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Terminal Pleistocene and Early Holocene Human Occupation in the Rainforests of East Kalimantan¹

Karina Arifin

This paper presents results of archaeological excavations at two rock shelters and a cave in the Berau region of East Kalimantan. The investigations produced significant new evidence for the occupation of tropical rainforest environments along the Upper Birang River by human foragers from at least the end of the Last Glacial Period. The substantial bone assemblages, human burials and material culture recovered during excavation have provided important insights into modes of subsistence, burial traditions and technological innovations from the terminal Pleistocene through the Holocene. The observed patterns in human cultural and ideological behaviour correspond well with evidence from elsewhere in Borneo and across Island Southeast Asia.

Introduction

The island of Borneo has produced significant Palaeolithic archaeological deposits encompassing much of the Late Pleistocene and Holocene, from as early as 50,000 years ago. Most well documented archaeological investigations have focused on Sarawak and Sabah in the west, in Malaysian Borneo. Of these, probably the most significant excavations have concentrated on the Niah Caves, Sarawak, where Tom and Barbara Harrisson identified a deep, well-stratified sequence of archaeological deposits spanning the Late Pleistocene to sub-recent, and recovered anatomically modern human remains dated to ca. 35,000 BP (Harrisson, 1957, 1958, 1970; Brothwell 1960; Bellwood 1997: 172; Barker et al. 2007; Barker 2013). Subsequent excavations have illustrated the complexities of human frequentation of the caves, the diverse foraging strategies employed, changes in lithic artefact repertoires with the increasing utilisation of plant processing technologies and the emergence of burial traditions in the early to mid-Holocene (Zuraina Majeed-Lowee 1981; Rabett et al. 2013). Other notable archaeological investigations that have enhanced our knowledge of Bornean and Southeast Asian prehistory have been conducted at Lubang Angin and Gua Sireh (Datan 1993), Madai and Baturong caves (Bellwood 1988), Bukit Tengkorak (Bellwood 1989; Chia 1997) and Tingkayu (Bellwood 1997: 177–180). Some research has been undertaken in Kalimantan, for example, Chazine (1994, 2005), Chazine and Ferrié (2008) and Widiyanto et al. (1997) have all reported on excavations at various caves and rock shelters that have produced evidence of flexed burials typical of the early to mid-Holocene.

¹ An earlier version of this paper was presented at the 17th Congress of the Indo Pacific Prehistory Association, Taipei, 2002.

However, the potential of these large limestone karst landscapes to provide new and significant data on human occupation and adaptation to humid tropical rainforest environments in the region is yet to be fully realised.

This paper addresses some of the outstanding questions regarding Palaeolithic human occupation of eastern Kalimantan. Archaeological excavations were conducted at two cave sites and a rock shelter: Liang Gobel, Lubang Payau and Kamanis in the Berau region along the Upper Birang River. The investigations demonstrate that Eastern Kalimantan possesses a rich Late Pleistocene and Holocene archaeological record comparable with that discovered to the west in Sarawak and Sabah, and provide significant new insights into human occupation of the region, technological innovation and cultural and ideological developments.

The archaeological investigations

Units of Analysis: Each trench in the various cave and rock shelter entrances was excavated using 5 cm, or in the case of LPY/D5 10 cm, spits. For accuracy in analyses, assemblages from each excavation pit were 'grouped' into different analytical units, which represent hypothetical units of activity, or phases of occupation. The 'boundaries' of each analytical unit were delineated by observations of the stratigraphic sequence excavated, and by the characteristics of recovered archaeological assemblages such as content and density of material culture. Thus, an analytical unit generally consisted of several 5 cm spits and straddled more than one stratigraphic unit. By distinguishing analytical units in this way it became possible to clearly determine spatial and temporal changes in the archaeological record at both the intra- and inter-site levels (Table 6.1).

Table 6.1 A summary of number of units recorded for Kimanis trenches KMS/C4, KMS/C8, KMS/TP and Lubang Payau LPY/C3; the numbers within the columns represent the spits and their depths below modern ground level allocated to each of the analytical units recorded for each site.

Unit	Spit/Depth (cm)			
	KMS/TP	KMS/C4	KMS/C8	LPY/C3
I	1-10 (0<x≤50 cm)	1-10 (0<x≤50 cm)	1-10 (0<x≤50 cm)	1-8 (0<x≤40 cm)
II	11-21 (50<x≤105 cm)	11-23 (50<x≤105 cm)	11-27 (50<x≤135 cm)	9-18 (40<x≤90 cm)
III	-	24-34 (105<x≤160 cm)	-	19-32 (90<x≤160 cm)
IV	-	35-42 (160<x≤200 cm)	-	-
V	-	43-61 (200<x≤295 cm)	-	-

Source: K. Arifin.

The following information is primarily drawn from Arifin (2004). Archaeological investigations were conducted at three cave and rock shelter sites in a limestone massif in the tropical rainforest in the upper reaches of the Birang River, about 60 km in a straight line from the east coast of Borneo (Figure 6.1). The three sites investigated were Liang Gobel, Lubang Payau and Kimanis.

Figure 6.1 Map of Borneo illustrating the location of the Upper Birang and other key archaeological sites across the island.

Source: After Arifin 2004: 9.

Liang Gobel was the smallest rock shelter (8 m long by 5 m wide) excavated in this study. It is situated on a 5 m high limestone wall, at 205 m above sea level (asl) and just a few metres from a path that leads to the site of Lubang Payau, no more than a few hundred metres away. A test pit (1 m x 2 m) labeled LGB/TP was excavated in the middle of the site. It possessed one unit split into three layers, consisting of loose brown ashy silts. Combined, the total depth of deposit was no more than 0.2 m. The excavations produced a small number of earthenware sherds, some lithics and some vertebrate and invertebrate remains.

Lubang Payau is a commercial bird's nesting cave with two tunnels leading to an underground river. The cave is situated at 206 m asl and has a chamber that covers approximately 10 m x 20 m with a flat platform at the entrance, before gradually sloping towards the interior. Two test pits were excavated in the middle of the entrance gallery. Trench LPY/C3 was the closest of the trenches to the cave entrance. It was excavated at the highest point in the cave floor and measured 1 m x 2 m with the long axis orientated east–west. This trench produced the most informative sequence of occupation in Lubang Payau, extending to a total depth of 1.6 m. LPY/C3 could be divided

into three units consisting of sandy silts (Unit I) overlying the silts and silty clays of Units II and III. Unit I had a depth of *ca.* 0.4 m and consisted of a sequence of thin deposits that contained earthenware pottery. Unit II comprised two stratigraphic layers of total depth *ca.* 0.45 m, with the upper containing the greatest density of archaeological materials, and concentrations diminishing towards the base of the unit. The upper of the two stratigraphic layers assigned to Unit III (total depth *ca.* 0.7 m) was really an extension of Unit II, but contained fewer cultural remains. The basal deposits were devoid of any evidence of human activity. Earthenware pottery was only recorded in the upper layers (Unit I) along with three shell scrapers manufactured from the mangrove bivalve *Geloina erosa*, most of the animal bones and shell. Stone artefacts were recovered throughout the archaeological sequences but with a concentration within Unit II. Although isolated human bones were recovered, no distinctive burials were identified.

