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Fossil vertebrate remains from Kut Island (Gulf of Thailand, Early Cretaceous)

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ABSTRACT

The Mesozoic vertebrate fauna from Kut Island includes hybodont sharks (*Hybodus* sp., *Isanodus paladeji,* a new species of *Heteroptychodus*), actinopterygians (Semionotiformes indet., *Lepidotes* sp.), indeterminate turtles, goniopholidid crocodiles, cf. *Theriosuchus* sp. and theropod dinosaurs. The new hybodont species is also present in the Sao Khua Formation and maybe also in the Phu Kradung Formation on the Khorat Plateau in northeastern Thailand. The occurrence of both *I. paladeji* and the new hybodont, together with heavily ornamented Semionotiformes teeth strongly suggest that this fauna is of the same age as the Sao Khua Formation one. Deposits from Kut Island are therefore younger than usually considered, and not older than Berriasian.

1. Introduction

Kut Island (Ko Kut in Thai) is located in the eastern part of the Gulf of Thailand, South South East Chang Island in Trad Province (Thailand) and close to the Cambodian border (Fig. 1). The tectonic affinities of the island are quite unclear, being considered as part of the Sibumasu block by Racey (2009) whereas it belongs to the Indochina block according to Ferrari et al. (2008). The first fossils of vertebrates were found there on the southeastern coast of the island by Michael F. Ridd, who later sent this material to Eric Buffetaut. As a result, a Thai-French party visited the island in 1981. They were able to find Ridd's locality and to discover a new one on the northeastern coast (Buffetaut and Ingavat, 1983). These faunas were described as containing hybodont sharks, some similar to *Bdellodus, Lepidotes* sp., turtles, crocodiles and possibly plesiosaurs (Buffetaut and Ingavat, 1983). This led these authors to consider these faunas as Jurassic in age, which was in accordance with the geological map of the area (Krong Khemarak Phoumin sheet at 1:250,000, Tansathien et al., 1979). According to this map, most of the island is made of the Phu Kradung and Phra Wihan formations, which were considered Jurassic in age at the time, and both fossiliferous localities are located in the Phu Kradung Formation. The latter Formation is now considered to be of late Jurassic or, more probably, earliest Cretaceous age whereas the Phra Wihan Formation is early Cretaceous (Carter and Bristow, 2003; Buffetaut and Suteethorn, 2007; Racey and Goodall, 2009). In February 2006, one of us (GC) had the opportunity to look at the teeth from Ko Kut attributed to *"Bdellodus"* in the collection of the Sirindhorn Museum (Sahat Sakhan, Kalasin Province, Thailand) and realized they belong instead to the genus *Heteroptychodus,* although being quite unlike the teeth normally found in the Khok Kruat Formation of northeastern Thailand (Cuny et al., 2007, 2008). New fieldtrips to Ko Kut were therefore jointly organized by the University of Mahasarakham and the Natural History Museum of Denmark in March and November 2007. It was possible to locate the site on the southeastern coast, South of Ao Kalang village (Ban Ao Kalang in Thai), but no fossils were found on the northeastern coast. According to Department of Mineral Resources' policy to protect fossiliferous sites, the exact location of the outcrop cannot be provided in this article. For scientific purposes, its GPS coordinates can be obtained on request from KL. These coordinates are also archived together with the specimens themselves. All the fossils collected in 2007 are housed in the collection of the Palaeontological Research and Education Centre, Mahasarakham University (PRC numbers).

2. Geological setting

Ko Kut is a large, 8 × 20 km, jungle-covered island in the eastern part of the Gulf of Thailand, near the Cambodian border. Most of the

