

## Preliminary report on vertebrate fossils from Cistern and Swamp Caves at Batu Caves near Kuala Lumpur

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**Abstract:** Many mammalian fossil teeth and bone fragments have been recovered from remnants of calcite cemented sediments attached to the walls and floors of two small caves, named as Cistern Cave and Swamp Cave, at the foot of Bukit Batu, Batu Caves near Kuala Lumpur. Most of the material are disarticulated and found in isolated groups within the sediments. No complete skeletons have been found. They appeared to have been washed in by streams after disarticulation by decay or scattered by scavengers. Their presence in middens of prehistoric humans is a further possibility but this is still in question as no associated charring or distinct tool marks have been found on them. The material found to date includes: common wild pig (*Sus scrofa*), bearded pig (*Sus barbatus*), bear (Ursidae- gen. et sp. indet.), macaque (*Macaca* sp.), Primates (non-human hominoid), tiger (*Panthera tigris*), southern serow (*Capricornis sumatraensis*), red muntjac/barking deer (*Muntiacus muntjak*), sambar deer (*Rusa unicolor*), Asian tapir (*Tapirus indicus*), rhinoceros (gen. et sp. indet.) and bat teeth. Comparative studies with equivalent cave fossil fauna across South-east Asia will be carried out to interpret the paleoenvironment and paleoclimatic changes by studying the vertebrate fossils in different levels of cave deposits from the area.