Trench LPY/D5 was situated towards the interior of the cave, *ca.* 2 m to the northeast of Trench LPY/C3, and measured 2 m x 2 m. LPY/D5 had a total depth of 0.5 m, but only the upper 0.3 m contained any archaeological materials (below this was sterile sandy silts). Within this single activity unit all but Spit 6 possessed earthenware pottery, with lithics, animal bone and shell to the base.

Three samples were dated from Lubang Payau using radiocarbon, one on charcoal and two on freshwater shell, all from LPY/C3 (Table 6.2). The two dates, one on charcoal, the other on freshwater shell, both from Spit 6 (Unit II), emphasise the problem of potential 'old carbon' uptake during the construction of the calcium carbonate shell in limestone karst regions (ANU-11152 and ANU-11260). This conclusion is supported by Bellwood (1988: 120) and Datan (1993: 17), who have suggested that at Madai Cave in Sabah and Gua Sireh in Sarawak, respectively, freshwater shell dates were approximately 500 years older than those on charcoal from the same stratigraphic layers. Spriggs (1989: 598) has argued that 'old carbon' in shell can result in unpredictable ages, potentially greater than 1,500 years older than those recorded for charcoal from corresponding deposits. In the case of the Upper Birang samples the error is probably even greater than this. For example, in Kimanis trench KMS/C4, a freshwater shell dated to 13,860±180 (ANU-11258) was derived from the same layer (Spit 24, 105–110 cm below the surface) as charcoal dated to 10,030±260 BP (ANU-11150) suggesting a potential 3,000 year deviation (see Table 6.2). As a result, only the charcoal dates from Lubang Payau and Kimanis are considered reasonably reliable in this study. Therefore, the only trustworthy sample from Lubang Payau is the charcoal from Unit II that produced a date of 5637–5081 cal. BP (ANU-11152). This date implies that pottery was introduced to the region after *ca.* 5000 BP, and that Unit II at Lubang Payau is of similar age to the upper sequence in the same unit at Kimanis (ANU-11148; see below and Table 6.2).

Kimanis is a large cave with an overhang at the entrance that forms a rock shelter. It is located at 2°27'4"N/117°24'38"E and 206 m asl, about 160 m west of Lubang Payau. The rock shelter forms a spacious dry area, with its surface sloping slightly to the west, towards the entrance of the cave. The habitable area under the rock shelter covers approximately 22 m x 8 m. Three trenches were excavated.

Test pit KMS/TP, measured 1 m² and was located furthest east and the greatest distance from the cave entrance. The five stratigraphic deposits were divided into two cultural units (Units I and II). Unit I consisted of several layers of brown or yellowish-brown ashy soil totaling between 0.5 m–0.7 m thick. This unit contained earthenware sherds, substantial amounts of bat bone, some stone artefacts, and damar. The lowest excavated layer of Unit II (recorded as Layer E) was excavated to between 0.4 m and 0.7 m depth. Excavation ceased when a flexed burial was encountered at 1.3 m below modern ground surface. Layer E contained some animal bone and shell but no earthenware pottery.

Table 6.2 A list of the radiocarbon dates from Lubang Payau and Kimanis.

Square/Spit	Unit/Depth (cm)	Material	Lab No.	Conventional Age (BP)	Calibrated Date (cal.BP) OxCal 4.2/ IntCal 13
LPY/C3 Spit 6	Unit II/ 25–30	Charcoal	ANU-11152	4610±110	5637–5081 (92.4%)/5069–5026 (3%)
LPY/C3 Spit 6	Unit II/ 25–30	Freshwater shell	ANU-11260	13,100±140	Not calibrated
LPY/C3 Spit 23	Unit III/ 110–115	Freshwater shell	ANU-11261	17,730±250	Not calibrated
KMS/C4 Spit 8	Unit I/ 35–40	Charcoal	ANU-11311	1270±240	1685–776 (94.1%)/1746–1697 (1.3%)
KMS/C4 Spit 11	Unit II/ 50–55	Charcoal	ANU-11148	4650±90	5639–5308 (79.8%)/5240–5105 (13.5%) / 5302–5282 (1.3%)
KMS/C4 Spit 20	Unit II/ 98	Charcoal	ANU-11149	8840±250	10,638–9452 (95.1%)
KMS/C4 Spit 24	Unit III/ 105–110	Charcoal	ANU-11150	10,030±260	12,582–11,116 (91.4%)/11,017–10,843 (3.7%)
KMS/C4 Spit 24	Unit III/ 105–110	Freshwater shell	ANU-11258	13,860±180	Not calibrated
KMS/C4 Spit 34	Unit III/ 155–160	Charcoal	ANU-11151	11,270±220	13,543–10,774 (94.7%)
KMS/C4 Spit 59	Unit V/ 280–285	Freshwater shell	ANU-11259	23,630±480	Not calibrated

Source: Following Arifin (2004: 104), except the recalibration using OxCal vers.4.2 (Bronk Ramsey 2009) IntCal 13 (Reimer et al. 2013).

Trench KMS/C4 was located 1.5 m west of KMS/TP and 6 m east of KMS/C8 in the rock shelter, relatively close to the south wall. The trench measured 1 m x 2 m with the long axis orientated north–south and was excavated to a maximum depth of 3 m below modern ground level. At *ca.* 1.5 m depth a flexed burial was uncovered in the northern portion of the trench, and only the southern half was excavated to rock fall. Nine layers of deposit varying in colour and texture from dark brown ashy silt to reddish-yellow ashy silt could be divided into five activity units (Figure 6.2). Unit I was the only phase of activity to contain pottery. The preceding Unit II (0.5 m–1.05 m) contained relatively few animal bones and a considerable amount of roof collapse. Unit III (1.05 m–1.6 m) produced by far the greatest number of stone tools, animal bones and molluscs, reflecting the most intensive occupation of the site. Unit IV (1.6 m–2 m) possessed fewer vertebrate remains and stone artefacts than Unit III, but still relatively high concentrations of shells. Unit V was excavated to a depth of 2.95 m before large rock fall finally prevented deeper investigation. This unit contained much fewer animal bones, lithics and shells than the overlying units, but several notable lenses of ash.

All seven radiocarbon dates for Kimanis are from KMS/C4. Excluding the freshwater shell dates, the remaining five charcoal assays suggest occupation from at least the end of the glacial period at *ca.* 13,000 cal. BP, and perhaps considerably earlier based on the freshwater shell date of 23,630±460 (ANU-11259) in Unit V, until less than 2,000 cal. BP. A date of *ca.* 5600–5300 cal. BP from Unit II indicates that the introduction of pottery certainly post-dates this date. If the Unit I date of 1685–776 cal. BP (ANU-11311) is considered representative, pottery might not have been introduced to the region until within the last 2,000 years.

Figure 6.2 An illustration of the four walls of Trench KMS/C4 showing the different archaeological layers and units excavated, and the approximate locations of radiocarbon dates.

Source: After Arifin 2004: 85; the dates have been recalibrated using OxCal vers.4.1 (Bronk Ramsey 2009) IntCal.13 (Reimer et al. 2013).

