

Excavations at Musang Cave, Northeast Luzon, Philippines

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THIS ARTICLE IS A SUMMARY site report of excavations at Musang Cave, a limestone cave located in the municipality of Peñablanca, in northern Luzon, Philippines (Fig. 1). The cave is in the western foothills of the Sierra Madre.

There are many archaeological sites in this region. From November 1976 to February 1977 researchers from the National Museum of the Philippines conducted an archaeological survey of approximately 35 km² in the area surrounding Musang Cave. In all, 71 caves and 7 rockshelters were located, 43 of which have archaeological remains. These are primarily habitation sites. In addition, 21 open sites, lithic workshops, and habitation sites were found (Ronquillo and Santiago 1977).

Musang Cave was used for habitation from approximately 10,000 B.C. to recently. Two different assemblages were excavated. The earlier one consists of flake tools, shell, and animal bone, and dates from approximately 10,000–4500 B.C. During this time the cave was used as a frequentation site by hunters and gatherers. The second assemblage dates from approximately 4500 B.C. to recently. It contains the same type of flake tools, shell, and bone as in the earlier period, but also contains pottery, human bone, and a few beads, earrings and other ornaments, a brass needle, and other artifacts. This assemblage is probably also the remains of hunters and gatherers, with the pottery and other new artifact types being obtained in trade from nearby agriculturalists.

The site is important for several reasons. It is one of the earliest dated sites in Luzon. The pottery dates from 4000 B.C. or possibly earlier. This is some of the earliest dated pottery from anywhere in the Philippines. Also of importance is the brass needle. It is possibly as old as 2680 B.C., which is a very early date for brass.

MUSANG CAVE

Musang Cave is located in the western foothills of the Sierra Madre, a transition zone between two major physiographic regions, the Cagayan Valley to the west, and the Sierra Madre to the east. This is a range of rugged mountains with peaks above 1800 m. The area of Musang Cave generally has over 200 cm of rain per year. Most

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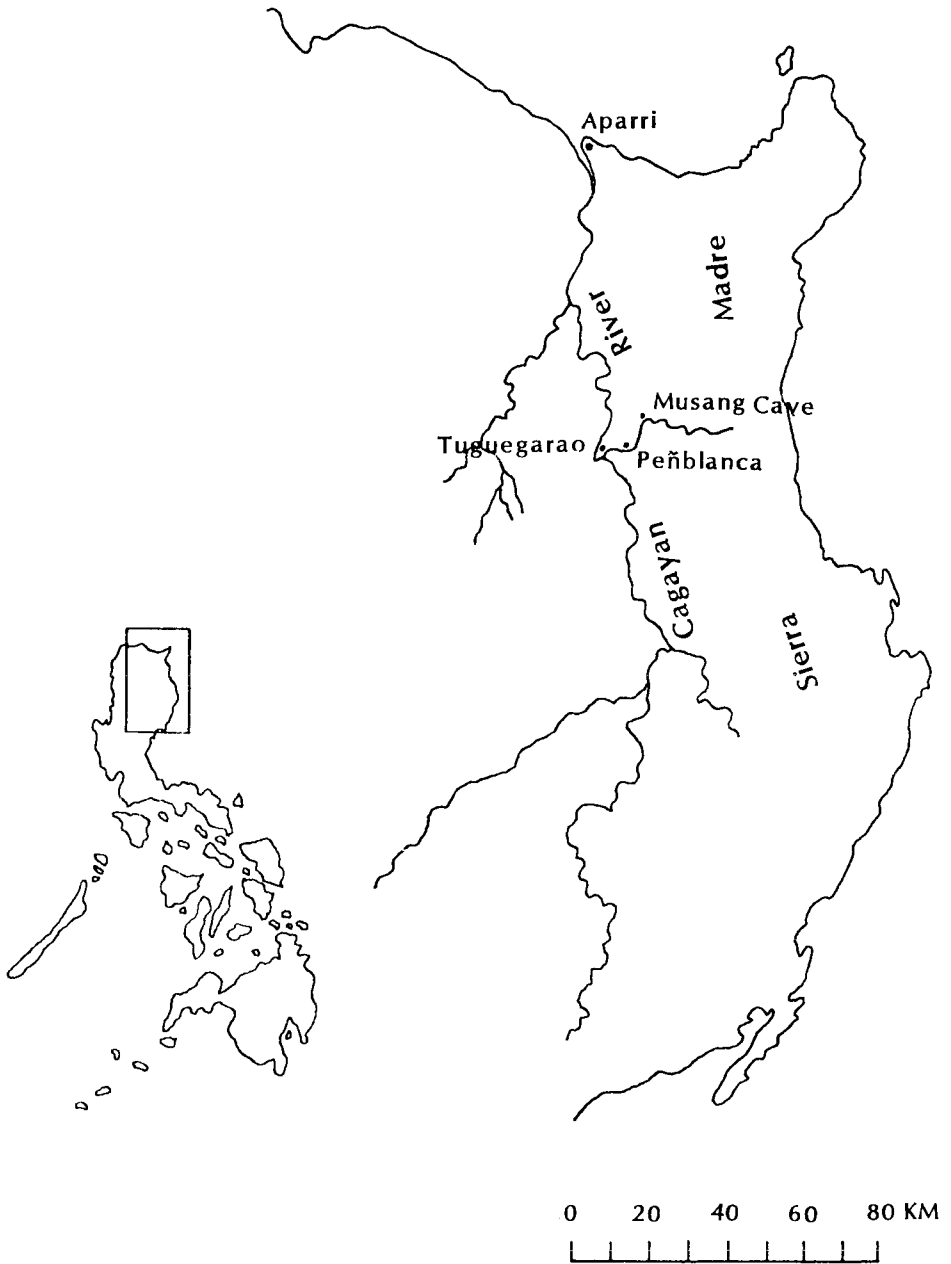


