

## High potential new Quaternary fossil cave sites in Merapoh (Pahang), with new geographic records for orangutan and Asian Black Bear

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**Abstract:** Cave sediments exceptionally rich with numerous vertebrate dental remains have been discovered in Merapoh, Pahang. To date, a total of 611 isolated teeth have been collected, consisting of the following taxa: Hystricid, *Rhizomys* spp. (?), *Helarctos malayanus*, *Ursus thibetanus*, *Neofelis nebuloso*, Canid (?), *Sus* spp., *Cervus unicolor*, medium-sized Cervids, *Tragulus* spp., *Capricornis sumatraensis*, large-sized Bovids, Rhinocerotid, Cercopithecines and Colobines, *Pongo* sp. and possibly other higher primates. The faunal assemblage resembles those discovered in western Peninsular Malaysia that have been dated from 33-500ky (thousand years). Cave morphology shows the fissure filled with the sediments could have been part of a subterranean stream. The absence of bones may indicate that most of the fossils have gone through a long history of reworking and other taphonomic processes, and only the most resistant dental remains have been preserved.

**Abstrak:** Enanpan gua yang kaya dengan pelbagai tinggalan gigi haiwan vertebrata telah ditemui di Merapoh, Pahang. Sehingga kini, 611 gigi individu telah dikutip, terdiri dari taxa berikut: Hystricid, *Rhizomys* spp. (?), *Helarctos malayanus*, *Ursus thibetanus*, *Neofelis nebuloso*, Canid (?), *Sus* spp., *Cervus unicolor*, Cervids bersaiz sederhana, *Tragulus* spp., *Capricornis sumatraensis*, Bovids bersaiz besar, Rhinocerotid, Cercopithecines dan Colobines, *Pongo* sp. dan kemungkinan primat yang lebih tinggi. Kumpulan fauna ini menyerupai kumpulan yang dijumpai di barat Semenanjung Malaysia yang telah ditentukan umur pada 33-500 ribu tahun. Morfologi gua menunjukkan fisur yang diisi dengan enapan mungkin adalah sebahagian dari aliran air bawah tanah. Ketiadaan tulang menunjukkan kebanyakan fosil telah mengalami sejarah kerja semula dan proses tafonomi yang lain sehingga hanya tinggalan gigi yang paling tinggi ketahanan terpelihara.

**Keywords:** Cave fossils, Quaternary vertebrate, cave sediments

### INTRODUCTION

Caves often act as vaults for important scientific new discoveries, particularly within the Quaternary context. Numerous Quaternary fossil teeth have been recorded from Peninsular Malaysia, most of them found in cave sediments and in alluvium, discovered mainly in association with past tin mining activities.

One of the first known Quaternary fossil collections from Peninsular Malaysia is from a tin-bearing alluvium cave sediment (possibly from Gunung Datuk, Kinta Valley in Perak) which was reported by Hooijer in 1962. An attempt to re-examine this collection was met with mixed success due to a lack of specific information on

the original site and the confusion over where the whole collection was kept (Lim, 2013). Detailed studies of Quaternary vertebrate fossils have been carried out after the discovery of highly rich cave sediments in Gua Badak C (Muhammad & Yeap, 2000) and a few other sites in Batu Caves (Yasamin *et al.*, 2012) in west Peninsular Malaysia, resulting in discoveries of assemblages of faunal remains dated from 33 to 500ky old (Yasamin *et al.*, 2013). Other reports mentioned Quaternary *Elephas* fossils (Lim, 2013) and Murinae (Ishlahuda *et al.*, 2019). The first report of orangutan fossils (*Pongo* sp.) from 6 sites in Peninsular Malaysia (Lenggong in Perak and Batu Caves in Kuala Lumpur) has extended significantly our knowledge about

the past distribution of the genus and its implication on Southeast Asian Quaternary paleoenvironment (Yasamin *et al.*, 2013). Yasamin *et al.* (2013) indicated that orangutan were present in Peninsular Malaysia at around 33 to 60ky ago in Batu Caves and at least 500ky in Lenggong.

