - Femora, posterior views, except a, d, f, g, h, medial views ; b, proximal view ; c, e, distal views. Ps - *Phuwiangosaurus sirindhornae* Mh - *Mamenchisaurus hochuanensis* (Young & Chao, 1972) Mc - *Mamenchisaurus constructus* (Young, 1958) Ez - *Euhelopus zdanskyi* (Young, 1935) Ba - *Brachiosaurus altithorax* (Riggs, 1903) Cs - *Camarasaurus supremus* (Osborn & Mook, 1921) Cg - *Camarasaurus grandis* (Osborn & Mook, 1921) Dh - *Dicraeosaurus hansemanni* (Janensch, 1914) D - *Diplodocus* (Osborn & Granger, 1901) Dc - *Diplodocus carnegii* (Hatcher, 1901) Ae - *Apatosaurus excelsus* (Ostrom & McIntosh, 1966) A - *Apatosaurus* (Osborn & Granger, 1901) B - *Bothriospondylus* (Lapparent, 1943) Ca - *Camarasaurus alenquerensis* (Lapparent & Zbyzewski, 1947) Drawings not to scale.

This femur is less massive than in *Apatosaurus excelsus*, *Camarasaurus supremus* or *Mamenchisaurus constructus* but less elongated than in *Euhelopus zdanskyi*, *Diplodocus carnegii* or *Haplocanthosaurus priscus* (Fig. 19). The head is situated above the level of the greater trochanter, more so than in *Camarasaurus supremus* but less so than in *Opisthocoelicaudia skarzynskii*. The head is close to that of *Camarasaurus grandis* and more developed transversally than in *Diplodocus carnegii*. In *Euhelopus zdanskyi, Omeisaurus junghsiensis* or *Camarasaurus supremus*, the head is less developed anteroposteriorly. The size of the head in comparison with the size of the shaft is smaller than in *Dicraeosaurus hansemanni*. The great trochanter of *Euhelopus zdanskyi* is more laterally situated relatively to the shaft than in this specimen. In posterior view, the lateral face of the great trochanter is less rounded than in *Barosaurus africanus*; it is more marked than in *Lapparentosaurus madagascariensis* and clearly shows an angle.

The anteroposterior flattening of the shaft is more marked than in *Lapparentosaurus madagascariensis*, *Dicraeosaurus hansemanni*, *Barosaurus africanus* or *Camarasaurus supremus*, in which the section is quite circular. The fourth trochanter is unlike the elongated and bumplike one of *Euhelopus zdanskyi*. It is more laterally situated in *Camarasaurus supremus*, and nearly in the middle of the shaft in *Euhelopus zdanskyi*. The fourth trochanter of *Dicraeosaurus hansemanni*, *Euhelopus zdanskyi* and *Omeisaurus junghsiensis* is much more prominent in medial view. The fourth trochanter of *Opisthocoelicaudia skarzynskii*, *Apatosaurus louisae*, *Apatosaurus excelsus*, *Dicraeosaurus hansemanni*, *Omeisaurus junghsiensis* and *Camarasaurus supremus* is situated more distally on the shaft. The curvature of the medial edge of the shaft is more pronounced under the head in *Euhelopus zdanskyi*, with a quite sharp constriction of the shaft. In *Lapparentosaurus madagascariensis* and *Omeisaurus junghsiensis* the constriction of the shaft under the head is less pronounced than in our specimen. The lateral deflection on the proximal third of the shaft is similar in *Brachiosaurus brancai*. This deflection is also well marked on the femur of *Euhelopus zdanskyi* but situated more proximally. The femur of *Camarasaurus supremus* is straighter in lateral view, but is mainly concave on the lateral edge. The steady distal broadening of the shaft is more abrupt in *Apatosaurus louisae* and *Apatosaurus excelsus*.

In distal view, the transversal development of the distal end is less important in *Camarasaurus supremus* and more so in *Euhelopus zdanskyi*. The distal condyles are less prominent posteriorly in *Barosaurus africanus*. The medial condyle of *Lapparentosaurus madagascariensis* is more extended medially and the lateral condyle is larger. The lateral condyle of the femur of *Brachiosaurus brancai* is less developed than in our specimen; but the large epicondyle is well developed in the same way, as in *Camarasaurus supremus* and in the sauropod from Laos (Hoffet, 1942). The epicondyles of *Euhelopus zdanskyi*, *Opisthocoelicaudia skarzynskii* and *Diplodocus carnegii* are less marked.

The head is situated above the level of the great trochanter, the shaft is flattened anteroposteriorly. The fourth trochanter, situated in the proximal half, and on the medial edge of the shaft, is very different from that of the Chinese sauropod genera. The lateral epicondyle is very well developed as in *Camarasaurus supremus*, the sauropod from Laos and *Brachiosaurus brancai*. This femur is close to that of *Brachiosaurus brancai*, and has some common characteristics with *Camarasaurus supremus* and the sauropod from Laos, and to a lesser degree with *Barosaurus africanus*.

Measurements (in cm) of the femora n°P.W.1-16, 17 of *P. sirindhornae*

	P.W.1-1	P.W.1-17
Total length	125	125
Proximal breadth	36	35
Proximal thickness	19	18
Distal breadth	39,5	48
Distal thickness	17	19
Minimum breadth of the shaft	22	21
Minimum thickness of the shaft	8,5	

FIBULA

P.W.1-18 (Fig. 20)

Only the left fibula, in very good condition, is preserved in that specimen. This slender bone is 77 cm long, its minimum shaft diameter is 8,9 cm.

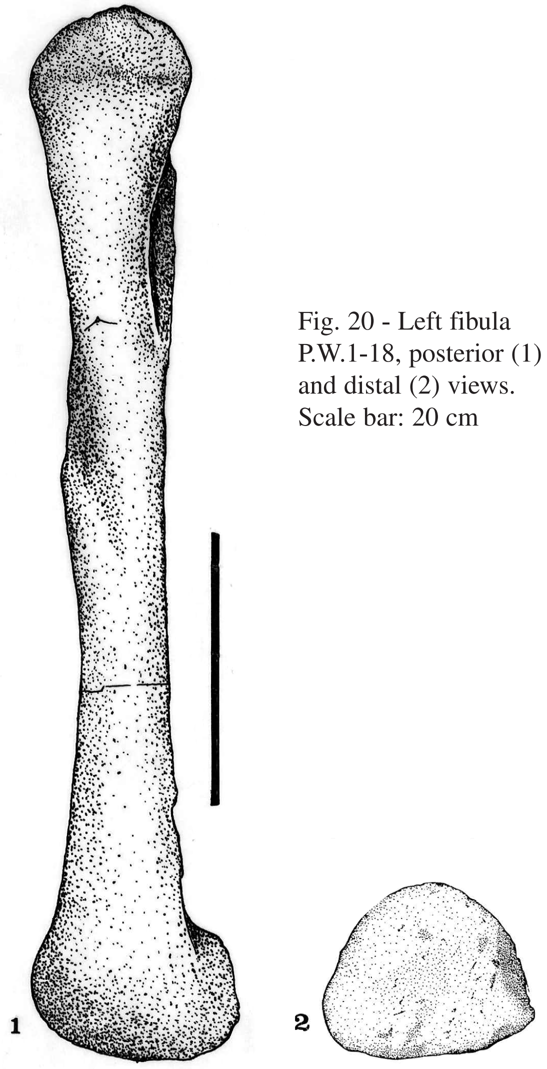


Fig. 20 - Left fibula P.W.1-18, posterior (1) and distal (2) views. Scale bar: 20 cm

The proximal end of the bone is greatly expanded anteroposteriorly and slightly transversally. In proximal view, the medial edge of the proximal end presents a sigmoid curvature, concave anteriorly and convex posteriorly. The anterior edge of the proximal end is very thin and forms a blade which runs all along the shaft as a sharp ridge. This ridge starts proximally on the anterior edge and continues in the middle of the medial face of the diaphysis.

The diaphysis is transversally flattened and twisted on its medial face. The diaphysis is posteriorly directed proximally and anteriorly directed distally. The lateral surface bears a large oval proximodistally elongated rugosity, posteriorly limited by a ridge. This ridge originates at the posterior edge of the diaphysis at mid-length, and is directed proximoanteriorly. The posterior edge of the shaft is thinner at the proximal end than at the distal one. All along the length of the diaphysis the posterior edge is rounded and get thicker at the level of the rugosity.

The distal end is more expanded anteroposteriorly than transversally. In distal view the rugose end is rounded and triangular. In lateral view, the medial edge of the distal end shows a club-like expansion.

The general shape of the bone is close to *Mamenchisaurus hochuanensis* but is less gracile than in *Euhelopus zdanskyi*, *Omeisaurus changshouensis*, *Omeisaurus tianfuensis*, *Apatosaurus excelsus*, *Diplodocus carnegii* and *Brachiosaurus brancai*. The fibula of *Opisthocoelicaudia skarzynskii* is much more massive. The proximal end is more flattened transversally in *Euhelopus zdanskyi* and less widened anteroposteriorly in *Camarasaurus grandis* and *Dicraeosaurus hansemanni*. The lateral bending is more pronounced in *Diplodocus carnegii*, and less so in *Apatosaurus excelsus* (where the fibula is quite straight). The distal end of the fibula of *Camarasaurus grandis*, *Omeisaurus tianfuensis* and *Omeisaurus changshouensis* is less widened; and less massive in *Apatosaurus excelsus*.

This fibula is slender, with a gentle lateral bending. In its general shape this bone is close to that of *Mamenchisaurus hochuanensis*.

Measurements (in cm) of the fibula n°P.W.1-18 of *P. sirindhornae*

Total length	77
Proximal breadth	16
Distal breadth	18,5
Minimum breadth of the shaft	8,9

Description of the referred material of *Phuwiangosaurus sirindhornae*

HYOID BONE

P.W.5-25 (Fig. 21)

This bone in very good condition is very slender, rod shaped and presents a marked curvature. Its shape is not symmetrical and indicates that this bone belongs to a pair. At the level of the curvature the bone becomes flatter. One of its end is slightly expanded, the other end tapers away.

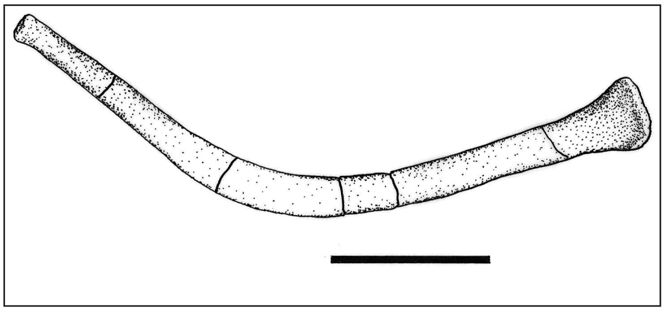


Fig. 21 - Hyoid bone P.W.5-25, lateral view. Scale bar: 3 cm

Hyoid bones have been reported in five genera of sauropods (*Shunosaurus*, *Omeisaurus*, *Apatosaurus*, *Camarasaurus* and *Brachiosaurus*), but these bones were isolated and no complete hyoid apparatus has been found articulated in its proper place (McIntosh, 1990). In *Shunosaurus lii* the description of the bone fits well with the bone here described. The hyoid bone in *Shunosaurus lii* is 16 cm long and presents a curvature similar to the one in our specimen. The shaft of the hyoid bone is slightly stouter in *Shunosaurus lii* but the ends present the same pattern. The hyoid apparatus illustrated for *Camarasaurus lentus* shows a long and uncurved rod-like bone associated to a pair of shorter rod-like bones; this apparatus is located under the lower jaw of the articulated skeleton (Gilmore, 1925). Neither the description nor the drawing give enough details about this bone, except its length of 16,5cm. In *Omeisaurus junghsiensis* the hyoid bone figured (Dong *et al.*, 1983, Pl.14) is very similar to the one in *Shunosaurus lii*, furthermore, this bone is larger and still stouter than in our specimen.

Measurements (in cm) of the hyoid bone n°P.W.5-25

Total length	16,2
Proximal width	1,8
Proximal breadth	1,3
Distal width	0,7
Distal breadth	0,6

CERVICAL VERTEBRAE

Anterior cervical vertebrae : P.W.5-30, -52 (Fig. 22)

These vertebrae are still being prepared. The vertebra P.W.5-30 is distorted and the neural arch collapses on the right side. Their general pattern is the same and fits with the less well preserved anterior cervical vertebra n°P.W.1-1.

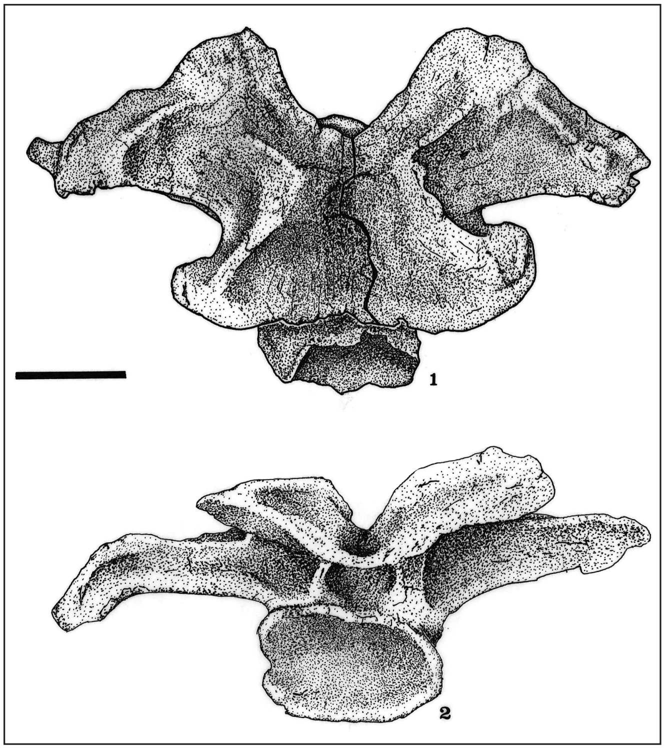


Fig. 22 - Cervical vertebra P.W.5-52, dorsal (1) and caudal (2) views. Scale bar: 10 cm

The centrum is strongly opisthocoelous and flattened dorsoventrally (even more so in P.W.5-52 due to a deformation during fossilisation). The cranial articular surface is flattened dorsoventrally and very prominent.