Trench KMS/C8 measured 1 m x 2 m and was dug to a depth of 1.3 m. Two units with layers of brown and yellowish-brown silts with ash very similar to those recorded in KMS/C4 were identified. Unit I was 0.5 m deep and was the only phase of activity to contain pottery, with relatively small amounts of animal bone, stone artefacts and invertebrates. Unit II was excavated to a maximum depth of 1.3 m. This phase of activity produced higher concentrations of vertebrate and invertebrate remains than Unit I, as well as sizable amounts of roof collapse.

As Kimanis produced the richest archaeological record with the greatest temporal range, the following discussion will be heavily weighted towards interpretation of this site, with a lesser focus on Liang Gobel and Lubang Payau.

Subsistence strategies

1. Vertebrate remains

Vertebrate remains from all the Upper Birang archaeological sites are very fragmented. This is typical for cave sites in Southeast Asia and probably results from a combination of anthropic taphonomic processes such as butchery and bone breakage for marrow extraction, considerable human foot traffic within the confines of cave entrances and rock shelters, and natural processes like roof collapse (see Piper and Rabett 2016). As a result the majority (greater than 50 per cent) of small bone fragments remain anatomically and taxonomically unidentified (Table 6.3). Of the remainder, levels of taxonomic identification are dependent on a number of variables that include the degree of preservation, survival of diagnostic anatomical features and the complexity and diversity of the family and/or genus the skeletal element is likely to belong to. For example, the Malay tapir (*Tapirus indicus*) is the sole survivor of its genus in the Late Pleistocene of SEA, and any bone fragments attributable to the tapir almost certainly come from this species. In contrast, the complex diversity of rodent murids (Muridae) makes it difficult to confidently differentiate the majority of anatomical elements recovered from the archaeological record beyond family level (Tables 6.4 and 6.5).

Table 6.3 Summary of the vertebrate remains recovered from the Upper Birang River sites recorded by trench, weight, number of identifiable taxa, Number of Identifiable Specimens (NISP) and Minimum Number of Individuals (MNI).

SITE	EXCAVATION PIT	UNIDENTIFIED SPECIMEN		IDENTIFIABLE SPECIMENS							
		WEIGHT	%	TAXA	%	NISP	%	WEIGHT	%	MNI	%
KIMANIS	KMS/C4	6815.9	64.9	36	78.3	6040	72	5690.2	72	290	61
	KMS/C8	1999	19.1	37	80.4	1763	21	1608.98	20	125	26
	Total	8814.9	84	42	91.3	7803	93	7299.18	92	415	87
LUBANG PAYAU	LPY/C3	1173.9	11.2	21	45.7	315	3.8	249.6	3.2	31	6.5
	LPY/CD5	433.5	4.1	18	39.1	208	2.5	261.1	3.3	19	4
	Total	1607.4	15.3	29	63	523	6.3	510.7	7	50	10
LIANG GOBEL	LGB/TP	64.7	0.7	12	26.1	52	0.7	95		13	3
TOTAL		10,487	100	46	100	8378	100	7905.38	100	478	100

Source: K. Arifin.

Table 6.4 The minimum numbers (MNI) of different taxa recovered from the various excavation trenches at Liang Gobel, Lubang Payau and Kimanis; those numbers in parentheses and question marks represent uncertain identifications; *Suidae – probably the bearded pig *Sus barabatus* but there is the possibility of introduced *S. scrofa*, especially in the later phases.

					Archaeological Trench				
Class	Order	Family	Taxon	Vernacular	KMS/C4	KMS/C8	LPV/C3	LPV/D5	LGB/TP
Actinopterygii				Ray-finned fishes	2	2		1	
Amphibia	Anura			Frogs and toads				?	
Reptilia				Reptiles	3	1			
	Testudines	Geoemydidae		Hardshell turtles	12?	4	2	?	1
		Trionychidae		Softshell turtles	4?	?			
	Squamata			Snakes		1			
		Colubridae		Snakes	3?	?			
		Pythonidae	<i>Python</i> sp.	Python	4?	2		1	1
		Varanidae		Monitor lizards	6	4	1	1	
		Agamidae		Iguanian lizards	3	1			

Class	Order	Family	Taxon	Vernacular	Archaeological Trench				
					KMS/C4	KMS/C8	LPY/C3	LPY/D5	LGB/TP
Aves				Birds	1	1			
	Galliformes			Pheasants, junglefowl etc.			1		
Mammalia	Dermoptera	Cynocephalidae	<i>Cynocephalus variegatus</i>	Colugo or flying lemur	1	1			
	Megachiroptera (Suborder)			Fruit bats		1			
	Microchiroptera (Suborder)			Insectivorous bats	169	62	6	2	1
	Primates	Cercopithecidae	<i>Presbytis</i> sp(p).	Leaf monkeys (Langurs)	7	2			
			<i>Trachypithecus cristatus</i>	Silvered langur	1	1	1		
			cf. <i>Nasalis larvatus</i>	Proboscis monkey	1				
			<i>Macaca fascicularis</i>	Long-tailed macaque	2	2			
			<i>Macaca</i> sp(p).	Macaques	4	3		1	
				Langurs and/or macaques	12	4	2	1	1
				Bornean gibbon	2		1		
		Hylobatidae	<i>Hylobates muelleri</i>		3(1)	1	1		
		Hominidae	<i>Pongo pygmaeus</i>	Orangutan					
	Rodentia	Muridae		Rats and mice	4	6	1		
		Sciuridae		Squirrels	2	3		1	
		Hystriidae		Porcupines	3	2		1	
				Rodents unident.	3	2	2		1
	Carnivora	Ursidae	<i>Helarctos (Ursus) malayanus</i>	Sun bear	6	2	1	1	2
		Mustelidae		Weasels, badgers and otters	2	3	1		
		Viverridae	<i>Viverra zangalunga</i>	Malay civet	2				
			<i>Arctictis binturong</i>	Binturong			1		
				Mongoose/civet unident.	3	1		1	
				Carnivores unident.	5	2	1	2	1
	Perissodactyla	Rhinocerotidae		Rhinoceros		1	1		
		Tapiridae	<i>Tapirus indicus</i>	Malay tapir	2	1		1	
	Artiodactyla	*Suidae	<i>Sus</i> sp(p).	*Pig	7	5	4	2	3
		Tragulidae	<i>Tragulus</i> sp(p).	Mouse deer		1	1		

					Archaeological Trendh					
Class	Order	Family	Taxon	Vernacular	KMS/C4	KMS/C8	LPY/C3	LPY/D5	LGB/TP	
		Cervidae	<i>Muntiacus muntjac</i>	Common barking deer	1					
			cf. <i>Rusa unicorn</i>	Sambar deer	1					
				Deer	5	2	2	1	1	1
		Bovinae		Cattle	5	1	1	1	1	1
				Unident. medium-sized mammal	7	?		13		
				TOTALS MNI	299	125	31	19	13	13

Source: K. Arifin.

Table 6.5 The Number of Individual Specimens (NISP) and Minimum Numbers (MNI) of different taxa recovered from within the various 'activity units' in Kimanis trench KMS/C4; those numbers in parentheses represent uncertain identifications; *Suidae - the most likely representative is the bearded pig *Sus barabatus* but there is the possibility of introduced *S. scrofa*, especially in the later phases.

