

USING COMMUNITY, COMPOSITION AND STRUCTURAL VARIATION IN TERMINAL PLEISTOCENE VERTEBRATE ASSEMBLAGES TO IDENTIFY HUMAN HUNTING BEHAVIOUR AT THE NIAH CAVES, BORNEO

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ABSTRACT

Variation in the temporal and spatial composition of large vertebrate communities is often used as a proxy for identifying local or regional differences in palaeoenvironment and/or hominid hunting strategy. Differences in the structure of vertebrate communities, however, are rarely identified in the archaeological record, and the relevance that any observed variation might have for our understanding of human foraging behaviour is rarely considered. In this paper we discuss the possible reasons for the significant differences in the population structure of the dominant taxa from two almost contemporaneous Terminal Pleistocene vertebrate assemblages that are the product of human hunting activities from the West Mouth and Lobang Hangus entrances to Niah Cave, Borneo. The results indicate that hunting strategy might have been determined by the vertical location of the two cave mouths and local variation in the ecology and topography of the surrounding environment.

INTRODUCTION

The Niah Cave Complex is situated in a northern outcrop of the Gunung Subis, a Miocene limestone massif on the northwestern plains of Sarawak, Borneo, in what is now Niah National Park (Fig. 1). The caves are renowned for their enormity and beauty, for the tens of thousands of bats that swarm out at dusk, the swiftlets that produce edible bird's nests, the main ingredient in the Chinese delicacy of bird's nest soup, and for the extensive archaeological excavations of Tom Harrisson, then Curator of the Sarawak Museum, Kuching, and his wife Barbara during the 1950s and 1960s.

Over a period of 12 years the Harrisson's directed a large-scale excavation of the deep cultural deposits in the northwest corner of Niah West Mouth and the east facing entrances of Gan Kira, Lobang Tulang and Lobang Hangus. They uncovered evidence of intermittent human use of the caves from as early as *circa* 40 kya and that continued intermittently throughout the Holocene, culminating with the utilization of several of the entrances for

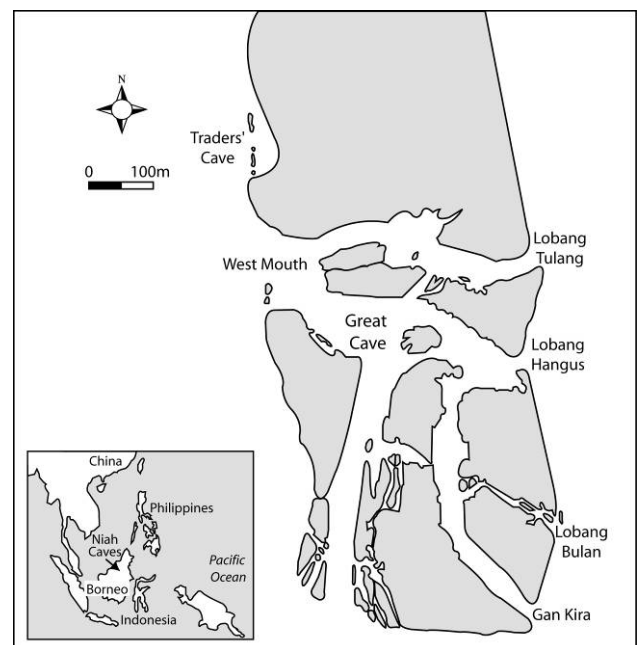


Figure 1. The geographic location and layout of the Niah Caves, Sarawak, northwestern Borneo.

burial of the dead during the local Neolithic (*c.* 5 kya onwards) and Metal Age (*c.* 2 kya onwards; Harrisson, T. 1958a, 1958b, 1959a, 1959b, 1966, 1967, 1970, 1973; Harrisson, B. 1967). Though Tom Harrisson published a series of interim articles on his work at Niah he never completed a definitive report outlining the nature and extent of the archaeological record he uncovered in the caves before his untimely death in 1976.

With the intention of answering some of the outstanding questions about the temporal and spatial character of human activity at Niah, from 2000 - 2003 a team of archaeologists and environmental scientists under the direction of Professor Graeme Barker spent short field seasons re-investigating the remnant archaeology left by Tom Harrisson in the entrances to Niah (Barker *et al.*, 2000, 2001, 2002, 2003, in prep.). Using on-site observations, scientific research and reference to the original written and photographic archives stored in the Sarawak

Museum, it was possible to reconstruct much of the palaeoenvironmental and archaeological history of the caves. New ^{14}C dates anchored the stratigraphy to an absolute chronology, confirmed the original dates for the 'deep skull' and demonstrated that intermittent human habitation of the caves could be traced back to at least *circa* 45 kya in the West Mouth (Barker *et al.* 2007) and *circa* 32.5 kya at Lobang H Angus (Barker *et al.*, in prep.). The project was also able to unravel some of the complexities of the late Pleistocene and early Holocene habitations of the cave and the sequence of Neolithic and Metal Age burial activity on the site.

One of the most extensive periods of habitation has been dated to 13.5 – 12.5 kya and identified in two of the cave mouths: under the northern rock overhang in the northwest corner of the West Mouth, and the entrance to Lobang H Angus. Samples from these two large vertebrate accumulations recovered during the Harrison excavations produced in excess of 20,000 large/intermediate-sized mammal, bird and reptile bones. The composition (types of taxa represented) of the two assemblages is very similar: both contain the remains of a wide variety of terrestrial, arboreal and aquatic animals. However, there are marked differences in the structure (proportions of different taxa represented) of the community between the two almost contemporaneous middens that cannot be accounted for through variability in taphonomic history. Cut mark evidence on some skeletal elements of different large-bodied and intermediate-sized taxa, the lack of porcupine gnawing, the inaccessibility of the two cave entrances for most terrestrial mammals and the absence of other scavengers and bone accumulators in Borneo, suggests that people were the primary accumulators of both mammal, reptile and bird assemblages. The accumulators of the tens of thousands of small vertebrate remains recovered from the cave are yet to be determined.