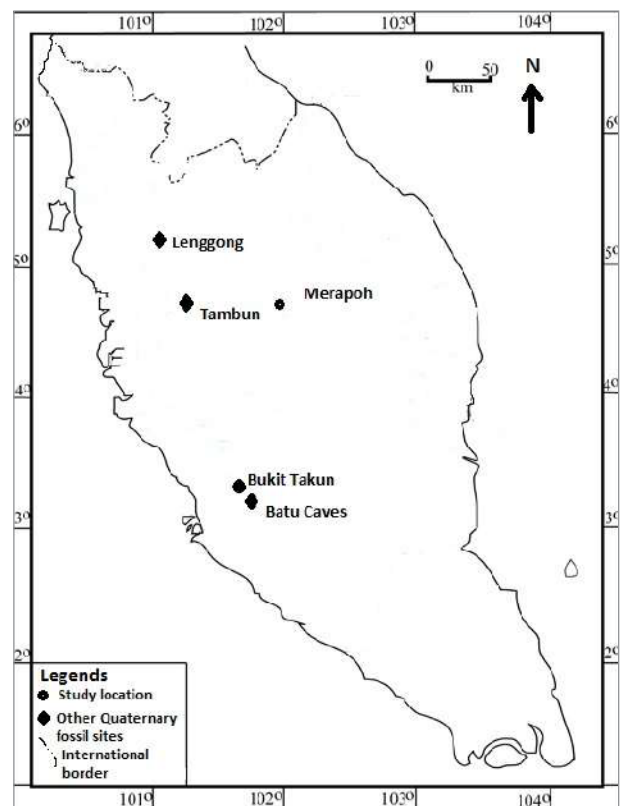
Systematic studies on Quaternary fossils found in caves within karstic landscapes have been carried out only recently. These previously reported fossil localities are mostly found on the western side of Peninsular Malaysia due to past sampling efforts which focused only on this part of the peninsula. Current research now expands its scope to include caves in the central and eastern part of the peninsular. The first report on Merapoh Quaternary vertebrate fossils described a new geographic record of the Asian Black Bear (*Ursus thibetanus*) from Gua Layang Rusa (Yasamin *et al.*, 2014). This initial finding has led to more surveys at the same site.

The Merapoh cave system (Figure 1) is developed in rocks of the Merapoh Limestone, which is stratigraphically part of the Gua Musang Group (Kamal *et al.*, 2016). Numerous studies in this area focused on the sedimentology of the Permo-Triassic sequence in the Gua Musang Group (Kamal *et al.*, 2016) and recent finding of Early Triassic conodonts believed to be an evidence for Triassic-Permian mass extinction in Peninsular Malaysia (Nelisa *et al.*, 2017; 2018). Ongoing research in Merapoh focusses on systematic studies of the Quaternary mammal fossils. The present paper highlights some of the preliminary findings from two significant cave sites, each with high potential in yielding important new discoveries.

## MATERIALS AND METHODS

Preliminary studies include observation of the geomorphology of the area using Google Maps in order to recognize karst hills, followed by confirmation in the field. Information about the existence and location of caves was gathered from local guides. A series of brief but detailed surveys of Gua Layang Rusa proved it to be highly productive where numerous vertebrate fossils were preserved and embedded in the cave floor. Breccia embedded on walls in another cave within the same complex, i.e. Gua Layang Mawas, was found to be fossil-bearing as well. Fossil-bearing caves are mapped manually using compass, measuring tapes and a laser range finder and drawn on graft papers. Occurrence of fossil teeth, location, depth and height of the fossiliferous sediments were noted. Other relevant geomorphological features, such as notches, collapsed limestone blocks were also added to the maps. The maps were subsequently drawn digitally using Freehand software (Figure 2).

Fossil samples were either collected from the surface of loose sediments or chiseled from harder material. These were bagged and labelled individually. Preliminary identifications were carried out using modern zoological reference collections in the Museum of Zoology



**Figure 1:** Location of the study area, and other reported Quaternary fossils sites such as Lenggong, Bukit Takun and Batu Caves (Yasamin *et al.*, 2013; Muhammad & Yeap, 2000) and Tambun (Hooijer, 1962; Lim, 2013).

(University of Malaya). Most samples were segregated at the genus level. Observations of the sediments were carried out based on type of deposition, grain size, potential materials suitability for age determination and degree of cementation.

## CAVE DESCRIPTION AND FAUNAL ASSEMBLAGES

On the surface, the limestone forms a number of small hills, typical of a mature tropical karst landscape. A total of 147 caves have been discovered. Several of the hills are located in the vicinity of the main river, Sungai Merapoh. Interpretation of Google Maps satellite imagery of Gunung Layang shows lineaments that are parallel to the current river (Figure 2).

Gua Layang Rusa forms a narrow passage trending northwest-southeast. The explored fissure is 39.5 m long and ends with a descent to another passage, which is unreachable due to a tight connection (Figure 2). Fossils are preserved in loose cave soils on the floor. The soils fill the narrow fissure with height not exceeding 1.2 m. The floor of this cave is located at about 3 m above the ground level. Parts of the soil are covered with 2 mm thick whitish, harder material believed to be coating from subsequent calcite deposition on top of the soil.

