VERTEBRATE FAUNAL REMAINS FROM MADAI CAVES (MAD 1/28), SABAH, EAST MALAYSIA

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INTRODUCTION

This report discusses the results of a study of the vertebrate faunal remains recovered from MAD 1/28, Madai Caves, Sabah, East Malaysia. The material was excavated in 1980 by Madeleine Piper and Peter Koon (Bellwood 1988a). The sample under study includes a total of 2168 bones, with a combined weight of 3384 g.[1] The vertebrate fauna includes mammals, reptiles, birds and fishes. In addition, the remains of invertebrates (molluscs and crustaceans) were also recovered during excavation, but these were not included in the present analysis.

The MAD 1/28 excavation comprised three one-meter squares, designated D28, E28, and F28. Bellwood (1988a) notes that the soil layers in the MAD 1/28 trench were not clearly defined or banded, and that the entire sequence should probably be regarded as a single layer. During excavation of the site the sequence was arbitrarily subdivided into four main layers, with layer 2 forming an upper archaeological unit, and layers 2a, 2b and 2c combined as a lower archaeological unit. Although layer 2 has a radiocarbon date of 9,150±100, the pottery indicates a commencement date for deposition of this layer sometime after 3000 BP (corresponding to the Idahan and Atas Periods) (Bellwood 1988a, b). Radiocarbon dates for freshwater shell samples from layers 2a and 2c indicate dates of occupation between 7,000 BP and 10,500 BP (corresponding to the Bilo-Sarapad Period) (Bellwood 1988a, b). If this interpretation is correct, the two archaeological units are separated by a depositional or erosional hiatus which may have lasted more than 4,000 years. However, there appears to be no discernible distinction between the faunal remains from the different layers or archaeological units, especially given the relatively small sample sizes involved, and in this report the fauna is considered as a whole.

PRESERVATION AND TAPHONOMY

The vertebrate remains from MAD 1/28 are fragmentary, and few of the specimens represent complete skeletal elements (of the limb bones recovered only 19.3% are entire). Almost half of the bone fragments (40.1%) have a maximum length of less than 20mm, while 93.4% are less than 40mm in length (Table 1). The longest bone fragment has a maximum length of 92.3mm. Similar indications of a high degree of fragmentation can be deduced from data on the weight of individual specimens. The average weight of teeth, bones and bone fragments from the site is only 1.56g (Table 2). This compares with 1.0g, 2.1g and 0.8g for average specimen weights from MAD 1, 2 and 3 respectively (Cranbrook 1988a). Although the degree of fragmentation is high throughout the sequence at MAD 1/28, there is a distinct decline in the average size and numbers of bones with increasing depth in the cave deposits (see Table 2).

Although some of this breakage can be attributed to diagenetic processes or damage during the recovery and sorting phase of the excavation, it is evident that much of the fragmentation had occurred prior to burial of the material. There is evidence to suggest that humans may have been directly responsible for a significant part of this damage. Burned bones are quite common throughout the sequence, and these generally exhibit the greatest degree of charring at the missing end of the bone. Small fragments of long bones of large mammals are abundantly represented in the collections, but they are too fragmentary to identify either anatomically or taxonomically. This pattern of damage is characteristic of assemblages where the bones have been smashed by humans in order to extract marrow (see Medway 1966).

In addition, several of the bones bear evidence of having been cut or prepared by humans. There are at least

Table 1: Distribution of maximum length of bones and bone fragments[1] at MAD 1/28

Maximum length of bone (mm)	Number of bones	% of sample
0-10	76	3.5
10-20	793	36.6
20-30	807	37.2
30-40	348	16.1
40-50	89	4.1
50-60	36	1.7
60-70	8	0.4
70-80	6	0.3
80-90	4	0.2
90-100	1	0.1
Totals	2,168	100.2

[1] Includes entire bones, bone fragments and teeth.