The differences in vertebrate community structure from archaeological deposits from the east and west entrances was first noticed by Harrison (1996), whilst studying primate remains from the Niah Caves. He argued that there was no simple explanation for the high proportions of long-tailed macaques (*Macaca fascicularis*) in the Lobang H Angus bone assemblage. Harrison did, however, suggest that the observed differences may be related to subtle variations in the forests surrounding the east and west mouths of the Gunung Subis, but this conclusion could only be confidently reinforced once the rest of the animal bone assemblage had been studied. We can now confirm that this structural difference in the vertebrate community extends to other families of taxa within the archaeological record.

Here, we outline the types of hunting activity identified during the Terminal Pleistocene at Niah and discuss some of the possible reasons for the observed differences in the structure of the two hunted populations of vertebrates in the West Mouth and Lobang H Angus.

UNDER THE NORTHERN ROCK OVERHANG - WEST MOUTH:

The huge West Mouth is by far the largest of the entrances to the 24 acre Niah Cave complex. Today, a boardwalk leads from the National Park headquarters situated on the banks of Sungai Niah for about 3.5 km to the cave entrance. In the past, however, passage from the river to the cave entrance meant passing through lowland dipterocarp rainforest, and culminated in a steep 15 m climb from the forest floor to the entrance over sharp, jagged limestone (Barton and Paz, in press).



Figure 2. The area 'area under the rock overhang' under excavation in 1958. Reproduced with the kind permission of the Sarawak Museum.

The Terminal Pleistocene bone assemblage discussed herein, and excavated by Tom Harrison, was located in the northwest corner of the archaeological site, in an area referred to as 'under the rock overhang' (Fig. 2). The sample of 11,140 fragments from the 1950s and 60s excavation archive studied in this project had accumulated in a shallow depression close to, and against the north wall of the cave. Charcoal from within this distinct bone horizon produced a ^{14}C date of $13,745 \pm 55$ (OxA-15162), using charcoal from the original Harrison excavations. The discreteness of the bone assemblage within the stratigraphic sequence and the comprehensive 'on site' bone records kept by Lord Medway in 1958 made the Terminal Pleistocene vertebrate assemblage under the rock overhang ideal for study (see Piper and Rabett in press a). All identifiable and indeterminate bone fragments from large/intermediate-sized (as small as squirrels and large rats) vertebrates were retained, though most of the tens of thousands of small vertebrate remains that must have been encountered during excavation in this area appear to have been discarded.

The presence of cut-marked bone fragments ($n=30$) in deposits of this age indicates that people were involved in the accumulation of the large mammal, reptile and bird remains discovered here. Skeletal element representation also provides good evidence that in most cases complete carcasses were being transported back to the West Mouth where they were disarticulated and butchered. Kill-site primary butchery and selective transportation of elements does not seem to have been practiced; hunting was probably therefore undertaken relatively close to the caves. High levels of fragmentation and the presence of impact scars on large mammal long bones imply that these elements were broken for marrow extraction during the course of on-site processing, smashed crania could be indicative of removal of brains. Re-fitting of bone fragments from the same or adjacent grid squares and differential subsurface weathering to the surfaces of individual pieces suggest that fragments lay undisturbed on or close to the ground surface for long periods before their eventual burial. The greater levels of abrasion observed in bones from close to the cave frontage imply that human activity was concentrated around the periphery of the overhang with little utilization of the area deeper under the overhang itself (see Piper and Rabett, in prep.).

Some bones, particularly those close to the north wall, demonstrated either moderate or severe effects of erosion, consistent with the kind of damage that might be expected from alternating periods of saturation and desiccation. Thus, it seems that the surface depression under the rock overhang was intermittently damp and soggy, and acted as a low-lying focus for moisture run-off from the cave entrance, dripping from the limestone curtain, and possibly even drainage from the interior. In contrast to the 35 – 45 kya vertebrate accumulations situated at deeper levels along the cave frontage (see Rabett *et al.* 2006), burnt or calcined bone were rare or absent in this Terminal Pleistocene assemblage, accounting for an average of just 3% per sampled grid square. Rodent gnawing was extremely rare (<0.1%) in the accumulation and modifications by other small scavengers were absent, though some bone modifications by animals such as monitor lizards cannot be discounted. This probably results from the inaccessibility of the two cave entrances from the forest floor and by the absence of large mammalian scavengers such as hyaenas and canids from Pleistocene of Borneo.

Studies of the archive records and photographs from the original excavations by the authors suggest that the vertebrate accumulation under the rock overhang was originally part of a much larger assemblage located to the south along a wider extent of the cave frontage, in what Tom Harrisson (1958a) referred to as the ‘frequentation zone’. Medway (1958) reported that there were no significant concentrations of bones anywhere in the ‘frequentation zone’, no spit with a significantly higher concentration of bones throughout the sequence or any true midden deposits where bones were piled upon each other. Nevertheless, there were scattered accumulations of bones from numerous different taxa, some apparently associated with ‘definite hearth rings’ that may indicate

defined activity areas during different periods of habitation (Medway 1958:629). Unfortunately, the extremely coarse-grained methods employed by Tom Harrisson in 1954 and 1957 to excavate this part of the site obliterated most of the evidence for the ‘frequentation zone’ and irreversibly mixed together large numbers of animal bones from different phases of activity.

Collectively, the animal bones are interpreted by the authors as the remains of meals that was transported and dumped in a little-utilized damp depression that existed under the rock overhang, with the main areas of human activity being centred to the south and west in Harrisson’s ‘frequentation zone’. This being the case, such evidence possibly indicates some sort of deliberate camp maintenance and organised delegation of space.

