

New Evidence of Sauropod Dinosaurs from the Early Jurassic Period of Thailand

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Abstract: The oldest dinosaur assemblages of Thailand deposit in continental sedimentary rocks of the Nam Phong Formation. Not only *Isanosaurus attavipatchi* was discovered but at least two more species of basal sauropods were found. A partial skeleton from Phu Hin Tan locality refers to sauropod taxon A. It is different from *Isanosaurus* and shares some characteristics with basal sauropods in the Early Jurassic. The sauropod taxon B was found in Non Sra Ard locality. Base on postcranial skeleton, sauropod taxon B shares some characteristics of the family Vulcanodontidae. Moreover, several fragments of the sauropods specimen are also found in Pha Khok Wang Yang and Phu Noi localities. All of the evidences above indicate that there are a highly diversity of sauropods in the Nam Phong Formation. At least three sauropod species (including *Isanosaurus*) were found in the Nam Phong formation. The issue about the age of the Nam Phong has been debated for a long time between the Triassic and Jurassic age. All of sauropodomorphs, in this study, are more likely the Early Jurassic period dinosaurs than the Triassic period dinosaurs. And they have deposited in the upper part of Nam Phong Formation.

Key words: *Isanosaurus*, sauropod dinosaurs, Early Jurassic, Nam Phong Formation, Thailand

1 Introduction

The first dinosaur bone in Thailand was found in 1976 (Ingavat and Janvier, 1981). Since then, a lot of dinosaur specimens were found in several localities in Thailand (Buffetaut and Ingavat, 1982; Buffetaut et al., 2000; 2008). Most of the dinosaur reports from Thailand point out on dinosaurs in the Late Jurassic-Early Cretaceous period whereas the dinosaur reports from the Late Triassic-Early Jurassic period are rare.

Sedimentary rock from Triassic-Early Jurassic period was found in several part of Asia such as the Ziliujing Formation in China (Luo and Wang, 2000), Kota Formation in India (Gillette, 2003) and the Huai Hin Lat and the Nam Phong Formations from Thailand (Racey, 2009). In case of Thailand, The lowermost unit is the Huai Hin Lat Formation. This formation is composed of fluvial and lacustrine sands, silts and mudstones deposit associated with volcanic rock; this unit is in Upper

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Triassic period (Carnian to Norian) based on palynological contents (Chonglakmani and Sattayarak, 1978; Racey et al., 1996; Racey, 2009) and vertebrate assemblages. The Huai Hin Lat Formation is unconformably overlaid by the Nam Phong Formation. The Nam Phong Formation consists of continental rocks formed in fluvial environments (braided and meandering channels interbedded with lacustrine or floodplain sequences). Palynological evidences indicated that the formation is not older than Pliensbachian (Late Early Jurassic period) (Racey, 2009). This result is in accordance with the seismic analysis which clearly divides this formation into two sections: 1) The Lower Nam Phong Formation which was formed in Upper Triassic period and 2) the Upper Nam Phong Formation, which is neither older than Pliensbachian nor younger than Late Jurassic period. Moreover, Racey (2009) suggested that environment of the Lower unit is alluvial fans and floodplains which underline its uncommitted with the Lacustrine dominated alluvial floodplain in Upper unit. Triassic-Early Jurassic

period dinosaurs in Thailand were found in several parts of the northeastern region (Fig. 1).

This paper summarizes current knowledge of the sauropods in the Triassic-Jurassic period boundary in Thailand, both from previous paper and the recent discovery. All of the dinosaurs described and illustrated in this paper were found in Nam Phong Formation and housed in the Sirindhorn museum (SM) and Palaeontological research and education centre, Mahasarakham University (PRC).

2 Phu Hin Tan Locality

2.1 Geological setting

The Phu Hin Tan locality is located in the Phu Hin Tan Mountain, Loei Province in the northeastern part of Thailand (Fig. 1). The locality forms by the maroon coarse

sand interbedded with granule-pebble and covered by moderately-poor sorted pebble conglomerate. Coarse bedding about thin bed layer is also found in the locality. All of dinosaur specimens were found in the massive rock of maroon coarse sand interbedded with granule-pebble.

2.2 Material

Several parts of dinosaur bones were found in Phu Hin Tan locality. All of them are rather complete and very well-preserved. The specimens were described in this study including three caudal vertebrae and one femur.