12 longbone and metapodial fragments from layers 2 and 2a that appear to have been cut into short segments (20-50mm long) with sharp transverse cuts at one or both ends of the bone, possibly made with a metal blade. In some cases the cut ends have been polished smooth. It is likely that these segments were used as beads, or at least blanks for beads. All are rather crudely made, and none shows any evidence of surface decoration. In addition, a small unidentifiable fragment of bone from level 2a appears to have been crudely perforated or punctured, and a partial metatarsal of a medium-sized bird[2], also from level 2a, has a deep transverse cut in the shaft which has allowed a narrow splinter of bone (3 x 40mm) to be removed. This evidence of bone working by humans is perhaps significant in light of previous observations that bone tools are extremely rare as archaeological occurrences at Madai. The paucity of bone artifacts at MAD 1/28 is in marked contrast to the situation at Niah Cave in Sarawak, where such artifacts are relatively common, at least in Neolithic levels younger than 8,000 BP (Harrisson 1958, 1959, 1978; Harrisson & Medway 1962; Medway 1966; Cranbrook 1988a). Bellwood (1988c) has suggested that this might be related to the greater availability of high-quality chert for tool manufacture at Madai.

The use of metal instruments, at least in level 2, is confirmed by the recovery of a rib fragment of a large mammal that bears a series of fine obliquely-oriented subparallel cuts and cut marks. A similar find from MAD 1 was reported by Cranbrook (1988a). Bellwood (1988d) notes that iron fragments were found throughout layer 2 at MAD 1/28, probably representing the remains of blade fragments of *parang*-like implements.

Table 2: Weight of teeth, bones and bone fragments by square and layer at MAD 1/28.

		SQUARE D28	E28	F28	TOTAL
Layer 2	n	234	225	299	758
	wt	458.5	482.3	490.6	1431.4
	X	2.0	2.1	1.6	1.9
	Density (bones/m^3)				632
Layer 2a	n	235	310	98	643
	wt	365.5	521.8	159.8	1047.1
	X	1.6	1.7	1.6	1.6
	Density (bones/m^3)				714
Layer 2b	n	9	263	50	322
	wt	4.2	349.8	78.7	432.7
	X	0.5	1.3	1.6	1.3
	Density (bones/m^3)				537
Layer 2c	n		374	71	445
	wt		426.9	45.6	472.5
	X		1.1	0.6	1.1
	Density (bones/m^3)				212
Layers All	n				2168
	wt				3383.7
	X				1.6
	Density (bones/m^3)				482

N = number of specimens; wt = total weight of bones; X = mean weight of bones.

Since some of the bones appear to be dried and weathered, it is clear that they were exposed on the surface as part of the general cave litter for some time prior to burial. In this case, some of the marked degree of breakage may be due to the effects of trampling, especially by the human visitors and occupants of the cave.

Due to the degree of fragmentation, only 26.8% of the sample can be reliably identified to anatomical element.

Of these, the majority represent relatively robust elements, such as mandibular fragments, distal humeri, proximal femora, proximal radii, proximal ulnae, astragali, calcanea and metapodials (Tables 3 and 4). Apart from a sizeable sample of isolated teeth (n=37) and some mandibular fragments, cranio-dental material is rare and extremely fragmentary. This has limited the ability to identify material from the site to particular taxa.

Table 3: Number and frequency of anatomical elements represented at MAD 1/28.

Anatomical Element		NISP	%
Cranio-dental elements			
Cranial fragments (incl. horn cores)		19	5.7
Mandibular fragments		18	5.4
Isolated teeth		37	11.1
Vertebrae			
Cervical		0	0.0
Thoracic		9	2.7
Lumbar		5	1.5
Sacrum		2	0.6
Caudal		20	6.0
Vertebral fragments		21	6.3
Forelimb			
Scapula fragments		5	1.5
Humerus	entire	2	0.6
	shaft	1	0.3
	proximal	3	0.9
	distal	12	3.6
Ulna	entire	2	0.6
	proximal	5	1.5
	distal	1	0.3
Radius entire		2	0.6
	proximal	8	2.4
	distal	2	0.6
Carpals		6	1.8
Metacarpal fragments or entire		3	0.9
Hindlimb			
Pelvic fragments		10	3.0
Femur	entire	4	1.2
	shaft	1	0.3
	proximal	8	2.4
	distal	2	0.6
Patella		1	0.3
Tibia	entire	1	0.3
	proximal	0	0.0
	distal	2	0.6
Fibula	entire	0	0.0
	proximal	1	0.3
	distal	0	0.0
Astragalus		5	1.5
Calcaneum		7	2.1
Other tarsals		5	1.5
Metatarsal fragments or entire		7	2.1
Other			
Rib fragments		20	6.0
Sternum		0	0.0
Clavicle		0	0.0
Metapodial fragments or entire		35	10.5
Phalangeal fragments or entire		39	11.7
Sesamoids		2	0.6
Total		**333**	**99.9**