LOBANG HANGUS

The three east-facing mouths of Niah – Lobang Tulang, Lobang H Angus and Gan Kira – are presently reached by a sequence of boardwalks that lead visitors from the West Mouth through the dark interior of the caves, a route that would have been laborious and treacherous in the past, if it was attempted at all (Fig. 3). A series of tracks used by the local Iban villagers skirt around the outside of the limestone outcrop a few hundred metres from the main West Mouth to another boardwalk that leads visitors from Gan Kira to a second outcrop that contains Kain Hitam – the ‘painted cave’. As such, movement between these entrances around the perimeter of the Gunung Subis deep in the past should not be discounted.

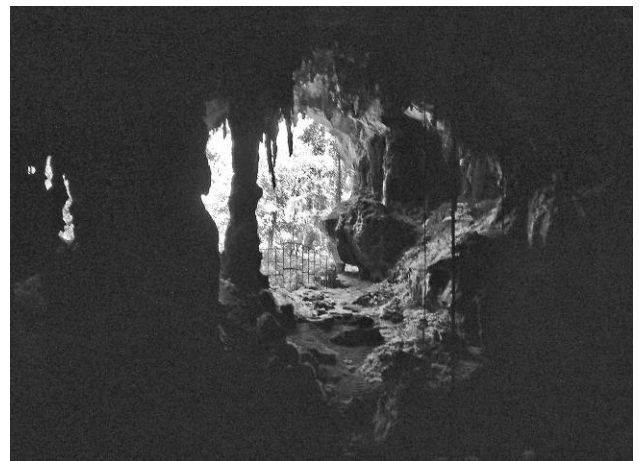


Figure 3. A view of the Lobang H Angus entrance from the interior of the cave. Photograph by K. Szabó.

Lobang H Angus (‘Burnt/scorched hole’) is the central and largest of the three east-facing entrances. The mouth of the cave has an average floor to roof height of 24 m and a width of c.30 m. The entrance platform is c.50 m long and slopes westwards from the entrance down towards the interior. There is then a vertical rock drop-off that requires one to climb a ladder to reach the mouth from inside the cave. The cave entrance opens on to a steep c.43 m cliff that extends to the forest floor close to

the banks of the Sungai Tangap, a tributary of Sungai Niah located to the west of the limestone massif. The entrance's high elevation means it overlooks the tree canopy and provides excellent views across the lowland plains to the north (Harrisson 1966).

Lobang Hangu produced one of the most important archaeological bone assemblages excavated by Tom and Barbara Harrisson at Niah. This has since been supplemented by a small sample of bones excavated from deeper in the cave entrance, behind a rock fall, by the Niah Cave Project (NCP) team in 2003 (see Barker *et al.* 2003). The sample of Terminal Pleistocene midden excavated by Tom Harrisson and studied in this project contained 9494 fragments and has been dated on charcoal from the same archaeological horizon to 12,520±50 bp (OxA-13936). In general, bones from this period of activity were remarkably well preserved (e.g. compared to those from the beneath the rock over-hang in the West Mouth).

During the Terminal Pleistocene, animal remains were deposited on a gentle slope close to the entrance of Lobang Hangu. Harrisson (1966) noted during its excavation that, contrary to the cave's name, evidence for fires or burning in the archaeological record was conspicuous by its absence – so much so that he (and members of the NCP project for that matter) was unable to find enough charcoal for a complete sequence of ¹⁴C dates. The lack of burnt and calcined material extends to bone, with only 257 (2.7%) burnt fragments recorded in the whole assemblage. Like the West Mouth, element representation indicates that whole carcasses of animals up to the size of, and including pigs were being transported back to the site. The locations of cut marks ($n=80$) on numerous skeletal elements suggests that various animals of different size and body weight were being disarticulated and butchered in similar, systematic ways (Piper and Rabett, in prep.; Rabett and Piper, in review). Considering the large size of bearded pigs and the inaccessibility of the cave entrance, it is likely that some of the primary butchery was carried out either at the kill site, or the base of Gunung Subis, to sub-divide the carcass and carry it up the very steep rock face to the cave entrance. Nevertheless the whole carcass was transported to the cave, suggesting that hunting parties consisted of more than one person.

Bone counts and distributions from different equal-sized Harrisson grid squares in the Lobang Hangu cave frontage indicate that no single, high concentration of fragments was identified that would suggest the presence of a distinctive midden and space dedicated to the disposal of waste. Most bone fragments demonstrated at least some limited post-depositional modification associated with trampling and re-working, implying that any bone concentrations may have been inadvertently dispersed as a result of human activity in the cave mouth. On the whole, however, the excellent preservation of most of the bone fragments would suggest that human activity was not intensive. A further notable feature of this assemblage is the inclusion of discarded articular ends of monkey limb bones, showing evidence of a method

known as the groove and snap technique to prepare lengths of long bone for tool production. This a specific technique of incising a groove around the diameter of a bone shaft at the point where the tool manufacturer wishes to break the bone. The groove helps to control the fracture and mitigates against longitudinal splitting of the bone. This suggests that a proportion of the significant worked bone assemblage from Lobang Hangu was being produced at or in the immediate vicinity of the site (Rabett and Piper, in review). The same technique of long bone shaft preparation has been observed in assemblages from the West Mouth, but not the midden accumulation discussed here.

In sum, the zooarchaeological data suggest that during the Terminal Pleistocene the interior of Lobang Hangu was possibly being utilized for the butchery and certainly the discard of hunted animal remains. There is no clear evidence of human habitation within the cave entrance itself, but the discard of waste from different butchery processes and bone artefact production implies that site occupation more than merely transient (see Piper and Rabett, in press b).