The neural arch is very low and very wide. The system of laminae is very well developed and the laminae are made of very thin bone. The neural spine shows a beginning of bifurcation. The parapophyses are very long craniocaudally and flattened dorsoventrally. The prezygapophyses and the postzygapophyses are almost horizontal (in P.W.5-30 the postzygapophyses are badly preserved). The well developed diapophyses present shallow oval depressions. The depressions correspond to the insertion of ligaments. These marks can not be seen on P.W.1-1 because of its poor preservation. In *Brachiosaurus brancai* these depressions are very numerous and situated on all the neural arch.

The cervical ribs are kept in connection. They show an anterior process. The length of the rib is about the same as the length of the centrum.

Measurements (in cm) of the cervical vertebrae n°P.W.5-30, -52 of *Phuwiangosaurus sirindhornae*

	P.W.5-30	P.W.5-52
Centrum length		
Centrum cran. height		
Centrum caud. height	9,5	
Centrum cran. width		
Centrum caud. width	16	
Width of diapophyses	32x2	
Width of postzyga.	14x2	
Length of neural arch	34,5	34,5
Total height	21	

DORSAL VERTEBRAE

Centrum : K.1-2, -3, -4, -30, P.W.4-2 (Fig. 23)

These centra are very similar to the centrum of the dorsal vertebrae P.W.1-4. The centrum is elongated and strongly opisthocoelous. The cranial articular surface is regularly convex. The caudal articular surface is regularly concave, with thin edges. The pleurocoel is deep and well defined with an almond shape. P.W.4-3 presents two faint keels on its ventral surface.

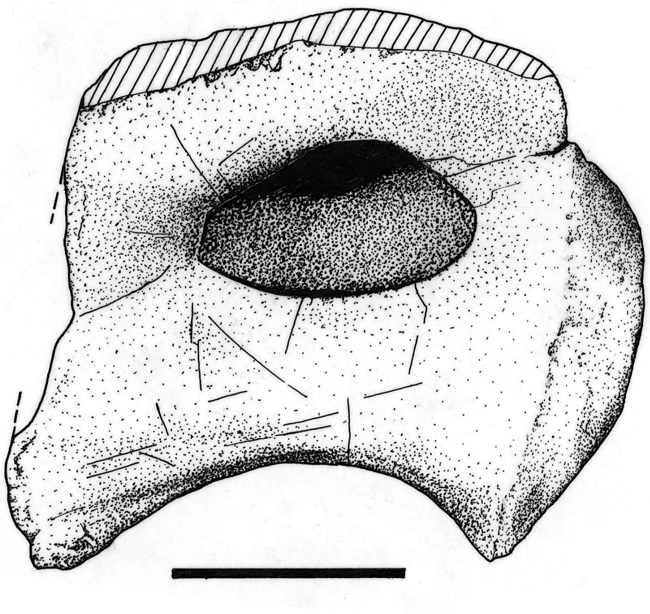


Fig. 23 - Dorsal vertebra K.1-30, lateral view.
Scale bar : 5cm

Measurements (in cm) of the centrum of the dorsal vertebrae n°K.1-2, -3, -4 and P.W.4-2, -3 of *Phuwiangosaurus sirindhornae*

	K.1-2	K.1-3	K.1-4	P.W.4-2	P.W.4-3
Centrum length	15,8	18,2	17,4	18	16,2
Centrum cran. height	-	-	-	-	-
Centrum caud. height	-	9,7	10,7	-	-
Centrum cran. width	-	-	-	15	11,8
Centrum caud. width	9,5	12	9,6	-	-

SACRAL VERTEBRAE

P.W.5-9, 10

This sacrum is composed of two parts found together but there is no fresh break to fit them back together. Three fused sacral vertebrae and two more show that the sacrum of *P. sirindhornae* was at least composed of five coossified vertebrae. Only the centra and the base of the last pair of sacral ribs are preserved.

The sacral vertebrae, the last one excepted, have elongated centra firmly fused to each other. The vertebrae are widened at the level where they meet. In this specimen the limits of the parapophyses are difficult to see, but they seem to be located in the cranial part of the centrum and not along all the length of the centrum.

The centrum of the last sacral vertebra is clearly shorter than the preceding ones and shows the characteristics of an anterior caudal on the ventral surface. Its caudal articular surface is flat and is less high and wider than in an anterior caudal vertebra. In caudal view, there is a marked depression at the level of the very wide neural canal. The ventral surface presents in its caudal part two bumps corresponding to the chevron facets.

The sacral ribs originate at the junction of two vertebrae. The last pair of sacral rib is directed craniolaterally. The caudal edge is rounded and the cranial edge is sharp, prolonged cranially by a lamina. This lamina merges with the centrum just caudally to the preceding sacral rib. In *Diplodocus longus* and *Bothriospondylus madagascariensis* the centra are more elongated than in our specimen. The centra are slightly compressed transversally, less so than in *Diplodocus longus*, *Dicraeosaurus hansemanni* or *Opisthocoelicaudia skarzynskii*. The centrum is compressed dorsoventrally, more so than in *Camarasaurus lentus*, *Camarasaurus supremus*, *Haplocanthosaurus priscus*, *Diplodocus longus* and *Barosaurus africanus*. In *Haplocanthosaurus priscus* the parapophyses extend to all the length of the centrum. In *Apatosaurus ajax* the parapophyses are situated more caudally on the centrum, they do not originate at the cranial end of the centrum. In *Diplodocus carnegii* the centrum presents a ventral keel absent in our specimen. The lateral surface of the centrum presents a shallow pleurocoel unlike the condition in *Opisthocoelicaudia skarzynskii* where there is no pleurocoel. As in *Opisthocoelicaudia skarzynskii*, the chevron bones are present since the last sacro-caudal vertebra.

As shown by this specimen the sacrum in *P. sirindhornae* is composed of at least five coossified vertebrae. The centra are elongated, transversally and dorsoventrally compressed, and firmly fused to each other. The centrum of the last sacral is shorter than the preceding ones and is similar to an anterior caudal. The facets for the chevron are marked, indicating that the chevron are present since the last sacro-caudal vertebra.

K.1-1

This sacral vertebra and a half is very similar to the sacral vertebrae P.W.5-9 & -10. The articular surface of the complete vertebra shows no mark of fusion, so it is probably the first sacral of the series.

Measurements (in cm) of the centrum of the sacral vertebrae n°K.1-1 of *P. sirindhornae*

Centrum length	14
Centrum cran. height	11,5
Centrum caud. height	-
Centrum cran. width	9
Centrum caud. width	-

CAUDAL VERTEBRAE

Anterior caudal vertebrae :
P.W.5-7 (Fig. 24),
P.W.6-4, K.1-5 to K.1-10, K.2-1, -3

The caudal vertebra P.W.5-7 is well preserved. In P.W.6-4 and in the series from Kalasin, only the centra are preserved. The centrum is slightly amphicoelous, short and high. In K.1-7 and -9 the centrum is more elongated than in K.1-5, -6. In P.W.6-4 the centrum is slightly higher than in P.W.5-7. In caudal view the centrum is wider dorsally than ventrally. There is no depression on the articular surfaces at the level of the neural canal. In lateral view the ventral surface is concave. The lateral surfaces are flat, slightly convex dorsoventrally and concave craniocaudally. In K.1-9 the lateral surface presents a faint longitudinal ridge. P.W.5-7 presents a slight depression ventrally to the transverse process.

The chevron facets are well marked caudally and triangular in shape. They are directed caudoventrally. Cranially the edge of the centrum is thickened at the level of the chevron of the preceding vertebra (mainly in P.W.5-7 and K.1-10). The ventral surface in K.1-10 is very slender and limited by two ridges.

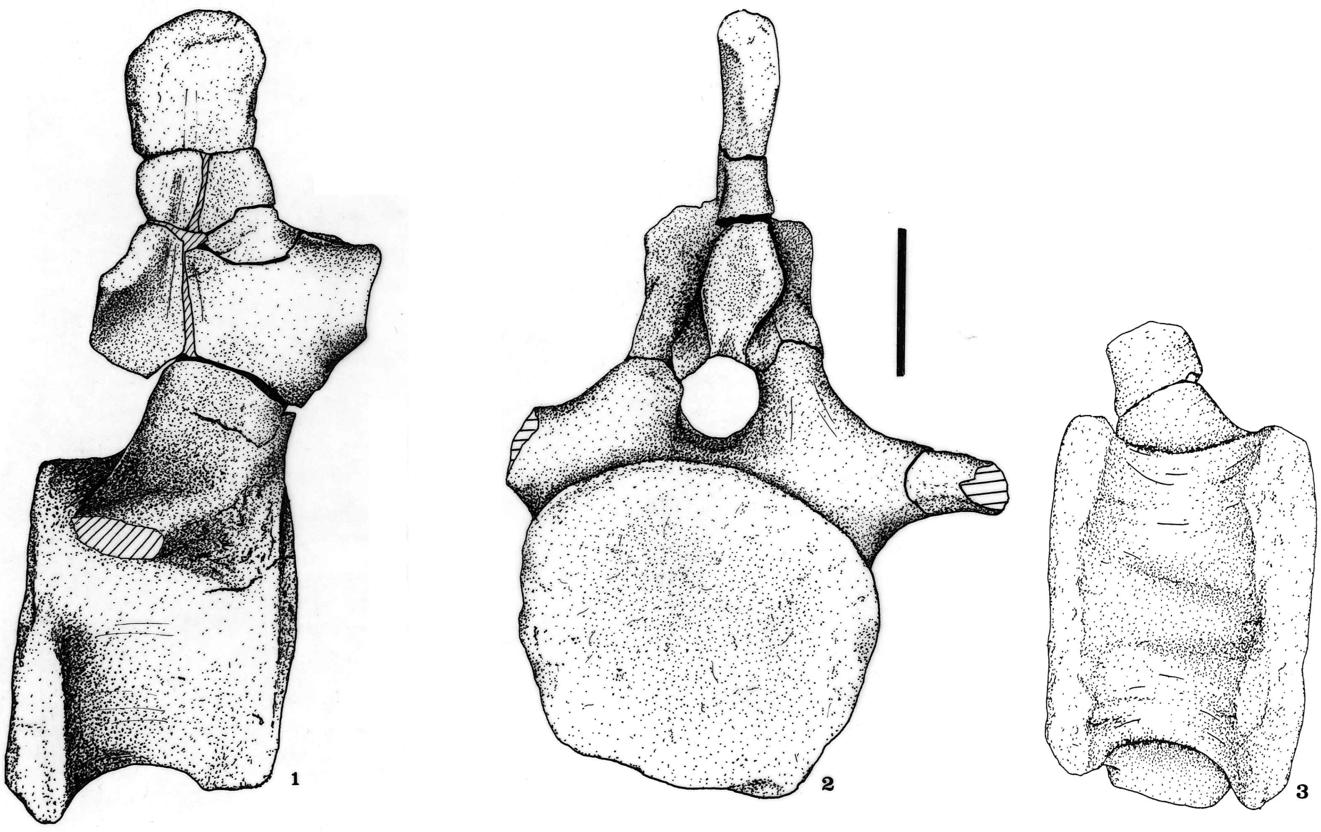
The transverse process is situated at the base of the neural arch, at mid-length of the centrum. The transverse process is directed laterocaudally. In K.1-5 the base of the transverse process is wide and thick.

The neural canal is large, higher than wide and uncovered by the neural arch caudally.

The base of the neural arch is situated closer to the cranial articular surface than the caudal one. The neural spine is high and thin, and slightly thickened dorsally. In lateral view the end of the spine is blunted. The spine is situated above the cranial half of the centrum.

The prezygapophyses are incomplete, they are dorsoventrally directed. A lamina joins the prezygapophysis to the base of the neural spine.

Fig. 24 - Anterior caudal vertebra P.W.5-7, lateral (1), caudal (2) and ventral (3) views. Scale bar: 5 cm



P.W.5-11

The vertebra P.W.5-11 is worn and only a part of the centrum is preserved. The centrum is very short and platycoelous. In cranial view, the centrum is subcircular in outline. The lateral and ventral surfaces are regularly convex dorsoventrally. The neural canal is circular in outline.

The shortness of the centrum indicates that this vertebra was situated very close to the sacrum in the caudal series.

P.W.9A-1, -2, K.1-11, -12, -13

These anterior caudal vertebrae are worn and poorly preserved.

Middle caudal vertebrae :

P.W.5-28 (Fig. 25)

The neural arch of this caudal vertebra is partly preserved. The vertebra presents a coossified chevron. The centrum is elongated, and slightly amphicoelous (with a bump on the cranial articular surface). In cranial view the centrum is nearly hexagonal in outline. In lateral view the ventral surface is concave. The remains of the transverse processes are very faint and situated at the base of the neural arch. The chevron facets are very well marked and continued cranially by strong ridges.

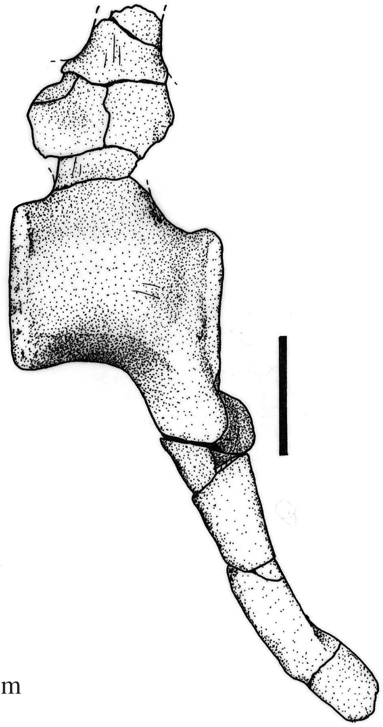


Fig. 25 - Middle caudal vertebra P.W.5-28, lateral view. Scale bar : 5 cm

The base of the neural arch is short craniocaudally and situated cranially on the centrum. The neural spine is incomplete and very thin transversally. The prezygapophyses are dorsoventrally directed.