Gua Layang Mawas consists of 2 small passages, both trending north-south (Figure 2). The first chamber is about 3 m wide and the highest ceiling is 18 m. Remnants of 50-80 cm thick fossil-bearing sediments are embedded in the 1.2 m high and 13 m long notch on the east side of the cave. These sediments are composed of subangular clasts of up to 0.5 cm long, encased in fine matrix and cemented by calcite.

A total of 611 of numerous vertebrate fossil teeth have been collected from both caves (Table 1). There are roughly identified as Hystricids, *Rhizomys* spp. (?), *Helarctos malayanus*, *Ursus thibetanus* (Figure 3), *Neofelis*

*nebuloso*, Canid (?), *Sus* spp., *Cervus unicolor*, medium-sized Cervids, *Tragulus* spp., *Capricornis sumatraensis*, large-sized Bovids, Rhinocerotid, Cercopithecines and Colobines, *Pongo* sp. (Figure 3).

### DISCUSSION

Due to the mature karst landscape, the karst hills are rather small, with short cave passages. Narrow fissures and passages are often part of subterranean drainage system in karst (Audra & Palmer, 2011). In Gua Layang Rusa, based on the cave association of the nearby stream that is currently situated 3m below the cave passage, the

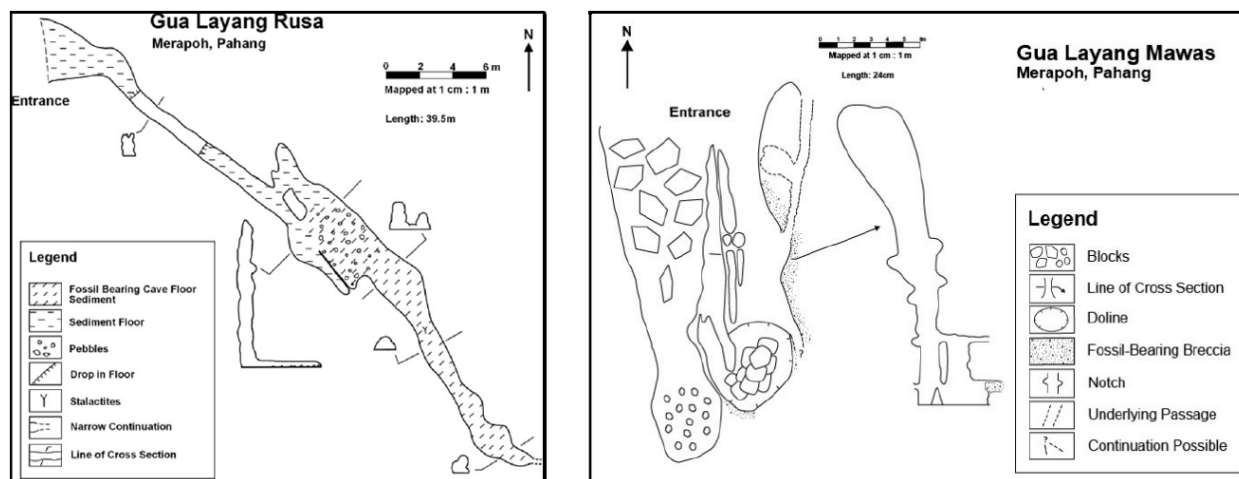
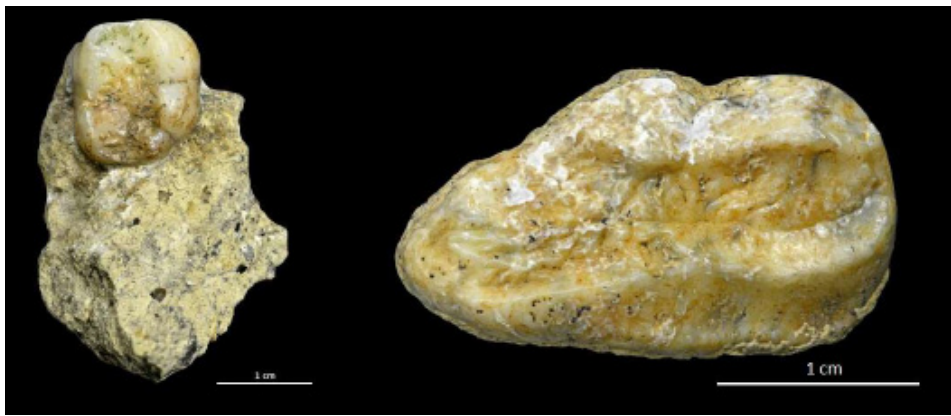


Figure 2: Maps and cross sections of Gua Layang Rusa and Gua Layang Mawas, with the locations of fossil-bearing sediments.