**Keywords:** vertebrate fossils, Batu Caves Kuala Lumpur

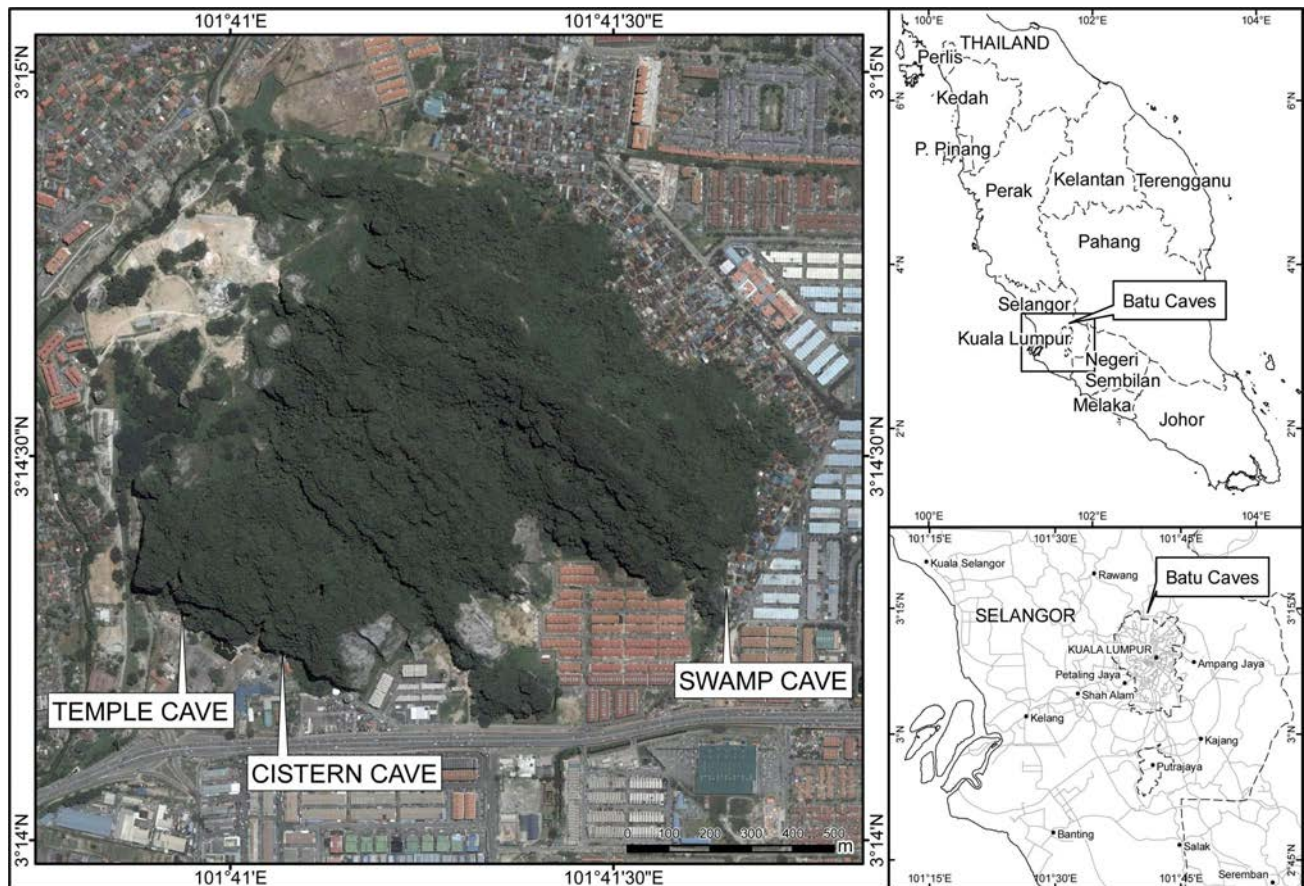
### INTRODUCTION

Very little research on vertebrate palaeontology has been published on Peninsular Malaysia. Most of them have been confined to mammalian remains found in alluvial tin-mines or in cave deposits associated with past human activities. Andrews (1905) found a tooth belonging to the extinct *Elephas namadicus* in Salak but the species identification of this specimen has been disputed by Peacock & Dunn (1968). Savage (1937) and Ingham & Bradford (1960) reported on the discovery of *Elephas maximus* teeth in Chemor within the alluvial sediments in the Kinta Valley. Hooijer (1962) reported the most significant collection of Middle Pleistocene palaeontological material found in a cave in the Tambun area which included an extinct antelope (*Duboisia santeng*) and hippopotamus, indicating a habitat of grassland interspersed with swampy patches. Davison (1994) had reported on remains of vertebrate bones and teeth of bats, primates, porcupine, bamboo rat, civet, wild dog, bear, tiger, wild boar, mouse deer, tapir, barking deer, sambar deer and seladang found in Gua Gunung Runtuh and nearby Gua Kelawar in Lenggong, Perak during the excavation of the roughly 10,000 years old Perak Man. He postulated that these remains were mainly from parts of animals used for food.

The existence of a well-preserved skeleton of a large vertebrate exposed on the travertine ceiling of a small cave at about 38 m above the Kinta Valley plain at Gua Naga Mas, Gunung Lanno, near Kepayang Village just south of Ipoh was reported by some members of the Malaysian

Nature Society in 1992. Its identity has still not been established with certainty. Tjia (2000) has suggested it could be a small tiger, a bear or a wild dog. Muhammad & Yeap (2000) reported on an exceptionally rich deposit of fossilized teeth and bones of mammals including *Bos gaurus* (gaur or seladang), *Rusa unicolor* (sambar deer), *Muntiacus muntjak* (barking deer) and *Paradoxurus* sp. (civet) in Gua Badak C in the Lenggong valley about 5 km from the Perak Man site.

One of the earliest reports on mammals in the Batu Caves area was by Ridley (1899) who reported that large wild animals including tiger, bear, wild ox, pig, muntjac, deer, and elephant were all found in the forest around Bukit Batu during that time but he also noted the general absence of any bones of these animals in the caves. Roe (1953) reported the discovery of the third upper molar of Indian elephant tooth (*Elephas maximus*) under about 20 ft. of tin-bearing alluvium resting on the granite bed rock in the Batu Valley near the Batu Caves. Williams-Hunts (1952) focused on human artifacts in his publication on Batu Caves with no mention of fossils. Wycherley (1972) recorded Ridley's exploration in several caves like the Quarry Cave, Fallen Cave and Sakai Cave in Bukit Batu. Some of these caves were completely destroyed even before Ridley left Malaya. Yussof (1977) remarked that the troglodenes such as bears, leopards, porcupines, and wild pigs, have not been recorded in and around Batu Caves recently. This is not unexpected as the surrounding forest around Batu caves has been cleared for development in the rapid



**Figure 1:** Location of Cistern and Swamp Caves at Batu Caves in Google Earth satellite image.

urbanization of Kuala Lumpur. Stauffer (1979) recovered a fossilized honeybee hive from a quarry face on the north side of the Bukit Batu.

In this study, abundant fossil vertebrate remains mostly of teeth and bone fragments of large and medium-sized mammals have been recovered from remnants of alluvial sediments left by guano hunters attached to the walls and floor of two small caves at the foot of Batu Caves.

### FOSSIL LOCALITIES

Bukit Batu, at more than 300 m high, is the most significant southern-most above ground limestone outcrop in Peninsular Malaysia. The hill is riddled with caves developed at different levels by probable Late Pleistocene to Holocene dissolution of the Silurian Kuala Lumpur Limestone that had been metamorphosed to marble. It was first discovered by the Europeans in 1878 with at least 16 caves in the hill other than the present Temple Cave. At least 6 of them were lost or were destroyed by quarrying (Medway, 1977a). Some of them are developed into Hindu shrines and for tourism while the rest are undeveloped caves. The vertebrate fossils in this report were collected from two small caves named the Cistern and Swamp Caves located at the base of Bukit Batu (Figure 1).