2.3 Systematic paleontology

Dinosauria Owen, 1842

Saurischia Seeley, 1888

Sauropodomorpha Huene, 1932

Sauropoda Marsh, 1878

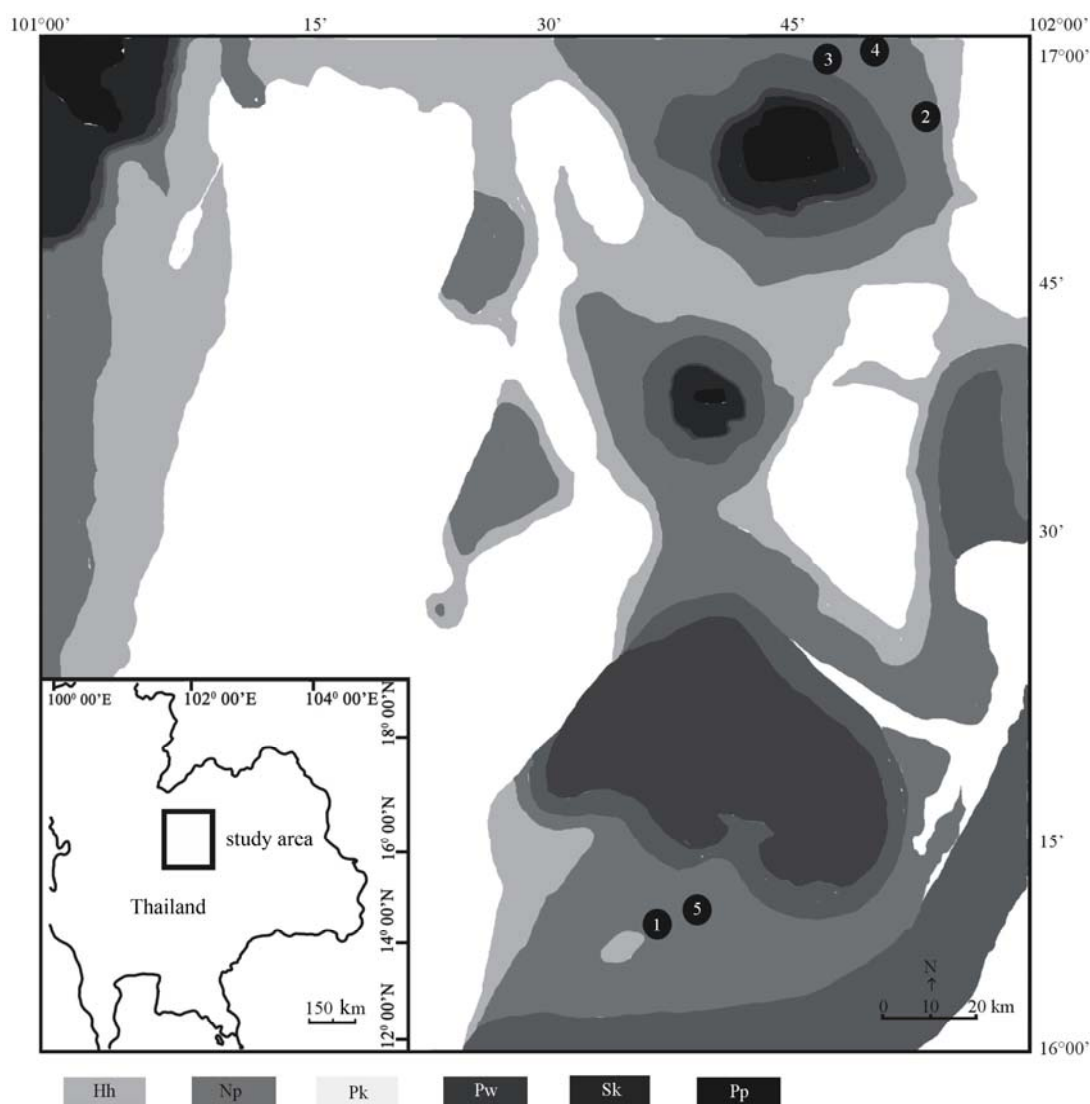


Fig. 1. Dinosaur localities in the Nam Phong Formation of Thailand in this study.

1= Phu Nok Khian (*Isanosaurus* locality); 2= Phu Hin Tan; 3= Pha Khok Wang Yang; 4= Phu Noi; 5= Non Sra Ard; "Hh = Huai Hin Lat Fm.; Np = Nam Phong Fm.; Pk = Phu Kadung Fm.; Pw = Pha Wihan Fm.; Sk = Sao Khua Fm.; Pp = Phu Phan Fm."

Gravisauria Allain and Aquesbi, 2008

Vulcanodontidae Allain et al., 2004

Sauropod Taxon A

2.4 Description

Caudal vertebrae: Three anterior caudal vertebrae were found in this locality (Fig. 2a-c). All of them are well-preserved and rather complete.

SM LI3-13 (Fig. 2a1-a6) is the first or one of the most

anterior caudal vertebrae of the dinosaur. The specimen is very short anteroposteriorly as in all sauropods. The centrum is 2.5 cm in anteroposterior length and about 12 cm lateromedial width. The proportion between anteroposterior length and lateromedial width is less than 0.5 as in all sauropods (Allain and Aquesbi, 2008). The specimen is slightly amphicoelous as known non-sauropod sauropodomorphs (Upchurch, 2004), but the anterior articular surface is less concave than the posterior one.