HUNTING STRATEGIES AT THE WEST MOUTH AND LOBANG HANGUS

The Terminal Pleistocene assemblage under the rock overhang in the West Mouth comprised 2006 bones identified to family or higher taxonomic level, with at least 27 mammal, 11 bird and eight reptile taxa represented. At Lobang Hangu, the assemblage from this period produced 3136 bone fragments that were identifiable to family or above, and was composed of similar proportions of taxa: 29 mammal, 10 bird and nine reptile (Tables 1 and 2). Some slight differences do occur in the taxa identified in the two assemblages, but these are

Table 1 (next page). The total number of individual specimens (NISP: uncorrected) of each vertebrate taxa identified in the Terminal Pleistocene sediments 'under the rock overhang' in the West Mouth that were possibly hunted by the human inhabitants of the caves. As analytical research continues we expect this list to be modified. *Initial studies of Bucerotidae remains have indicated that both *Anthraceros coronatus* (pied hornbill) and *Anorrhinus galeritus* (bushy-crested hornbill) might also be present in the accumulation, but these identifications require further confirmation.

Table 2 (page 93 following). The number of individual specimens (NISP: uncorrected) of each vertebrate taxa identified in the Terminal Pleistocene bone assemblages from Lobang Hangu that were possibly hunted by the human inhabitants of the caves. As analytical research continues we expect this list to be modified. *Initial studies of Bucerotidae remains have indicated that *Anthraceros coronatus* (pied hornbill), *Anorrhinus galeritus* (bushy-crested hornbill) and *Rhyticeros corrugatus* (wrinkled hornbill) might also be present in the accumulation, but these identifications require further confirmation. **Biometric analyses suggest both *Muntiacus muntjac* and *Muntiacus napu* are represented.

Class	Family	Taxon	Common Name	NISP	
Aves	Accipitridae	Accipitridae spp.	Hawk	17	
		<i>cf. Accipiter trivirgatus</i>	Crested Goshawk	4	
		<i>cf. Ictinaetus malayensis</i>	Black Eagle	1	
		<i>Haliastur indus</i>	Brahminy Kite	1	
		<i>Macheiramphus alcinus</i>	Bathawk	8	
		<i>Spizeatus</i> spp.	Changeable Hawk Eagle	2	
	Bucerotidae*	<i>cf. Anthracoceros malayanus</i>	Black Hornbill	3	
		<i>Buceros cf. rhinoceros</i>	Rhinoceros Hornbill	6	
		Bucerotidae spp.	Hornbill	13	
	Corvidae	Corvidae sp.	Crow?	1	
Phasianidae	<i>Arborophila</i> spp.	Partridge	1		
	Phasianidae spp.	Wild Fowl	6		
Strigidae	<i>Ketupa ketupa</i>	Buffy Fish Owl	1		
Mammalia	Bovidae	<i>Bos</i> spp.	Cattle	15	
	Cercopithecidae	Cercopithecidae	Monkey	174	
		<i>Macaca fascicularis</i>	Long-Tailed Macaque	16	
		<i>Macaca nemestrina</i>	Pig-Tailed Macaque	2	
		<i>Macaca</i> spp.	Macaque	8	
		<i>Presbytis (presbytis)</i> spp.	Leaf Monkey (not silvered langur)	17	
		<i>Presbytis</i> spp.	Leaf Monkey	17	
		<i>Presbytis cristata</i>	Silver Langur	2	
	Cervidae	<i>Cervus unicolor</i>	Sambar Deer	15	
		<i>Muntiacus cf. muntiacus</i>	Bornean Muntjac	8	
	Felidae	<i>Felis bengalensis</i>	Leopard Cat	3	
		<i>Felis</i> spp.	Cat (not tiger or clouded leopard)	8	
		<i>Panthera tigris</i>	Tiger	1	
		<i>Neofelis nebulosa</i>	Clouded Leopard	2	
	Hylobatidae	<i>Hylobates</i> spp.	Gibbon	1	
	Hystricidae	Hystricidae spp.	Porcupine	7	
	Manidae	<i>Manis javanica</i>	Pangolin	3	
	Mustelidae	<i>Lutra sumatrana</i>	Hairy-nosed Otter	1	
		<i>Martes flavigula</i>	Yellow-throated Martin	1	
		Mustelidae spp.	Mustelid	1	
	Pongidae	<i>Pongo pygmaeus</i>	Orangutan	91	
	Rhinocerotidae	<i>Dicerorhinus sumatrensis</i>	Sumatran Rhinoceros	1	
	Sciuridae	<i>Ratufa affinis</i>	Giant Squirrel	4	
		Sciuridae spp.	Squirrel	3	
	Suidae	<i>Sus cf. barbatus</i>	Bearded Pig	864	
	Tapiridae	<i>Tapirus indicus</i>	Malay Tapir	1	
	Tragulidae	<i>Tragulus napu</i>	Greater Mouse Deer	7	
		<i>Tragulus</i> spp.	Mouse Deer	1	
	Ursidae	<i>Helarctos malayanus</i>	Sun Bear	3	
	Viverridae	<i>Arctictis binturong</i>	Binturong	12	
		<i>Paguma larvata</i>	Masked Palm Civet	2	
		<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	2	
		<i>Viverra zangalunga</i>	Malay Civet	2	
		Viverridae spp.	Civet Cat	13	
	Reptilia	Bataguridae	Bataguridae spp.	Hard-shelled Turtle	387
			<i>Cyclemys dentata</i>	Asian Leaf Turtle	13
			Geoemydinae (Sub-family) spp.	contains <i>Cyclemys/Heosemys</i>	5
			<i>Heosemys spinosa</i>	Spiny Hill Turtle	8
			<i>Notochelys platynota</i>	Malayan Flat-shelled Turtle	15
		Pythonidae	<i>Python cf. reticulatus</i>	Reticulated Python	7
		Trionychidae	<i>Amyda cartilaginea/ Pelochelys cantorii</i>	Asian Soft-shelled Turtle /Giant Soft-shelled Turtle	2
			<i>Amyda cartilaginea</i>	Asian Soft-shelled Turtle	22
			<i>Dogania subplana</i>	Malaysian Soft-shelled Turtle	7
			Trionychidae spp.	Soft-shelled Turtle	55
		Varanidae	<i>Varanus cf. salvator</i>	Water Monitor	2
			<i>Varanus</i> spp.	Monitor Lizard	111
		Total NISP			