Cistern Cave (N 3°14'15.6" and E 101°41'08.4"), is a small undeveloped cave at ground level near to the toilets located about 30 m east of the foot of the Batu Cave Temple

steps. It was partially used as a rubbish dump after guano mining. Price (1996, 2001) reported it as an ancient cave among the group of caves in Selangor. Mammalian fossil teeth have been found in remnants of calcite-cemented cave-fill sediments left behind by the guano diggers.

Swamp Cave (N 3°14'18.9" and E 101°41'38.5") is presently undergoing development for tourism. This cave is located about 1 km east of the Batu Cave Temple steps next to the Madrasah Ar-Rahman, a small Islamic school behind some food stalls at the foot of the cliff where the entrance to the cave is located. The cave derived its name from the swamp that partially fills up low-lying sections of its passages.

Many fossil mammalian teeth and bone fragments have been recovered from the calcite cemented remnants of alluvial stream sediments found attached to the walls and floors of this cave.

### OCCURRENCE OF FOSSILS

All the vertebrate remains, consisting of teeth and bone fragments, were collected from the remnants of alluvial deposits in the Cistern and Swamp Caves. Most of the fossils were found together in loose clusters or groups except for a few solitary teeth. No complete skeletons have been found. More recent cave formations like stalagmites, stalactites and flowstone have precipitated over or adjacent to some of these fossil-bearing cave deposits.

Eight groups of fossils were found in Cistern Cave deposited within three different levels of chambers (lower, intermediate, and upper level chambers). They could have been created by the removal of the uncemented cave floor deposits in between them during guano extraction. All the fossils were only recovered from the lower and intermediate level chambers at heights of between 1.00 m near Group 5 to 2.80 m near Group 2 above the cave floor. Figure 2 shows the plan view and cross sections for Cistern Cave with the locations of the fossil groups.

Six fossil groups were found in Swamp Cave as shown in Figure 3. All of them are from the same cave level. The fossils were distributed at heights of between 0.65 m near Groups 2 and 3 to 1.50 m near Group 5 with reference to the cave floor. Most of the fossils from Swamp Cave were recovered from calcite cemented alluvial sediments attached to the cave wall.

Both the Cistern and Swamp Caves samples contain a highly diversified fauna ranging from large carnivores and herbivores to small fossils like bats.

**COLLECTING AND PROCESSING METHODS**

Reconnaissance surveys were first conducted to locate the fossils exposed on the surface of remnant cave deposits in the two caves. The caves were then mapped and the locations of the fossils were carefully documented both in the maps and cross sections cutting across the fossiliferous sediments in the caves. Field sketches were also made to show the relationship to the entombing sediments.

The fossils were photographed *in situ* before being extracted with the aid of a hammer and chisel. They were taken back to the lab for cleaning. The fossils were first

scrubbed with brushes, rephotographed if necessary and then further cleaned with an electric engraving vibro-tool. Bulk samples were also collected for future processing with dilute formic acid for smaller vertebrate remains such as the teeth and bones of bats and rodents.

**MEASUREMENTS AND COMPARISON**

The cleaned fossils were photographed and measured according to standard measurements as applied to animal bones from archaeological sites following Von den Driesch (1976). All the measurements were taken in millimeters (mm) with digital vernier calipers (Duwell model for smaller specimens of less than 150 mm with a resolution of 0.01 mm and error of  $\pm 0.03$  mm to  $\pm 0.04$  mm and larger Precise model for bigger specimens up to 300 mm with a resolution of 0.01 mm and error  $\pm 0.02$  mm). The maximum length, width and height were measured for each tooth and bone described and recorded.

The cleaned fossils were then identified by comparison with modern reference specimens from Malaysia and adjacent countries found in the Zoological Museum in the University of Malaya and photographs of specimens from the Natural History Museum (London), and the University of the Philippines.

**RESULTS**

**Distribution of vertebrate fossils in Cistern Cave**

Eight fossil clusters or groups of mammalian remains were found in Cistern Cave. They consist of bone fragments and teeth of mainly herbivores trapped in remnants of cave floor deposits in the lower and intermediate chambers of the cave. No fossils were found in the upper level chamber.