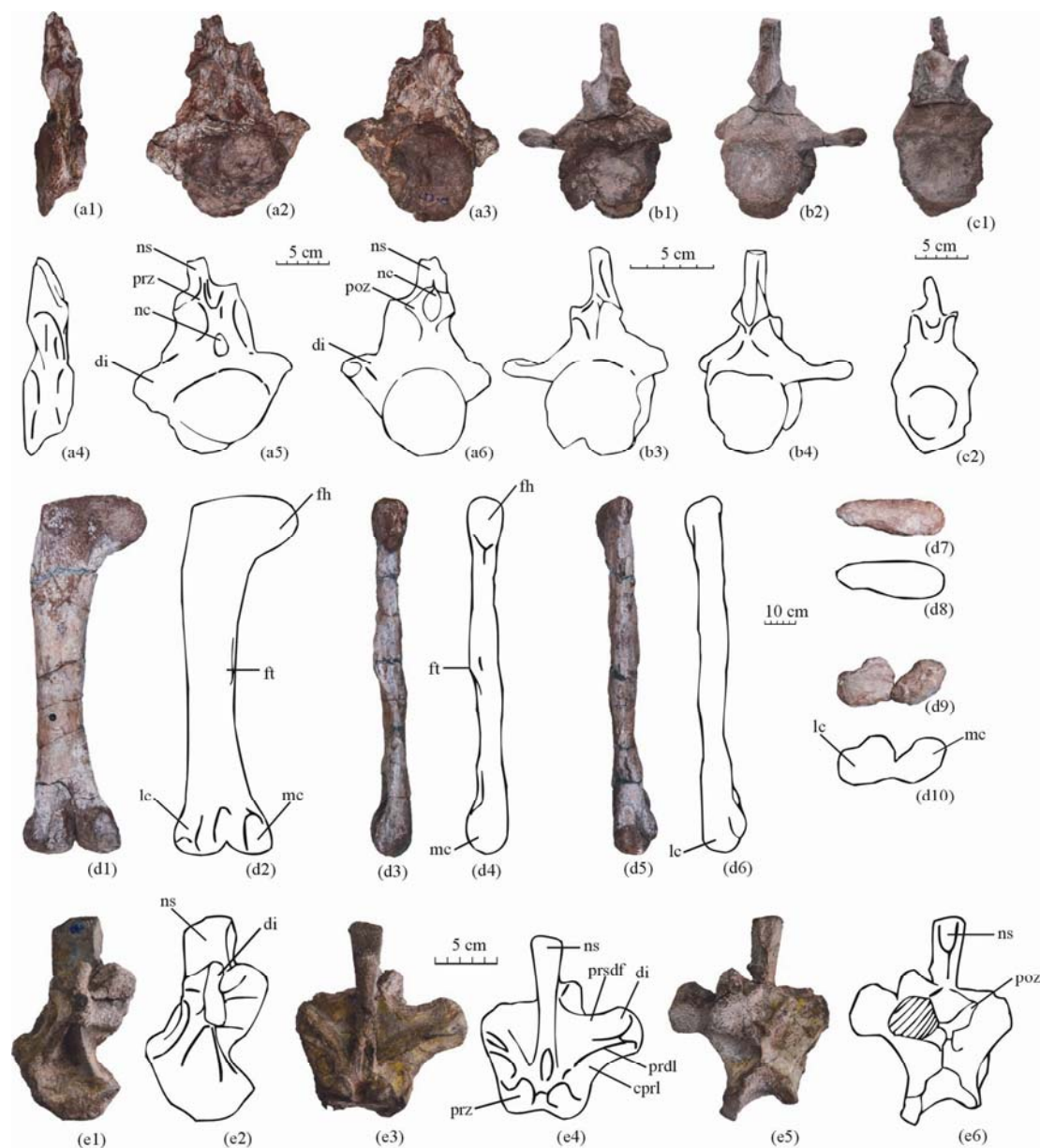


Fig. 2. (a, b and c), caudal vertebrae from Phu Hin Tan locality (SM LI3-13, PRC LI3-1 and PRC LI3-2) in lateral view (a1, a4), anterior view (a2, a5, b2, b4, c1 and c2) and posterior view (a3 and a6). (d), Complete left femur in lateral (d1 and d2), proximal (d3 and d4), ventral view (d5 and d6), anterior view (d7 and d8) and posterior view (d9 and d10). (e), A neural arch of anterior dorsal vertebra from Pha Khok Wang locality (PRC LI5-1) in lateral view (e1 and e2), anterior view (e3 and e4) and posterior view (e5 and e6).

cpvf – Centroprezygapophyseal fossa; di – dipophysis; fh – femoral head; ft – fourth trochanter; lc – lateral condyle; mc – medial condyle; nc – neural canal; ns – neural spine; poz – postzygapophysis; prdl – prezygodiapophyseal lamina; prsdf – prezygapophyseal spinodiapophyseal fossa; prz – prezygapophysis. Scale bar: 5 cm.

This character is in contrast to the deeply excavate in the anterior articular surface in *Tazoudasaurus*. Both of anterior and posterior articular surfaces are circle in outline. The anterior articular surface is smaller than the posterior one both in length and height. The length is equal to lateromedial width in the anterior articular surface whereas the length is smaller than lateromedial width in the posterior articular surface. The ventral surface is concave and strongly grooved as in all sauropods. The character functions as the guidance of the caudal blood vessels (Cooper, 1984). The specimen is anteroposteriorly constricted. Thus, natural shape of the lateral surface is rather difficult to identify. The transverse process is large, well-developed and located in the middle part of the proximoventral length of the centrum as in most of sauropods (Galton and Upchurch, 2004). The neural spine is flatten transversely. Prezygapophysis and poszygapophysis are rather prominent. Prezygodiapophyseal lamina (prdl) is robust and well-developed as centroprezygapophyseal lamina (cppl). Prezygapophyseal centrodiapophyseal fossa (prcdf) and postzygapophyseal centrodiapophyseal fossa (pocdf) are well-developed and larger than *Tazoudasaurus*, *Cetiosaurus*, *Camarasaurus* and *Apatosaurus*.

PRC LI3-1 (Fig. 2a1-a4) is the second specimen of anterior caudal vertebrae. Both of centrum and neural arch were preserved in the specimen. The specimen is rather similar to SM LI3-13. However, the specimen is well-preserved and presents more natural shape than SM LI3-13. The posterior articular surface is more concave than the anterior one. The ventral part is concave as the lateral surface. The transverse processes are rather well-developed and situated towards the anterior end of the centrum. Prezygapophysis and poszygapophysis are prominent and clearly seen in the lateral view. Prezygodiapophyseal lamina (prdl) is robust and well-developed. Neural arch is rather similar to most of the basal sauropods.

PRC LI3-2 (Fig. 2c1-c2) is an additional caudal

vertebra in the locality. The specimen is not complete. Transverse process and tip of the neural spine are broken whereas prezygapophysis, poszygapophysis and neural arch lamina are well-preserved. In outline, the specimen is similar to PRC LI3-1 and SM LI3-13 but thicker than PRC LI3-1 and SM LI3-13.