The chevron bone is coossified to the vertebra only on the left side, the junction is free on the right side. The chevron is flattened transversally and presents a caudoventral curvature. The chevron is 16 cm long.

P.W.5-2 (Fig. 26)**, P.W.6-1**

Only the centra are preserved in these vertebrae. The centrum is elongated and amphiplatyan. In caudal view the centrum is subcircular in outline, nearly hexagonal, slightly wider transversally. In lateral view the ventral surface is slightly concave. The lateral surface is flat, slightly convex dorsoventrally and concave craniocaudally. The ventral surface in the caudal part presents two well marked facets for the chevrons. These facets are continued cranially by a ridge along the lateral borders of the ventral surface.

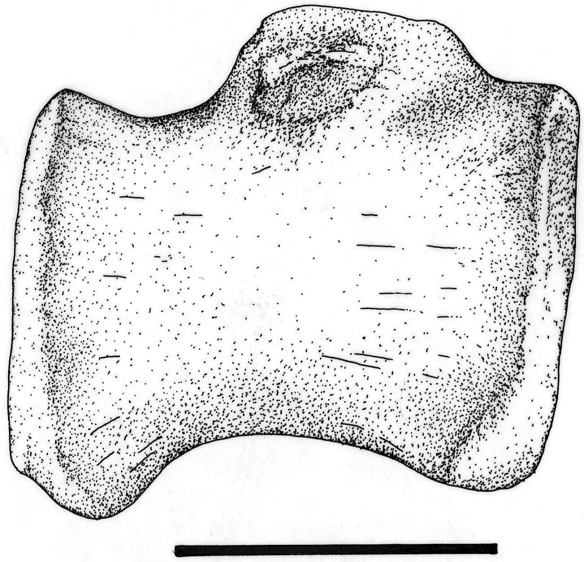


Fig. 26 - Middle caudal vertebra P.W.5-2, lateral view. Scale bar : 5 cm

The remains of the transverse processes are situated at the base of the neural arch, a little more ventrally. In P.W.6-1 a faint ridge runs along the lateral surface.

The neural canal is wide. The neural arch is situated in the cranial part of the centrum.

P.W.5-27 (not completely prepared)

This incomplete neural arch shows a transversally flattened neural spine. The spine is short, stout and smooth on its sides.

Posterior caudal vertebrae :
P.W.4-25, P.W.5-1, -3, -4, -5, -6 (Fig. 27)**, -32, -33, -59, P.W.6-2, -3, K.1-14**

The centrum is amphicoelous and very elongated (mainly P.W.5-3, -4 and P.W.6-2, -3). There is a strong lateral constriction. The centrum is enlarged at both ends. In cranial view the articular surface is circular in outline with a shallow depression on the floor of the neural canal. The chevron facets are very faintly marked.

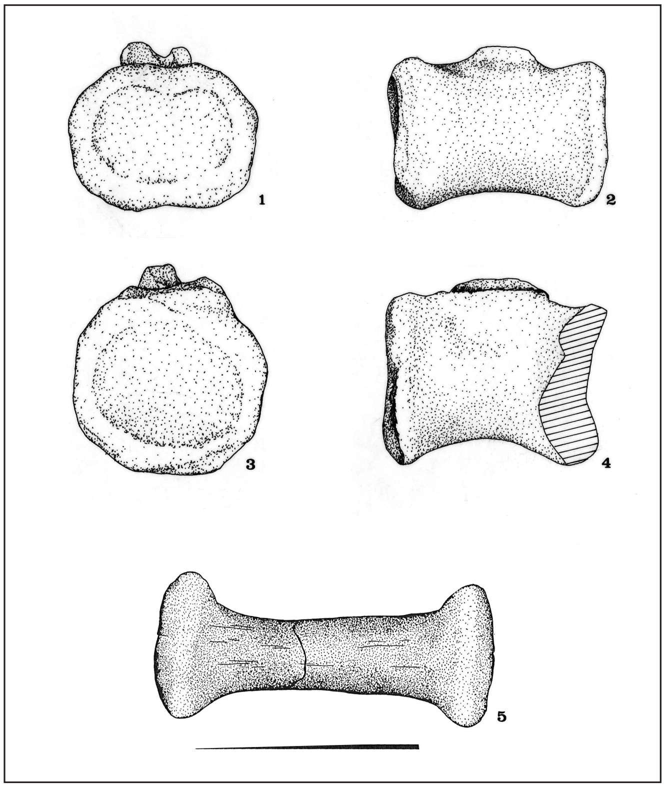


Fig. 27 - Posterior caudal vertebrae P.W.5-5, cranial (1) and lateral (2) views, P.W.5-6, cranial (3) and lateral (4) views, P.W.5-4, ventral view (5). Scale bar: 5 cm

The neural canal is narrow. The neural arch is situated in the cranial part of the centrum.

In P.W.5-32 and -33 the neural arch is preserved. The base of the neural arch is slightly wider than the centrum, forming a bump along the walls of the neural canal. The neural arch is very low and elongated craniocaudally.

The zygapophyses overhang the centrum both cranially and caudally. The neural spine is reduced caudally to a small expansion above the postzygapophyses.

The anterior caudal vertebrae present amphicoelous (or amphiplatyan) centra, unlike the condition in *Diplodocus carnegii* or in the Chinese genera where the centra are procoelous, or unlike *Opisthocoelicaudia skarzynskii* where the centra are opisthocoelous. As in *Opisthocoelicaudia skarzynskii* the chevron can be ossified to the centrum. In the posterior caudal vertebrae the centrum is very elongated and amphicoelous.

The spine is short, smooth and stout, in the middle caudal vertebrae and very reduced in the posterior caudal vertebrae.

SACRAL RIBS

K.1-33 (Fig. 28)

Sacral ribs are poorly figured in descriptions of sauropods, but there are some in Hatcher, 1903a, Marsh, 1896 and Borsuk-Bialynicka, 1977. The sacral ribs are very uneasy to observe on mounted skeleton and, as in *Euhelopus zdanskyi*, this part can remain incompletely freed of sediment.

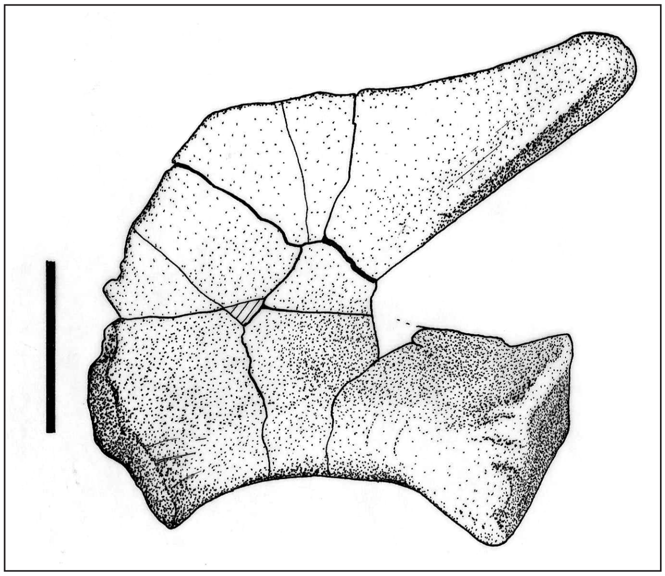


Fig. 28 - Sacral rib K.1-33. Scale bar : 5cm

The rib is quadrangular in shape. This stout sacral rib is probably from the caudal part of the sacrum.

CHEVRON BONES

K.1-22, P.W.5-31, -34, -56 (Fig. 29)**, -64, P.W.5A-12, P.W.6-5** (Fig. 30)**, -8, -11**

Except for P.W.5-56 all these chevrons present the same pattern. They resemble of the type of *Camarasaurus* more than the type of *Diplodocus*. They are elongated proximodistally, flattened transversally and with free proximal expansions. The proximal end is widened craniocaudally and slightly so transversally. There is no junction between the proximal articular surfaces, as in *Camarasaurus supremus* and *Brachiosaurus brancai* and contrary to *Patagosaurus fariasi*, *Diplodocus carnegii*, *Apatosaurus excelsus*, *Dicraesaurus hansemanni*, *Omeisaurus junghsiensis*, *Mamenchisaurus constructus* and *Mamenchisaurus hochuanensis*, where the haemal canal is enclosed in bone. The bifurcation is deeper in our specimens than in *Camarasaurus supremus* or in *Brachiosaurus brancai*. The wideness of the blade is regular all along its length unlike the enlarged one in *Apatosaurus excelsus*. In lateral view, the blade becomes blunted at its end. The blade is regularly curved caudoventrally. There is no cranial expansion of the distal end of the blade as is the case in *Diplodocus carnegii*, *Diplodocus longus* and *Mamenchisaurus hochuanensis*.

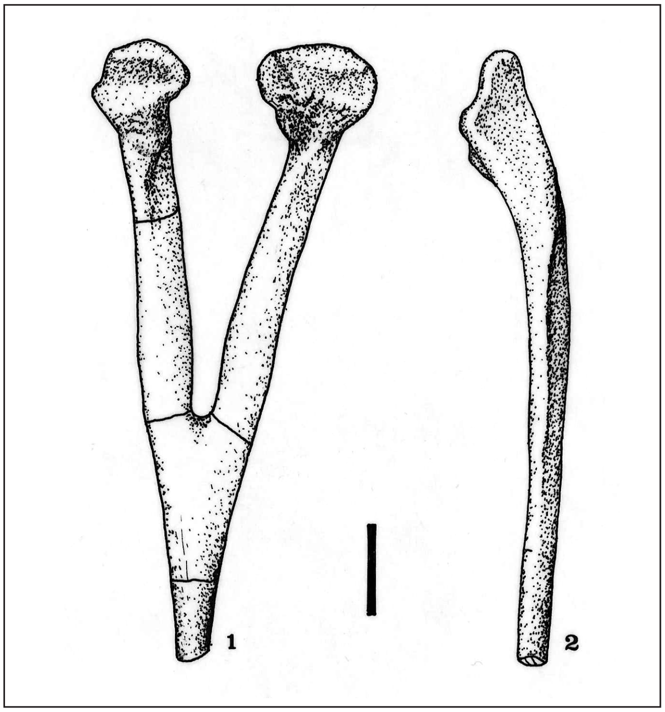


Fig. 29 - Chevron bone P.W.5-56, caudal (1) and lateral (2) views. Scale bar : 2 cm

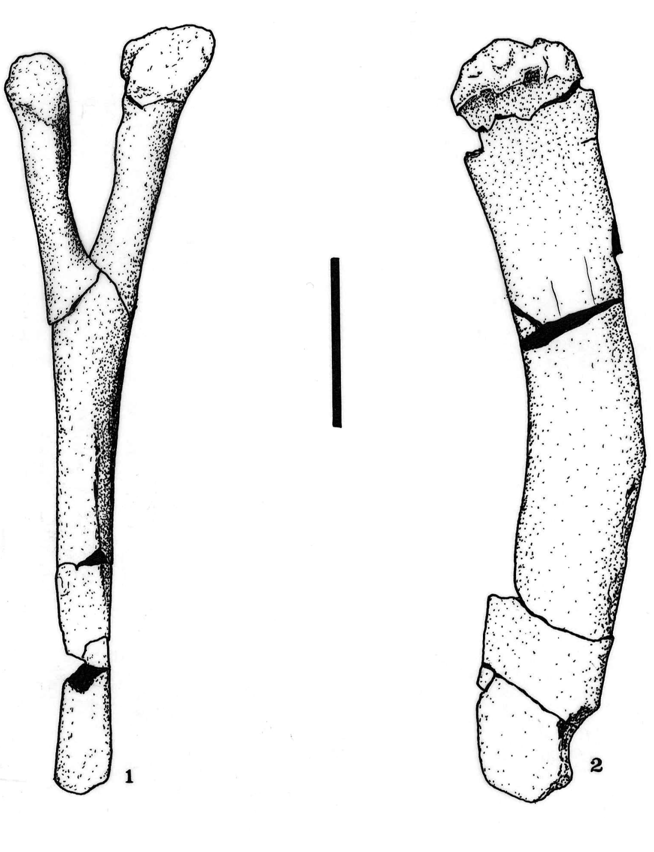


Fig. 30 - Chevron bone P.W.6-5, caudal view (1) and lateral view (2). Scale bar : 2 cm

The chevron P.W.5-56 presents a different shape of the blade, instead of the typical transversal flattening, this chevron is flattened dorsoventrally. The distal end tapers away. The section is more rounded in shape than for the chevrons described above. This kind of chevron is very similar to the chevron of *Camarasaurus grandis* figured by Marsh (1896, Pl.39). The curvature of this chevron is more pronounced, and the direction is mainly caudal. This chevron can correspond to one of the first chevrons in the series, and more caudally the chevrons are of the preceding kind.

The chevron bones preserved here are flattened transversally (except for one) and with free proximal end. These chevrons are of a *Camarasaurus*-type more than a *Diplodocus*-type. Some of them are fused to the centrum on anterior caudal vertebrae, this character can depend on the individual age of the specimen and on the position of the vertebra.