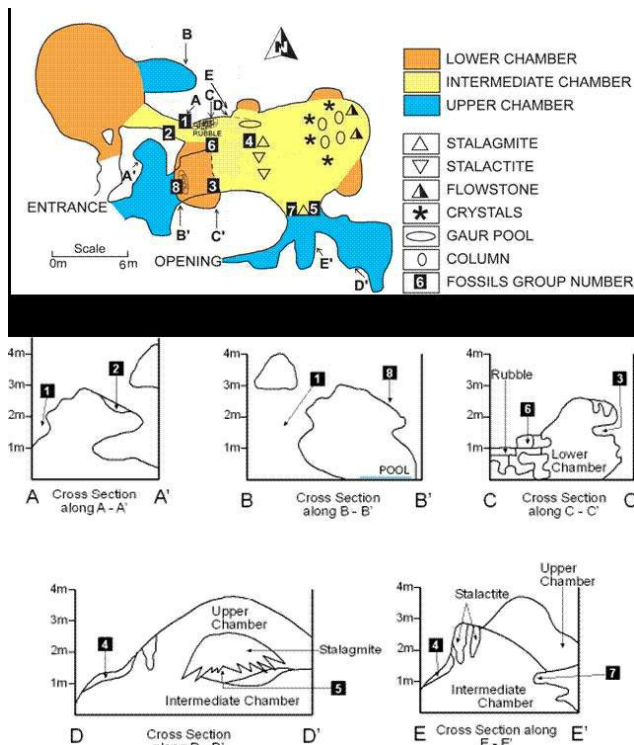


Figure 2: Map and cross-sections for Cistern Cave with fossil groups.

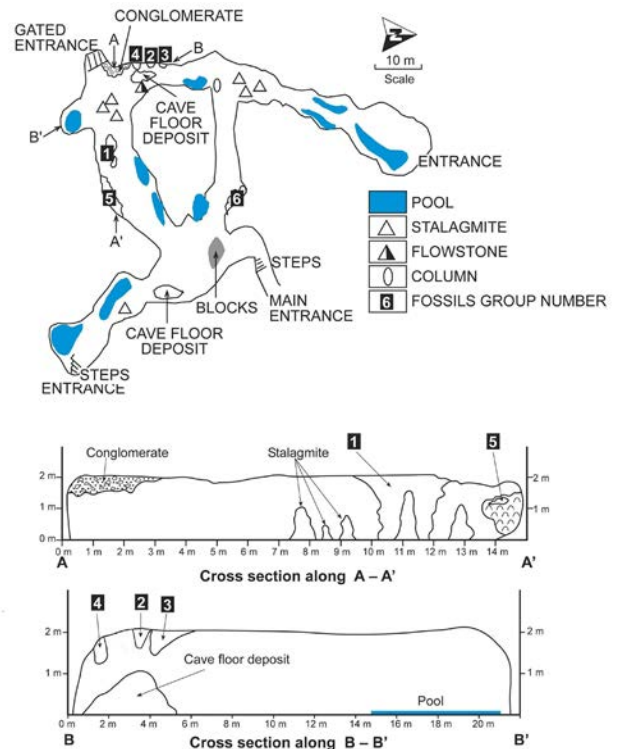


Figure 3: Map and cross-sections for Swamp Cave with fossil groups.