Femur: The complete left femur was found in this locality (Fig. 2d). Although the specimen has the femur length as in *Isanosaurus* (about 76 cm), it is slimmer than *Isanosaurus*. The proximal view shows that the specimen is pear shaped outline. Both medial and lateral surfaces are convex. The maximum anteroposterior length of medial end is twice of lateral end. The femoral head projects dorsomedially as in *Isanosaurus* and *Kotasaurus*. The greater trochanter is not distinctly separated from the femoral head. However, it is not a well-defined neck connecting to the head with the shaft of the femur as in *Kotasaurus*, and less developed than *Isanosaurus* whereas a lesser trochanter is lack as in most of prosauropod and *Isanosaurus*.

The femoral shaft is straight and anteroposteriorly flattened as in most of sauropods, but less developed than the massive and robust femoral shaft of *Isanosaurus*. The fourth trochanter of the specimen is located at the midlength on the caudomedial of femur shaft as in Middle – Late Jurassic period sauropod dinosaur. The fourth trochanter is prominent but less developed than *Isanosaurus*. It has a slightly declined tip as in *Kotasaurus*, unlike in *Isanosaurus*.

The femur expands its distal end as in all sauropodomorphs (Fig. 3). Both of medial and lateral condyles more developed than prosauropods such as *Plateosaurus*. It is well developed as *Kotasaurus*, and *Cetiosaurus*. Although both of condyles are massive but less developed than *Isanosaurus* and *Tazoudasaurus*. Medial condyle is large and takes an outward curve from the main margin of the bone, whereas the lateral condyle is smaller and parallel with the femoral shaft as in most of sauropods.

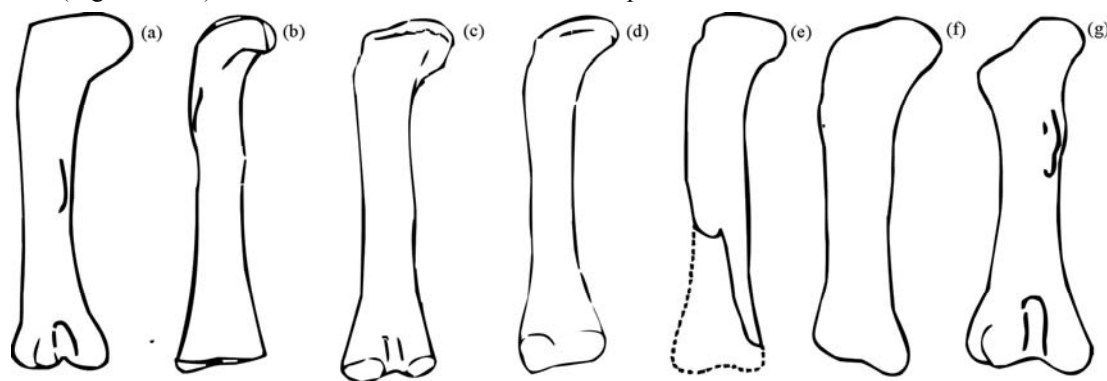


Fig. 3. Outline illustration of posterior view of femur of Phu Hin Tan specimen (a), *Plateosaurus* (b), *Barapasaurus* (c), *Kotasaurus* (d), *Vulcanodon* (e), *Cetiosaurus* (f) and *Isanosaurus* (g).

2.5 Discussion

Although only three anterior caudal vertebrae and one femur were found in the locality, several characters of them are rather significant in term of taxonomy data. The caudal centra are amphicoelous as *Isanosaurus*. The length of the femoral shaft is equal to *Isanosaurus*. The femoral shaft of Phu Hin Tan specimen is anteroposteriorly flattened as in most of eusauropods whereas *Isanosaurus* femur is robust and rather massive. The fourth trochanter of Phu Hin Tan specimen is prominent as in most of basal sauropods but less developed than *Isanosaurus*. Moreover, the fourth trochanter of Phu Hin Tan specimen is in the middle part of femoral shaft as in Early – Late Jurassic sauropod dinosaurs. It is thus clear that all available materials from Phu Hin Tan refer the different species of *Isanosaurus*.

3 Pha Khok Wang Yang Locality

3.1 Geological setting

The Pha Khok Wang Yang locality is about 300 meters from the Wang Yang forestry grad office (Fig. 1). Numerous of petrified woods were found in this locality, but all of them are fragment and have not been studied in the detail yet. The locality forms by conglomerated and fine-medium sandstone. Cross bedding also found in the locality. Dinosaur bones in this locality are rather fragment and some of them are covered by conglomerated concretion.

3.2 Material

The most complete specimen (Fig. 2e) in the locality is a nearly complete neural arch of anterior dorsal vertebra (PRC LI5-1).

3.3 Systematic palaeontology

Sauropoda Marsh, 1878

Gravisauria Allain and Aquesbi, 2008

Sauropod indet.

3.4 Description

The laminae of the neural arch is well-developed. In anterior view, prezygapophysis (prz) is small and less developed whereas the robust of prezygodiapophyseal lamina (prdl) was appeared. The prdl located between large area of prezygapophyseal spinodiapophyseal fossa (prsdff) and smaller area of prezygapophyseal centrodiapophyseal fossa (prcdf). The centroprezygapophyseal fossa (cprf) is small and less developed. The spinoprezygapophyseal lamina (sprl) is robust, well-developed, and nearly vertical from a central portion.

In lateral view, prezygodiapophyseal lamina (prdl),

prezygapophyseal centrodiapophyseal fossa (prcdf) and posterior centrodiapophyseal lamina (pcdl) are found. All of them are well-developed especially in prdl. Prcdf is narrow and shallow. Postzygodiapophyseal lamina is broken whereas the centrodiapophyseal fossa (cdf) and the postzygapophyseal centrodiapophyseal fossa (pocdf) are large and moderately deep.

