CHAPTER FOUR

MICROVERTEBRATE FOSSILS

4.1 Introduction

More than 230 microvertebrate fossil specimens have been currently recovered from the same sites that produced the in situ macrovertebrate assemblages from Batu Caves, Selangor and Lenggong Valley, Perak.

Single samples of sediments from the same layers containing the macro fossils were collected from: Badak Cave C (Cluster 5), Ngaum Cave (Cluster 2), Cistern Cave (Cluster 5), Swamp Cave (Cluster 4), and two samples from Villa Cave (Cluster 4) and from Dark Cave near the entrance. The samples were dissolved in 70% of dilute formic acid mixed with 30% buffer (made by reacting of with acid) and leaving them overnight. The residue left from dissolution was washed under running water then put it in the oven to dry. The dried residue was screened with sieves of 35 and 60 meshes and picked under a binocular microscope. Some microfossils were also found associated with the macrofossils and recovered manually or by washing with water and sieving especially those from the muddy parts like in Villa Cave/Batu Caves.

The microfossils recovered include: a more or less complete lower and upper jaw associated with the teeth mainly of bats and isolated teeth with many bones fragments. The materials were compared with specimens of extant fauna in collections of the Zoological Museum in the University of Malaya. All the microfossils in this study have been deposited in this museum.

The majority of the taxa include the Megachiroptera, Microchiroptera, Tupaiidae, Soricidae, Muridae.

Due to time constraints, only a preliminary examination could be conducted for the micro taxa to identify in general where possible the micro mammals recovered from the caves studied whether extracted by the dissolving in acid (Table 4.1) or found associated with the macro fauna as tabulated (Table 4.2) below. It is envisaged that more detailed work these microfossils can be done by future researchers as time does not allow me to study them in greater detail.

4.2 Description

These micro fossils are only described in general and briefly identified to provide some basic background information on their association with the macrofossils which are the main focus of this study.

4.3 Order Chiroptera Blumenbach, 1779

This order accounts for the vast majority of the assemblage and can be divided into two groups, the Megachiroptera (Family Pteropodidae) or Fruit Bats and Microchiroptera or Insectivorous Bats. Medway (1965), Aldridge & Cranbrook (1963), and Cranbrook (1966 & 1968) examined and recorded many bat remains from cave deposits in Niah Cave, Malaysia.

4.3.1 Megachiroptera Dobson, 1875 (Fruit Bats), Plate 8 (A1- A3)

A. Megachiroptera gen. et sp. indet.

Most of the Megachiroptera eat fruit while some feed on plants or pollen. Their cheek teeth are relatively rounded or elongated in cross section while the incisors are small and canines are conical and pointed.

This group is represented in this study by isolated upper and lower well preserved teeth and also a jaw bone. They were found in all the sites except for Badak Cave C in Lenggong Valley.

4.3.2 Microchiroptera Dobson, 1875 (Insectivorous Bats) Plate8 (B1& B2)

A. Microchiroptera gen. et sp. indet.

The Insectivorous Bats are characterized by a W-shaped pattern on the occlusal surface of the lower molar teeth. The third lower molar is smaller than the other molars and the posterior limb of the W on that tooth is smaller than the anterior limb in most genera. This group makes up or constitutes a large proportion of the microvertebrate fossils in all the sites studied consisting of different isolated teeth and also a jaw bone with teeth attached.

4.4 Order Scandentia Wagner, 1855

4.4.1 Family Tupaiidae Gray 1825 (Treeshrew)

Remains from this family are rare in this study (Table 4.1). Previously this family was classified under the Insectivora and Primates but is now classified in a separate order, Scandentia. They are small omnivorous mammals native to the tropical forests of Southeast Asia.

A. Tupaiidae gen. et sp. indet.

This group has pointed incisors with the third lower incisor being reduced in size. The upper molar has a shallow ectoflexus (buccal indentation) while the trigonid basin in the lower molars is clearly situated higher than the talonid basin and these two basins appear unequal in size. The hypoconulid is closely associated with the entoconid. However, it is not easy to distinguish between this group and the others based on the general features of the teeth only thus preventing more detailed identification at present.

4.5 Order Insectivora Bowdich, 1821

4.5.1 Family Soricidae G. Fischer, 1814 (Shrew), Plate 8 (D)

Shrews are the smallest mammals in the world and difficult to identify. The color, number, and the size of the teeth can help in identification. Many species described from Borneo and Peninsular Malaysia are accompanied by behavioral and morphological studies (Medway, 1960b), (Cranbrook, 1963), (Davison, 1979 & 1984) (Davison *et al*., 1982).
In the current study, shrews are only present in small numbers from Cistern Cave? Villa Cave? Badak Cave C? , and from Dark Cave.