Class	Order	Family	Taxon	UNIT 1		UNIT 2		UNIT 3		UNIT 4		UNIT 5		TOTALS	
				NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Actinopterygii															
Reptilia															
			Ray-finned fishes	4	1	2	1							6	2
			Reptiles			1	1	2	2					3	3
	Testudines	Geoemydidae	Hardshell turtles	73	1	224	1	641	8	12	1	6	1	956	12
		Trionychidae	Softshell turtles	4	1	8	1	87	1			1	1	100	4
	Squamata		Snakes												
		Colubridae	Snakes	3	1	11	1	18	1					32	3
		Pythonidae	Python sp.	12	1	37	1	154	1	3	1			206	4
		Varanidae	Monitor lizards	7	1	42	3	76	2					125	6
		Agamidae	Iguanian lizards			1	1	3	2					4	3
Aves			Birds			1	1							1	1
Mammalia	Dermoptera	Cynocephalidae	Cynocephalus variegatus					1	1					1	1
	Microchiroptera (Suborder)		Insectivorous bats	1419	46	1555	88	143	30	1	1	142	4	3260	169

Class	Order	Family	Taxon	Vernacular	UNIT 1		UNIT 2		UNIT 3		UNIT 4		UNIT 5		TOTALS	
					NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
	Primates	Cercopithecidae	<i>Presbytis</i> sp.(p).	Leaf monkeys (Langurs)			2	2	15	5					17	7
			<i>Trachypithecus cristatus</i>	Silvered langur	1	1									1	1
			cf. <i>Nasalis larvatus</i>	Proboscis monkey	1	1									1	1
			<i>Macaca fascicularis</i>	Long-tailed macaque					1(1)	1(1)					1(1)	1(1)
			<i>Macaca</i> sp.(p).	Macaques	2	1	8	1	14	2					24	4
				Langurs and/or macaques	11	1	27	1	270	8	10	1	2	1	320	12
		Hylobatidae	<i>Hylobates muelleri</i>	Bornean gibbon			1	1	1	1					2	2
		Hominidae	<i>Pongo pygmaeus</i>	Orangutan	0(1)	0(1)			10	1			3	2	13(1)	3(1)
	Rodentia	Muridae		Rats and mice	1	1	1	1	4	2					6	4
		Sciuridae		Squirrels					2	1	1	1			3	2
		Hystriidae		Porcupines	1	1	1	1	1	1					3	3
				Rodents unident.	3	1	4	1	11	1					18	3
	Carnivora	Ursidae	<i>Helarctos (Ursus) malayanus</i>	Sun bear	4	1	2	1	38	2	1	1	2	1	47	6
		Mustelidae		Weasels, badgers and otters	4	1	8	1							12	2
		Viverridae	<i>Viverra zibetha</i>	Malay civet					2	2					2	2
				Mongoose/civet unident.			3	1	13	2					16	3
				Carnivores unident.			2	1	5	3	1	1			8	5
		Tapiridae	<i>Tapirus indicus</i>	Malay tapir			3	1	1	1					4	2

Class	Order	Family	Taxon	Vernacular	UNIT 1		UNIT 2		UNIT 3		UNIT 4		UNIT 5		TOTALS	
					NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
	Artiodactyla	*Suidae	<i>Sus</i> sp.(p).	*Pig	12	1	45	1	495	3	13	1	10	1	575	7
		Cervidae	<i>Muntiacus muntjac</i>	Common barking deer					2	1					2	1
			cf. <i>Rusa unicorn</i>	Sambar deer					1	1					1	1
				Deer			10	1	96	2	5	1	2	1	113	5
		Bovinae		Cattle	3	1	7	1	40	2	4	1			54	5
				Unident. Medium-sized mammal	3	1	9	1	77	3	10	1	2	1	101	7
				TOTALS INCL Microchiroptera	1568	65	2015	116	2225	92	61	11	170	13	6040	299
				TOTALS EXCL Microchiroptera	149	19	460	28	2082	62	60	10	28	9	2780	130

Source: K. Arifin.

Although a systematic analysis of butchery was not conducted on the bone assemblages from the Upper Birang sites, the presence of burnt bones and the strong similarities between these bone accumulations and those recovered from sites such as Niah where a thorough examination of human exploitation was undertaken (see Piper and Rabett 2016) strongly suggests that most, if not all, the remains of large and medium-sized mammals and reptiles were accumulated by people. Some animals, especially bats and rodents may have died in, or been brought back into, the caves and rock shelters by carnivores. The vertebrate assemblages include a diverse range of taxa that occupied a variety of ecological niches. By far the most abundant taxa recorded (MNI) in the Upper Birang sites were insectivorous bats, particularly at Kimanis. Although many species of bat are troglodytes and would have inhabited the dark recesses of the caves and probably represent part of the caves' natural death assemblage, some could also have been hunted. For example, Stimpson (2016) identified the hunting of particular species of at Niah Caves, Sarawak from at least 40,000 years ago. However, close examination of the spatial distribution of bats compared to the main animal bone accumulations at Kimanis indicates that the Chiroptera bones amassed in the later phases of activity (Units I and II), whereas large and intermediate-sized mammals and reptiles were recovered primarily from Unit III. This perhaps indicates natural rather than anthropic modes of accumulation for bats. In fact, if bats are excluded in KMS/C4, approximately 75 per cent of all mammals and reptiles were recorded in Unit III (Table 6.5) and probably date to the terminal Pleistocene, between 13,000–11,000 cal. BP.

A broad diversity of arboreal and terrestrial mammals and reptiles appear to have been hunted or captured during the terminal Pleistocene and early Holocene at Kimanis and Lubang Payau, including a variety of carnivores, monitor lizards (*Varanus* sp(p).), softshell (Trionychidae) turtles, sun bear (*Helarctos* (*Ursus*) *malayanus*), cattle (Bovinae) and tapirs (*Tapirus indicus*). Large deer, probably Sambar appears to have been relatively common in the environments of the Upper Birang. However, in KMS/C4 pigs (*Sus* cf. *barbatus*), primates and hardshell turtles (Geoemydidae) dominate the hunted vertebrate communities in the terminal Pleistocene. Several primates are represented in the assemblages including habitual arboreal taxa such as the Bornean gibbon (*Hylobates muelleri*) and the orangutan (*Pongo pygmaeus*). The most common primates though are the macaques (*Macaca* sp(p).) and leaf monkeys (*Presbytis* sp(p).).

The presence of both the silvered langur (*Trachypithecus cristatus*) and proboscis monkey (*Nasalis larvata*) in Unit I are intriguing. Both these species are most commonly found in coastal mangrove swamp forests or peat forests, though they do also frequent riverine forests (Meijaard et al. 2008). Indeed, Arifin (2004: 127) reports that the proboscis monkey is the most common species of primate encountered along the Birang River today.