In posterior view, spinopostzygapophyseal lamina (spol) is very well-developed and rather prominent. A small hypantrum (hyp) is located at the lower end of spol. Spinopostzygapophyseal fossa (spof) is shallow whereas the postzygapophyseal centrodiapophyseal fossa (pocdf) is rather deep.

3.5 Discussion

Although, only one neural arch was preserve, the laminae of the specimen is well-developed. Bonaparte (1999) indicated that prezygodiapophyseal lamina, spinoprezygapophyseal lamina, centrodiapophyseal lamina and spinopostzygapophyseal lamina began to appear in the basal sauropods such as Lessemsaums in Late Triassic period of Africa, but they are less developed than the more advanced sauropods. These characters also appear and are similar to the Pha Khok Wang Yang specimen.

4 Phu Noi Locality

4.1 Geological setting

The Phu Noi location is the vertebrate fossil locality in Nam Phong Formation close to Pha Kok Wang Yang locality (Fig. 1). The geological deposited of the locality is similar to Pha Khok Wang Yang locality. The sediment in this locality consists of fine-medium sand and moderated-well sorted granule-pebble conglomerate.

4.2 Material

All of dinosaur bones were found in the surface whereas the bone beds were gone. 21 dinosaur bones were found. Unfortunately, all of them are rather fragment. The most interesting specimen from the field is PRC LI12-1.

4.3 Systematic palaeontology

Sauropoda Marsh, 1878

Gravisauria Allain and Aquesbi, 2008

Sauropod indet.

4.4 Description

PRC LI12-1 is the proximal part of ulna. Proximally, it is triangular in outline, as in many of basal sauropodomorphs. The anterior part is rather concave, whereas the posterior part is particularly convex. Both the medial and lateral possesses is well developed whereas the

posterior process is less developed than most of the advanced sauropod. The lateral process is distinctly thicker and shorter than the medial one whereas the medial process is gently concave as in most of the sauropodomorphs.

4.5 Discussion

Bonnan and Yates (2007) showed that the outline of the proximal end in ulna is triangular in most of the prosauropod, and it was transformed into the crescent-like shape in the eusauropodomorphs. The lateral process is less developed in basal sauropodomorphs and advanced eusauropodomorphs. Base on the reasons above, PRC LI12-1 is relatively similar to Vulcanodon in the Early Jurassic period of Zimbabwe.

5 Non Sra Ard Locality

5.1 Geological setting

The specimens in this study were discovered in Ban Non Sra Ard locality, Chaiyaphum Province (Fig. 1). All of them deposited in brown-reddish sandstone and conglomerate, fine sand stone interbedded with shale and mudstone in the Nam Phong Formation.

5.2 Material

Numerous vertebrae, complete ulna, pubis and astragalus.

5.3 Systematic palaeontology

Sauropoda Marsh, 1878

Gravisauria Allain and Aquesbi, 2008

Sauropod Taxon B

5.4 Description

5.4.1 Vertebrae

Although numerous vertebrae were found, most of them are fragment. Only the centra and neural spines of dorsal and caudal vertebrae were preserved. The size of the vertebrae indicates that this dinosaur is rather big.

5.4.2 Dorsal vertebrae

SM CH8-24(Fig. 4a) is an anterior mid-dorsal vertebra. Only centrum was preserved. The anteroposterior length is 15.9 cm. The dorsoventral height of anterior articular surface is 17.9 cm, whereas the posterior articular surface is 15.5 cm. The anterior articular surface is rather flat and rounded in outline. The posterior articular surface is rather concave and ovoid in outline. The dorsal area is wider than ventral area. The lateral surface is constricted, especially the center part of centrum. A shallow depression locates in the upper part of the base of the neural arch of the lateral surface. The ventral surface is rather concave

and spool shape in outline.

Several posterior mid-dorsal vertebrae were preserved. One of them is SM CH8-40 (Fig. 4b). The anteroposterior length of SM CH8-40 is 11.5 cm. The dorsoventral height of anterior articular surface is 13 cm, whereas the posterior articular surface is 11 cm. Both of anterior and posterior articular surfaces are concave and oval shape. As in anterior mid-dorsal vertebra, the lateral and ventral surface is very concave. A shallow depression at the lateral surface is deeper and wider than anterior mid-dorsal vertebra.

5.4.3 Caudal vertebrae

Several caudal vertebrae were found in this locality. SM CH8-16 (Fig. 4c) is the most complete anterior caudal vertebra in this study. All of centrum, neural canal, prezygapophyseal centrodiapophyseal fossa (prcdf) and postzygapophyseal centrodiapophyseal fossa (pocdf) were preserved. As in most of the sauropodomorphs, the centrum is rather short. The anteroposterior length of the specimen is 8.9 cm; the dorsoventral height of anterior articular surface is 14.7 cm, whereas the dorsoventral height of posterior articular surface is 16 cm. The proportion between anteroposterior length and dorsoventral height in both of anterior and posterior articular surface is about 0.6. The anterior articular surface is rather flat and round in outline. The posterior articular surface is oval shape and slightly concave. Although most of diapophysis was not preserved but large prcdf and pocdf are similar to several species of the basal sauropod, such as Tazoudasaurus and Cetiosaurus. The lateral surface is slightly concave as in most of non-eusauropod sauropodomorphs and basal sauropods.