FAUNAL REMAINS

The fauna from the site includes invertebrates (molluscs and crustaceans) and vertebrates (fishes, reptiles, birds and mammals). The invertebrate remains from MAD 1/28 are not included in the present study, but they have been discussed briefly in several earlier reports (Bellwood 1988e; Cranbrook 1988a). Molluscs make up a significant component of the fauna, with shells being appreciably more common than vertebrate remains. The molluscan fauna from MAD 1/28 is apparently quite diverse (comprising at least 13 genera), and includes marine and freshwater gastropods and bivalves, as well as terrestrial gastropods (Bellwood 1988e). However, more than 70% of the molluscs recovered from MAD 1/28 belong to *Balanocochlis* sp., a freshwater gastropod that is found commonly in archaeological levels at Baturong and Madai (Bellwood 1988c). The only other invertebrate remains identified are crab claws, which are rare, but are found throughout the sequence.

Table 4: Survivorship of anatomical elements at MAD 1/28.

Element	Number of elements in composite mammal[1]	Minimum number of element recovered from site	% Survivorship[2]
Mandibular fragments	2	18	100.0
Humerus	2	14	77.8
Femur	2	12	66.7
Radius	2	10	55.6
Ulna	2	7	38.9
Calcaneum	2	7	38.9
Metapodials	16	45	31.3
Astragalus	2	5	27.8
Sacrum	1	2	22.2
Tibia	2	3	16.7
Caudal vertebrae	15	20	14.8
Isolated teeth	34	37	12.1
Lumbar vertebrae	6	5	9.3
Phalanges	48	39	9.0
Thoracic vertebrae	14	9	7.1
Other tarsals	8	5	6.9
Fibula	2	1	5.6
Patella	2	1	5.6
Carpals	16	6	4.2

[1] Based on average number of elements found in *Sus*, *Bos*, *Cervus*, *Dicerorhinus*, *Rattus*, *Viverra*, *Macaca* and *Homo*.

[2] % survivorship of elements = 100 x number of elements recovered ÷ number of elements in composite animal ÷ maximum MNI. MNI based on mandibular fragments = 9.

Of the vertebrate remains, those of mammals comprise more than half (54.2%) of all specimens recovered, followed in importance by reptiles (37.5%), fishes (6.3%) and birds (2.0%). The rarity of bird bones at MAD 1/28 is

consistent with the findings of Cranbrook (1988a), who reported that they were uncommon at other Madai sites.

Reptiles are well-represented at MAD 1/28. These consist mainly of carapace fragments of freshwater turtles. At least two chelonian families are represented in the collections - the Trionychidae and Bataguridae - of which the latter comprises 85% of the turtles. This is consistent with the predominance of batagurids in the present-day herpetofauna of Borneo (Iverson 1992). However, since turtle carapaces can fragment into a large number of individual pieces, and since these fragments tend to be extremely durable and easily recognisable, the apparent frequency of turtles in the fauna is certainly over-represented. The fact that few chelonian cranial and postcranials bones have been recovered from MAD 1/28 would tend to confirm this suspicion. Nevertheless, even after eliminating carapace fragments from the calculations, reptiles still represent a significant component of the vertebrate fauna (16.8%). Varanids are most commonly represented (56.6% of reptiles), followed by snakes and lizards (31.6%), and turtles (11.8%). The turtles were clearly introduced into the cave by humans, but whether or not the other reptiles were food items or simply cave visitors is not possible to determine.