Measurements (in cm) of the chevron n°K.1-22, P.W.5-31, -34, -56, -64, P.W.5A-12 & P.W.6-5, -11 of *P. sirindhornae*

	K.1-22	P.W.5-31	P.W.5-34	P.W.5-56	P.W.5-64	P.W.5A-12	P.W.6-5	P.W.6-11
Length	-	16,3	18,4	13,7	-	-	-	-
Proximal transversal width	5,7	4,4	-	6,2	-	-	5,4	5,7
Proximal end thickness	3,8	3	-	2	1,9	1,8	4,2	4,5
Depth of the bifurcation	6,9	7	-	8,2	-	4,2	7,2	7,3

STERNAL PLATES

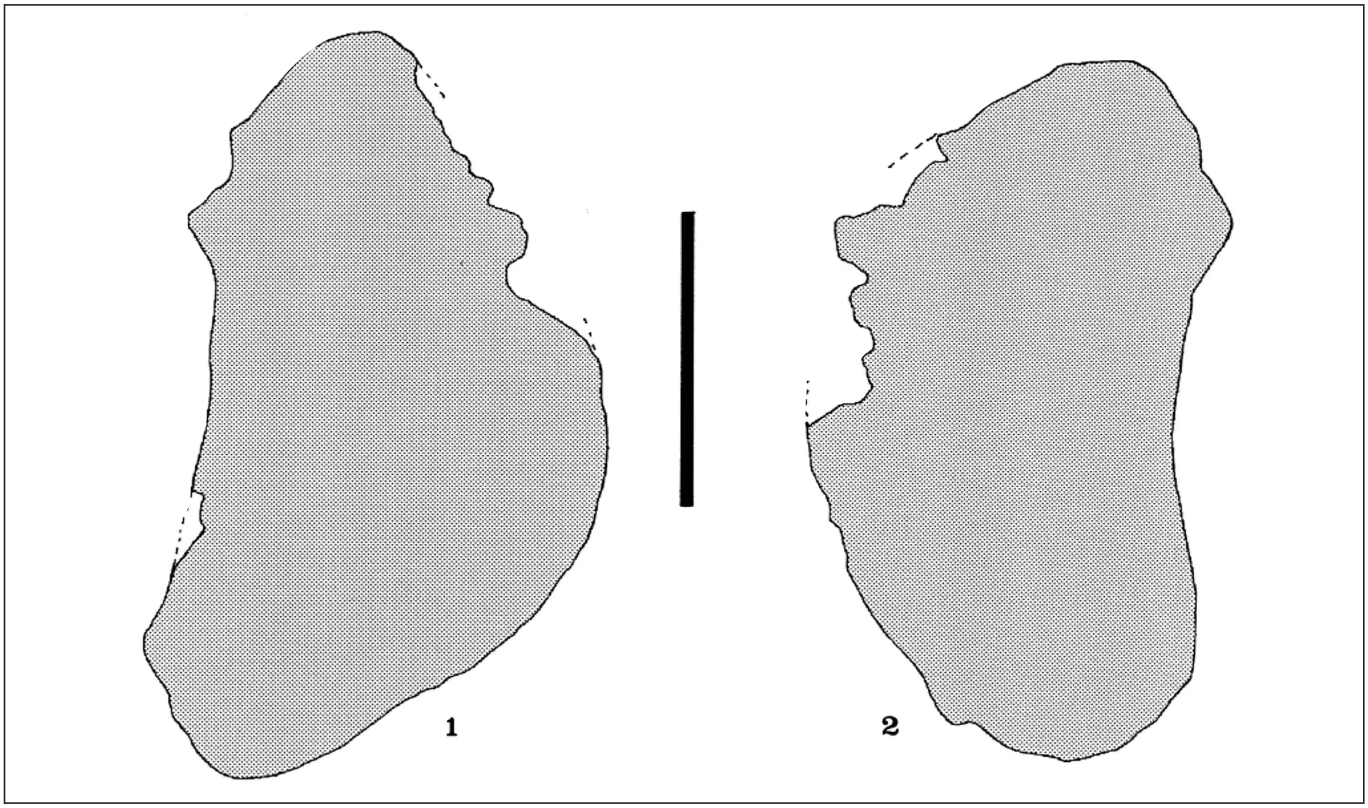
P.W. 5-69, 70 (Fig. 31)

This pair of sternal plates is well preserved. For comparisons, problems occur because of the different orientations of the plates in publications. The plates are here considered to have the functional orientation represented in Borsuk-Bialynicka, 1977.

The plates are roughly oval in shape (great length dorsoventral) and very flattened craniocaudally. They are wider transversally in the ventral part than in the dorsal one.

In *Omeisaurus tianfuensis* the plate is more regularly oval in shape, less curved laterally. The plate in *Barosaurus lentus* is more elongated than in P.W. 5, the ventral part is more slender in cranial view. *Haplocanthosaurus delfsi* also has a more elongated plate. *Camarasaurus lentus* presents a more rounded plate, with a prominent dorsal part. In *Shunosaurus lii* and *Omeisaurus junghsiensis* the plates are also more rounded.

Fig. 31 - Outlines of the sternal plates P.W.5-70 (1), P.W.5-69 (2). Scale bar : 20 cm



The shape of the plate in *Mamenchisaurus hochuanensis* is very different from our specimen in that the medial edge of the plate is straight and that the laterodorsal part of the plate is much more developed.

Our specimens show a saddle-like shape, as in *Opisthocoelicaudia skarzynskii* and *Omeisaurus tianfuensis* and more so than in *Apatosaurus excelsus*; in lateral view, the plates are concave cranially, and in dorsal view they are slightly convex cranially. In *Barosaurus lentus* the concavity of the plate is dorsal in lateral view. A marked curvature is present on the lateral border of the plate in P.W.5, more marked than in *Omeisaurus tianfuensis* or *Apatosaurus excelsus*; on the contrary, in *Haplocanthosaurus delfsi* the curvature is medial and the lateral border is convex in cranial view.

The plates are thick craniocaudally in the dorsal part and very thin in the ventral one. The laterodorsal part of the plate shows anteriorly a well marked elongated bump, as in *Opisthocoelicaudia skarzynskii*.

SCAPULA

K.1-29 (Fig. 32)

This right scapula is incomplete at its distal end but the proximal end is well preserved in its ventral part. This scapula is identical to P.W.1-7. The glenoid surface is very smooth and on the contrary the coracoid border is rugose. The largest thickness of the proximal end is on the dorsal border of the glenoid surface. On the lateral surface the strong ridge is at right angle to the direction of the shaft just like in P.W.1-7.

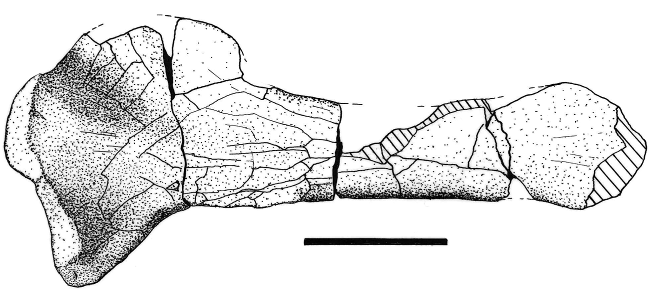


Fig. 32 - Right scapula K.1-29, medial view.
Scale bar : 20 cm

Measurements (in cm) of the scapula n°K.1-29 of *P. sirindhornae*

Proximal breadth	36
Proximal thickness	19,3

P.W.5-39

A very well preserved scapulocoracoid seems to exhibit a few differences with the type specimen P.W.1-7. At the time of writing the specimen is not fully prepared and remains in its plaster jacket. Nevertheless, some characteristics can be seen, such as the proportions or the strong lateral ridge. This lateral ridge is clearly at right angle to the shaft. The ventral edge of the shaft presents the same marked rim as in P.W.1-7 at the level of the constriction. The glenoid border is similar to the one in P.W.1-7. The coracoid is very similar to the juvenile one P.W.5A-30. The length of the distal blade seems much longer than in P.W.1-7. The distal end is slightly expanded in the same proportion as in P.W.1-7, but the constriction at the beginning of the blade, distally to the proximal end, is much pronounced. The coracoid is clearly fused to the scapula, except in the ventral part of the scapular border where they remain unfused. In P.W.1-7 there is no evidence of fusion between the coracoid and the scapula. The coracoid in P.W.1 is too badly preserved to see its edges, and both bones were not found close together.

Despite the differences, because of some clear common characteristics (position of the lateral ridge, marked rim on the ventral edge, glenoid border) with P.W.1-7, and considering the individual variation among the well known sauropod genera, this specimen is attributed to *P. sirindhornae*. In the light of new discoveries a further revision of this specimen will be conducted.

HUMERUS

K.1-28 (Fig. 33)

The right humerus K.1-28 is very similar to the humerus P.W.1-8. The bone is robust in the same way. The distal end is well preserved but the medial edge of the proximal end and the head are missing. The deltopectoral crest is well developed, its direction is anterior. The base of the crest is thick. The lateral surface of the crest is slightly depressed. The crest runs down to mid-length of the shaft, on the lateral edge. The crest is prolonged by a ridge until the lateral condyle. The posterior intercondylar groove is deep and elongated in the proximal direction. The distal condyles are well marked. The medial condyle is triangular in shape, the lateral condyle is more rounded in shape. The anterior surface presents two small bumps, one is situated in the middle of the width of the distal edge, and the second one is situated more laterally, on the distal edge. The medial one is thinner and more developed anteroposteriorly than the lateral one.

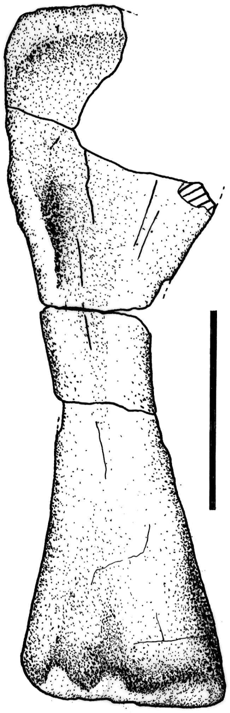


Fig. 33 - Right humerus K.1-28, anterior view. Scale bar : 20 cm

Measurements (in cm) of the humerus n°K.1-28 of *P. sirindhornae*

Total length	69
Proximal breadth	-
Distal breadth	21
Minimum breadth	10

RADIUS

P.W.5-22 (Fig. 35)**, K.1-36** (Fig. 34)**, -37, -38**

P.W.5-22 is a fairly complete right radius, K.1-36 is a complete left radius, K.1-37 is the proximal end of a left radius and K.1-38 is the distal end of a left radius.

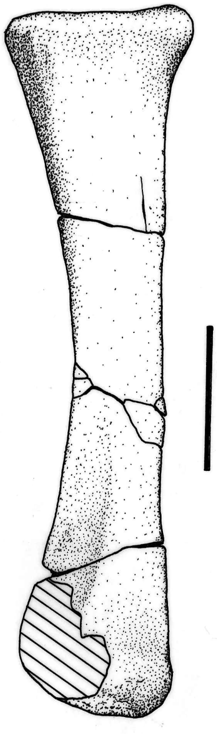


Fig. 35 - Right radius P.W.5-22. Scale bar : 10 cm

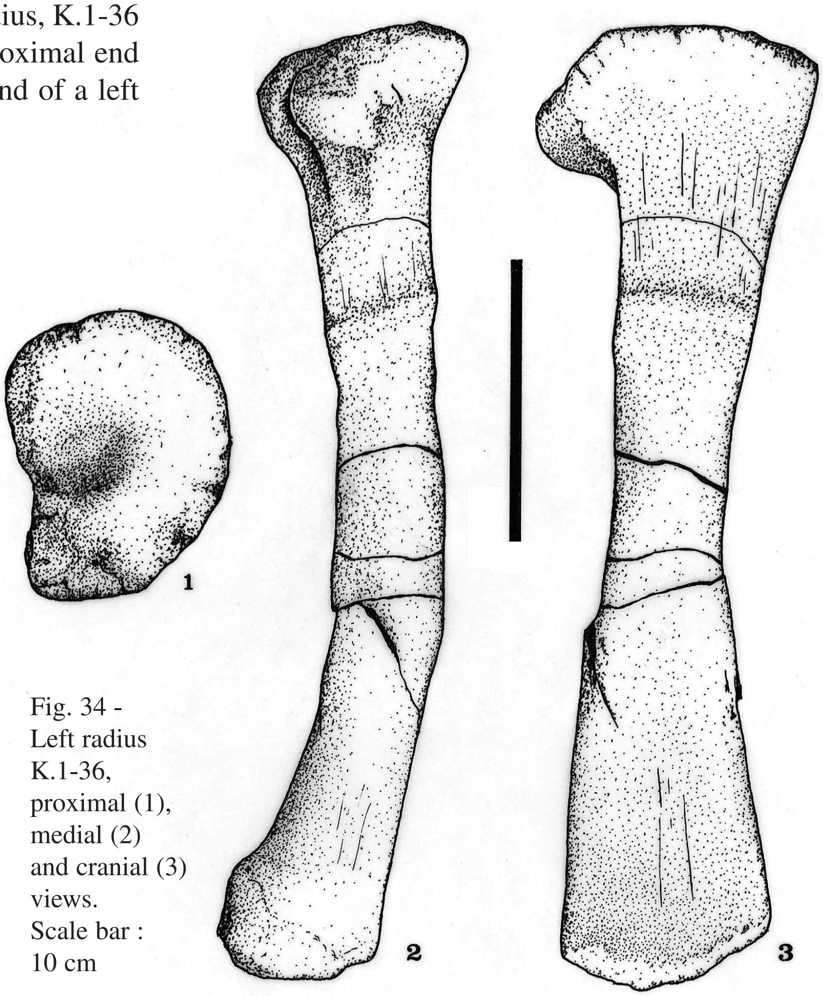


Fig. 34 - Left radius K.1-36, proximal (1), medial (2) and cranial (3) views. Scale bar : 10 cm

The radius is an elongated bone with slightly expanded ends. The proximal end is slightly depressed and rugose. In proximal view the proximal end presents a medial expansion well marked also in cranial view. The proximal end is expanded more transversally than craniocaudally.

In proximal view the cranial surface of the shaft is convex and the caudal surface is slightly concave. The shaft is gently curved, with a caudal concavity. This curvature is increased in K.1-36 where the bone is crushed. In cranial view the shaft is enlarged laterally in the distal direction and medially in the proximal direction. On the complete radius the caudal surface presents two protuberances, one is medially situated near the proximal end and the other is laterally situated near the distal end. The lateral tuberosity is prolonged proximally by a lateral ridge. The medial tuberosity is prolonged distally by a medial ridge, where the interosseous muscle was inserted. The shaft is rounded cranially and forms a ridge laterally.

