

## Preliminary note on a small ornithopod dinosaur from the Phu Kradung Formation (terminal Jurassic – basal Cretaceous) of Phu Noi, north-eastern Thailand

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### Abstract

The lower jaw of a small ornithopod from Phu Noi, a rich fossil locality in the lower part of the Phu Kradung Formation (terminal Jurassic - basal Cretaceous) of Kalasin Province, north-eastern Thailand, is briefly described. This the best ornithopod specimen hitherto recovered from the Phu Kradung Formation and it shows a combination of characters suggesting that it belongs to a new taxon.

**Keywords:** Ornithopoda, mandible, Phu Kradung Formation, Late Jurassic, Thailand

### Introduction

The Phu Kradung Formation of north-eastern Thailand contains abundant dinosaur remains, among which mamenchisaurid sauropods are especially well represented<sup>1</sup>. Sinraptorid theropods have also been found<sup>2</sup>. Few ornithischian remains have hitherto been reported from the Phu Kradung Formation. They include a stegosaur vertebra<sup>3</sup> and a femur of a small ornithopod<sup>4</sup>. In the present preliminary paper, we report the discovery of a new specimen from the Phu Noi fossil locality, which provides important new evidence about the small ornithopods from the Phu Kradung Formation.

### Geographical and geological setting

The specimen (Palaeontological Research and Education Centre, Maha Sarakham University, n° PN 13-09) described below was found in the course of palaeontological excavations carried out by the Palaeontological Research and Education Centre of Maha Sarakham University at Phu Noi, a small hill (as the Thai name indicates) near the village of Ban Din Chi, in Kalasin Province, northeastern Thailand (see location map in Cuny et al.<sup>5</sup>). There, the brown, grey and greenish mudstones of the Phu Kradung Formation yield an

abundant and diverse vertebrate fauna, comprising hybodont sharks<sup>5</sup>, bony fishes<sup>6</sup>, turtles, teleosaurid crocodylians, sauropods (including mamenchisaurids), theropods<sup>7</sup> (including sinraptorids) and pterosaurs.

The age of the Phu Kradung Formation is still relatively uncertain. It was long considered as Late Jurassic, but on the basis of palynological evidence Racey and Goodall (2009)<sup>8</sup> consider that most of it belongs to the Early Cretaceous, with the lower part possibly being Late Jurassic. The Phu Kradung Formation probably covers a relatively long time span and in all likelihood the fossil localities it contains are not all of exactly the same age. According to Deesri et al. (in press)<sup>6</sup>, the Phu Noi locality is in the lower part of the Phu Kradung Formation and a Late Jurassic age is likely.

### Description

The specimen is a nearly complete small left dentary (length : 90.30 mm), only the anterodorsal region being damaged. Because of this damage to the anterior part, the total number of alveoli in the tooth row is not completely certain. Anterior to the well preserved part of the tooth row, there seems to have been three alveoli, the anteriormost being smaller than the others and sepa-

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rated from them by a toothless space. The more posterior alveoli are confluent. The total number of tooth emplacements may have been 13. There is a toothless anterior « spout » between the anteriormost alveolus and the decurved symphyseal area. This region must have been partly covered by the predentary.

The height of the dentary increases gradually from front to back. The posterodorsal process is not displaced laterally relative to the tooth row, it is posterior to it. Its anterior margin is concave and its posterior margin vertical. There are fine striations on the labial face of its tip, probably indicating the contact with the coronoid bone. Laterally to the tooth row, the dentary is convex dorsoventrally, forming a very weak sloping shelf. There are only a few elongate foramina in that area, one of them much larger than the others. Ventrally, the lateral face of the bone curves smoothly into the ventral face. In dorsal and ventral views, the bone is S-shaped, the symphyseal region curving medially to meet its right counterpart.

In medial view, Meckel's canal forms a groove along the ventral margin of the bone. This groove becomes narrower anteriorly and extends up to the symphyseal area. Its ventral edge is a sharp bony blade. Dorsally to the groove, the dentary forms a smooth vertical surface, which is limited dorsally by a furrow formed by coalescent foramina. In the posterior region, the crowns of two replacement teeth can be seen emerging from that furrow.