A. Soricidae gen. et sp. indet.

The collection in this study include: a single enlarged incisor from each jaw, 2 to 5 small unicuspid teeth (canine and premolars), and 4 large multicusped teeth (one premolar and 3 molars). The upper margin of the first upper premolar is extremely concave while the two basins in the lower molars are relatively semi-equal in size.

4.6 Order Rodentia Bowdich, 1821

All rodents have single pairs of large, curved, chiseling, upper and lower incisors, separated by a gap (diastema) from the premolars and no canine.

Rodents represented in this study come from in two sites, Villa Cave, Batu Caves and Badak Cave C, Lenggong Valley, obtained by both acid digestion and other ways (Tables 4.1 and 4.2).

4.6.1 Family Muridae Gray, 1821, Plate 8 (C1- C5)

Two murid species are identified as: *Maxomys surifer* (Miller 1900) from Villa Cave, Batu Caves Massif and *Chiropodomys gliroides Blyth* 1856, from Badak Cave C, Lenggong Valley (Table 4.1) with the help of Dr. Yaowalak Chaimanee (personal communication, 2011).

Regionally, these two species are found in the Indochinese and Sundaic subregion plus China and India for the latter. Systematic description of these species among other rodents in Thailand had been done by Chaimanee (1998).

Generally, the micro fauna currently recovered indicate a palaeoenvironment that is related to an evergreen forest in tropical or subtropical lowland and mountain habitats and the occurrence of these mammals in different localities in the Upper Pleistocene might be due to either ecological or climatic changes (Medway, 1963; Heaney *et al*., 2011).

The taxa are less in number in both (Badak Cave C and Ngaum Cave) in Lenggong Valley compared with the others (Cistern, Swamp, Villa, Dark Caves) in Batu Caves. This deficiency is undoubtedly due to a bias in sampling because only two samples were collected and processed from Badak Cave C and Ngaum Cave compared to six samples from Batu Caves.

Table 4.1 Microvertebrate fossils recovered by acid digestion.

Cistern Cave/ Batu Caves Massif	
Field Number	**General Identification**
CCS 1	Lower molar; Megachiroptera; Plate 8 (A3)
CCS 2	Last upper molar; Microchiroptera
CCS 3	Upper premolar; Microchiroptera
CCS 4	Upper molar; Microchiroptera
CCS 5	Lower incisor; Microchiroptera
CCS 6	Canine
CCS 7	Claw
CCS 8	Claw
CCS 9	Lower premolar; Microchiroptera
CCS 10	Upper premolar; Megachiroptera
CCS 11	Lower molar; Microchiroptera
CCS 12	Lower Canine; Microchiroptera
CCS 13	Upper incisor; Megachiroptera
CCS 14	Upper molar; Shrew?
CCS 15	Lower premolar; Megachiroptera
CCS 16	Broken tooth; Megachiroptera
CCS 17	Claw
CCS 18	Lower Canine; Microchiroptera
CCS 19	Claw
CCS 20	Lower premolar; Microchiroptera
CCS 21	Lower Canine; Microchiroptera
CCS 22	Claw
CCS 23	Tooth fragment
CCS 24	Upper Canine; Megachiroptera

Table 4.1, continued

CCS 25	Lower Canine; Microchiroptera
CCS 26	Bones fragment
CCS 27	Incisor; Microchiroptera
CCS 28	Incisor; Microchiroptera
CCS 29	Lower molar; Microchiroptera
CCS 30	Upper premolar; Treeshrew?
CCS 31	Upper premolar; Megachiroptera
CCS 32	Lower Canine; Microchiroptera
CCS 33	Bone
CCS 34	Bone
CCS 35	Broken canine
CCS 36	Bones fragment
CCS 37	Bones fragment
CCS 38	Bone
CCS 39	Bone
CCS 40	Bone
CCS 41	Bone
CCS 42	Bone
CCS 43	Bone
Swamp Cave/ Batu Caves Massif	
SCS 1	Upper molar; Microchiroptera
SCS 2	Upper premolar; Megachiroptera
SCS 3	Bones fragment
SCS 4	Lower molar; Microchiroptera
SCS 5	Lower molar; Microchiroptera
SCS 6	Upper molar; Microchiroptera