Fig. 1. Northeast Luzon.

rain falls from October to March. This season also has frequent typhoons, but their effect is minimized because of the mountains to the east. The natural vegetation of the region is dipterocarp forest (Wernstedt and Spicer 1967:45, 49, 91).

The cave is in a hill that slopes to the Pinacanan de Tuguegarao River, located at 40 m above sea level. The cave is 65 m above sea level, and faces south.

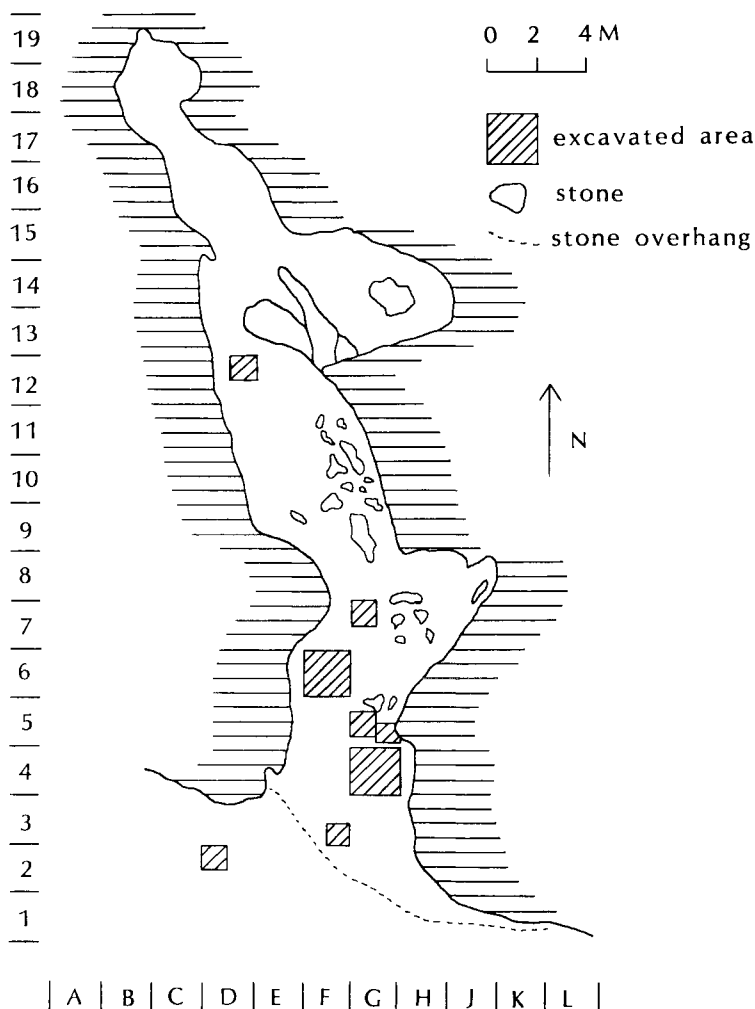


Fig. 2. Floor plan of Musang Cave.