The distal end is rounded in cranial view, and oval in shape and in distal view, with a thinner lateral part. The distal surface is puckered. The medial part of the distal surface is directed at right angle to the direction of the shaft. The lateral part of the articular surface is directed laterodistally. From the most caudal part of the distal surface a rounded ridge buttresses the distal end and merges with the middle of the shaft, at the level of the lateral tuberosity.

In *Opisthocoelicaudia skarzynskii* both ends are more expanded and the constriction of the shaft is more pronounced than here. In *Barosaurus africanus* and *Brachiosaurus brancai* the shaft of the radius is much more elongated, but the ends are expanded in the same way. In *Dicraeosaurus sattleri* the radius is more elongated. The shaft is more flattened in *Opisthocoelicaudia skarzynskii* than in our specimens.

METACARPALS

K.1-39 (Fig. 36)

This right metacarpal from the second digit is well preserved. It is elongated and slightly flattened craniocaudally. The shaft is thin and both ends are slightly expanded, the distal one less so than the proximal one.

The proximal end is flat, rugose and of fairly triangular shape in proximal view. The cranial edge is convex, the laterocaudal edge is flat and the mediocaudal edge is concave.

The caudal surface of the shaft bears a strong ridge merging mediodistally with a tuberosity. This tuberosity is triangular in shape and limited caudally and laterally by two ridges. It corresponds to the contact with the metacarpal of the first digit. The lateral surface of the shaft is a ridge, which is enlarged distally. In lateral view the cranial surface is flat and the caudal surface is curved toward both ends.

The distal end is composed of two condyles. The medial condyle is more developed craniocaudally than the lateral one. In distal view the distal end is fairly rectangular in outline.

Measurements (in cm) of the metacarpal n° K.1-39 of *P. sirindhornae*

Total length	21,3
Proximal breadth	8,9
Proximal thickness	4,5
Distal breadth	6,5
Distal thickness	4,5
Minimum shaft breadth	4,9
Minimum shaft thickness	3

Measurements (in cm) of the radius n° P.W.5-22, K.1-36, -37, -38 of *P. sirindhornae*

	P.W.5-22	K.1-36	K.1-37	K.1-38
Total length	49	33,5	-	-
Proximal breadth	13	10	10,7	-
Proximal thickness	-	7,1	7,4	-
Distal breadth	11	7,5	-	10,5
Distal thickness		5,3	-	7,3
Minimum shaft breadth		3,7	-	-
Minimum shaft thickness		3,4	-	-

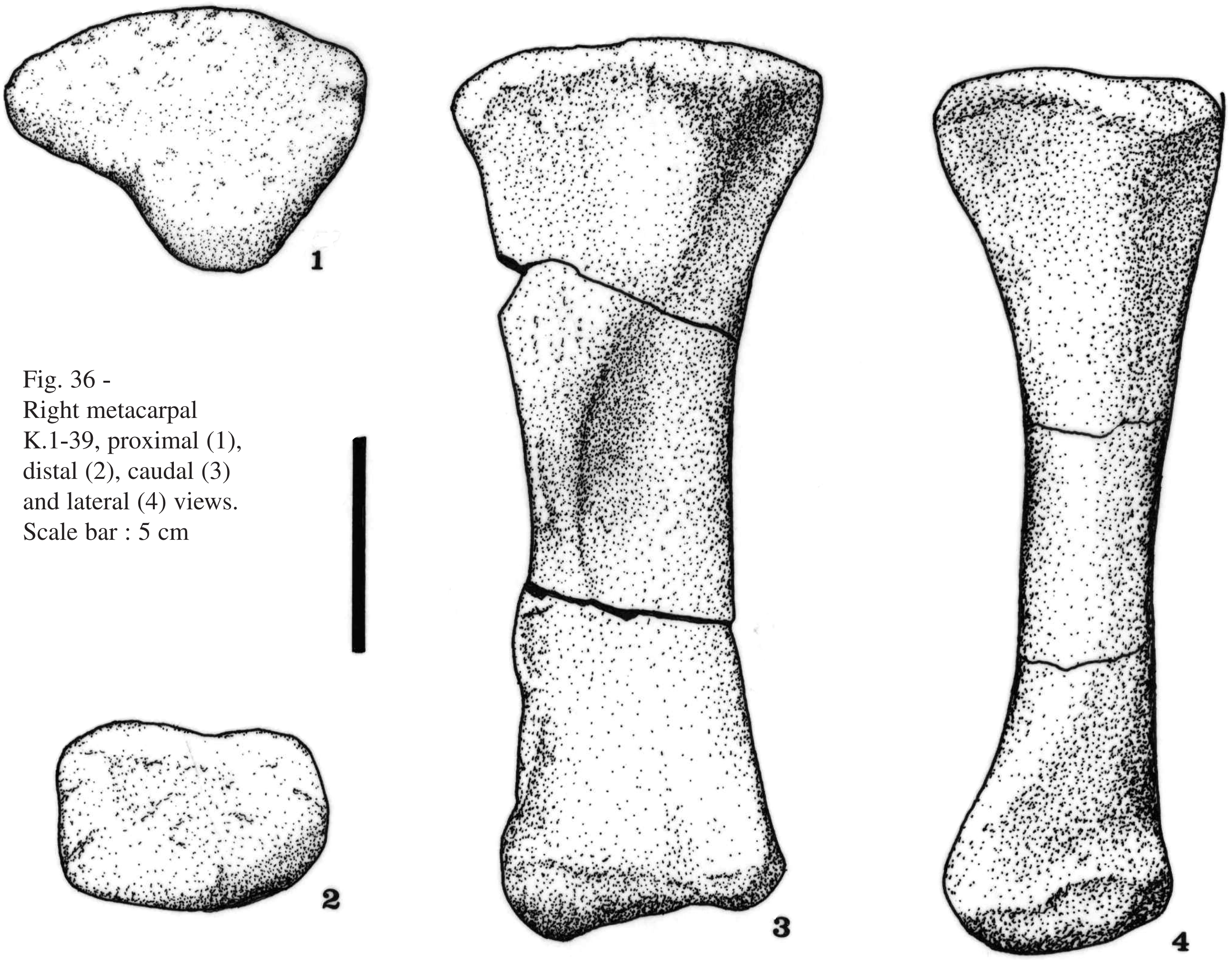


Fig. 36 -
Right metacarpal
K.1-39, proximal (1),
distal (2), caudal (3)
and lateral (4) views.
Scale bar : 5 cm

PUBIS
K.1-15, 16, 17, 18

K.1-15 is a fairly complete right pubis, K.1-16 and K.1-17 are respectively the proximal and distal ends of a similar right pubis, and K.1-18 is the very damaged proximal end of a larger pubis.

The obturator foramen is not enclosed in bone as in P.W.1-12. This character, associated to moderate size, indicates that the specimen was probably not fully grown. The iliac border is wide, oval in shape and slightly concave. The acetabular border is wide and short as in P.W.1-12. The proximal end is less rounded cranially than in P.W.1-12. The cranial edge is rounded and the caudal edge is thin. The distal end is slightly widened. Except for the area of the obturator foramen this pubis is very similar to the pubis P.W.1-12.

Measurements (in cm) of the pubis n°K.1-15 of *P. sirindhornae*

Total length	49
Proximal breadth	17,9
Proximal thickness	8
Distal breadth	12,5

FEMUR
P.W.5-49 (Fig. 37)**, K.1-32, -34**

P.W.5-49 is a complete left femur slightly twisted in its distal half. K.1-32 is the proximal end of a worn femur and K.1-34 is the distal end of a very broken femur (only the lateral epicondyle is preserved).

The head of P.W.5-49 is more rounded than in P.W.1-16, but in proximal view the proximal end of P.W.5-49 is similar to P.W.1-16 (the great trochanter is missing in P.W.5-49).

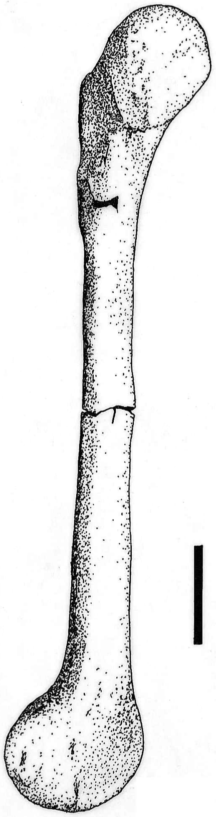


Fig. 37 - Left femur P.W.5-49, medial view. Scale bar : 10 cm

The femur P.W.5-49 is more elongated than P.W.1-16, -17 and in caudal view the shaft is slightly curved (this curvature may have been increased by deformation). In lateral view this femur is very close to P.W.1-17 by the flatness of the shaft and the expansions of the proximal and distal ends. The fourth trochanter is slightly less developed in P.W.5-49 than in P.W.1-17, but is situated at the same level on the medial edge of the shaft.

The distal end presents well marked condyles, these condyles are directed more medially than in P.W.1-16. These condyles are slender and less rounded than in P.W.1-16. The medial epicondyle is more developed than the lateral one, like in P.W.1-16 and the lateral epicondyle is strongly developed in the same way. The differences in the elongation of the shaft, in the thickness of the distal condyles and their direction can be attributed to differences in individual age. P.W.5-49 is smaller than p.W.1-16 and can be attributed to a younger individual.

In K.1-34 the distal end presents the same proportions (mainly for the lateral epicondyle) as in P.W.1-16 but this specimen is too poorly preserved to allow a more accurate comparison.

The strongly developed epicondyle and the shape and situation of the fourth trochanter are very similar in the femur P.W.1-16. The differences observed can be attributed to different growth stage and to individual variation.

Measurements (in cm) of the femur
n° P.W.5-49 of *P. sirindhornae*

Total length	82
Proximal breadth	23
Proximal thickness	9
Distal breadth	21
Distal thickness	17
Minimum shaft breadth	12,5
Minimum shaft thickness	5

TIBIA

P.W.4-1, -12, K.1-23, 24, 25, 26, 27 (Fig. 38, 39)

P.W.4-1 is the poorly preserved proximal end of a right tibia, P.W.4-12 is a fairly complete tibia in two parts, K.1-23 is a fairly complete left tibia, K.1-24 and K.1-25 are respectively the proximal and the distal ends of a left tibia, K.1-26 and K.1-27 are respectively the proximal and the distal ends of a right tibia. Because of their similar size K.1-23 and K.1-26, -27 probably belong to the same individual. The other left tibia is larger. These tibiae are close to the tibiae in *Barosaurus africanus*, *Camarasaurus supremus*, *Brachiosaurus brancai* and *Lapparentosaurus madagascariensis*.

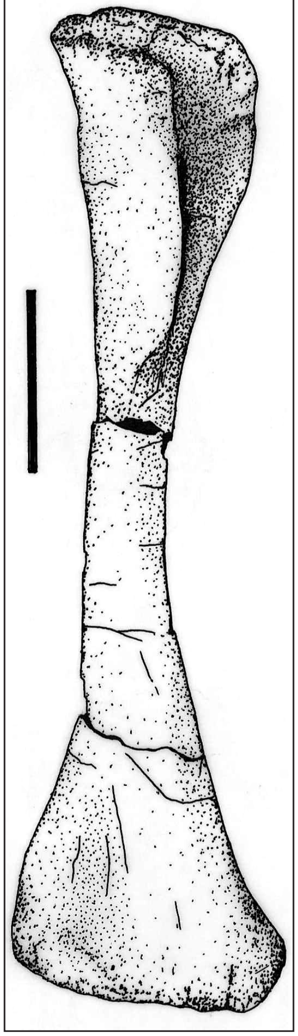


Fig. 38 - Left tibia K.1-23, anterior view. Scale bar : 10 cm

In *Apatosaurus excelsus* the tibia is stouter but the distal and proximal ends are close to our specimens. The tibia in *Opisthocoelicaudia skarzynskii* is stouter.

The proximal end is widened transversally and slightly so craniocaudally. In *Omeisaurus tianfuensis* the proximal end is less developed craniocaudally. The cranial surface of the proximal end is flat and slightly directed medially. The proximal end tapers progressively toward the shaft. The caudal surface of the proximal end presents a marked strongly buttressed tuberosity (even more marked in P.W.4-1).

The cnemial crest is oriented craniolaterally and extends until the third of the length of the shaft. The cnemial crest is prolonged more distally by a ridge running from the lateral edge to the medial edge of the cranial surface. Caudally to the cnemial crest there is a deep depression on the lateral surface. The section of the shaft is triangular, with a small lateral side.

The distal end is anterocaudally widened and slightly so transversally, in *Lapparentosaurus madagascariensis*, *Tornieria robusta* and *Dicraeosaurus hansemanni* the distal end is more widened. The distal end presents two well defined surfaces separated by a groove. The medial process is longer than the lateral one. It is slender caudally and very wide cranially. To the contrary the lateral process is wide caudally and slender cranially. The distal surface of the medial process is directed anterolaterally and the distal surface of the lateral process is directed posteromedially. The cranial surface of the distal end shows the ridge coming from the cnemial crest and the medial edge.

This tibia is similar to those of most sauropods, with a slightly widened distal end.