2. Osseous artefacts

Bone artefacts were not common in the Upper Birang sites only being found in the upper units at Kimanis (N=7) and Lubang Payau (N=5). Provisional analysis suggests they were all manufactured from longitudinally split fragments of mammalian long bone. These had then been modified through oblique grinding to produce points (unipoint or bipoint) or spatulae (see Rabett 2002 for terminology). Preliminary observations (no systematic microscopic analysis was undertaken) indicated that some artefacts possessed smooth and/or polished surfaces near the tip suggesting use-wear perhaps as piercing implements or awls. Generally speaking though, the small overall number of bone artefacts recovered from within large bone accumulations would perhaps indicate that other organic materials such as bamboo, rattan and palm as well as stone provided substantially more raw materials for artefact production than bone.

The osseous artefacts from Kimanis were all recovered from below the ceramic horizons in deposits with abundant animal bones and shell and likely date to the terminal Pleistocene/early Holocene. In Lubang Payau bone implements were recorded from within and below the ceramic levels.

3. Invertebrates and shell artefacts

In all sites, the mollusc assemblages were dominated by the freshwater snails *Brotia* sp. (Table 6.6). These were present in small numbers from the basal deposits of KMS/C4 to contemporary ground surface in Lubang Payau. In trenches KMS/C4 and KMS/C8, *Brotia* sp. accounted for 95.6 per cent of the total MNI counted (6399/287; Table 6.7). Trench KMS/C4 indicated that the densest accumulations were within Units III and IV, and associated with the largest concentrations of animal bone dated to *ca.* 13,000–11,000 cal. BP. A high proportion of the shells were missing the apex, a pattern of deliberate human breakage of the natural vacuum within the gastropod that enables easier removal of the fleshy body.

In LPY/C3, the greatest numbers of *Brotia* sp. were concentrated in Unit II and the basal deposits of Unit I, just below a radiocarbon date of 5637–5081 cal. BP (ANU-11152). This suggests that the majority of shells were collected in the mid-Holocene. The accumulations peter out below layers containing pottery. In contrast, *Brotia* sp. was common throughout the deposits of LPY/D5, to modern surface. Overall, this suggests differential periods of intermittent collection and shell dumping within these two caves' entrances, but the practice of freshwater snail consumption continued from the late Pleistocene through the Holocene. *Brotia* sp. can be found close to the archaeological sites in the Birang River and are still being eaten by the contemporary inhabitants of the region today.

Several other freshwater, terrestrial and arboreal snails likely found within the local environments around the caves were identified including *Paludomus* sp(p), *Cycloporids* and *Amphidromus* sp(p). Of more interest is the small number of 'exotic' marine Mollusca identified in the assemblages (Tables 6.6 and 6.7). The coast is now some 60 km in a straight line from the Upper Birang sites, and even if sea level change potentially increased (in the Pleistocene) or shortened (during the Holocene high sea stand) that gap, it would still mean transportation over a considerable distance from coast to cave. The species collected and returned to the sites also derive from different ecological zones. For example, *Cypraea* spp. (cowry shell) is commonly found in shallow/deep marine environments, whereas the bivalve *Geloina erosa* and gastropods *Terebralia* and *Telescopium* inhabit mangrove swamps.

At Kimanis cowry shells were found throughout the ceramic and upper preceramic layers. The oldest specimen was from Unit III and potentially associated with a date of 12,582–11,116 cal. BP (ANU-11150). The dorsal surfaces of the shells had been removed and the edges ground flat, and probably strung for ornamental purposes. It was clear from the fragmentary remains of the *Geloina erosa* valves that they had been modified and probably used as tools. Close examination of the margins indicated that they had either been retouched and/or showed evidence of use wear (Figure 6.3). It is possible that these artefacts were used for either scraping or cutting functions. Edge damage and step fractures indicate that the shell tools might have been used on relatively hard materials, and possibly over a considerable length of time. Shell implements were primarily found in ceramic-bearing deposits, but the deepest and potentially oldest specimen was recovered from Kimanis Unit II in association with a date of 10,638–9452 cal. BP (ANU-11149).

Table 6.6 The various Mollusca and Arthropods recovered during excavation at Liang Gobel, Lubang Payau and Kimanis listed by environmental preference, minimum number of individuals (MNI) and weight in grams; *species with a preference of mangrove swamps; **Brachyura = true crabs.

Environment	Class	Family	Taxon	KMS/C4		KMS/C8		LPV/C3		LPV/D5		LGB/TP	
				MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)	MNI	Weight (g)
Freshwater	Gastropodia	Unionidae	<i>Broia</i> sp(p).	5968	28186.1	431	2260.8	3922	16851.5	1638	5345	206	1025.5
		Thiaridae	<i>Paludomus broti</i>	4	2	9	5	646	997	273	430	69	86
			<i>Paludomus vondenbuschianus</i>	13	18	15	7.7	7	68	1	5	0	0
	Malacostraca	**Brachyura (Infraorder)		71	31.5	5	2.7	5	9.2	4	2.6	1	1.8
Land	Gastropodia	Cyclophoridae	<i>Cyclophorus borneense</i>	41	67.2	22	184	181	560.5	192	670	166	465
			<i>Cyclophorus</i> sp(p).	0	0	0	0	20	19.5	3	?	0	0
			<i>Pterocyclus terribiliatus</i>	7	3.3	2	1	0	0	0	0	0	0
			<i>Leptopoma geotrochiforme</i>	0	0	2	1	4	4	0	0	0	0
			<i>Naninia</i> sp.	3	8.2	0	0	7	9	0	0	0	0
		Ariophantidae	<i>Amphidromus</i> sp(p).	13	38.6	19	192.1	38	147	11	65.5	27	72
Marine/ Estuarine	Bivalvia	*Corbiculidae	<i>Geloina erosa</i>	12	33.6	33	57.6	18	71.5	15	76	1	1.9
		Arcidae	<i>Arca granulosa</i>	0	0	0	0	1	11.8	0	0	0	0
			<i>Anadara granosa</i>	0	0	0	0	11	85	15	127.2	0	0
	Gastropodia	Nautilidae	<i>Nautilus</i> sp.	1	0.5	2	0.6	0	0	0	0	0	0
		*Potamididae	<i>Terebralia sulcata</i>	0	0	0	0	1	3	2	10.3	0	0
			<i>Telescopium telescopium</i>	0	0	0	0	0	0	1	26.7	0	0
		Cypraeidae	<i>Cypraea moneta</i>	6	5.3	7	6.5	0	0	0	0	0	0
		Muricidae	<i>Chicoreus capucinus</i>	0	0	0	0	0	0	1	4.4	0	0

Source: K. Arfin.

Table 6.7 The Minimum Number (MNI) of different genera and species of Mollusca recorded from each unit within trench KMS/C4.

Environment	Class	Family	Taxon	UNIT 1 MNI	UNIT 2 MNI	UNIT 3 MNI	UNIT 4 MNI	UNIT 5 MNI	TOTALS MNI
Freshwater	Gastropodia	Unionidae	<i>Brodia</i> sp(p).	55	106	3090	2301	416	5968
		Thiaridae	<i>Paludomus broti</i>			4			4
			<i>Paludomus vondenbuschianus</i>			12		1	13
Land	Gastropodia	Cyclophoridae	<i>Cyclophorus borneense</i>	27	3	10		1	41
			<i>Pterocyclus termilabiatius</i>		4	1	2		7
		Ariophantidae	<i>Naninia</i> sp.		1	2			3
		Camaenidae	<i>Amphidromus</i> sp(p).		4	5		4	13
Marine/Estuarine	Bivalvia	*Corbiculidae	<i>Geloina erosa</i>		1?	1?			2?
	Gastropodia	Nautilidae	<i>Nautilus</i> sp.			1			1
			TOTALS	82	119	3125	2303	422	6050

Source: After Arifin 2004: 136.