Three functional teeth are preserved. One is in an anterior position, while the other two are located in the posterior part of the jaw. They are well preserved and show a well-developed ornamentation of ridges on the enamelled lingual surface. The margins of the laterally compressed crowns bear distinct denticles. The labial faces of the teeth bear no enamel and show wear facets. The crown of the anteriormost tooth is relatively small and diamond-shaped, the more posterior teeth are larger and fan-shaped, indicating some heterodonty. The ornamented lingual faces do not show a prominent median ridge, and there is no strong basal cingulum. Visible replacement teeth show similar characters. There are distinct facets on the mesial and distal margins of the

teeth, for the reception of adjacent teeth, which suggests the existence of an incipient dental battery, which was not as developed and did not involve as many successive teeth as those of advanced iguanodontians and hadrosaurs.

## Identification

The fan-shaped teeth with a strongly ridged crown indicate that the specimen belongs to an ornithischian dinosaur. Among ornithischians, thyreophorans, including stegosaurs and ankylosaurs, have more robustly built mandibles which do not show a well-defined and erect posterodorsal process, and their teeth show a strong cingulum not present in the Phu Noi specimen. Basal ceratopsians such as *Psittacosaurus*, which is known from the Khok Kruat Formation of Thailand<sup>9</sup>, have a deeper mandible and their teeth show a very strong median ridge, not seen here. The position and shape of the posterodorsal process, the slenderness of the dentary and the teeth lacking a strong cingulum indicate that the Phu Noi mandible belongs to an ornithopod.

The Phu Noi ornithopod shows neither the more or less advanced dental battery, nor the laterally displaced posterodorsal process seen in iguanodontids and especially in hadrosaurids. A number of small ornithopod taxa, belonging to more or less basal families (heterodontosaurids, hypsilophodontids, dryosaurids, etc.) are known from the Jurassic and Cretaceous of various parts of the world, including Asia. The specimen from Phu Noi needs to be compared with these forms. Preliminary comparisons seem to indicate that it shows a distinct combination of characters (with a rather advanced dentition) and is different from all hitherto known taxa. This will in all likelihood result in the erection of a new taxon.

## Conclusion

Although some isolated postcranial bones from the Phu Kradung Formation indicated the occurrence of small ornithopods<sup>4</sup>, the available material was too scanty to allow an accurate identification. The newly discovered mandible from Phu Noi, which bears several well-preserved teeth, provides much better evidence about those

ornithopods from the Phu Kradung Formation. Additional comparisons are needed, especially with Asian forms of similar geological age, to establish more precisely its position among basal ornithopods, but the observations made so far strongly suggest that it belongs to a new taxon. This find improves our knowledge of dinosaur diversity in the Phu Kradung fossil assemblages and testifies to the palaeontological importance of the exceptional Phu Noi site.

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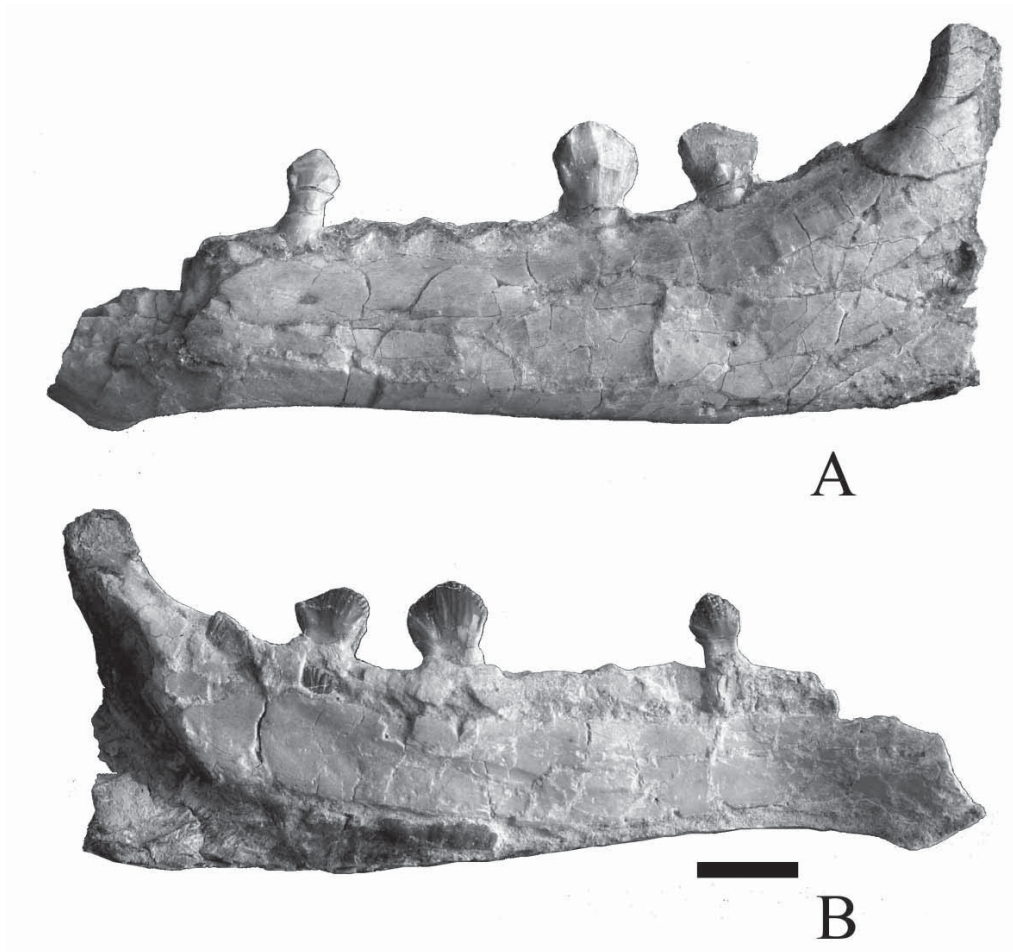