Class	Family	Taxon	Common Name	NISP	
Aves	Accipitridae	<i>cf. Accipiter trivirgatus</i>	Crested Goshawk	1	
		Accipitridae spp.	Hawk	2	
		<i>cf. Ictinaetus malayensis</i>	Black Eagle	2	
		<i>Haliastur indus</i>	Brahminy Kite	2	
		<i>Macheiramphus alcinus</i>	Bathawk	2	
		<i>Spizeatus</i> sp.	Changeable Hawk Eagle	1	
	Bucerotidae*	<i>Buceros cf. rhinoceros</i>	Rhinoceros Hornbill	6	
		Bucerotidae spp.	Hornbill	15	
		<i>cf. Anthracoceros malayanus</i>	Black Hornbill	4	
	Phasianidae	Phasianidae spp.	Wild Fowl	4	
	Strigidae	<i>Ketupa cf. ketupa</i>	Buffy Fish Owl	3	
		Strigidae spp.	Owl	4	
		<i>Strix leptogrammica</i>	Brown Wood Owl	1	
	Mammalia	Bovidae	<i>Bos</i> spp.	Cattle	3
Cervidae		<i>Cervus unicolor</i>	Sambar Deer	1	
		<i>Muntiacus</i> spp.**	Muntjac	9	
Suidae		<i>Sus barbatus</i>	Bearded Pig	1095	
Tragulidae		<i>Tragulus cf. napu</i>	Greater Mouse Deer	27	
Felidae		Felidae spp.	Cat	34	
		<i>Felis bengalensis</i>	Leopard Cat	9	
		<i>Felis cf. planiceps</i>	Flat-Headed Cat	1	
		<i>Neofelis nebulosa</i>	Clouded Leopard	1	
Mustelidae		<i>Aonyx (Amblonyx) cinera</i>	Oriental Small-Clawed Otter	3	
		<i>Martes flavigula</i>	Yellow-Throated Martin	1	
		Mustelidae spp.	Mustelid	2	
Viverridae		<i>Arctictis binturong</i>	Binturong	133	
		<i>Arctogalidia trivirgata</i>	Small-Toothed Palm Civet	1	
		<i>Hemigalus cf. derbyanus</i> .	Banded Palm Civet	1	
		<i>Herpestes</i> spp.	Mongoose	2	
		<i>Paguma larvata</i>	Masked Palm Civet	7	
		<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	1	
		Viverridae spp.	Civet Cat (not Binturong)	104	
		<i>Viverra tangalunga</i>	Malay Civet	2	
Ursidae		<i>Helarctos malayanus</i>	Sun Bear	1	
Erinaceidae		<i>Echinorex gymnurus</i>	Moonrat	1	
Rhinocerotidae		<i>Dicerorhinus sumatrensis</i>	Sumatran Rhinoceros	1	
Manidae		<i>Manis javanica</i>	Pangolin	9	
Cercopithecidae		Cercopithecidae	Monkey	514	
		<i>Macaca fascicularis</i>	Long-Tailed Macaque	13	
		<i>Macaca nemestrina</i>	Pig-Tailed Macaque	1	
		<i>Presbytis (presbytis)</i> spp.	Leaf Monkey (not silvered langur)	8	
		<i>Presbytis cristata</i>	Silver Langur	4	
Hylobatidae		<i>Hylobates</i> spp.	Gibbon	4	
Pongidae		<i>Pongo pygmaeus</i>	Orangutan	128	
Hystricidae		Hystricidae spp.	Porcupine	10	
	<i>cf. Hystrix brachyura</i>	Common Porcupine	2		
	<i>Trichys fasciculata</i>	Long-Tailed Porcupine	2		
Sciuridae	Sciuridae spp.	Squirrel	80		
	Petauristinae spp.	Flying Squirrel	8		
	<i>Ratufa affinis</i>	Giant Squirrel	19		
Reptilia	Bataguridae	Bataguridae spp.	Hard-Shelled Turtles	311	
		<i>Cyclemys dentata</i>	Asian Leaf Turtle	18	
		<i>Heosemys spinosa</i>	Spiny Hill Turtle	7	
		<i>Notochelys platynota</i>	Malayan Flat-Shelled Turtle	26	
	Crocodylidae	<i>Crocodyllus cf. porosus</i>	Estuarine Crocodile	1	
	Pythonidae	<i>Python reticulatus</i>	Reticulated Python	32	
	Testudinidae	<i>Manouria emys</i>	Asian Brown Tortoise	1	
	Trionychidae	<i>Amyda cartilaginea</i>	Asian Soft-Shelled Turtle	10	
		<i>Dogania subplana</i>	Malaysian Soft-Shelled Turtle	2	
		Trionychidae spp.	Soft-Shelled Turtle	30	
	Varanidae	<i>Varanus</i> spp.	Monitor Lizard	404	
		<i>Varanus cf. salvator</i>	Water Monitor	5	
				Total NISP	3136

restricted to species such as the small-toothed palm civet (*Arctogalidia trivirgata*) that contribute no more than one or two bones to the total.

The data suggest that the principal large-bodied terrestrial vertebrate hunted at both sites was the bearded pig (*Sus barbatus*). Bearded pigs follow trails that they themselves produce as they migrate through the forest. In the recent past the hunters of Borneo have either used dogs to track down and bring pigs to bay so that they can be speared at close quarters, or used stealth to creep up and shoot pigs with a blowpipe dart tipped with poison (Puri 2005). However, there is currently no solid evidence for canids, either domestic or wild, in Borneo during the Late Pleistocene or Early Holocene and it is unlikely that the blowpipe is of any great antiquity on the island (Sellato 2002).