Musang Cave is 37 m long and varies in width from 3 m to 10 m. The front part of the cave, from the mouth back 16 m, has a ceiling varying from 3–4 m high. This part of the cave is well lit. The cave then angles to the left somewhat. This central part of the cave, from 16 to 24 m, has a very high ceiling, from 20–24 m high, and at one point, about 1 m by 2 m in area, there is an opening in the ceiling. This opening lets in little light, due to the configuration of the stones surrounding it, and the vegetation on the hill above the cave. The back part of the cave varies in height from 1 m to 5 m and is very dark.

During the rainy season there are a few places where water drips from the ceiling, but little water comes in through the opening in the central part of the cave. The floor of the cave is generally level, though there are many stones on the surface, particularly in the central and back areas (Figs. 2 and 3).

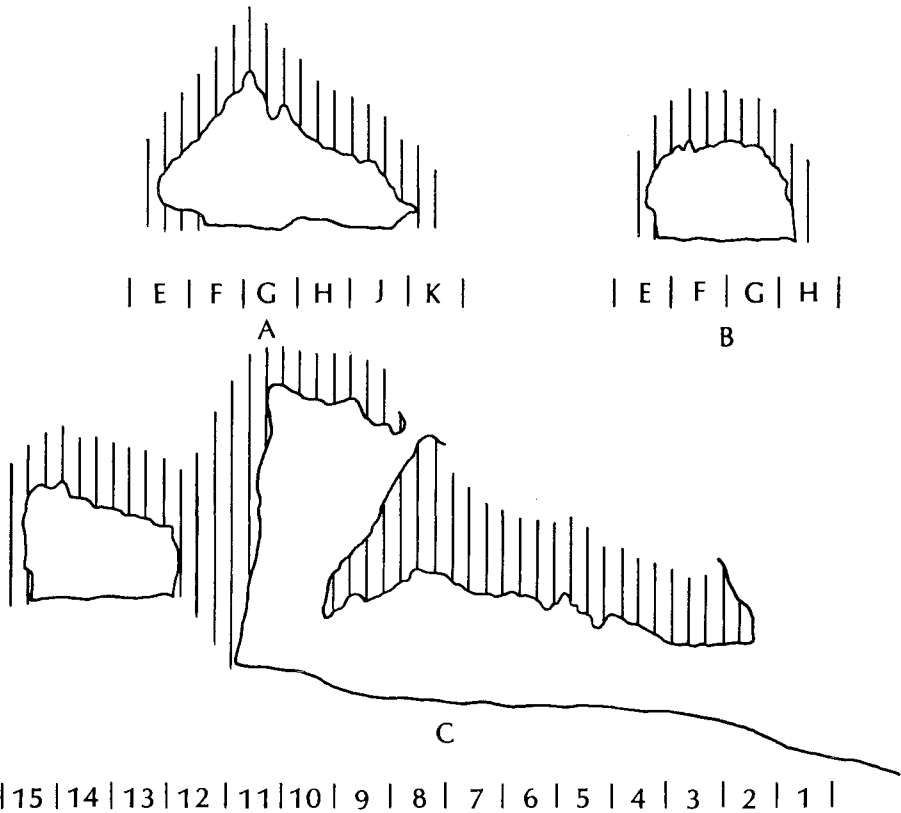


Fig. 3. Cross sections: A at center of 8, B at 4/5, C at G/H.

THE EXCAVATIONS

I conducted excavations at Musang for six weeks from late November 1976 to early February 1977. I hired and trained two local men as excavators.

The cave floor was divided into a 2 m grid pattern on a north-south baseline and was designated by numbers and letters (Fig. 2). Two 2 m squares and six 1 m squares were excavated to bedrock. The soil was excavated in 10 cm or 15 cm arbitrary levels, but followed natural soil layers where they were present. All of the soil was excavated by trowel and screened through 1.5 mm screen.

Initial inspection of the cave revealed that the surface of the front part of the cave was littered with sherds, but the central and back areas had very few. Also, the central and back areas were dark, and would have been difficult to excavate without artificial lighting, which was not available. Therefore, most of the excavation was confined to the front part of the cave, which also seemed much more suitable for habitation than the central and back areas.