The rarity of fish bones is noteworthy in view of the fact that humans were evidently exploiting other riverine and marine resources, such as molluscs, crabs and turtles. However, the majority of fish bones recovered were relatively large and robust elements, so a taphonomic and/or collecting bias against smaller, more fragile bones cannot be ruled out. The paucity of birds and micromammals in the fauna provides additional support for such a bias.

Mammal remains are abundant, although the degree of fragmentation of the bones makes taxonomic identifications difficult. Nevertheless, nineteen species, including humans, have been identified (Table 5). The most common mammals at MAD 1/28 are suids (41.4%) and cercopithecids (28.0%), and the assemblage is typical of prehistoric cave sites in Borneo in having these two groups predominate (Medway 1958a, 1959a, 1977a, b; Hooijer 1961, 1962; Harrison 1996). The suid cranio-dental remains can all be referred to the bearded pig (*Sus barbatus*), although it cannot be ruled out that some of the isolated postcranial remains might belong to the domestic pig (*Sus scrofa*). Cranio-dentally, cercopithecids are represented by an edentulous maxillary fragment and five isolated teeth; all assigned to the longtailed macaque (*Macaca fascicularis*). Monkeys are also represented by 46 postcranial specimens, but these are difficult to assign to a particular taxon. They all belong to relatively small species, consistent in size with *Macaca fascicularis* or *Presbytis* spp. Other non-human primates from MAD 1/28 include the remains *Pongo pygmaeus* and *Hylobates* sp., which together comprise 3.8% of the mammalian fauna.

Table 5: List of vertebrate taxa from MAD 1/28.

Mammalia		
Artiodactyla		
Suidae		
	Sus barbatus	Bearded pig
Bovidae		
	Bos javanicus	Banteng
Cervidae		
	Cervus unicolor	Sambar deer
	Cervus sp.	
	Muntiacus cf. *muntjak*	Bornean red muntjac
Perissodactyla		
Rhinocerotidae		
	Dicerorhinus sumatrensis	Sumatran rhinoceros
Pholidota		
Manidae		
	Manis javanica	Pangolin
Rodentia		
Sciuridae		
	Ratufa affinis	Giant squirrel
	Petaurista sp.	Giant flying squirrel
Muridae		
	Rattus sp.	Rat
Carnivora		
Ursidae		
	Helarctos malayanus	Sun bear
Viverridae		
	Viverra tangalunga	Malay civet
Felidae		
	Panthera tigris	Tiger
Primates		
Cercopithecidae		
	Macaca fascicularis	Long-tailed macaque
Hylobatidae		
	Hylobates sp.	Gibbon
Hominidae		
	Pongo pygmaeus	Orang-utan
	Homo sapiens	Human
Chiroptera		
Pteropodidae		
	Pteropus vampyrus	Flying fox
Hipposideridae		
	Hipposideros diadema	Diadem roundleaf bat
Aves		
Reptilia		
Chelonia		
Trionychidae		
Bataguridae		
Squamata		
Varanidae		
	Varanus sp.	
Teleosti		

Most other species of large mammals are uncommon, being represented by a few isolated specimens only. These are as follows: *Bos javanicus* (naviculo-cuboid and two phalangeal fragments); *Cervus* spp. (two lower molars and a phalanx); *Muntiacus* cf. *muntjak* (lower molar and two podials); *Dicerorhinus sumatrensis* (podial); *Manis javanicus* (terminal phalanx); *Helarctos malayanus* (lower molar); *Panthera tigris* (navicular); and *Viverra tangalunga* (proximal ulna). With the exception of the tiger, all of these species are found today in the immediate environs of Madai Caves.

The discovery of a navicular of a tiger from MAD 1/28 is especially significant, because this species is absent from the modern-day Bornean fauna. In fact, this is only the second known archaeological occurrence of a

Table 6: Number of individual specimens (NISP), minimum number of individuals (MNI) and percentage of mammalian taxa at MAD 1/28.