Measurements (in cm) of the tibiae
n°P.W.4-1, -12, K.1-23 of *P. sirindhornae*

	P.W.4-1	P.W.4-12	K.1-23
Total length	-	71	55
Proximal breadth	20,3	35	22
Proximal thickness	-	16	-

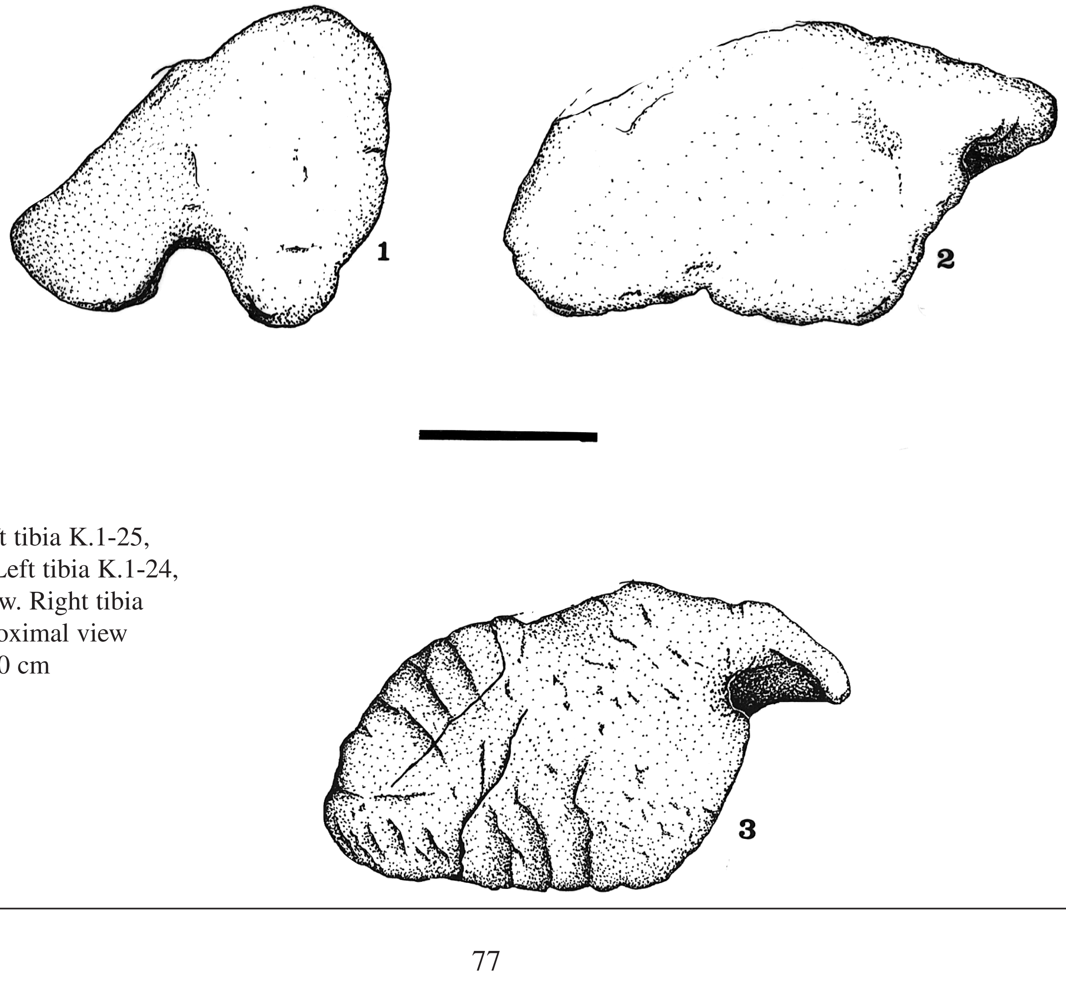


Fig. 39 - Left tibia K.1-25, distal view. Left tibia K.1-24, proximal view. Right tibia P.W.4-12, proximal view
Scale bar : 10 cm

FIBULAE

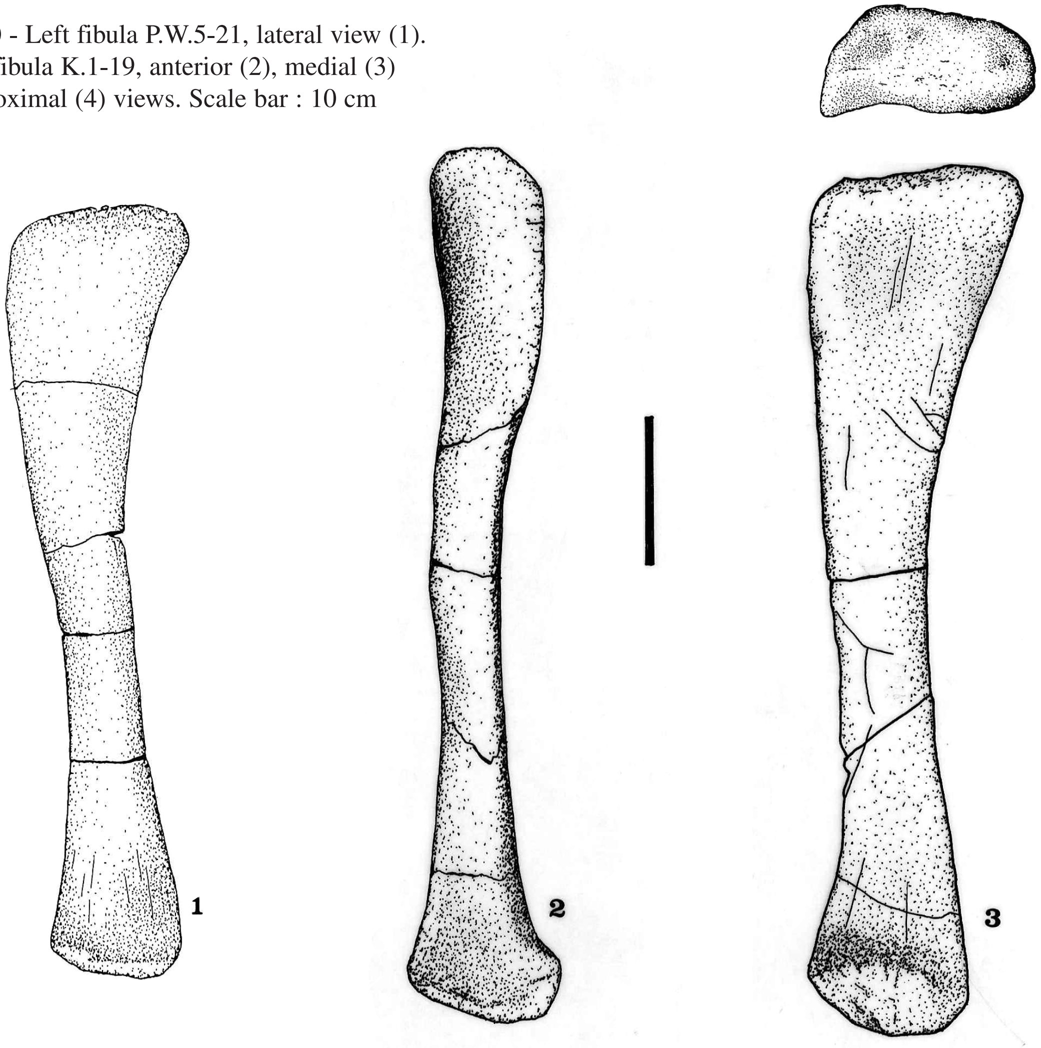
K.1-19, 20, 21, P.W.5-21 (Fig. 40)**, P.W.5B-1**

The right fibula K.1-19 is very well preserved. K.1-20 is the proximal end of a left fibula and K.1-21 is the distal end of what may be the same fibula. The size of the fibulae of both sides is similar and can correspond to the larger tibia from Kalasin. These fibulae are similar to the fibula P.W.1-18 with very little variations such as the proximal end thicker in P.W.1-18 than in the others. In P.W.5-21 the medial surface is a little more concave than in K.1-19. In distal view the lateral surface is more pronounced in K.1-19 than in P.W.5-21. P.W.5-21 is a little more flattened than P.W.1-18. The fibula P.W.5B-1 presents a rugose proximal surface and, together with its small size, this suggests that it belongs to a young individual.

Measurements (in cm) of the fibulae n°K.1-19, 20, 21, P.W.5-21 and P.W.5B-1 of *P. sirindhornae*

	K.1-19	K.1-20	K.1-21	P.W.5-21	P.W.5B-1
Total length	60	-	-	52,5	-
Proximal breadth	15	16	-	12,5	8,1
Proximal thickness	7,3	-	-	-	3,7
Distal breadth	11,2	-	9,7	9,3	-
Distal thickness	9,2	-	-	-	-
Minimum breadth	6,5	-	-	-	-

Fig. 40 - Left fibula P.W.5-21, lateral view (1). Right fibula K.1-19, anterior (2), medial (3) and proximal (4) views. Scale bar : 10 cm



PHALANX

P.W.5-17, -58

These phalanges may correspond to the proximal phalanx of respectively the right and left second digit.

Measurements (in cm) of the phalanx n° P.W.5-58 of *P. sirindhornae*

Total length	4,3
Proximal breadth	6,1
Distal breadth	5,1

K.1-35

This phalanx is the ungual phalanx of the first left digit. Its end is broken. The phalanx is slightly curved. The lateral surface is flat and the medial surface is convex. Several holes are present on the lateral surface. In proximal view the bone is expanded craniocaudally and slightly so transversally. Cranially the proximal surface is directed medially. In lateral view, the proximal end presents a concavity in the plantar part.

P.W.5-15 (Fig. 41)

P.W.5-15 is a complete ungual phalanx from the first right digit. This claw is very close to the one in *Barosaurus africanus*, but slightly less curved and less transversally expanded than in this genus.

P.W.5-16

This phalanx is probably from the second right digit; it is more flattened transversally than in the preceding ungual phalanx.

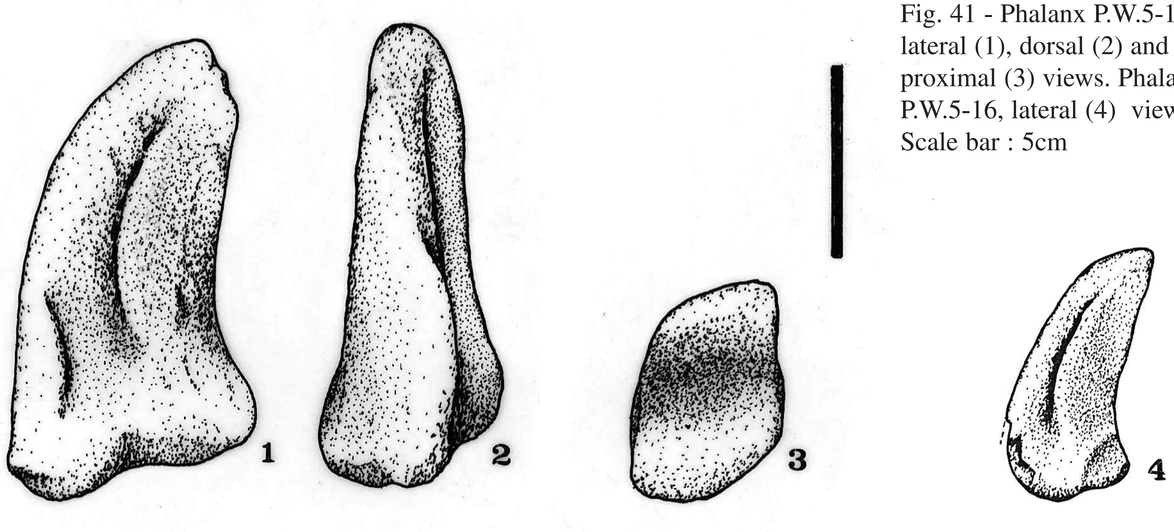


Fig. 41 - Phalanx P.W.5-15, lateral (1), dorsal (2) and proximal (3) views. Phalanx P.W.5-16, lateral (4) view. Scale bar : 5cm

CONCLUSIONS

As mentioned above, the main aim of the present paper is to provide a detailed description of the type of *Phuwiangosaurus sirindhornae* and of some complementary material, not to discuss the affinities of this dinosaur in great detail, since in this regard the newly discovered cranial material, currently under study, will provide essential new evidence.

One of our initial assumptions was that *Phuwiangosaurus sirindhornae* might turn out to be related to the Jurassic sauropods included by Upchurch (1995, 1998) in the Euhelopodidae (*Datousaurus*, *Euhelopus*, *Mamenchisaurus*, *Omeisaurus*, *Shunosaurus*). This assumption was based on biogeographical considerations and partly on the assignment of the Sao Khua Formation to the Jurassic, which has turned out to be incorrect, since an Early Cretaceous age is indicated by palynological evidence (Racey *et al.*, 1994, 1996). Our comparisons based on the postcranial skeleton clearly show that *Phuwiangosaurus* does not resemble the Euhelopodidae. In those Chinese genera, the cervical vertebrae show a trend toward a strong transversal compression. To the contrary, in *Phuwiangosaurus sirindhornae*, the flattening occurs dorsoventrally, leading to very broad cervical vertebrae. Moreover, the bifurcation occurring on the last cervical vertebrae is very shallow in the Chinese genera; conversely, it is very deeply marked in *P. sirindhornae*. These characteristics show that *P. sirindhornae* presents no close affinities with the Euhelopodidae. In the shape of the cervical vertebrae and the femur, *P. sirindhornae* is reminiscent of the Camarasauridae. But many differences in the dorsal vertebrae and the girdles prevent *P. sirindhornae* from being attributed to the Camarasauridae. The vertebrae show an advanced level of complexity which is lacking in the Vulcanodontidae and the Cetiosauridae. Finally, there are no convincing common derived characteristics that could be used in favour of an attribution to the very specialised Diplodocidae, Titanosauridae, Brachiosauridae or Dicraeosauridae. When *Phuwiangosaurus sirindhornae* was originally described in 1994, it was not assigned to any definite family of sauropods (Martin *et al.*, 1994).

Light was shed on the possible affinities of *Phuwiangosaurus* by the discovery of teeth and jaw elements associated with skeletons of *Phuwiangosaurus* at Wat Sakawan (Suteethorn *et al.*, 1995 ; Buffetaut & Suteethorn, 1999). The slender teeth, with a lanceolate crown, are quite different from the broader, spoon-shaped teeth of the Euhelopodidae, and they closely resemble those of *Nemegtosaurus*, a Late Cretaceous sauropod from Mongolia and China placed in the family Nemegtosauridae by Upchurch (1994, 1995), together with *Quaesitosaurus*, also from the Upper Cretaceous of Mongolia (see also Upchurch, 1999, for a discussion of the Nemegtosauridae). This led to the suggestion that “ *Phuwiangosaurus* may be close to the ancestry of *Nemegtosaurus* and related Late Cretaceous forms ” (Buffetaut & Suteethorn, 1999), including the recently reported Late Cretaceous sauropod from Shanxi, China (Pang *et al.*, 1995), known from a postcranial skeleton resembling that of *Phuwiangosaurus* and teeth similar to those of *Nemegtosaurus*.