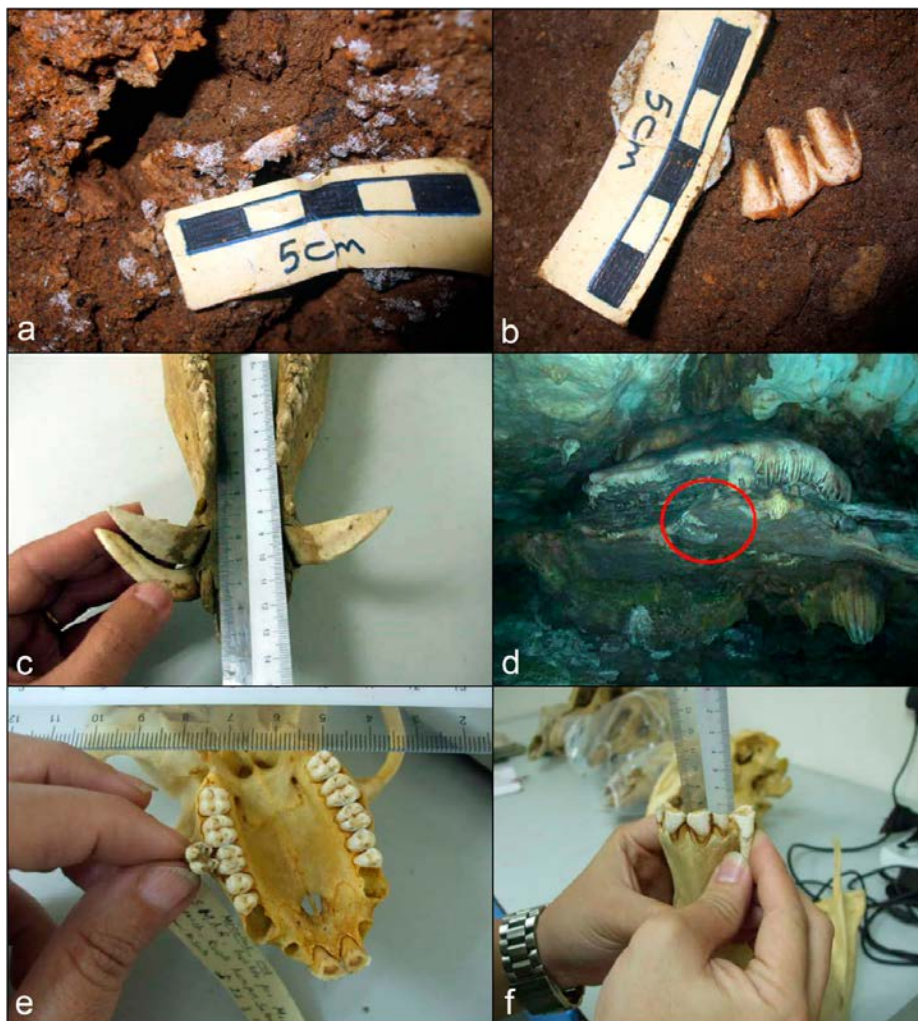
Groups 1, 2, 4, 5, and 7 were located in the intermediate chamber while Groups 3, 6 and 8 were located in the lower chambers. Group 1 was located about 6 m to the east after entering about 6 m from the main entrance. The fossils were found at 1.7m above the cave floor. They consist of fragmentary bones and teeth embedded in a strongly cemented hard sedimentary layer of brownish coloured coarse grained sandy deposit. Group 2 was located 2 m away from Group 1 to its southwest within the same layer. Two specimens were recovered from Group 2, one of which was the jaw bone of a bat with teeth attached (Figure 4a) and the other a tooth fragment that has yet to be identified. Group 3 was located 5 m to the southeast of Group 2. It is in the lower chamber which is about 2 m below the level of the cave floor that has been partially dug up for guano extraction. This group contains several small fragmentary bones and seven large teeth including that which belonged to a young medium-sized bovid identified as a southern serow (*Capricornis sumatraensis*) (Figure 4b).

Group 4 was located about 5 m north-northeast from Group 3 in the northern part of the cave. Stalagmites and gour pools are present next to it. Remnants of this bed are found sticking to the roof of the crystal chamber. The

fossils identified from this bed include teeth of the common wild pig (*Sus scrofa*) (Figure 4c) and the upper molar of a bearded pig (*Sus barbatus*) and the canine, premolar and molar of the red muntjac (*Muntiacus muntjak*).

Group 5 was located 1.16 m below a mushroom-shaped stalagmite about 7 m to the southeast of Group 4 (Figure 4d). This group yielded ten samples of teeth including remains of a bat, wild pig (*Sus scrofa*), bearded pig (*Sus barbatus*), southern serow (*Capricornis sumatraensis*) and macaque (*Macaca* sp. indet.) (Figure 4e).

Group 6 is 4 m north of Group 3 in the lower chamber. Two samples found in the rubble near this group were identified as the 4<sup>th</sup> upper left premolar of the common wild pig (*Sus scrofa*) and 2<sup>nd</sup> lower left incisor (Figure 4f) of an Asian tapir (*Tapirus indicus*). Group 7 is about 1.5 m west of Group 5 and was located inside a small hole 1 m above the intermediate chamber cave floor. The fossils found in Group 7 include a molar of the common wild pig (*Sus scrofa*) (Figure 5a) and premolar of the bearded pig (*Sus barbatus*). Group 8 was located at the lower chamber with Groups 3 and 6 near a small pool of water. A small bone (bat?) was found *in situ* with other fragments of bones in this group.



**Figure 4:** Fossils from Cistern Cave. a) jaw bone with 3-4 teeth attached (?bat) from Group 2; b) 3<sup>rd</sup> lower right molar of southern serow (*Capricornis sumatraensis*) with sharp crown indicating a young animal from Group 3; c) lower right canine of common wild pig (*Sus scrofa*) from Group 4; d) fossil Group 5 (circled) below mushroom shaped stalagmite; e) 1<sup>st</sup> upper left molar of macaque (*Macaca* sp.) from Group 5; f) 2<sup>nd</sup> lower left incisor of Asian tapir (*Tapirus indicus*) from Group 6.