Table 4.1, continued

SCS 7	Upper molar; Microchiroptera
SCS 8	Upper molar; Microchiroptera
SCS 9	Claw
SCS 10	Claw
SCS 11	Lower Canine; Microchiroptera
SCS 12	Lower Canine; Megachiroptera?
SCS 13	Upper molar; Microchiroptera
SCS 14	Lower premolar; Microchiroptera
SCS 15	Lower incisor; Microchiroptera
SCS 16	Teeth fragment
SCS 17	Lower incisor; Microchiroptera
SCS 18	Bones fragment
SCS 19	Long bone
SCS 20	Bones fragment
SCS 21	Small vertebra
Villa Cave/ Batu Caves Massif	
VCS 2	Left upper first molar ; Family Muridae, a Sundaic rat (*Maxomys surifer*); Plate 8 (C1)
VCS 3	Left upper first molar ; Family Muridae, a Sundaic rat (*Maxomys surifer*); Plate 8 (C2)
VCS 4	Upper molar; Megachiroptera
VCS 5	Right lower first molar; Family Muridae, a Sundaic rat (*Maxomys surifer*); Plate 8 (C3)
VCS 6	Left upper second and third molar; Family Muridae, a Sundaic rat (*Maxomys surifer*) Plate 8 (C4)
VCS 7	Lower jaw bone with two molars attached; Shrews?
VCS 8	Premolar of bat
VCS 9	Bone
VCS 10	Upper incisor; Rodent

Table 4.1, continued

VCS 11	Upper jaw bone with three teeth attached; Microchiroptera
VCS 12	Lower jaw bone with two premolar teeth attached; Megachiroptera; Plate 8 (A1)
VCS 22	Upper jaw bone with five teeth attached; Microchiroptera
VCS 23	Claw?
VCS 24	Upper incisor; Microchiroptera
VCS 25	Upper incisor; Microchiroptera
VCS 26	Lower molar; Microchiroptera
VCS 27	Upper incisor; Rodent
VCS 28	Upper Canine; Megachiroptera
VCS 30	Lower premolar; Megachiroptera
VCS 31	Upper premolar; Microchiroptera
VCS 32	Lower premolar; Microchiroptera
VCS 33	Lower premolar; Microchiroptera
VCS 34	Vertebra
VCS 35	Bone
VCS 36	Bone
VCS 37	Bones fragment
VCS 38	Upper jaw bone with two teeth attached; Microchiroptera
VCS 39	Tooth?
VCS 40	Lower premolar; Microchiroptera
VCS 41	Canine of bat
VCS 42	Upper molar; Microchiroptera
VCS 43	Lower molar; Microchiroptera
VCS 44	Lower canine; Microchiroptera
VCS 45	Lower molar; Megachiroptera
VCS 46	Lower premolar? Molar?; Microchiroptera
VCS 47	Lower premolar; Microchiroptera

Table 4.1, continued

VCS 48	Lower premolar; Microchiroptera
VCS 49	Lower molar; Microchiroptera
VCS 50	Lower molar; Megachiroptera
VCS 51	Upper Canine; Megachiroptera
VCS 52	Lower canine; Microchiroptera
VCS 53	Lower jaw bone without teeth
VCS 54	Claw
VCS 55	Lower premolar; Megachiroptera
VCS 56	Lower premolar; Megachiroptera
VCS 57	Claw
VCS 58	Bone
VCS 59	Lower premolar; Microchiroptera
VCS 60	Claw
VCS 61	Bone
VCS 62	Upper molar; Microchiroptera
VCS 63	Claw
VCS 64	Claw
VCS 65	Lower molar tooth
VCS 66	Upper molar; Microchiroptera
VCS 67	Upper molar; Microchiroptera
VCS 68	Claw
VCS 69	Bones fragment
VCS 70	Upper molar; Microchiroptera
VCS 71	Upper molar; Megachiroptera
VCS 72	Bone
VCS 73	Tooth?

Table 4.1, continued

VCS 74	Fragmented lower molar tooth; Treeshrews?
VCS 75	Claw
VCS 76	Lower incisor; Microchiroptera
VCS 77	Upper molar; Microchiroptera
VCS 78	Lower molar; Microchiroptera
VCS 79	Upper molar; Microchiroptera
VCS 80	Lower molar; Megachiroptera
VCS 81	Bone
VCS 82	Tooth?
VCS 83	Upper molar; Microchiroptera
VCS 84	Vertebra
VCS 85	Bone
VCS 86	Bone
VCS 87	Bone
VCS 88	Bone
VCS89	Bone
VCS 90	Bone
VCS 91	Bones fragment
VCS 92	Bone
VCS 93	Bones fragment
VCS 94	Bones fragment
VCS95	Bones fragment
VCS 96	Bone
VCS 97	Bone
VCS 98	Bone
VCS 99	Broken vertebra