Figure 6.3 An example of retouched fragments of shell artefact from the Upper Birang River sites.

Source: After Arifin 2004: 248.

4. Stone artefacts

A total of 1,319 stone artefacts weighing 43 kg were analysed from the Upper Birang sites. In total, more than 70 per cent of the lithic assemblage came from Kimanis, 27 per cent from Lubang Payau and only 1 per cent from Liang Gobel. Kimanis also produced more than 94 per cent of the stone artefacts by weight. This was primarily due to the number of calcareous sandstone implements manufactured and/or utilised from shattered roof fall from the cave roof.

All three archaeological sites produced stone artefacts manufactured on similar raw materials. Overall they consisted of 42 per cent chert, 16 per cent volcanic rocks, 12 per cent calcareous sandstone and 9 per cent unidentified sedimentary rock, while 5 per cent consisted of miscellaneous microgranodiorite, limestone, crystalline limestone, sandstone, calcareous siltstone, milky quartz and quartzite. There appeared to be little spatial or temporal change in raw material preference or types of tool manufactured throughout the archaeological sequences that might have indicated, amongst other things, technological change. The only exception to this general rule was the introduction of milky quartz artefacts in the upper activity units (Units I and II), coinciding with the first appearance of bipolar flaking (bipolar flakes and cores).

Aside from implements produced on calcareous sandstone, all raw materials must have been derived from somewhere other than the limestone caves in which they were found. Remnant cortex on some artefacts indicated that most, if not all had been manufactured from river pebbles. Observations on the stone within the Upper Birang River close to the archaeological sites showed that the stone in the riverbed close to the rock shelters and cave consisted of small pieces of siltstone. The likelihood is that raw materials for tool production were acquisitioned from further upstream in rivers nearby.

Figure 6.4 Lithic implements from KMS/C4: utilised flakes (2 & 3), retouched flakes (5 & 6), and utilised and retouched flakes (7-16).

Source: After Arifin 2004: 443.

Twenty different types of artefact/artefact fragment could be identified, with flakes (37 per cent of the total stone items analysed), followed by shatters (20 per cent), flake fragments (15 per cent), flake shatters (10 per cent), and heat shatters (9 per cent) dominating. Other specimens included bipolar flakes, *érailure* flakes, retouched flakes, retouched cores, unidirectional cores, multidirectional cores, bipolar cores and core fragments. The presence of primary flaking and cores suggests that pebble reduction and artefact production were occurring on site.

Figure 6.5 Lithic implements from KMS/C4: hammerstone fragments (17 & 18), hammerstone and grindstone (19), and grindstone fragment (20).

Source: After Arifin 2004: 444.

Of these, 41 stone implements were recorded, accounting for just 3 per cent of the total lithic assemblage. Most of these had been produced using the hard hammer technique flaking pebble cores. Represented were lost or discarded utilised flakes, utilised and retouched flakes, retouched flakes, retouched cores, hammerstones and hammerstone fragments, and grindstone fragments (Figures 6.4 and 6.5).

In total, 13 different types of activity involving stone tool use could be discerned within the lithic assemblages (Table 6.8). For example, use-wear analysis showed that several implements possessed use scars with bending initiation and step terminated fractures, as well as edge rounding between use fractures, characteristic of scrapers used on resistant materials, such as hard wood or bone (Kamminga 1982: 69). The existence of highly reflective silica polish on some implements perhaps indicates utilisation in processes such as the stripping rattan, palm leaves or bamboo, or the manufacture of basketry. In some instances, non-silica polish on the working edge of implements suggested functional use in activities such as hide working or butchery. On one artefact, the presence of bending fractures is reminiscent of damage reported by Kamminga (1982: 34) to have resulted from cutting fresh meat. Other artefacts have concave working edges suggestive of tools used to produce and/or maintain cylindrical objects, such as wooden shafts.

Table 6.8 Activities undertaken in Upper Birang sites according to the evidence of lithic items.

No.	Activity	Categories of artefacts
1	Non-specific stone knapping	Flake or flake fragment
		Core or core fragment
		Flake shatter
2	Bipolar flaking	Bipolar flake
		Bipolar core
		Utilised and retouch flake with one of the lateral margins removed by bipolar blow
3	Pressure flaking?	Hammerstone fragment
4	Retouching	Retouched flake
		Retouched core
		Utilised and retouched flake
5	Backing retouch	Utilised and retouched flake
6	Light duty hammering	Hammerstone
		Hammerstone fragment
7	Use and discard of non-specific implement	Utilised flake
		Retouched flake
		Retouched core
		Utilised and retouched flake
8	Use and discard of implement for maintenance activity such as making wooden object	Utilised flake
		Utilised and retouched flake
9	Use and discard of implement for light duty activity, such as butchering and cutting	Utilised flake
		Utilised and retouched flake
10	Use and discard of implement for stripping palm leaves, bamboo or rattan to make mat or basketry	Utilised flake
11	Use and discard of grindstone for ochre grinding and other material	Grindstone fragment with ochre stain
12	Use and discard of implement with ochre stain	Retouched flake
13	Burning activities	Heat shatter

Source: After Arifin 2004: 233.

Amongst the retouched artefacts is a small implement of crystalline quartz from KMS/C4 Unit III dating to the terminal Pleistocene or early Holocene. This specimen had deliberate 'backing' retouch along the left lateral margin, a characteristic of implements that have been hafted (Figure 6.4, no. 16). In fact, the very tiny size of all the crystalline quartz implements might indicate they were specifically designed for hafting. Other evidence of possible hafting includes utilised flakes from KMS/C4 and KMS/C8 Unit I with a black substance coating the artefact surfaces that could represent remnant-hafting mastic. Other implements were more likely handheld, especially between the thumb, index and middle fingers.

Two grindstones, one of white quartzite from KMS/C4 Unit III and the other a fragment of crystalline limestone from Unit II of the same excavation square are notable. The specimen from Unit III was a flattened oval pebble with both surfaces moderately convex and smooth (Figure 6.5, no. 19). Subsequent use as a hammerstone had resulted in the removal of a flake from each end of the artefact. The Unit II specimen was a flat stone that retained a thin layer of ochreous residue in depressions suggesting it was used as a pallet (Figure 6.5, no. 20). These specimens probably date to the terminal Pleistocene and mid-Holocene respectively.

Burnt and heat-shattered stone was a relatively common modification observed in almost all the stone assemblages from the three archaeological sites.

5. Pottery

All the ceramics recorded from the Upper Birang archaeological sites were within the upper units of excavation. Two dates of 5637–5081 cal. BP (ANU-11152) from LPY/C3 and 5639–5308 cal. BP (ANU-11148) from Kimanis indicate that all pottery was derived after the mid-sixth millennium BP. If a date of 1685–776 cal. BP (ANU-11311) from within the Unit I pottery-bearing deposits of Kimanis is considered reliable then the introduction of ceramics to the Upper Birang might not have occurred until after 2,000 years ago.