It may be added in conclusion that further cranial elements of *Phuwiangosaurus*, including a braincase, recently discovered at a new site in Kalasin Province, appear to fully confirm the idea that the Thai form belongs to the Nemegtosauridae. This material is currently under study and will be described in a later paper.

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Appendixes :

APPENDIX 1 : DESCRIPTION OF THE OUTCROPS YIELDING DINOSAUR REMAINS IN NORTHEASTERN THAILAND

KHON KAEN PROVINCE

The Phu Wiang mountains, where occur most of the outcrops, are formed of two concentric ranges. The external range is the higher and culminates at 726 m and the internal range is 465 m high. Phu Wiang is located at about 70 km North West of the town of Khon Kaen (Fig.1, 2). Phu Wiang is a synclinal of North East/South West axis.

Phu Wiang site 1: Phu Pratu Teema (P.W.1)
Historical setting
This site was discovered in 1982. The excavation of the partially articulated skeleton went on until 1987.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Resistant red, grey and green siltstones.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae* : partially articulated skeleton
-Theropoda indet. : teeth
Bibliography
Buffetaut 1983b, 1984 ; Buffetaut & Ingavat 1985 ; Buffetaut & Suteethorn, 1989, 1993 ; Buffetaut *et al.* 1993

Phu Wiang site 1A: (P.W.1A)
Historical setting
This site was discovered in 1981.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Fine grained greenish sandstones.
Faunal list
-Sauropoda indet : phalanx and two incomplete femora
-Theropoda indet. : teeth
-Theropoda : Compsognathidae indet. : tibia
-Theropoda : *Siamosaurus suteethorni* : 8 teeth
-Crocodylia indet. : teeth
-Crocodylia : *Goniopholis phuwiangensis* : dentary
-Chelonia indet. : plates
-Actinopterygii indet. : scales
-Hybodont indet. : tooth
Bibliography
Buffetaut, 1983a, 1983b, 1984 ; Buffetaut & Ingavat, 1983a, 1983b, 1984, 1985, 1986a, 1986b ; Buffetaut & Suteethorn, 1993 ; Buffetaut *et al.*, 1993

Phu Wiang site 2: Tham Ghia (P.W.2)
Historical setting
Site discovered in 1989.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Bones are in a non resistant layer of brown siltstone, under a sandstone and a conglomerate layer.
Faunal list
-Sauropoda indet : Seven cervical vertebrae in connection
Bibliography
Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Phu Wiang site 3: Huai Pratu Teema (P.W.3)
Historical setting
1976 marks the discovery of the first dinosaur bone in Thailand, the distal extremity of a sauropod femur . In 1978 two more vertebrae of sauropod were discovered. The first excavation at that site by the Thai-French paleontological team took place in 1989 and displayed several bone fragments in their very hard matrix. In 1993 and 1994 excavation were carried outthere and provided more sauropod bones. The site is protected by a light building. The excavation of the bones from this site will request a lot of time considering the hardness of the matrix.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Very hard fine grained sandstone.
Faunal list
-Sauropoda indet.
-Theropoda indet. : teeth
Bibliography
Ingavat *et al.*, 1978 ; Ingavat & Taquet, 1978 ; Buffetaut , 1981, 1982, 1983a, 1983b, 1984 ; Buffetaut & Ingavat, 1985 ; Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Phu Wiang site 4: Noen Sao Eh (P.W.4)
Historical setting
Site discovered in 1990.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Non resistant reddish brown siltstone
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Actinopterygii indet. : scales
-Chelonia indet. : plates
-Crocodylia indet. : plates
Bibliography
Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Phu Wiang site 5: Sum Ya Ka (P.W.5)
Historical setting
This site was discovered in 1991 by John and Moo Lek. They were looking for a new locality after a lightning struck near them while they were working at site 1.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Pale red claystone with grey green lenses.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Theropoda indet. : teeth and vertebrae
Bibliography
Martin *et al.*,1993

Phu Wiang site 5A: (P.W.5A)
Historical setting
This site is about ten meters far from site 5 and was discovered in 1993.

Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Red claystone with lime nodule conglomerate.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Ornithomimidae indet.
-Theropoda : *Siamosaurus* : tooth
-Crocodylia indet. : teeth
-Chelonia indet. : plates
-Pelecypod indet.
Bibliography
Martin *et al.*, 1993

Phu Wiang site 5B: (P.W.5B)
Historical setting
This site is located at the same place as site 5, in the layer above. This site yielded bones when we were excavating to reach the lower layer of site 5.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
The sedimentology is similar to site 5A, it is the same layer. Red claystone with lime nodule conglomerate.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Theropoda indet.
-Pelecypods

Phu Wiang site 6: Dong Keng (P.W.6)
Historical setting
This site was discovered in 1991.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Bones come from between a non resistant layer of red claystone and a layer of red sandstone
Faunal list
-Sauropoda indet.
Bibliography
Martin *et al.*, 1993

Phu Wiang site 7 : Phu Noi (P.W.7)
Historical setting
This site was discovered in 1992.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
The layer where the bones are coming from is not yet located. We have only been picking up the bones washed out by erosion.
Faunal list
-Sauropoda indet.
-Theropoda indet.
-Crocodylia indet.
Bibliography
Martin *et al.*, 1993

Phu Wiang site 9A: (P.W.9A)
Historical setting
This site was discovered on July 25, 1993.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Red brown claystone with green lenses in the upper part and siltstone with limestone nodules.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae* : two vertebrae
-Theropoda indet. : teeth

Phu Wiang site 11 : Sum Bak Low (P.W.11)
Historical setting
This site was discovered in July, 1993.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Bones are found between a hard sandstone layer and the limestone conglomerate above.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Actinopterygii indet. : scales
-Theropoda indet. : teeth
-Pelecypods

Phu Kao site 1 (P.K.1)
Historical setting
This site was discovered in 1992.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Weathering sandstone.
Faunal list
-Sauropoda indet. : weathered femur
Bibliography
Martin *et al.*, 1993

KALASIN PROVINCE

Kalasin site 1: Phu Pha Ngo (K.1)
Historical setting
In 1991, at Phu Pha Ngo about 40 identifiable bones (and many bone fragments) were found near a temple. A large part of these bones were discovered by the driver of the expedition, all together in a pile, close to the temple. These bones, thought to be elephant bones, were placed here by the workers during the erection of the temple. An excavation took place some time later, yielding new bones of at least three different individuals.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Red sandstone and lime nodule conglomerate.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae*
-Crocodylia indet. : teeth
-Chelonia indet. : plates
-Actinopterygii indet. : scales
Bibliography
Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Kalasin site 2: Ban Nong Mek (K.2)
Historical setting
This site was discovered in 1991.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.

Sedimentology
Lime nodule conglomerate.
Faunal list
-Sauropoda : *Phuwiangosaurus sirindhornae* : vertebrae and ribs
-Crocodylia : *Siamosaurus suteethorni* : teeth
Bibliography
Martin *et al.*, 1993

Kalasin site 4 : Wat Sak Kawan (K.4)
Historical setting
In 1980 a sauropod humerus was discovered in a Buddhist temple. The monks used to collect archaeological objects and potteries, and they thought that this bone was petrified wood. Varavudh Suteethorn went there and took one of the three parts of this bone, a few months later he went back and, thanks to the abbot Kruvichit Thakhoum, could get the two missing parts.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Lime nodule conglomerate interbeded with claystone.
Faunal list
-Sauropoda indet. : humerus
Bibliography
Buffetaut, 1982, 1983a, 1983b ; Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Kalasin site 5: Pond (Phu Pha Ngo) (K.5)
Historical setting
In 1992 villagers digging a pond discovered some bones they brought to the Phu Pha Ngo temple.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Red claystone with layers of lime nodule conglomerate.
Faunal list
-Sauropoda indet.

Kalasin site 6: Top of the hill (Phu Pha Ngo) (K6)
Historical setting
This site was discovered in 1992.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Conglomerate interbeded with claystone.
Faunal list
-Sauropoda indet : proximal end of a femur.

Sakhon Nakhon Province
Sakhon Nakhon site 1: Huai Huat (S.N.1)
Historical setting
This site was discoverd in 1992.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Red claystone.
Faunal list
-Sauropoda indet. : fragments
-Theropoda indet. : teeth
-Actinopterygii indet. : scales and vertebrae
-Chelonia indet. : plates
-Crocodylia : *Goniopholis phuwiangensis*

Bibliography
Martin *et al.*, 1993

UDON THANI PROVINCE
Khok Doo site 1 : (K.D.1)
Historical setting
This site was discovered on November 22, 1993.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Sandstone covered with conglomerate.
Faunal list
-Sauropoda indet. : ungual phalanx
-Theropoda indet. : teeth

Khok Doo site 2 : (K.D.2)
Historical setting
This site was discovered in 1993
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Sandstone.
Faunal list
-Sauropoda indet. : humerus

Nong Bua Lam Phu Province
Nong Bua Lam Phu site 1 : Phu Hin Lat Tuppha (N.B.1 = U.T.1)
Historical setting
This site was discovered in 1980.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Hard red brown sandstone.
Faunal list
-Sauropoda indet. : scapula
Bibliography
Buffetaut, 1981, 1982, 1983a, 1983b ; Buffetaut & Suteethorn, 1993 ; Martin *et al.*, 1993

Mukdahan Province
Mukdahan site 2 : (M.2)
Historical setting
This site was discovered in 1993.
Stratigraphic level and age
Sao Khua Formation, Early Cretaceous.
Sedimentology
Lime nodule conglomerate interbedded with sandstone.
Faunal list
-Sauropoda indet. : rib and limb bones
-Chelonia indet. : plates
-Actinopterygii indet. : scales

APPENDIX 2 : LIST OF THE SAUROPOD MATERIAL FROM THE LOWER CRETACEOUS OF THAILAND (K-4 excluded).

All the material is kept by the Department of Mineral Resources of Bangkok, Thailand.

PHU WIANG : site 1

P.W. 1-1	Cervical vertebra
P.W. 1-2	Cervical vertebra
P.W. 1-3	Cervical vertebra
P.W. 1-4	Dorsal vertebrae
P.W. 1-5	Dorsal vertebra
P.W. 1-6	Dorsal vertebra
P.W. 1-7	Left scapula
P.W. 1-8	Left humerus
P.W. 1-9	Left ulna
P.W. 1-10	Left ilium
P.W. 1-11	Right ilium
P.W. 1-12	Left pubis
P.W. 1-13	Right pubis (distal end)
P.W. 1-14	Left ischium
P.W. 1-15	Right ischium
P.W. 1-16	Left femur
P.W. 1-17	Right femur
P.W. 1-18	Left fibula
P.W. 1-19	Coracoid (fragment)
P.W. 1-20	Chevron
P.W. 1-21	Right rib (proximal end)
P.W. 1-22	Rigth scapula (distal end)
P.W. 1-	Rib
P.W.1-	Rib

PHU WIANG : site 1A

P.W. 1A-1	Phalanx
P.W. 1A-	Femur (in D.M.R. in Khon Kaen)
P.W. 1A-	Femur (incomplete)

PHU WIANG : site 3

P.W. 3-1	Anterior dorsal vertebra (in place)
P.W. 3-2	Left sternal plate (in place)
P.W. 3-3	Right sternal plate (in place)
P.W. 3-4	Femur distal end
P.W. 3-5	Dorsal vertebra
	Bone fragments in place

PHU WIANG : site 4

P.W. 4-1	Tibia, proximal end
P.W. 4-2	Dorsal vertebra
P.W. 4-3	Dorsal vertebra
P.W. 4-4	Anterior caudal vertebra
P.W. 4-5	Anterior caudal vertebra
P.W. 4-6	Right femur of juvenile (proximal end)
P.W. 4-7	Right femur of juvenile (distal end)
P.W. 4-8	Right femur of juvenile (distal end)
P.W. 4-9	Left femur of juvenile (proximal end) (cut)
P.W. 4-10	Right femur of juvenile (proximal end) (cut)
P.W. 4-11	Right femur of juvenile (proximal end) (cut)
P.W. 4-12	Right tibia (2 parts)
P.W. 4-13	Posterior caudal vertebra of juvenile (centrum)
P.W. 4-14	Posterior caudal vertebra of juvenile (centrum)
P.W. 4-15	Posterior caudal vertebra of juvenile (centrum)
P.W. 4-16	Posterior caudal vertebra of juvenile (centrum)
P.W. 4-17	Posterior caudal vertebra of juvenile (centrum)
P.W. 4-18	Posterior cervical vertebra of juvenile (centrum)
P.W. 4-19	Scapula distal end (2 parts)
P.W. 4-20	Femur proximal end of juvenile (cut)
P.W. 4-21	Anterior caudal vertebra of juvenile (centrum)
P.W. 4-22	Anterior caudal vertebra of juvenile (centrum)
P.W. 4-23	Anterior caudal vertebra of juvenile (centrum)
P.W. 4-24	Anterior caudal vertebra of juvenile (centrum)
P.W. 4-25	Posterior caudal vertebra (centrum)
P.W. 4-	Pubis, distal end
P.W. 4-	Pubis, incomplete proximal end