Taxon		NISP	MNI	% NISP (% MNI)
Suidae				41.4 (10.3)
Sus barbatus	Bearded pig	77	3	
Bovidae				1.6 (3.4)
Bos javanicus	Tembadau	3	1	
Cervidae				3.2 (10.3)
Cervus unicolor	Sambar deer	2	1	
Muntiacus cf. *muntjak*	Bornean red muntjac	3	1	
Indeterminate cervids		1	1	
Rhinocerotidae				0.5 (3.4)
Dicerorhinus sumatrensis	Sumatran rhinoceros	1	1	
Manidae				0.5 (3.4)
Manis javanica	Pangolin	1	1	
Rodentia				8.1 (17.2)
Ratufa affinis	Giant squirrel	2	1	
Petaurista sp.	Giant flying squirrel	2	1	
Rattus sp.	Rat	1	1	
Indeterminate rodents		10	2	
Carnivora				2.7 (13.8)
Helarctos malayanus	Sun bear	1	1	
Viverra tangalunga	Malay civet	1	1	
Panthera tigris	Tiger	1	1	
Indeterminate carnivores		2	1	
Cercopithecidae			3	28.0 (10.3)
Macaca fascicularis	Long-tailed macaque	6		
Indeterminate cercopithecids		46		
Hominoidea				10.8 (13.7)
Hylobates sp.	Gibbon	2	1	
Pongo pygmaeus	Orang-utan	5	1	
Homo sapiens	Human	13	2	
Chiroptera				3.2 (13.7)
Pteropus vampyrus	Flying fox	1	1	
Hipposideros diadema	Diadem roundleaf bat	4	2	
Indeterminate chiropterans		1	1	
Total		**186**	**29**	**100.0 (99.5)**

tiger on Borneo (the tip of an unerupted canine was recorded from superficial levels at Niah Cave), and it helps to confirm previous indications that tigers were native to the island, and only became extinct during the Holocene (Hooijer 1963; Medway 1977a). Other mammals absent from Borneo today, but known from the archaeological record, include the Javan rhinoceros (*Rhinoceros sondaicus*), the dhole (*Cuon alpinus*), and the Malayan tapir (*Tapirus indicus*) (Medway 1959b, 1960, 1965; Hooijer 1963; Rookmaaker 1977; Cranbrook 1986, 1988b; Harrison 1996). In addition, the Asian elephant (*Elephas maximus*), which is today restricted to a relict population in northeastern Borneo, may have been re-introduced on the island during historic times (Hooijer 1955, 1972; Von Koenigswald 1958; Medway 1964a; Harrisson & Harrisson 1971; Payne *et al.* 1985; Santiapillai & Jackson 1990).

The disappearance of these large mammals on Borneo is probably related to late Pleistocene eustatic fluctuations that caused climatic and vegetational changes (Medway 1977a; Harrison 1996). During the Last Glacial Maximum, at around 18,000 BP, the mean annual temperature in lowland Borneo was probably 3-7°C lower than at present, and rainfall was reduced and more seasonally distributed (Petersen 1969; Haile 1971; Biswas 1973; Verstappen 1975; Medway 1977a; Whitmore 1981; Van der Kaars & Dam 1995; Harrison 1996; Linsley 1996). The resulting drier, seasonal forest provided suitable habitats for large herbivorous mammals and their dependant guild

Table 7: Comparison of the body weight distribution of mammalian species at MAD 1/28 and the modern local fauna.

Average body weight (kg)[1]	Total local fauna (No. of species)[2]	Fauna from MAD 1/28	
		No. of species	% represented
0 - 1	45	1	2.2
1 - 10	33	6	18.2
10 - 45	5	1	20.0
45 - 180	4	4	100.0
> 180	6	3	50.0

1 Body weight classes derived from Andrews *et al.* 1979. Body weight data for Bornean mammals were obtained or estimated from Payne *et al.* 1985.