Table 4.1, continued

VCS 100	Bone
VCS 101	Bones fragment
VCS 102	Canine of bat
VCS 103	Lower incisor; Rodent
Dark Cave/ Batu Caves Massif	
DCS 1	Canine of bat
DCS 2	Lower premolar; Megachiroptera
DCS 3	Lower molar; Microchiroptera; Plate 8 (B1)
DCS 4	Lower canine; Megachiroptera
DCS 5	Lower premolar tooth
DCS 6	Upper premolar; Megachiroptera
DCS 7	Upper jaw bone with premolar and molars teeth; Microchiroptera; Plate 8 (B2)
DCS 8	Lower molar; Microchiroptera
DCS 9	Lower canine; Microchiroptera
DCS 10	Upper molar; Megachiroptera
DCS 11	Broken tooth
DCS 12	Lower molar; Megachiroptera
DCS 13	Lower molar; Microchiroptera?
DCS 14	Lower premolar tooth
DCS 15	Lower molar; Microchiroptera
DCS 16	Lower premolar; Microchiroptera
DCS 17	Broken tooth
DCS 18	Upper molar; Shrew; Plate 8 (D)
DCS 19	Lower molar; Microchiroptera?
DCS 20	Broken tooth
DCS 21	Upper molar; Microchiroptera
DCS 22	Lower molar; Megachiroptera

Table 4.1, continued

DCS 23	Upper molar; Megachiroptera
DCS 24	Claw
DCS 25	Broken tooth
DCS 26	Bone fragment
DCS 27	Broken tooth
DCS 28	Broken tooth
DCS 29	Broken tooth
DCS 30	Broken tooth
DCS 31	Bones fragment
DCS 32	Lower premolar tooth
DCS 33	Upper molar; Microchiroptera
DCS 34	Broken tooth
DCS 35	Lower premolar; Microchiroptera
DCS 36	Bones fragment
DCS 37	Broken tooth
DCS 38	Upper Canine; Megachiroptera
DCS 39	Upper Canine; Megachiroptera
DCS 40	Lower jaw bone with one molar attach; Microchiroptera
DCS 41	Upper premolar; Microchiroptera
DCS 42	Lower molar; Microchiroptera
DCS 43	Lower premolar; Megachiroptera
DCS 44	Lower jaw bone with two teeth attach?
DCS 45	Lower molar; Microchiroptera
DCS 46	Broken tooth
DCS 47	Lower molar; Microchiroptera
DCS 48	Canine of bat
DCS 49	Upper molar; Microchiroptera

Table 4.1, continued

DCS 50	Lower molar; Megachiroptera
DCS 51	Upper molar; Microchiroptera
DCS 52	Broken tooth
DCS 53	Incisor; Microchiroptera
DCS 54	Upper molar; Microchiroptera
DCS 55	Broken canine
DCS 57	Lower premolar; Microchiroptera
DCS 58	Broken tooth
DCS 59	Broken tooth
DCS 60	Lower molar?
DCS 61	Broken tooth
DCS 62	Vertebra
DCS 63	Upper Canine; Megachiroptera
DCS 64	Bones fragment
DCS 65	Vertebra
DCS 66	Upper incisor; Megachiroptera

Badak Cave C/ Lenggong Valley	
BDCS 1	Bones fragment
BDCS 3	Right lower first molar; Family Muridae, (*Chiropodomys gliroides*); Plate 8 (C5)
BDCS 4	Lower molar; Microchiroptera
BDCS 5	Lower molar; Shrews? Broken tooth
BDCS 6	Lower premolar; Microchiroptera
BDCS 7	Fragmented vertebra
BDCS 8	Bone
BDCS 9	Fragmented vertebra
BDCS 10	Bones fragment

Table 4.1, continued	**Ngaum Cave/ Lenggong Valley**
NCS 1	Lower premolar; Megachiroptera; Plate 8 (A2)
NCS 2	Lower premolar; Megachiroptera
NCS 3	Upper canine; Microchiroptera
NCS 4	Bones fragment
NCS 5	Upper incisor
NCS 6	Fragmented upper premolar tooth
NCS 7	Teeth fragment

Table 4.2 Microvertebrate fossils recovered by washing without acid digestion.

Cistern Cave/ Batu Caves Massif	
Field Number	**General Identification**
CC 2-1	Lowe jaw bone with four teeth attached; Microchiroptera
CC 4-6	Lower molar; Microchiroptera
CC 5-5	Upper canine; Microchiroptera
CC 5-10	Lower molar; Microchiroptera
CC 5-11	Upper molar; Megachiroptera
CC EX2	Fragmented upper canine; Microchiroptera
Villa Cave/ Batu Caves Massif	
VC 1-3	Bone, ulna?
VC 4-10	Lower jaw bone with incisor and one premolar teeth attached; Rodents
VC 4-19	Fragmented jaw bone without any teeth
VC 4-23	Bone fragment
VC EX9	Bone fragment

Table 4.2, continued	**Dark Cave/ Batu Caves Massif**
DC 11	Vertebra
DC 12	Broken vertebrae
DC 13	Fragmented jaw bone
Badak Cave C/ Lenggong Valley	
BDC EX16	Lower jaw bone with complete teeth attached; Rodents