Figure 1 Lower jaw of small ornithomimid (PN 13-09) from the Phu Kradung Formation at Phu Noi, in labial (A) and lingual (B) views. Scale bar : 10 mm.

## Ginglymodian fishes (Actinopterygii, Holostei) from Thailand: An overview

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### Abstract

Isolated ganoid fish scales are not uncommon in Mesozoic deposits of Thailand. Traditionally referred to 'semionotiform' or *Lepidotes*-like fishes, they were not assigned to well-defined taxa and are of little use for palaeontological reconstructions. During the last fifteen years, however, the discovery of well-preserved articulated fish specimens, with ganoid squamations, allowed us to properly define new taxa, to search for phylogenetic relationships and to address the place of these fishes in palaeoenvironments. So far two genera and three species of ginglymodians have been named on the basis on material from the Phu Kradung Formation, but at least nine different taxa have been recognized ranging from the Late Triassic to the Aptian. Phylogenetic analyses of *Thaichthys* and *Isanichthys* indicate that they belong, or are closely related, to the Lepisosteiformes. The palaeogeographical distribution of the four known *Isanichthys* species is restricted to the northern margin of the Tethys during the Middle Jurassic to the basal Cretaceous. The palaeobiogeographical signal of *Thaichthys* is more ambiguous, its closest relatives having been found in the early Late Cretaceous of western Gondwana (South America and Africa).

**Keywords:** Cretaceous, Ginglymodi, palaeobiogeography, phylogeny

### Introduction

Mesozoic deposits worldwide, both marine and freshwater in origin, have yielded isolated ganoid scales commonly referred to 'semionotiforms' or *Lepidotes*-like fishes. These scales can generally be distinguished from ganoid scales of non-neopterygian fishes (the 'palaeonisciforms') because the abdominal flank scales usually bear a pair of processes on their anterior margin in complement to the dorsal process<sup>1,2</sup>. Their abundance in the fossil record is due in part to their strong mineralization, being constituted of a bony basal plate cover with an enamel layer. Except some research that attempt to identify the systematic affinities of isolated scales on the basis of the micro-ornamentation of the enamel layer<sup>3,4,5,6</sup>, a taxonomical assignment is usually not possible with no

articulated material, in particular if no articulated cranial material is preserved. Relatively complete specimens in anatomical connexion of ginglymodians, however, are known for a long time in various Lagerstätten worldwide, and their study have enabled researchers to propose phylogenetic relationships within the group, and to consider relationships of these fishes with other actinopterygians. Classically, the Holostei gathered the living Amiiformes and Lepisosteidae, together with some extinct groups. Patterson (1973)<sup>7</sup> questioned this concept: he regarded the Holostei as a non-monophyletic group and considered the Semionotidae as Halecostomi, i.e. as closer to teleosts than to gars (Lepisosteidae). Alternatively, Olsen and McCune (1991)<sup>8</sup> regarded the Halecomorphi and the Lepisosteidae as forming a clade with the Macrosemiidae

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