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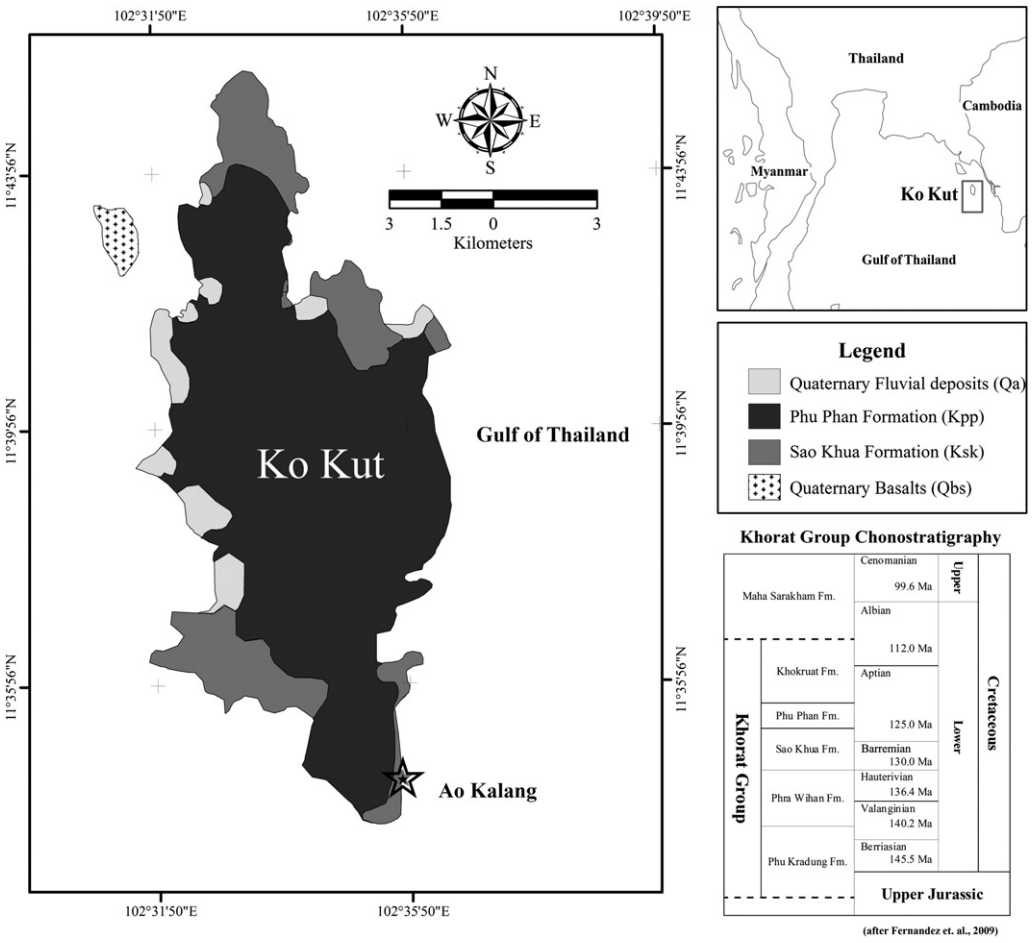

Fig. 1. Location and simplified geological map of Ko Kut. The star indicates the location of the fossiliferous site. A synthetic geological column and chronostratigraphy of the Khorat Group (adapted from Fernandez et al., 2009) is provided in the lower right corner (Figure drawn by Athiwat Wattanapituksakul).

island is made of sandstone, which were so far attributed to the Phra Wihan Formation. These sandstones are white to brown, limonitic, medium-grained and well-cemented with intercalated conglomeratic sandstones. Cross-bedding and ripple-marks are common. The south and north coasts consist of a series of siltstones and reddish-brown shales, well-bedded and laminated as well as reddish-brown, fine grained and cross-bedded sandstones, commonly showing ripple-marks. These were considered to belong to the Phu Kradung Formation (Tansathien et al., 1979, but see our discussion below). Alluvial sand, silt and clay of Quaternary age are found on the western coast (Tansathien et al., 1979).

The fossiliferous site near Ban Ao Kalang is a rocky beach where a series of predominantly red and grey sandstones and siltstones outcrop. The whole series is approximately 1 m thick and in its middle part there is a bed of indurated, dark grey conglomeratic sandstone, which is 30 cm thick, and which outcrops on a surface of approximately 40 m^2. All the fossils were collected from this bed, which is also rich in charcoal. The description of the site matches well the one provided by Buffetaut and Ingavat (1983, p. 72), and there is little doubt that all the fossils came from the same horizon.

3. Systematic palaeontology

Chondrichthyes Huxley, 1880
Elasmobranchii Bonaparte, 1838
Hybodontiformes Maisey, 1987
Hybodontidae Owen, 1846
Hybodontinae Maisey, 1989
Hybodus Agassiz, 1837
Hybodus sp.
Fig. 2A–F.

Material: Four incomplete isolated crowns (PRCMC16-19).

Description: The largest crown (PRCMC19) measures 8 mm mesio-distally, 2 mm labio-lingually and is 4 mm high. The crowns show an asymmetrical, triangular outline in labial or lingual views and their surface is covered by 10 to 13 strong ridges, quite straight on the lingual side but anastomosing at the base of the labial side (Fig. 2A and B). The ridges run from the base to the apex of the crowns, except at the base of the lingual side, where there are additional short ridges. The crowns are compressed labio-lingually, but the lingual side is more convex than the labial one (Fig. 2C).

PRCMC18 shows more developed cutting-edges than the other teeth and has a rather D-shaped outline in apical view (Fig. 2F). The apex of the cusp is missing, which suggests a crown much higher than PRCMC19 (Fig. 2D and E).

Discussion: The labio-lingually compressed teeth from Ko Kut are quite reminiscent of those of *Secarodus* Rees and Underwood, 2008, but they are easily separated from those of this genus as they lack well-developed, partly serrated cutting edges and a labial protuberance at the base of the crown. Moreover, their ornamentation is more developed than in the teeth of *Secarodus*. Their well-developed ornamentation allows also differentiating these teeth