Hunters using direct contact or projectile technologies (as opposed to remote ones such as trapping) permit contingent choices in prey selection to be made. Ethnographic evidence suggests that hunters using such technologies will actively select a target animal from within a group. For example, studies of age structure from tooth eruption and attrition in the mandibles of pigs collected by an old Penan hunter using a blowpipe showed that only adult or aged individuals were targeted, irrespective of sex (Cranbrook and Labang 2003). These results contrast markedly with the pig assemblages recovered from the Terminal Pleistocene deposits at the West Mouth and Lobang Hangus – where juvenile, sub-adult and adult pigs were all equally well represented in the middens (see Piper and Rabett in press a, b). Alternatively, trapping may have been only one of the techniques used to capture pigs in the past – a conclusion supported by the age structure of the pigs identified in both archaeological records. Contemporary hunters use a range of generalized and specialized traps that they set along paths well utilized by pigs (Low 1848; St John 1863).

Other large and intermediate-sized nocturnal and diurnal mammals such as the muntjac (*Muntiacus* spp.), mouse deer (*Tragulid* spp.) and Sambar deer (*Cervus unicolor*) also take advantage of the trails produced by pigs from time to time, and this makes them susceptible to entrapment in devices primarily set for pigs. This may go some way to explain the small numbers of these taxa in the archaeological assemblages. Indigenous groups in Borneo also have a range of ingenious devices that they employ to capture numerous different small mammals, ground-dwelling birds and reptiles including leg and neck snares and baited traps (Sloan 1975) and such methods may be of some antiquity.

The hunting of arboreal and semi-arboreal taxa, which are very well represented in the assemblages from both the sites under study here, would certainly have required the employment of very different range of tactics to those used to capture terrestrial vertebrates. Some primate taxa can be caught using baited traps, particularly those that spend a considerable amount of time in low scrub and have diverse diets such as the inquisitive long-tailed macaque (Philip Piper personal observation: see Fig. 4, a



Figure 4. To reach the bait a macaque has to clamber along the horizontal branch and put its head through the wire noose. The trap is sprung when the small twig holding the bait releases the heavy rocks hanging below the branch. In the past, thin but strong strands of rattan were used instead of wire; Photograph by P.J. Piper.

neck trap). The leaf monkeys (*Presbytis* spp.) and orangutan (*Pongo pygmaeus*) on the other hand are much more reluctant to descend from the relative safety of trees, and the gibbon is restricted to the high canopy. Although, some individuals of taxa associated with the high canopy of the rainforest could reflect opportunistic capture of injured animals that have fallen to the ground, this is unlikely to explain the high proportions of primates in the assemblage. The age composition of the hunted Cercopithecidae (macaque and leaf monkey) community, especially at Lobang Hangus, suggests that prime adults, some with the very young still attached, were being selectively targeted by hunters (Piper and Rabett, in review). Some viverrids can also be targeted during the day. The binturong for example, leaves the safety of tree holes on warm sunny days to sun itself high in the tree canopy (Ogilvie 1958).

The recovery of a number of bone points from the Niah deposits provide clear evidence of at least one hunting strategy. The bone points had been extensively modified through fine grinding and scraping techniques, with particular attention paid to functional shape. Only a very few of these points demonstrate use wear or edge polish indicative of repeated use for tasks such as drilling or boring (Reynolds *et al.*, in prep.). Most consist of the tip and part of the shaft and, given that manufacturing traces often extend right up to the basal fractures on several pieces, likely represent the snapped front portions of longer implements. This and other types of damage noted is consistent with experimental studies that demonstrate a tendency to break either at the tip or across the spine at the first unsupported point, namely immediately outside the bound haft (Guthrie 1983; Pasveer 2005; Rabett 2002). There is currently no evidence from body part representation that would suggest the caching of particular skeletal elements for the future production of projectile points and other bone tools. However, the

proximal and distal end off-cuts of primate femora suggest that this long and relatively straight skeletal element was certainly sought after for tool production.

The difference between the broken points recovered from the Terminal Pleistocene at Niah and ethnographic blowpipe darts is that the former demonstrate damage consistent with the high velocity impact required to penetrate deep into an animal's body, rather than the subtle piercing of the skin necessary to transfer poison from a dart into the bloodstream. Thus, it has been argued that the Terminal Pleistocene hunters at Niah were using some form of recoil or leverage weapon (e.g. bow and arrow or possibly, though less likely, a light spear), rather than the blowpipe (Piper and Rabett, in review). Projectile technology could also have been employed to target the raptors and hornbills identified in both archaeological assemblages. Local peoples of Palawan in the Philippines however have many other ingenious techniques for catching birds such as snares mounted on tree branches and glues (Cooper Cole 1922). The noisy hornbill is especially susceptible to capture during breeding when the female is sealed in the nest hole (Bennett *et al.* 1997).

Several well-represented taxa in these archaeological assemblages are not only arboreal but also nocturnal, including the Felidae and Viverridae components – particularly marked at Lobang Hangu. Contemporary hunters will use directed light (e.g. torches) to shine a beam off the reflective retinas of the prey (Puri 2005). Of course, this type of technology would not have been available in the past, and it is not possible to use undirected light from, say burning staves to produce the same effect. Some hunters, such as the Semang of Malaysia, employ other techniques to capture nocturnal animals during the day by trapping them in their nest holes (Hitomi Hongo, pers. comm.).

A number of strictly aquatic taxa are also present in the bone assemblages. The Asian soft-shelled turtle (*Amyda cartiliaginea*) for example is found buried in the mud and silts at the bottom of rivers or ponds. One method of capturing large soft-shelled turtles is to penetrate the soft leathery carapace by wading through the river and stabbing a barbed harpoon into the soft mud (Peter Pritchard, pers. comm.). The Malayan soft-shelled turtle (*Dogania subplana*), on the other hand, is found in small fast moving streams hiding under rocks. Another technique commonly used to capture aquatic prey is poison, whereby the sap from particular tubers is poured into a river suffocating both fish and turtles alike (Harrison 1950). Hard-shelled turtles are often encountered whilst tracking through the forest, or they can be dug from their holes in muddy riverbanks (Medway 1958).