### Distribution of vertebrate fossils in Swamp Cave

Swamp Cave has only one level of cave floor after development as a tourist cave except for some areas covered by remnant cave floor sediments about 1 m above the cave floor. Six fossil groups have been recovered from this cave. Groups 1, 2, 3, 4 and 5 were located in the main passage to the west with its axis oriented in a north-south direction.

Group 1 was embedded in a 1.0 to 1.5 m thick remnant layer of strongly cemented, brown coloured medium to coarse sandy alluvial sediment near a few stalagmites at 5.6 m from Group 5. The lower molar and canine of *Sus* sp. and 1<sup>st</sup> upper molar of southern serow (*Capricornis sumatraensis*) with fragmentary bones (Figure 5b) were found in this group. Groups 2, 3 and 4 were located on a different patch of remnant alluvial beds attached below an overhang in the original wall extending from the small gated entrance located to the south of the cave.

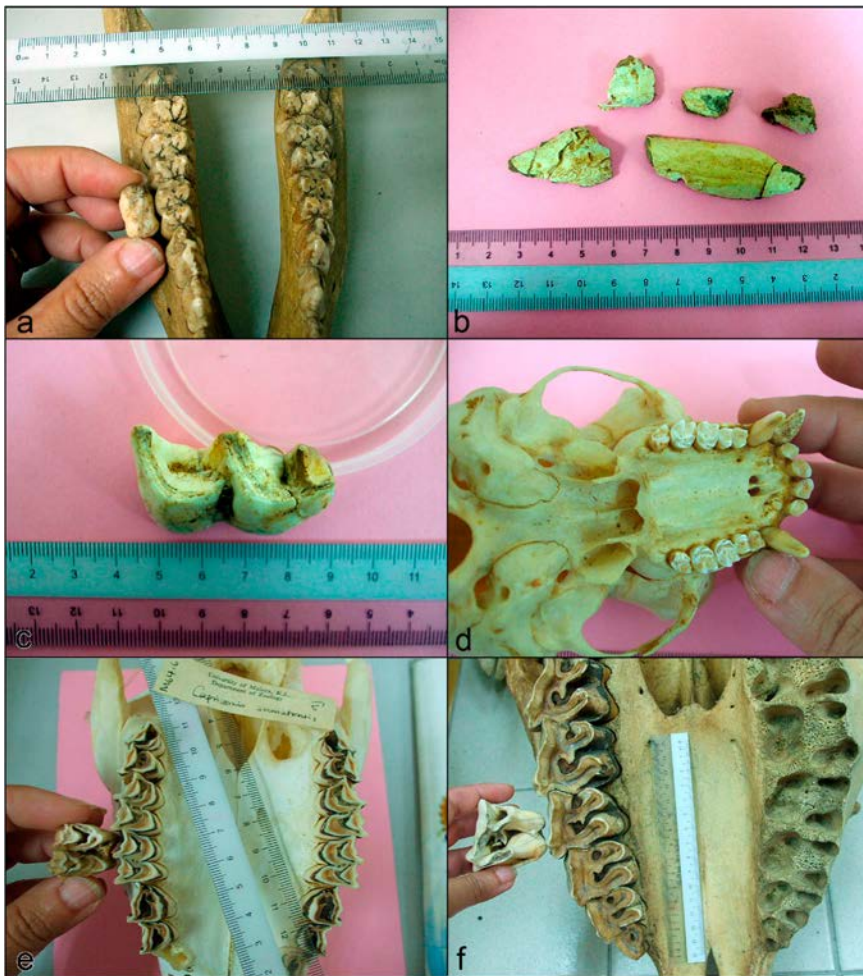
Group 2 located at 20 m southwest of Group 1 contained the lower molar of a rhinoceros, (gen. et sp. indet.) (Figure 5c) and a large bovid (gaur?) that has yet to be positively identified. Group 3 was the best preserved fossil group in this cave. The fossils were embedded in a 1m thick layer of cemented cream coloured, medium to coarse grained sandy to gravelly alluvium below the cave wall. It contained the teeth of the common wild pig (*Sus scrofa*) and upper right

canine of a macaque (*Macaca* sp. indet.) (Figure 5d). The incomplete tooth of a bear (*Ursidae*-gen. et sp. indet.) and the molar of the common wild pig (*Sus scrofa*) were found in Group 4 at 3m south of Group 3 which is 7m from the gated entrance. The lower premolar of a wild pig (*Sus scrofa*) was found in Group 5 located to the east of Group 1. The 1<sup>st</sup> lower premolar of a southern serow (*Capricornis sumatraensis*) (Figure 5e) was found stuck to the roof of the cave at 1 m above the cave floor in Group 6 located north of Group 5 in an northwestern branch of the cave system.