All the pottery was made by hand through modelling and the use of the paddle and anvil technique. The majority of sherds were plain, but a few (with the greater number at Lubang Payau) possessed simple paddle-impressed, cord-marked or incised decoration (Figure 6.6). Based on rim shapes, diameters, carinations and base fragments, it is likely that most of the pottery consisted of globular cooking pots very similar to ethnographic examples in Sarawak (Morrison 1954–1955; Freeman 1957) and the cooking pots of the Kenyah Lepo' Ké or Apau Ping of Kecamatan Long Pujungan, East Kalimantan (Arifin and Sellato 1999). None of the sherds possessed red-slipped exteriors characteristic of the Neolithic pottery from sites such as Bukit Tengkorak in Sabah (Bellwood 1989).

A few of the potsherds have inclusions of rice husk as temper. This implies that the visitors to the caves and rock shelters of the Upper Birang either belonged to, or had direct or indirect contact with, agricultural communities within the last two millennia or so.

Figure 6.6 Incised rim sherds from Lubang Payau.

Source: After Arifin 2004: 257.

Discussion

Archaeological excavations in the Upper Birang have demonstrated that initial human occupation of this region of East Kalimantan can be dated to the Late Pleistocene. Until recently, Kimanis had the deepest and oldest archaeological record in the region with the earliest reliable date coming from the base of Unit III at 13,543–10,774 cal. BP (ANU-11151). However, the archaeological record extends into Unit V and perhaps indicates initial colonisation by at least the end of the Last Glacial Maximum.

Kimanis is situated at *ca.* 200 m asl and it is likely that the cooler, drier climates that existed at the end of the Pleistocene in Borneo had a significant impact on the local and regional environment (see Bird et al. 2005; Würster et al. 2010). A provisional study of the phytolith samples from Unit V by Bowdery (in Arifin 2004: 374) seems to support this conclusion, in that a number of (undefined) tree species seem to be absent from the floral record, compared to the later phases of cave sediment deposition, possibly as a result of changes in the levels of forest cover. At Niah, systematic pollen analysis has demonstrated that during the Late Pleistocene there was relatively rapid climate-driven environmental change, from extremes of warm, moist dense tropical rainforest to much cooler climates when a diverse mixture of submontane and lowland woodland predominated within ecological communities with no modern parallels (Hunt et al. 2007; Barton et al. 2013). At Kimanis the presence of arboreal taxa such as leaf monkeys, orangutan and the sun bear in lower Unit IV and Unit V would suggest that forest cover of some sort was maintained, if only periodically, during the final stages of the Late Pleistocene in the Upper Birang.

Evidence of human activity in the earliest recorded phases at Kimanis is relatively scant and consists of a few stone flakes and flake fragments manufactured primarily from chert. This might indicate that frequentation of the cave was intermittent and over a short duration by small mobile forager groups. In addition to primates the Late Pleistocene foragers appear to have hunted pig and deer, and caught or trapped hardshell turtles. There is no evidence for the persistence of members of the now extinct middle Pleistocene megafauna such as the giant pangolin (*Manis* cf. sp. *Palaeojavanica*), a species that was recorded in the *ca.* 40,000 BP deposits at Niah (Hoojier 1960; Cranbrook 2000; Piper et al. 2007).

In the upper layers of Unit IV and in Unit III there is a significant increase in density of human activity at Kimanis. This intensification in occupation coincides with dates of 13,543–10,774 cal. BP (ANU-11151) and 12,582–11,116 cal. BP (ANU-11150). A similar pattern of increased cave frequentation and magnitude of habitation at the end of the Pleistocene has been recorded at Niah (Rabett et al. 2013), at Song Terus (Sémah and Sémah 2012) and Song Gupuh (Morwood et

al. 2008) in Java and at Ille Cave on Palawan (Lewis et al. 2008). It has been argued that this reflects the movement of human populations inland from coastlines as the marine incursion disrupted ecological systems and reduced resource predictability (Piper and Rabett 2014).

Dense forest cover during the terminal Pleistocene close to Kimanis is suggested by the diversity of arboreal taxa represented in the hunted assemblage such as the flying lemur (*Cynocephalus variegatus*), squirrels (Sciuridae) and sun bear.

The human communities appear to have engaged in broad spectrum foraging using a variety of capture techniques to trap various small carnivores, aquatic softshell turtles and monitor lizards, hunt cattle and deer and collect shellfish from local rivers.

The most abundant prey taxa are pigs, leaf monkeys and macaques – a hunting pattern similar to that observed at Niah during the terminal Pleistocene and Holocene (Piper and Rabett 2009). Rabett and Piper (2012) argued that the significant increase in hunting of arboreal primates at the end of the Pleistocene in Borneo and Java was possibly related to a combination of closure of the tropical rainforests resulting in larger monkey populations, and/or advances in technology as indicated by the appearance of bone projectile points as proxy evidence for the introduction of range weaponry. Although no osseous projectile points were identified at Kimanis, the presence of small stone tools suitable for hafting from Unit III onwards suggests that hafting technology was already present at the site from this period onwards.

The presence of Malay tapir in the Upper Birang region of East Kalimantan is an important new biogeographic record. In all likelihood this species is now extinct in Borneo but has been recorded in several archaeological assemblages in Sarawak from the Late Pleistocene to sub-recent times (Medway 1960; Cranbrook and Piper 2013; Piper and Cranbrook 2007). At Kimanis the oldest tapir bones were recovered from a layer between two radiocarbon dates of 13,543–10,774 cal. BP (ANU-11151) and 12,582–11,116 cal. BP (ANU-11150). The most recent record is from within the pottery-bearing deposits at Lubang Payau, which suggests the Malay tapir was still present in the late Holocene. The records from Sarawak and now East Kalimantan would suggest that the Malay tapir was formerly widespread across Borneo from the east to west coasts of the island. The presence of rhinoceros in the terminal Pleistocene also extends the known range of this large browser to the east coast of Borneo during the early and/or mid-Holocene. The Upper Birang remains may represent the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) that is clinging to survival in Tabin National Park in Sabah (van Strien et al. 2008) and/or the Javan rhinoceros (*Rhinoceros sondaicus*) that is now extinct on Borneo, but has been identified in the archaeological record of Niah Cave (see Cranbrook 1986; Cranbrook and Piper 2007).

Another key feature of the late Pleistocene onwards in SEA is the emergence and spread of bone technologies. Van Es (1930) was the first to document the presence of osseous artefacts in layers predating ceramic horizons at the site of Gua Lawa, close to the village of Sampung in East Java. Subsequently, further investigations in the region resulted in the discovery of similar bone technologies within comparable stratigraphic locations just below the ceramic horizon at 19 other cave and rock shelter sites, and they probably all date to the early and/or mid-Holocene. Currently, the earliest records of bone technology come from the West Mouth of Niah Cave (Reynolds et al. 2013), Lang Longrien in the Thai Peninsula (Anderson 1990), Song Terus in East Java (Kusno 2006) and Matja Kuru II East Timor (O'Connor et al. 2014) variously dated to between 45,000 and 30,000 BP. By the early to mid-Holocene, osseous artefacts are relatively common across all of Mainland and ISEA (Rabett and Piper 2012). The earliest osseous artefacts recovered from Kimanis appear to coincide neatly with the observed rise in bone technologies at other sites across ISEA in the terminal Pleistocene/early Holocene. As at Kimanis and Lubang Payau bone tools appear to have served a variety of locally required functions, including piercing implements.