SM CH8-4 (Fig. 4d) is the middle caudal. Both of neural arch and centrum were preserved in this study. The anteroposterior length of it is 9.5 cm; the dorsoventral height of anterior articular surface is 5.2 cm, whereas the dorsoventral height of posterior articular surface is 4.9 cm. The centrum is rectangular in lateral and cross-section. Moreover, it is elongate spool in both of the dorsal and ventral views. Both of the anterior and posterior articular surfaces are slightly concave. As in most of basal sauropod, both of anterior and posterior articular surfaces are slightly more dorsoventral height than mediolateral width. The lateral surface is rather as concave as the ventral surface. In this vertebra, the neural spine is located along the anterior part of centrum. The neural spine is broken, only fragmented of postzygapophysis and prezygapophysis were preserved. The prezygapophysis is rather low, thin and small. It is situated beyond the anterior articular end of the centrum, whereas shape of the neural arch and postzygapophysis are uncertain because both of them are broken.

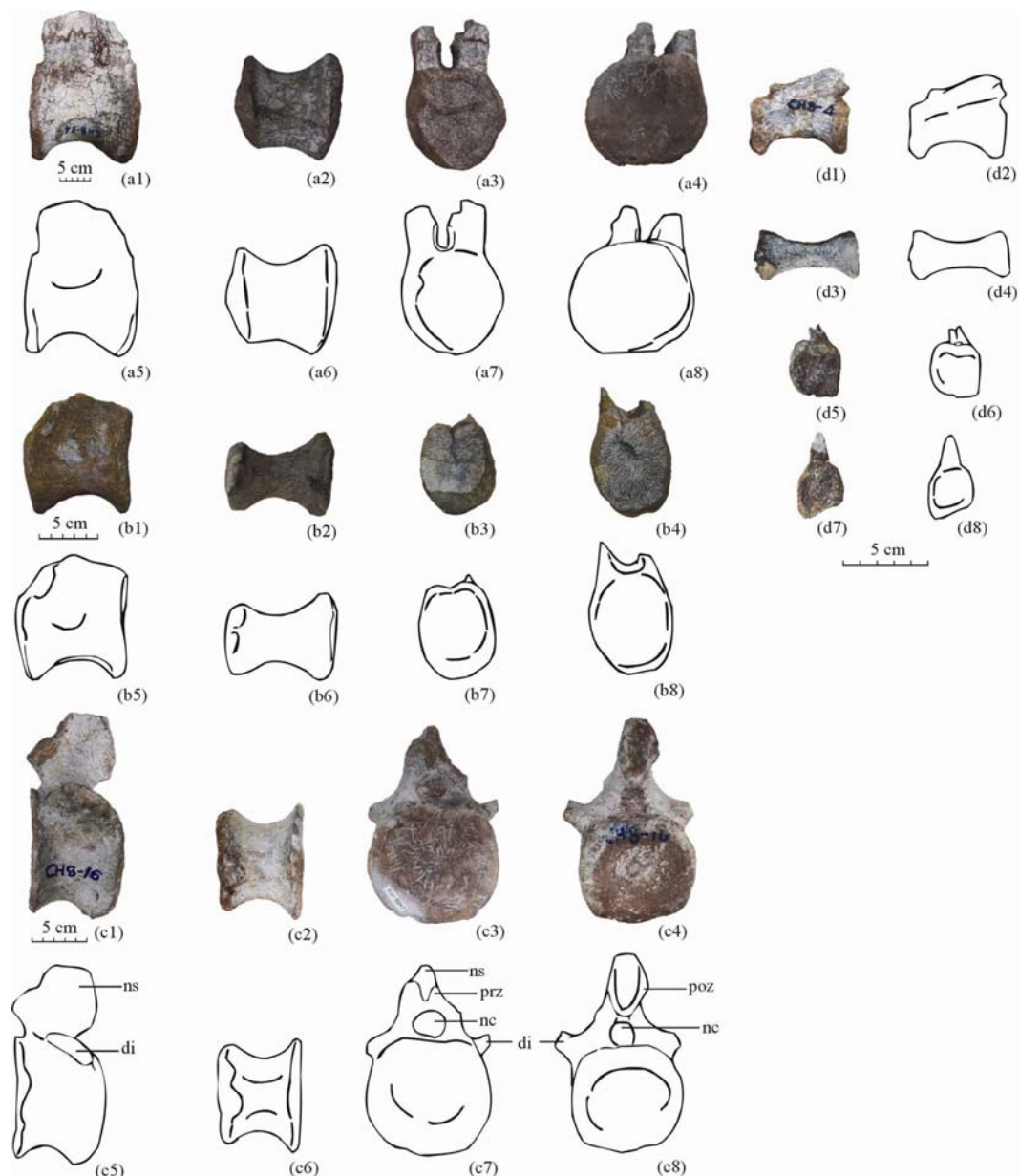


Fig. 4. Vertebrae specimens from Phu Noi locality.

(a), An anterior mid-dorsal vertebra (SM CH8-24) in lateral view (a1 and a5), ventral view (a2 and a6), anterior view (a3 and a7) and posterior view (a4 and a8). (b), A posterior mid-dorsal vertebra (SM CH8-40) in lateral view (b1 and b5), ventral view (b2 and b6), anterior view (b3 and b7) and posterior view (b4 and b8). (c), An anterior caudal vertebra (SM CH8-15) in lateral view (c1 and c5), ventral view (c2 and c6), anterior view (c3 and c7) and posterior view (c4 and c8). (d), A middle caudal vertebra (SM CH8-4) in lateral view (d1 and d3), ventral view (d2 and d4), anterior view (d5 and d6) and posterior view (d7 and d8). Abbreviations: nc, neural canal; ns, neural spine; poz, postzygapophysis; prz, prezygapophysis. Scale bar: 5 cm.