### Ex situ fossils

Fourteen samples of *ex situ* fossils were found on loose material in the Cistern and Swamp Caves in addition to the *in situ* fossils recovered. These fossils had most probably dropped from the roof during weathering or more likely been dislodged during guano extraction. Some might even be more recent material brought in by streams or animals or humans.

The fossils recovered are the teeth of the, common wild pig (*Sus scrofa*), bearded pig (*Sus barbatus*), rhinoceros (gen. et sp. indet.) (Figure 5f), tiger (*Panthera tigris*), southern serow (*Capricornis sumatraensis*), red muntjac (*Muntiacus muntjak*) and unidentified bone fragments.



**Figure 5:** Fossils from Cistern Cave (CC) and Swamp Cave (SC). a) 1<sup>st</sup> lower left molar of common wild pig (*Sus scrofa*) from Group 7 (CC); b) bone fragments from Group 1 (SC); c) lower molar of rhinoceros (gen. et sp. indet.) from Group 2 (SC); d) upper right canine of macaque (*Macaca* sp.) from Group 3 (SC); e) 1<sup>st</sup> upper left molar southern serow (*Capricornis sumatraensis*) from Group 6 (SC); f) 4<sup>th</sup> upper left premolar of rhinoceros (gen. et sp. indet.) from the floor (CC).



**Figure 6:** 3<sup>rd</sup> lower left molar of bearded pig (*Sus barbatus*) from Group 7 in Cistern Cave.



**Figure 7:** Small sink holes with remnants of alluvial sediments above the fossiliferous alluvial bed near Group 4 in Swamp Cave.

### Faunal composition

A total of 75 teeth and bone fragments of large to small mammals have been recovered from the two caves. This is not the final number as numerous other specimens had still not been extracted especially in Cistern Cave. The level of confidence involved in the identification of each specimen is highly variable, varying from tentative in cases of broken specimens and species for which no comparative material is available to certain for the better preserved specimens. The vertebrate fauna identified from Cistern Cave is shown in Table 1 and Swamp Cave in Table 2. They include 13 kinds of medium to large sized mammals. There is not much difference between the composition of the species recovered from Cistern Cave and Swamp Cave. Mammals like the common wild pig (*Sus scrofa*), bear (Ursidae-gen.et sp. indet.), macaque (*Macaca* sp. indet.), primates (non-human hominoid), southern serow (*Capricornis sumatraensis*), red muntjac (*Muntiacus muntjak*), Asian tapir (*Tapirus indicus*), and rhinoceros (gen. et sp. indet.) and bone fragments are commonly represented at both sites. Fossils found only from one site are the teeth of bearded pig (*Sus barbatus*),

**Table 1:** List of vertebrate teeth from Cistern Cave with numbers of specimens found.

Common wild pig ( <i>Sus scrofa</i> )	10
Bearded pig ( <i>Sus barbatus</i> )	6
Bear (Ursidae-gen.et sp. indet.)	2
Macaque ( <i>Macaca</i> sp. indet.)	1
Primates (non-human Hominoid)	1
Tiger ( <i>Panthera tigris</i> )	1
Southern serow ( <i>Capricornis sumatraensis</i> )	3
Red muntjac ( <i>Muntiacus muntjak</i> )	1
Asian tapir ( <i>Tapirus indicus</i> )	1
Rhinoceros (gen. et sp. indet.)	1
Bat	5
Total:	32

**Table 2:** List of vertebrate teeth from Swamp Cave with numbers of specimens found.

Common wild pig ( <i>Sus scrofa</i> )	3
Bear (Ursidae-gen.et sp. indet.)	1
Macaque ( <i>Macaca</i> sp. indet.)	1
Primates (Non-human Hominoid)	3
Southern serow ( <i>Capricornis sumatraensis</i> )	3
Red muntjac ( <i>Muntiacus muntjak</i> )	1
Sambar deer ( <i>Cervus unicolor</i> )	1
Asian tapir ( <i>Tapirus indicus</i> )	1
Rhinoceros (gen. et sp. indet.)	1
Total:	15



**Figure 8:** Conglomerate bed extending from gated entrance along north wall of Swamp Cave.

tiger (*Panthera tigris*) and bat bones in Cistern Cave and sambar deer (*Rusa unicolor*) in Swamp Cave.