The repertoire of stone debitage and other artefacts suggests the inhabitants of the Upper Birang region produced tools locally to undertake a variety of different tasks that included plant processing, butchery and hide working. The majority of lithic implements appear to have been produced expediently, utilised and discarded. However, use wear analysis also demonstrated that some artefacts were manufactured in order to shape wooden shafts for durable implements that would have been hafted.

There is evidence for the increasing use of pounders, grindstones and pestles and mortars for plant processing and grinding resins and minerals such as haematite across SEA in the early Holocene (Bellwood 1997: 181; Rabett et al. 2013; Simanjuntak 2002). The crystalline limestone pebble with evidence of ochre processing from Unit II falls within this category of artefact and probably dates to the mid-Holocene. The hammerstone reused as a grindstone from Unit III might imply that grinding technology extends back to the terminal Pleistocene in the Upper Birang region.

At least two burials were recorded in KMS/C4 Unit III and at the base of Unit II in KMS/TP. Though these burials could have been dug into preceding archaeological deposits from later phases of activity, the presence of tightly flexed inhumations in the terminal Pleistocene and early Holocene is consistent with other records across SEA. The emergence of these burial traditions seems to be linked to the regional development of complex new ideologies that, amongst other things, involved belief in the afterlife. At Niah, the two oldest interments recorded within the terminal Pleistocene/early Holocene burial grounds are both flexed, and date to 11,270–11,698 cal. BP (OxA-15157) and 8354–8454 cal. BP (OxA-16161) and are probably of a similar age to those discovered at Kimanis. The methods by which burials were treated at Niah were diverse and included flexion, seated inhumations, flexed decapitations and secondary burial. Cremation is another ritual behavior recorded at Niah (Lloyd-Smith 2012; Rabett et al. 2013). Several cremation burials have also been recovered at Ille Cave, Palawan Island in the Philippines. Samples of bone from Burial 758 produced dates of 9260–9006 cal. BP (OxA-16020) and 9425–9280 cal. BP (OxA-15982; Lewis et al. 2008). Close examination of bone surfaces indicated that this individual had been de-fleshed, dismembered and the long bones shattered prior to being burnt. Further examples of early to mid-Holocene (mostly flexed) burials include those from Gua Braholo, Song Keplek, Song Terus and Pawon on Java (Simanjuntak 2002; Détroit, 2006: 199; Noerwidi 2011/2012) and at Gua Cha, Gua Teluk Kelawar and Gua Peraling in Peninsular Malaysia (Zuraina Majid 2005).

During the mid-Holocene (KMS/C4, KMS/C8 and LPY/C3), foragers frequenting the Upper Birang continued to hunt and capture a diverse range of forest mammals and reptiles and collect *Brotia* sp. and freshwater crabs in rivers close to the caves and rockshelters. Contact with the coast is evident through the presence of several mangrove and marine species of mollusc that were utilised as decorative ornaments (*Cypraea* spp.) or as cutting or scraping tools (*Geloina erosa*). Similar tools have been found in caves and rockshelters in East Java such as Bale, Pawon, Peturon, Gede and Suruh in the northern Limestone Massif of Tuban (Willems 1939; van Heekeren 1972). Scrapers manufactured from *Geloina erosa* have also been reported from coastal and inland sites in East Timor like Lie Seri (Glover 1986: 75).

Use of forest plant products is evident through the presence of damar resin in Units I and II of LPY/C3, which indicates that this secreted resin was being used as an illuminant or a sealant. A small fragment of candlenut (*Aleurites moluccana*) from KMS/C8 might reflect use of this nut for its rich oil (Arifin 2004: 150–151).

Pottery first occurs in the archaeological record after 5000 cal. BP, and possibly as late as 2,000 years ago. All the pottery appears to have had a utilitarian function and consisted primarily of globular cooking pots. Fragments of rice chaff were identified in some of the pottery fabrics, suggesting that the visitors to the Upper Birang were either associated with or in contact with communities that

produced or had access to rice agricultural products. However, none of the other material culture such as quadrangular stone adzes or stone and shell ornamentation associated with the regional appearance of Malayo-Polynesian speaking populations that have been identified at sites like Bukit Tengkorak in Sabah or the northern Philippines were recovered from the three Upper Birang archaeological sites. Thus, it is perhaps more likely that the communities inhabiting the rugged limestone regions of Berau maintained a forager lifestyle but had access to traded pottery from inhabitants of sedentary settlements nearby (Arifin 2006). Bulbeck (in Arifin 2004: 391) reached much the same conclusion through analysis of the teeth of the individuals recovered from preceramic (N=7) and ceramic (N=3) layers in the Upper Birang cave sites. He argued that the limited calculus build-up and absence of caries in both the terminal Pleistocene/early to mid-Holocene individuals, and those from the pottery-bearing horizons suggested that they all had a similar forager diet. The expansion of agriculture in the region might be quite a recent phenomenon.

Conclusion

The excavations of Liang Gobel, Lubang Payau and Kimanis have demonstrated that the limestone karst formations of the Berau region of Eastern Kalimantan possess cave and rockshelter sites with significant Late Pleistocene and Holocene archaeological records comparable with those recorded in Sabah and Sarawak. The investigations have shown that human frequentation of the Upper Birang River is evident from the terminal Pleistocene onwards, and potentially extends back at least as far as the end of the Last Glacial Maximum. Evidence for increased cave utilisation by larger human populations over prolonged periods along with a broadening of subsistence strategies and the proliferation in the hunting and trapping of arboreal taxa such as primates is a feature of human adaptation across Java and Borneo at the end of the Pleistocene. The increasing use of bone as a raw material from the Late Pleistocene onwards reflects similar trends observed across Mainland and ISEA, and the discovery of flexed inhumations and burnt human remains indicates that the local forager populations of Eastern Kalimantan were integrated into the social, cultural and ideological networks that were emerging across the region in the early Holocene.

Acknowledgements

This contribution is an excerpt from my PhD thesis research, which was funded by The Australian National University and UNESCO. I would like to thank my supervisor, Peter Bellwood, and various people for helping me with the analysis (Rokhus Due Awe, Colin Groves, Ken Aplin and Erik Meijaard (vertebrate faunal identifications), Ian Loch (mollusc identifications), John Seelley (geoarchaeological analysis), Peter Hiscock and Jo Kamminga (lithics analysis), Doreen Bowdery (phytolith identifications), Glenn Summerhayes (pottery analysis) and David Bulbeck (human remains identifications)) and drawings (Dubel Driwantoro and Mudjiono).

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This text is taken from *New Perspectives in Southeast Asian and Pacific Prehistory*,
edited by Philip J. Piper, Hirofumi Matsumura and David Bulbeck, published 2017
by ANU Press, The Australian National University, Canberra, Australia.