5.4.4 Ulna

A complete right ulna (SM CH8-5) (Fig. 5a) was found in this study. It is a robust element. The proximal end is triradiate. It is composed of lateral and medial processes as in other sauropodomorphs. The lateral process is thicker and wider than the medial process, whereas the medial process is slightly longer than the lateral process as in the other sauropodomorphs. The radial fossa is rather concave as in most of basal sauropod. The olecranon region is well-developed, robust and wider than *Vulcanodon* and *Tazoudasaurus*. Below the proximal head, the ulna shaft is

subtriangular in cross section. The distal end becomes elliptical, and also becomes antero-posteriorly flattened and lateromedially wide as in all sauropodomorphs.

5.4.5 Pubis

A complete right pubis (SM CH8-6) (Fig. 5b) was found in this study. In overview, the specimen is elongate and slightly curved at lateral border and distal end, whereas the proximal end is distinctly curved. The proximal end of pubis expands mediolaterally. The proximal end is more developed than *Vulcanodon* and *Tazoudasaurus*, but well

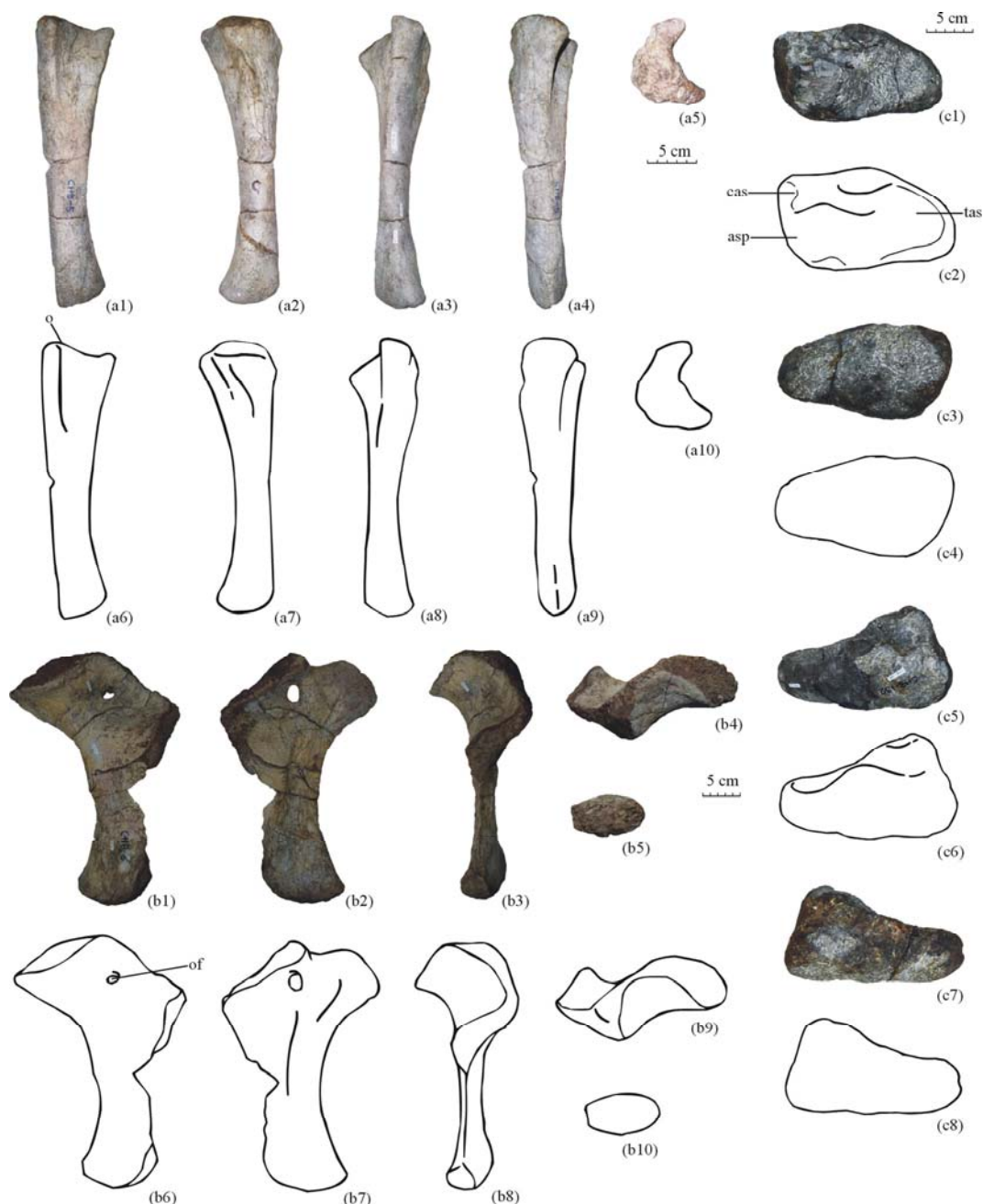


Fig. 5. Dinosaur specimens from Phu Noi locality.

(a), A complete right ulna (SM CH8-5) in lateral (a1 and a6), medial (a2 and a7), anterior (a3 and a8), posterior (a4 and a9) and proximal view (a5 and a10). (b), A complete right pubis (SM CH8-6) in anterior (b1 and b6), posterior (b2 and b7), medial (b3 and b8), proximal (b4 and b9) and distal view (b5 and b10). (c), A complete astragalus (SM CH8-132) in dorsal (c1 and c2), ventral (c3 and c4), posterior (c5 and c6) and anterior view (c7 and c8). Abbreviations: asp – ascending process of the astragalus; cas, calcaneal articular surface; o – olecranon; of – obturator foramen; tas – tibial articular surface. Scale bar: 5 cm.

developed as in *Spinophorosaurus*. The iliac articular surface is rough and anteriorly deflected as in most of the sauropodomorphs, but it is less developed than *Vulcanodon* and *Tazoudasaurus*. Acetabulum is broad smooth and crescent-like shape. The obturator foramen is oval shape in outline. It incorporates into the caudodorsal margin of the pubis as most of the sauropodomorphs. The obturator foramen of CH8-6 is smaller and less developed than most of the prosauropod, *Vulcanodon*,

Spinophorosaurus and *Tazoudasaurus*. The pubis shaft is mediolaterally compressed. Its lateral margin is thicker than the medial margin. A prominent and long crest runs on the posterior surface of blade of the pubis from the lateral wall of the obturator foramen.