The most common items were the teeth of the common wild pig (*Sus scrofa*). A total of 13 identified specimens were recovered from the two caves. All of them are within the size range for the equivalent tooth given in different published references for *Sus scrofa*. Comparative measurements with reference material and previous studies are presented in Table 3. Ten isolated teeth from Cistern Cave were identified as belong to *Sus scrofa*. Two were from old adults with worn occlusal surfaces. Six are young with sharp cusps and the rest are subadults. Four of them (third lower molar) were identified as belonging to *Sus scrofa* based on measurements (range of the length and the width shown in Table 3). A 3<sup>rd</sup> and 4<sup>th</sup> upper left premolar and one lower right canine

**Table 3:** Measurements (in millimeter) of lower and upper cheek teeth of modern and archaeological specimens of the common wild pig (*Sus scrofa*). L=length, W=width, N=number of specimens.

PRESENT REPORT				COMPARATIVE MEASUREMENTS				
T O O T H	Sample No.	Cistern Cave (CC)	Swamp Cave (SC)	Zoological Museum University Malaya	Medway (1969)	Medway (1977b)	Bacon <i>et al.</i> (2008)	Cranbrook (1979) Recent ( <i>S. Scrofa</i> ) from Peninsular Malaysia & Sumatra
<b>M<sub>1</sub></b>	CC7-2	N(1) L=16.8 W=10.7		L=15.4 W=15.0 (Left)				L=14.4-16.9 W=10.5-12.1
<b>M<sub>3</sub></b>	CC4-1 CC5-1 CCEX3 CCEX4  SC1-1 SC3-1 SC4-1	N(4) L=29.6-33.5 W=14.4-19.0	N(3) L=31.8-36.6 W=11.6-20.7	L=30.9 W=19.7 (Right)		L=29.0-40.0 W=16.0-19.0	L=30.6-46.8 W=16.4-20.3	L=29.0-40.0 W=16.0-19.0
<b>P<sup>4</sup></b>	CC6-2	N(1) L=13.8 W=14.0		L=12.0 W=15.8 (Left)		L=11.9-12.7 W=13.7-14.3	L=12.6-14.4 W=11.3-15.7	
<b>M<sup>2</sup></b>	CC4-9	N(1) L=23.4 W=17.0		L=22.6 W=21.4 (Right)	L=20.8-21.7	L=18.0-22.1 W=16.0-20.2	L=19.2-25.1 W=17.4-21.0	L=18.0-22.1 W=16.0-20.2

have also been assigned to this species. Three samples from Swamp Cave have been identified as *Sus scrofa* with two of them being the third left and right lower molars and one 3<sup>rd</sup> lower left premolar

#### Extension of range of the bearded pig (*Sus barbatus*)

Apart from *Sus scrofa*, we have also identified remains of the bearded pig (*Sus barbatus*) (Figure 6). This is of special interest from a zoogeographical perspective as neither fossils or living specimens of the species have previously been reported from this part of the peninsula. The present discovery is thus significant in extending the historical range of the species on the West coast further south and this generally concurs with Meijaard (2000), which suspected a wider distribution in former times for the populations in Peninsular Malaysia.

#### DISCUSSION AND FUTURE WORK

The discovery of abundant vertebrate fossil bones and teeth of many different animals in the limestone caves at the foot of Batu Caves is remarkable considering the very accessible nature of the caves in an urban setting. There is variation in the composition of the mammals found in the faunal assemblages. They ranged from micro vertebrates like bats to large mammals like bovids and rhinoceros. A good mixture of carnivores such as tigers, omnivores like

pigs and herbivores such as sambar deer and bovids were found indicating a rich and varied forested environment that used to exist in the Batu Caves area. The micro environments have yet to be worked out in detail.

Further work is also required to establish how were these disarticulated teeth and bones deposited within the cave deposits. Could they have fallen down sinkholes (Figure 7) or died naturally in the caves before being disarticulated and scattered by other animals such as porcupines? Could they have been washed in by streams in flood after they have rotted? Could some of the harder material like teeth been reworked from earlier deposits? A water deposited conglomerate (Figure 8) was found extending 7.7 m from the gated entrance along the wall into the cave at a height of 1.6 m above the cave floor at Swamp Cave indicating that active erosion and deposition by streams in the area had carved out the caves. Were they remnants of meals by animals and/or prehistoric humans? We have not detected definite gnaw marks or charring on the skeletal fragments with associated man-made tools or eaten shell-fish to date to confirm they were from any prehistoric midden deposit. Both caves have been used partly as domestic rubbish dumps so some of the *ex situ* material not encased in cemented cave floor sediments could be more recent discards.

When were they deposited? Samples of the cave deposits housing the fossils have been taken for dating by Dr. Kira Westaway from Macquarie University in Sydney,

Australia. Dates are critical to further work to correlate these finds with others in the region that would enable us to work out the palaeoenvironment, changing climates and faunal migration patterns in the past.

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