SPATIAL VARIATION IN HUNTING STRATEGIES: THE WEST MOUTH AND LOBANG HANGUS

The composition of the vertebrate faunas from the two sites indicates that the Terminal Pleistocene inhabitants of these caves were using a range of techniques to hunt a wide diversity of arboreal (including nocturnal), terrestrial, semi-arboreal and aquatic animals in the local

forests, rivers and ponds close to Niah. The presence of the gibbon (*Hylobates* sp.) and other taxa restricted to the high canopy suggest that the local environment consisted primarily of dense, mature lowland tropical rainforest, possibly interspersed with some more open woodland. The similarity in composition of the fauna indicates that the hunters occupying the entrances on either side of the Gunung Subis were employing a comparable range of strategies and techniques. This is not unexpected, as the middens are almost contemporaneous and the two cave mouths are no more than a few hundred metres apart.

However, when quantification of the minimum numbers of individuals and the number of individual specimens are adjusted to accommodate for intra- and inter-assemblage comparisons between taxa¹ there is a significant difference in the structure of the dominant families of mammals identified in the two hunted communities ($X^2 = 95.8$; d.f. = 2; $p = 0.00$; Figs 5 - 8). There appears to be no intra-assemblage sub-aerial or post-depositional variability between the remains of different taxa that would account for low numbers of say, viverrids in the West Mouth midden. Furthermore, the similarity in composition of the hunted fauna, the modes of deposition and the expected skeletal element representation for each taxon varies little between the two assemblages, implying no evidence that people had deliberately or inadvertently biased the presence or absence of different taxa in the two assemblages. Thus, we must consider other possibilities to explain the structural variation in the two hunted assemblages.

Pigs and other terrestrial ungulates account for the largest proportion of vertebrate prey in both accumulations, but in the West Mouth make up a much bigger proportion than at Lobang Hangu. In contrast, the midden at Lobang Hangu contains proportionately higher numbers of semi-arboreal and arboreal taxa with the monkeys and viverrids constituting over 56% of the entire assemblage. This implies that arboreal and semi-arboreal taxa were being targeted more often at Lobang Hangu than the West Mouth. One possible reason for this structural variation in the animals hunted could stem from local differences in environment and topography. The flora around the West Mouth is dominated by dense lowland dipterocarp rainforest whereas the vegetation immediately surrounding Lobang Hangu is predominantly lowland swamp forest prone to erratic flooding (Harrison 1966). These differences, if they existed in the past, might have influenced the local abundances of different arboreal and terrestrial taxa, particularly if periodic flooding events restricted access to the area surrounding Lobang Hangu to those ungulates and other ground living species that do not readily swim.

¹ Rectification in this sense is the zooarchaeological quantification of only those bones that can be identified in all the families of vertebrate being compared. This permits unbiased comparisons to be made between the different taxa identified within an archaeological assemblage.

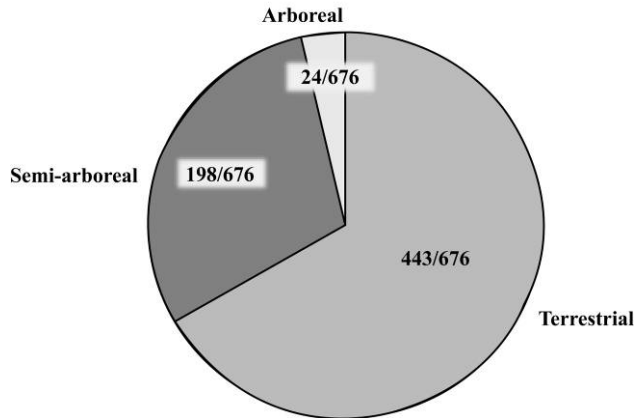


Figure 5. The number of individual specimens (NISP) identified to taxa 'under the rock overhang' associated with arboreal, semi-arboreal and terrestrial habitats (Total NISP = 676).

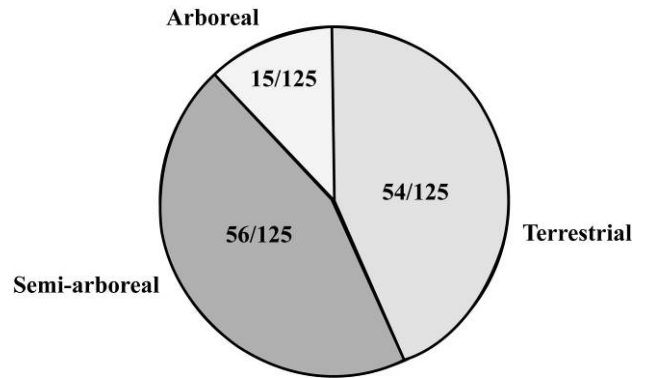


Figure 8. The minimum number of individuals (MNI) identified to taxa in the Lobang Hangus assemblage associated with arboreal, semi-arboreal and terrestrial habitats (Total MNI = 125).

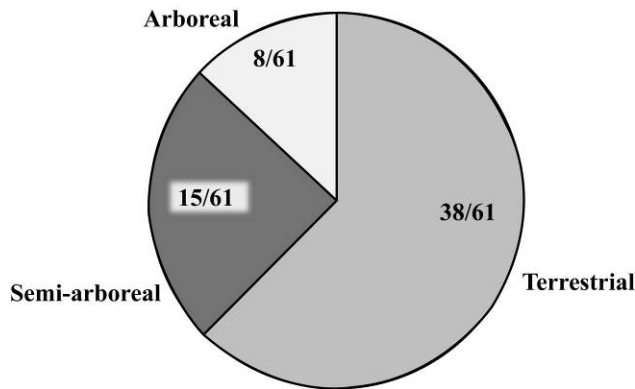


Figure 6. The minimum number of individuals (MNI) identified to taxa 'under the rock overhang' associated with arboreal, semi-arboreal and terrestrial habitats (Total MNI = 61).