The distal end of the pubis is greatly expanded anteroposteriorly, especially along its lateral margin and distal end as in *Spinophorosaurus*, *Camarasaurus*, *Apatosaurus* and more expanded than most of the

prosauiropod, *Vulcanodon*, *Tazoudasaurus* and *Barapasaurus*. In anterior view, the distal end is more developed than *Vulcanodon* and *Dashanpusaurus*. It is rather bent as in *Tazoudasaurus* and *Spinophorosaurus*. The distal margin in posterior view shows a triangular shape of distal articular surface. The distal view shows that it is rather oval shape in cross section; rounded in the anterior margin but rather straight in the posterior margin. It is rather convex with irregular surface as in most of the sauropodomorphs in distal view.

5.4.6 Astragali

Two astragali were found. Both of them belong to the right astragalus. The first one (SM CH8-149) (Fig. 5c) is bigger but less complete than the second one (SM CH8-132). The proximal view shows that the astragalus outline are less rectangular than most of prosauropod, but more triangular than most of sauropods. The SM CH8-132 (Fig. 5c) shows that, the lateral end is wider anteroposteriorly than the medial end. This character is similar to *Vulcanodon*, *Tazoudasaurus* and *Spinophorosaurus*, but contrast to most of non-eusauropod sauropodomorphs. The proximal articular surface is shallowly concave, especially the medial area whereas the ascending process still appears in the lateral end as in most of basal sauropod. The posterior fossa is separated from the tibial articular surface by shallow and less developed crest extending posteromedially from the medial side of the ascending process. Moreover, the posterior fossa of the astragalus is divided unequally by a rounded, rather thick, and well-developed crest that extends posteromedially as in other sauropods, including *Vulcanodon* and *Tazoudasaurus*. The calcaneal articular surface is rather shallow and less developed than *Vulcanodon* and *Tazoudasaurus*. The anterior margin is slightly concave transversally as in *Tazoudasaurus*, whereas the posterior one is fairly convex as in *Vulcanodon* and less developed than *Tazoudasaurus*. In anterior view, the medial side is proximodistally compression as in most of basal sauropod and less developed than most of prosauropod, whereas the lateral side has the prominent and well-developed posterior fossa, which is lesser extent than neosauropod, but absent in the non-eusauropod sauropodomorphs. The posterior view shows that the prominent ascending process as in most of non-eusauropod sauropodomorphs and basal sauropod but more developed than neosauropod. The lateral articular surface is slightly concave and as smooth as in *Vulcanodon*, whereas the medial one is rather smooth and oval shape in outline as in other sauropodomorphs.

Discussion. Most of dinosaur specimens from Non Sra Ard village, Chaiyaphum Province are difficult to compare with *Isanosaurus*, because most of them are not complete.

Moreover, cervical vertebra, scapula, sternal and femur are not found in this locality. Although posterior dorsal vertebrae are rather similar to *Isanosaurus*, but most of its characters also found in other basal sauropods. Therefore, these evidences cannot be used as a confirmation in species level. The complete specimens in the locality are including ulna, pubis and astragalus. In case of ulna, it is triradiate shape as in most of basal sauropods whereas the olecranon region is well-developed, robust and wider than *Vulcanodon* and *Tazoudasaurus*. The basal sauropod character as in ulna specimen is also found in its astragalus.

In overview, the pubis (SM CH8-6) is rather similar to most of the basal sauropods. However, the obturator foramen of CH8-6 is smaller and less developed than most of the prosauropod, *Vulcanodon*, *Spinophorosaurus* and *Tazoudasaurus*. The distal end of the pubis is greatly expanded anteroposteriorly, as in *Spinophorosaurus*, *Camarasaurus*, *Apatosaurus* and more expanded than most of the prosauropod, *Vulcanodon*, *Tazoudasaurus* and *Barapasaurus*. Most of the characters above indicate that the pubis is more developed than in other basal sauropods.

Base on pubis character, it is clear that SM CH8 should be a different species from other sauropods.

6 Conclusions

Sauropods remains in the Nam Phong Formation are now known from 6 localities (included *Isanosaurus* locality) in the northeastern Thailand. Although most of sauropod specimens in this study are rather fragments, the results from this work indicate that the diversity of sauropods in the Nam Phong Formation is higher than the previous work. Not only *Isanosaurus* was reported but at least two more species of basal sauropods are found. Although the specimens from Phu Noi and Pha Khok Wang Yang, Loei Province are rather fragment, several characters indicate that all of them belong to basal sauropods. In case of systematics, the specimens from Phu Hin Tan, Loei Province and the specimens from Non Sra Ard village locality, Chaiyaphum Province are more interesting. A partial skeleton from Phu Hin Tan refers to sauropod taxon A. It is different from *Isanosaurus* and shares some characters with *Tazoudasaurus*, basal sauropods in the Early Jurassic period of Africa, whereas the sauropod taxon B which was found in Non Sra Ard village locality shares some characteristics of the family Vulcanodontidae. All evidence from this study indicated that sauropods in this study are more similar to the Early Jurassic than Triassic dinosaurs. Thus, Phu Hin Tan and Non Sra Ard village locality should be belonging to the upper part of the Nam Phong Formation in the Early

Jurassic age.

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