Table 1: Broad-group faunal composition from Layang complex and proportional breakdown of identifiable specimens. Taxon with asterisk denotes new biogeographical record for Peninsular Malaysia.

Taxon	Number of Specimens
<b>Porcupines/ Bamboo Rats (?)</b> Hystricids, <i>Rhizomys</i> spp. (?)	108
<b>Bears – Malayan Sun Bear, *Asian Black Bear</b> <i>Helarctos malayanus</i> , <i>*Ursus thibetanus</i>	6
<b>Other carnivores – Clouded Leopard, Wild Dog</b> <i>Neofelis nebuloso</i> , Canid (?)	2
<b>Pigs</b> <i>Sus</i> spp.	259
<b>Deer/ Mouse-deer/ Serow/ Wild Cattles</b> <i>Cervus unicolor</i> , medium-sized Cervids, <i>Tragulus</i> spp., <i>Capricornis sumatraensis</i> , large-sized Bovids	158
<b>Rhinoceroses</b> <i>Dicerorhinus/ Rhinoceros</i>	2
<b>Monkeys</b> Cercopithecines and Colobines	57
<b>*Orangutan</b> <i>*Pongo</i> spp.	6
<b>Undetermined</b>	13
<b>Total</b>	<b>611</b>



**Figure 3:** Orangutan lower molar partially exposed through breccia (left) and Asiatic black bear molar (right).

sediments may have been brought into the passage when the stream level was high and flowed along the cave fissure. It is believed that the river system in caves was abandoned as the base level fell, subsequently forming the current drainage flow. Faunal dental remains are preserved in the sediments and subjected to following cave depositional process of secondary calcite deposits on top of the sediments. On the other hand, in Gua Layang Mawas, coarser material in the form of breccia may have been deposited by a flow with higher energy to fill up the passage, followed by an episode of erosion leaving the fossil-bearing breccia preserved on part of the notches in the passage.

These sites have similarities with other cave sites with vertebrate fossils, such as in Lenggong (Muhammad & Yeap, 2000; Yasamin *et al.*, 2013) and Batu Caves (Yasamin *et al.*, 2013) in terms of the composition of faunal assemblages. However, Gua Badak C contains numerous bones that are associated with the fossil teeth (Muhammad & Yeap, 2000; Yasamin *et al.*, 2013), while a small amount of undetermined bone fragments is present in Gua Layang Rusa, and none from Gua Layang Mawas. This may imply different degrees of reworking between these two sites.

Compared with other similar fossil-bearing Quaternary sites thus far reported from Peninsular Malaysia (Yasamin *et al.*, 2013; Figure 1), the sheer number of identifiable specimens (Table 1) collected from the Merapoh sites is noteworthy. As a whole, the Merapoh sites also yielded a sizeable proportion of non-pig artiodactyls (25.9% of total fauna) which may provide important information on the prevailing environments at the particular geological period during which the fossiliferous sediments were deposited. Given such a high productivity of the sites, it is very likely that further explorations will reveal scientifically interesting and rare representations of Southeast Asian Quaternary mammal fauna. This prediction is partially borne out by the results reported here, namely, the first discovery of orangutan fossils from any area east of the Titiwangsa Main Range within Peninsular Malaysia

and additional materials of the Asian Black Bear. Since both species no longer exist in modern-day Peninsular Malaysia (Lekagul & McNeely, 1977; Payne & Francis, 1985; Francis, 2008), the recovery of their fossils from caves in Merapoh has greatly enriched our understanding of their palaeobiogeography. The full potential of the Merapoh sites in yielding meaningful scientific data hinges on effective protection of the caves and continuous financial assistance to support long term multidisciplinary study of the sites.

### CONCLUSION

Systematic studies on Quaternary mammal fossils are relatively new in Peninsular Malaysia. Ongoing studies have yielded new biogeographical records of *Pongo spp.* and *Ursus thibetanus*. A short-termed but extensive survey in the Layang complex in Merapoh has proven that these high potential sites may provide more important findings and may answer some pertinent questions such as the evolution of mammals and their adaptation to the habitat changes in this part of Southeast Asia during the Quaternary. Planned future studies will include comprehensive and conclusive investigations on systematic excavation of the sites, various types of absolute dating techniques to facilitate the correlation of the chronology with other important Quaternary paleontology sites in Indomalayan region.

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