2 The total fauna includes all modern species with recorded occurrences in southeastern Sabah, as well as those species that are extinct on Borneo today but are known from prehistoric sites in Sabah (i.e. dhole, tapir, Javan rhinoceros, tiger). This represents the maximum number of species that potentially could be represented in the fauna from MAD 1/28.

of carnivores. With the establishment on Borneo of non-seasonal perhumid tropical rainforests during the Holocene, habitats for these large mammal species became suboptimal, leading either to declining numbers (*Dicerorhinus sumatrensis* and ?*Elephas maximus*) or local extinctions (*Tapirus indicus*, *Rhinoceros sondaicus*, and *Panthera tigris*).

Small mammals are remarkably rare at MAD 1/28, comprising only 11.3% of the mammalian fauna. Skeletal remains of rodents and bats are often extremely common in cave sites, such as Niah Cave (Medway 1958a, b 1964b; Aldridge & Cranbrook 1963; Cranbrook 1966), but they are poorly represented at MAD 1/28. Moreover, the size distribution of rodent postcranials is heavily skewed towards medium-sized and large species (those exceeding 150 g), indicating a distinct bias against preservation of elements belonging to smaller species. Although almost half of all mammalian species (excluding bats and marine mammals) in the modern local fauna have an average body weight of less than 1 kg, only one species recovered from MAD 1/28 (*Rattus* sp.) falls into this size category (Table 7). As with the low frequency of other microvertebrates at the site, this is presumably a consequence of ecological, taphonomic or collecting bias, or a combination of these factors.

HUMAN SKELETAL REMAINS

A number of large bone fragments of different consistency from the majority of faunal remains (i.e., softer, more lightweight, friable and cancellous), often found in association, are likely to represent the poorly-preserved remains of human burials interred in shallow graves in the cave soil or placed in coffins on the surface. These burials intrude down to at least level 2a. Some charred and cut bones are also tentatively identified as belonging to humans, providing evidence that the cave may have been used as a site for funereal (or cannibalistic) practices. However, only thirteen isolated bones and teeth can be *definitively* identified as human, and these comprise 7.0% of the anatomically identifiable bones from the site.

SUMMARY

This report presents the results of a study of the vertebrate faunal remains recovered during excavations at MAD 1/28, Madai Caves in Sabah, East Malaysia. The main results can be summarised as follows:

(1) More than two thousand bones, bone fragments and isolated teeth were recovered, comprising the remains of mammals (54.2%), birds (2.0%), reptiles (37.5%), and fishes (6.3%).

(2) The vertebrate remains are mostly fragmentary. Although some of this breakage can be attributed to diagenetic processes or damage during the recovery and sorting phase of the excavation, much of the fragmentation apparently occurred prior to burial. Humans were evidently directly responsible for a significant part of this damage, as indicated by the occurrence of smashed bone, charring and cutmarks. The degree of fragmentation of the bones makes anatomical and taxonomic identifications difficult.

(3) The collection includes a number of bone artifacts, but these are much less common at Madai than they are in contemporary levels at Niah Cave, Sarawak.
(4) Nineteen species of mammals have been identified, including humans. The most common mammals are the bearded pig (*Sus barbatus)* and monkeys, and in this respect the MAD 1/28 assemblage is typical of prehistoric cave sites in Borneo. Most other species of mammals are relatively uncommon, being represented by a few isolated specimens only. Most significant is the discovery of a navicular of a tiger (*Panthera tigris*), a species absent from the modern-day Bornean fauna. This specimens helps to confirm previous indications that tigers were native to Borneo during the late Pleistocene and Holocene.
(5) Small mammals (i.e., bats, insectivores, and rodents) are extremely rare at MAD 1/28, presumably as a result of ecological, taphonomic or collecting biases.
(6) Thirteen isolated bones and teeth can be identified definitely as belonging to humans, although a number of large bone fragments of different consistency from the majority of faunal remains are likely to represent poorly-preserved remains of human burials.

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NOTES

1. This latter weight is less than the previous value of 3843 g reported by Bellwood (1988b), due to the exclusion of items subsequently identified as non-bone.

2. Birds are of special ritual significance for Borneans, even today, and their limb bones are quite commonly used for manufacturing beads and other personal ornaments (Harrisson 1958; Harrisson & Medway 1962).

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