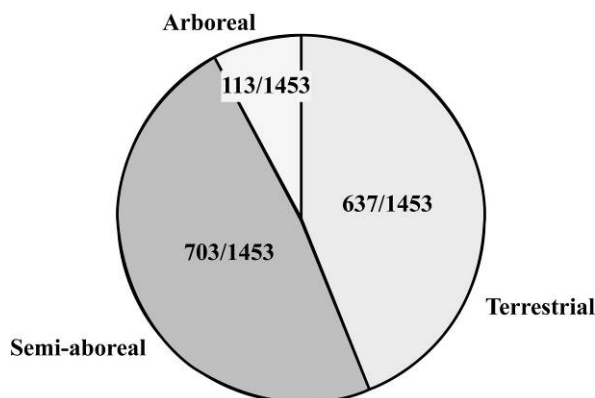


Figure 7. The number of individual specimens (NISP) identified to taxa in the Lobang Hangus assemblage associated with arboreal, semi-arboreal and terrestrial habitats (Total NISP = 1453).

Another taxon that has a much higher presence at Lobang Hangus than the West Mouth is the monitor lizard (*Varanus* spp.). It is unlikely that these prolific scavengers would have died in such quantity whilst feasting on human refuse, so it can be assumed that the remains represent hunted prey.

Monitor lizards are extremely adept swimmers, like swampy areas and feed on small vertebrates and carrion. They are commonly caught in baited traps along with other diurnal and nocturnal carnivores. Thus, higher abundances of this taxon within assemblages that also contain high proportions of carnivores and small omnivores might not be unexpected as some of the methods of capturing monitor lizards can overlap with taxa such as felids and viverrids (Sloan 1975).

Another interesting difference between the Terminal Pleistocene record of the West Mouth and Lobang Hangus is the number of osseous tools recovered. Analysis of these is ongoing, so conclusions are presently provisional. So far, 37 worked bone and tooth fragments have been recovered from deposits beneath the rock overhang in the West Mouth. Five of these have been confirmed as points, of a total of twelve recovered from Late Pleistocene deposits.

By comparison, a total of 83 pieces of worked bone has been identified from contemporary deposits at Lobang Hangus. Of these, 24 can be classified as worked points, with 13 exhibiting a combination of manufacture and use-damage consistent with that expected for projectiles. The remaining 11 are classed as 'expedient' points, that show less labour investment in working, finishing and use (following a procedure adapted from Choyke 1997). The function of points in this category is less clear owing to the limited extent of their modification, but use as low investment armatures is quite plausible.

Even taking into account the slight variation in sample sizes between the two accumulations, initial results suggest that a considerably higher proportion of the worked bone fragments from Lobang Hangus can be attributed to use as projectiles (an even higher proportion, if one includes the low investment pieces).

Combined with the predominance of primates, felids and viverrids this implies that a greater emphasis was placed on hunting arboreal game at Lobang Hangus than in the West Mouth, and that hunting with projectiles and trapping were most likely two important methods of procuring small and intermediate-sized taxa.

The platform at the entrance to Lobang Hangu overlooks an almost sheer drop to the forest floor, 43 m below. A patient and observant hunter would have been afforded excellent views of movement in the tree canopy and a vantage point from which to target game with a range weapon that is not possible through the dense foliage from the forest floor. The West Mouth is equally elevated above the forest floor, distance and drop to the canopy would have limited hunting opportunities from within the cave itself.

CONCLUSION

The large and well-preserved Terminal Pleistocene bone assemblages recovered from the West Mouth and Lobang Hangu entrances to Niah Cave have provided invaluable insights into the hunting strategies employed by the human inhabitants of the caves. The similarity in the composition of the vertebrate faunas indicates that visitors to both sites were using a range of different hunting techniques to capture prey from a variety of ecological zones within the mature lowland tropical rainforests surrounding the caves.

However, the identification of notable differences in the structure of the vertebrate communities from the two entrances reveals subtle variation in the human subsistence and technological behaviours at Niah during this period.

We contend that such notable variation in the structure of the vertebrate communities from the West Mouth and Lobang Hangu are most parsimoniously explained as a result of the conscious tailoring of hunting strategies to take advantage of and compensate for differences in the local topographic and environmental conditions that existed on either side of the Niah outcrop. Variability in topography probably had a strong influence on the composition and structure of the local vegetation and this in turn impacted on the presence, absence and abundance of arboreal, semi-arboreal and terrestrial taxa inhabiting the environments surrounding the cave entrances. The higher proportions of primates and viverrids at Lobang Hangu suggest that the east side of the outcrop was a favoured location for capturing these types of prey. The primates (and to a certain extent snoozing civet cats) could have been targeted from the high vantage point of Lobang Hangu with its elevated position close to the tree canopy – certainly with the advantage of a range weapon such as the bow and arrow.

This study has shown that early hunting and gathering groups who frequented Niah Cave had an intimate knowledge of the environments of Pleistocene north Borneo and specific understanding of resources afforded by the subtly different habitat in the vicinity of the Gunung Subis itself. They possessed the technological capabilities to enable them to modify and tailor hunting strategies to compensate for these variations in prey abundance. It further demonstrates that generalised interpretations of hunter-gatherer behaviour based on single-site records should be treated with caution, as the form of subsistence activities and the means used to achieve them, by near-

contemporaneous (or possibly even the same) groups is, from this evidence, subject to modification in response to subtle differences in the structure of the local environment.

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