PHU WIANG : site 5

P.W. 5-1	Dorsal vertebra of juvenile (centrum)
P.W. 5-2	Anterior caudal vertebra (centrum)
P.W. 5-3	Caudal vertebra (centrum)
P.W. 5-4	Caudal vertebra(centrum)
P.W. 5-5	Caudal vertebra (centrum)
P.W. 5-6	Caudal vertebra (centrum)
P.W. 5-7	Anterior caudal vertebra with neural arch
P.W. 5-8	Caudal vertebra (water worn)
P.W. 5-9	Sacral vertebrae
P.W. 5-10	Sacral vertebrae
P.W. 5-11	Caudal vertebra with neural arch
P.W. 5-12	Femur (young)
P.W. 5-13	Caudal vertebra with coossified chevron
P.W. 5-14	Caudal vertebra with coossified chevron
P.W. 5-15	Ungual phalanx
P.W. 5-16	Ungual phalanx
P.W. 5-17	Phalanx
P.W. 5-18	Phalanx
P.W. 5-19	Fragment indet.
P.W. 5-20	Left femur (young)
P.W. 5-21	Left fibula (young)
P.W. 5-22	Right radius (49 cm long)
P.W. 5-23	Left tibia (very small)
P.W. 5-24	Radius (very small)
P.W. 5-25	Hyoid bone
P.W. 5-26	Caudal vertebra
P.W. 5-27	Neural arch of the vertebra n° P.W.5-26
P.W. 5-28	Caudal vertebra with coosified chevron
P.W. 5-29	Ischium (very small)
P.W. 5-30	Cervical vertebra (in plaster jacket)
P.W. 5-31	Chevron bone
P.W. 5-32	Caudal vertebra with neural arch
P.W. 5-33	Caudal vertebra with neural arch
P.W. 5-34	Chevron bone
P.W. 5-35	Cervical vertebra of juvenile (centrum)
P.W. 5-36	2 cervical vertebrae in connection (in plaster jacket)
P.W. 5-37	Cervical vertebra (in plaster jacket)
P.W. 5-38	Cervical vertebra (in plaster jacket)
P.W. 5-39	Scapula and fused coracoid
P.W. 5-48	Sacral rib of juvenile
P.W. 5-49	Left femur (82 cm long)
P.W. 5-50	Dorsal vertebra (neural arch)
P.W. 5-51	Vertebra (centrum)
P.W. 5-52	Cervical vertebra
P.W. 5-53	Rib
P.W. 5-54	Rib

P.W. 5-55	Ulna
P.W. 5-56	Chevron
P.W. 5-57	Dorsal vertebra (neural arch)
P.W. 5-58	Phalanx
P.W. 5-59	Posterior caudal vertebra (centrum)
P.W. 5-60	Caudal vertebra
P.W. 5-61	Anterior caudal vertebra of juvenile (centrum)
P.W. 5-62	Caudal vertebra
P.W. 5-63	Sacral rib of juvenile (incomplete)
P.W. 5-64	Chevron proximal end
P.W. 5-65	Ribs
P.W. 5-66	Phalanx
P.W. 5-67	Sacral rib of juvenile
P.W. 5-68	Right ilium of juvenile
P.W. 5-69	Left sternal plate (in plaster jacket)
P.W. 5-70	Right sternal plate (in plaster jacket)

PHU WIANG : site 5A

P.W. 5A-1	Left femur
P.W. 5A-2	Right femur
P.W. 5A-3	Ilium (in plaster jacket)
P.W. 5A-4	Neural arch of juvenile (fragment)
P.W. 5A-6	Tibia of juvenile (proximal end)
P.W. 5A-7	Middle caudal vertebra of juvenile (centrum)
P.W. 5A-8	Pubis of juvenile (proximal end)
P.W. 5A-9	Dorsal vertebra of juvenile (centrum)
P.W. 5A-10	Sacral vertebra of juvenile (unfused)
P.W. 5A-11	Anterior dorsal rib of juvenile
P.W. 5A-12	Chevron bone (proximal end)
P.W. 5A-13	Sacral rib of juvenile
P.W. 5A-14	Right humerus of juvenile
P.W. 5A-15	Caudal vertebra (centrum)
P.W. 5A-16	Ungual phalanx (claw)
P.W. 5A-17	Metapod
P.W. 5A-18	Phalanx
P.W. 5A-19	Sacral vertebra of juvenile (centrum)
P.W. 5A-20	Cervical vertebra of juvenile (centrum)
P.W. 5A-21	Cervical vertebra of juvenile (centrum)
P.W. 5A-22	Cervical vertebra of juvenile (centrum)
P.W. 5A-23	Phalanx
P.W. 5A-24	Phalanx
P.W. 5A-25	Dorsal vertebra of juvenile (centrum) (very small)
P.W. 5A-26	Posterior caudal vertebra
P.W. 5A-27	Dorsal vertebra of juvenile
P.W. 5A-28	Dorsal vertebra
P.W. 5A-29	Rib
P.W. 5A-30	Coracoid of juvenile
P.W. 5A-31	Ischium of juvenile (proximal end)
P.W. 5A-32	Phalanx (2 parts)
P.W. 5A-33	Rib
P.W. 5A-34	Cervical vertebra of juvenile (neural arch fragment)
P.W. 5A-35	Ischium distal end
P.W. 5A-36	Dorsal vertebra of juvenile (neural arch fragment)
P.W. 5A-37	Cervical vertebra of juvenile (centrum)
P.W. 5A-38	Dorsal vertebra of juvenile (neural arch fragment)
P.W. 5A-39	Metapod end
P.W. 5A-40	Anterior caudal vertebra of juvenile (centrum)
P.W. 5A-41	Rib
P.W. 5A-42	Cervical vertebra of juvenile (neural arch)
P.W. 5A-43	Dorsal vertebra of juvenile (neural arch)
P.W. 5A-44	Scapula of juvenile (proximal end)
P.W. 5A-45	Cervical vertebra
P.W. 5A-46	Left astragalus of juvenile
P.W. 5A-47	Left metacarpal IV (proximal end)
P.W. 5A-48	Caudal vertebra (neural arch)
P.W. 5A-49	Distal end of indet. metacarpal
P.W. 5A-50	Half cervical vertebra
P.W. 5A-51	Caudal vertebra with elongated neural arch
P.W. 5A-52	Distal end of the pubis n° P.W. 5A-8

PHU WIANG : site 5B

P.W. 5B-1	Fibula
P.W. 5B-2	Sacral rib of juvenile (incomplete)
P.W. 5B-3	Indet metacarpal
P.W. 5B-4	Indet metatarsal
P.W. 5B-5	Part of chevron

PHU WIANG : site 6

P.W. 6-1	Anterior caudal vertebra
P.W. 6-2	Caudal vertebra
P.W. 6-3	Caudal vertebra
P.W. 6-4	Anterior caudal vertebra
P.W. 6-5	Chevron
P.W. 6-6	Anterior caudal vertebra
P.W. 6-7	Cervical vertebra
P.W. 6-8	Chevron
P.W. 6-9	Cervical vertebra (in plaster) (N° 6-8 in DMR)
P.W. 6-10	Caudal vertebra
P.W. 6-11	Chevron
P.W. 6-	Chevron
P.W. 6-	Ribs

PHU WIANG : site 7

P.W. 7-1	Phalanx
P.W. 7-2	Phalanx (incomplete)

PHU WIANG : site 11

P.W.11-1	Cervical vertebra (juvenile)

KALASIN : site 1

K. 1-1	Sacral vertebra
K. 1-2	Dorsal vertebra
K. 1-3	Dorsal vertebra
K. 1-4	Dorsal vertebra
K. 1-5	Caudal vertebra
K. 1-6	Caudal vertebra
K. 1-7	Caudal vertebra
K. 1-8	Caudal vertebra
K. 1-9	Caudal vertebra
K. 1-10	Caudal vertebra
K. 1-11	Caudal vertebra
K. 1-12	Caudal vertebra
K. 1-13	Caudal vertebra
K. 1-14	Caudal vertebra
K. 1-15	Right pubis
K. 1-16	Right pubis (proximal end)
K. 1-17	Right pubis (distal end)
K. 1-18	Right pubis
K. 1-19	Right fibula
K. 1-20	Left fibula (proximal end)
K. 1-21	Left fibula (distal end)
K. 1-22	Chevron

K. 1-23	Left tibia
K. 1-24	Left tibia (proximal end)
K. 1-25	Left tibia (distal end)
K. 1-26	Right tibia (proximal end)
K. 1-27	Right tibia (distal end)
K. 1-28	Right humerus
K. 1-29	Right scapula
K. 1-30	Dorsal vertebra
K. 1-31	Caudal vertebra
K. 1-32	Femur proximal end (the other end is in the Science Museum, Bangkok)
K. 1-33	Sacral rib
K. 1-34	Femur (distal end)
K. 1-35	Ungual phalanx
K.1-36	Left radius
K.1-37	Left radius (proximal end)
K.1-38	Left radius (distal end)
K.1-39	Metapod
K.1-	Femur
K.1-	Sternal plate
K.1-	Left scapula (proximal end)
K.1-	Right ilium
K.1-	Ribs

KALASIN : site 2

K.2-1	Anterior caudal vertebra
K.2-2	Vertebra
K.2-3	Anterior caudal vertebra
K.2-4	Anterior caudal vertebra

KHOK DOO : site 1

K.D.1-1	Ungual phalanx

KHOK DOO : site 2

K.D.2-1	Right humerus

APPENDIX 3: PAPERS INCLUDING SAUROPOD DESCRIPTIONS AND ILLUSTRATIONS USED FOR COMPARISONS

Amargasaurus : Olshevsky, 1992 ; Bonaparte, 1994
Amygdalodon : Casamiquela, 1963 ; Bonaparte, 1978
Apatosaurus : Marsh, 1877, 1878a, 1879a, 1879b, 1881a, 1881b, 1883, 1896 ; Osborn, 1899b, 1904 ; Osborn & Granger, 1901 ; Hatcher, 1902 ; Peterson & Gilmore, 1902 ; Riggs, 1903b ; Mattew, 1905 ; Holland, 1915a, 1915b, 1923 ; Mook, 1917 ; Gilmore, 1936 ; McIntosh & Berman, 1975 ; Berman & McIntosh, 1978 ; Ostrom & McIntosh, 1966 ; McIntosh, 1981
Barapasaurus : Jain *et al.*, 1975
Barosaurus : Marsh, 1890 ; Fraas, 1908 ; Lull, 1917, 1919 ; Janensch, 1929a, 1961 ; Norell *et al.*, 1991 ; Dodson, 1992
Bellusaurus : Dong, 1988, 1990
Bothriospondylus : Lydekker, 1895 ; Dorlodot, 1934 ; Lapparent, 1943
Brachiosaurus : Riggs, 1903a ; Janensch, 1914, 1929a, 1935, 1950a, 1950b, 1961 ; Lapparent & Zbyszewski, 1957 ; Lapparent, 1960 ; Jensen, 1987
Camarasaurus : Cope, 1877a, 1878a, 1878b, 1878c ; Marsh, 1878b, 1879a, 1889, 1896 ; Osborn & Granger, 1901 ; Riggs, 1901 ; Osborn, 1898, 1904, 1924 ; Mook, 1914 ; Holland, 1919, 1923, 1924a ; Osborn & Mook, 1921 ; Gilmore, 1925 ; Lull, 1930 ; Lapparent & Zbyszewski, 1957 ; Ellinger, 1950 ; Ostrom & McIntosh, 1966 ; McIntosh, 1981 ; Lucas & Hunt, 1985 ; Jensen, 1988 ; Miller *et al.*, 1992 ; Hunt & Lucas, 1993
Cetiosaure de Tilougguit : Monbaron & Taquet, 1981 ; Taquet, 1986
Cetiosaurus : Owen, 1841a, 1875 ; Jones, 1970 ; Crowther & Martin, 1986 ; J. Martin, 1986, 1987
Datousaurus : Dong & Tang, 1984 ; Miller, 1988
Dicraeosaurus : Janensch, 1914, 1929a, 1929b, 1935, 1961
Diplodocus : Marsh, 1878b, 1884, 1890, 1896 ; Osborn, 1899a, 1904 ; Hatcher, 1900, 1901, 1903b ; Osborn & Granfer, 1901 ; Holland, 1905, 1910, 1923, 1924b ; Gilmore, 1932 ; Ostrom & McIntosh, 1966 ; McIntosh & Berman, 1975 ; Hallet, 1991 ; Hunt & Lucas, 1993
Dystylosaurus : Jensen, 1985
Euhelopus : Wiman, 1929, Young, 1935 ; Mateer & McIntosh, 1985
Haplocanthosaurus : Hatcher, 1903a, 1903d ; McIntosh & Williams, 1988
Lancanjiangosaurus : Zhao, 1986
Lapparentosaurus : Ogier, 1975 ; Bonaparte, 1986a
Mamenchisaurus : Young, 1954,1958 ; Young & Chao, 1972 ; Dong *et al.*, 1990 ; Russel & Zheng, 1993
Nemegtosaurus : Nowinski, 1971
Nurosaurus : Dong, 1992
Omeisaurus : He, Li, Cai & Gao, 1984 ; Li, 1988 ; Young, 1937b, 1939, 1942, 1958 ; Dong *et al.*, 1983, 1989
Opisthocoelicaudia : Borsuk-Bialynicka, 1977
Patagosaurus : Bonaparte, 1979, 1986b
Pelorosaurus : Mantell, 1850 ; Owen, 1875 ; Hulke, 1869, 1870, 1872, 1879, 1880, 1882 ; Seeley, 1870, 1889 ; Sauvage, 1901
Pleurocoelus : Marsh, 1888, 1896 ; Sauvage, 1897-1898 ; Hatcher, 1903c ; Gallup, 1989
Protognathosaurus : Zhang, 1988 ; Olshevsky, 1991
Quaesitosaurus : Kurzanov & Bannikov, 1983
Rebbachisaurus : Lavocat, 1954 ; Lapparent, 1960
Rhoetosaurus : Longman, 1926, 1927
Sanpasaurus : Young, 1944 ; Rozhdesvensky, 1966, 1967 ; Dong *et al.*, 1983
Seismosaurus : Gillette & Bechtell, 1989 ; Gillette, 1991 ; Hunt & Lucas, 1993
Shunosaurus : Dong & TAng, 1984 ; Zhang *et al.*, 1984 ; Zhang, 1988 ; Zheng, 1991 ; Gee, 1988 ; Dong *et al.*, 1983, 1989
Supersaurus : Jensen, 1985, 1987
Tienshanosaurus : young, 1937a
Tornieria : Janensch, 1961
Ultrasauros : Jensen, 1985, 1987 ; Olshevsky, 1991
Volkheimeria : Bonaparte, 1986b
Vulcanodon : Raath, 1972 ; Cooper, 1984
Zigongosaurus : Hou, Chao & Chu, 1976
Zizhongosaurus : Dong *et al.*, 1983

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