In front of the cave there is a gentle slope for several meters before a sharper drop to the river. This area in front of the cave was probably used by the prehistoric inhabitants of the cave. Unfortunately, several years before I excavated, this area was

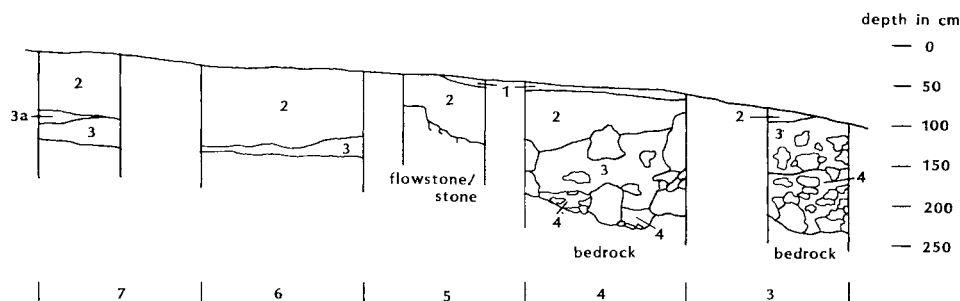


Fig. 4. Stratigraphic profile of excavated areas at F/G. Key: 1. Dark brown 7.5 YR 3/2. Very hard sandy clay loam. Pottery, animal bone, shell, flake tools. 2. Dark brown 10 YR 3/3. Hard sandy clay loam. Pottery, animal bone, shell, flake tools. 3. Dark, yellowish brown 10 YR 4/4. Hard clay with many small (0.5–1.5 cm) pieces of limestone. Animal bone, flake tools, and shell; no sherds. Squares G4 and G5 of this layer contained the shell midden. 3a. Dark yellowish brown 10 YR 4/4. Soft, sandy clay with many small pieces of limestone. A few sherds and shells. 4. Very dark grayish brown 10 YR 3/2. Very stony, hard clay. No cultural remains.

greatly disturbed by a bulldozer in an attempt to build a road to a nearby tourist cave. The local people told me that the bulldozer uncovered “many pots and bones” which were swept down the hill.

Stratigraphy

The cave soils are a mixture of windblown soils, bird and bat wastes, and weathered limestone. The excavation revealed five soil layers (Fig. 4). The upper layer, soil layer 1, was a very hard, sandy clay loam, dark brown (7.5 YR 3/2) soil, found only in part of the southeast area of the cave. Soil layer 2, also a dark brown (10 YR 3/3), hard, sandy clay loam, was much more extensive and was present in all excavated areas. It varied in thickness from 60 cm to 130 cm. In the back of the cave (square D12) this soil went from the surface to bedrock at 120 cm.

In the front part of the cave, soil layer 2 was underlain by soil layer 3, a hard, dark yellowish brown (10 YR 4/4) clay soil with many small (0.5–1.5 cm) pieces of limestone. This soil is thickest in the southeast area of the cave (G4). Soil layer 3a was the same color as 3 and had the same small stones, but is differentiated because it is a soft, sandy clay soil. It overlies soil layer 3, but was present only in part of the north section of the front of the cave (G7). Below soil layer 3 in most of the front area was soil layer 4, a hard, very stony, very dark grayish brown (10 YR 3/2) clay soil.

In soil layers 2 and 3 there were slight color changes and slight bedding lines of small stones. These were more or less horizontal and followed the lines of the surface of the cave.

Excavated Areas

The information on what materials were excavated where is given in Table 1. The following are descriptions of various aspects of the excavated squares and some excavation procedures.

TABLE 1. EXCAVATED MATERIALS

SQUARE	Ex- CAVA- TION LEVEL	DEPTH FROM SURFACE (CM)	SOIL LAYER	PIG BONE	PIG TEETH	DEER BONE	DEER TEETH	HUMAN BONE	SHELLS	FLAKE TOOLS	FLAKES	OTHER PIECES OF STONE	SHERDS	OTHER
G4	1	0-14	1	328		28	10	12	33	4	1	2	693	4 sherds blue and white porcelain, ground red chert bead, turquoise glass bead, fragment tubular green glass bead, iron fragment, spherical green glass bead, fragment ground stone tool
	2	14-31	2	438	4			9	10	11	9	8	660	3 bird vertebrae, brass needle, fired clay earring, 2 bone points, fragment of shell bracelet, 9 fragments boar tooth pendant(?), 4 cowrie shells, 1 bone point, fired clay earring
	3	31-41	2	668	1	39		20	92	45	47	66	906	
	4	41-54	2	479	13			7	27	30	28		803	
	5	54-65	2	173	1			12	16	4	1		202	
	6	65-75	2	100				11	14	6	8	6	60	
	7	75-89	2	19				2		3	3	3	6	
	4a	41-54	3	120					414	33	76	104		
	5a	54-65	3	212			7		933	47	122	135		
	6a	65-75	3	201			1		1114	76	70	63		
	7a	75-89	3	181			2		947	62	72	83		
	8	89-100	3	99			5		864	32	74	30		
	9	100-110	3	47			5		967	27	24	30		
	10	110-120	3	14					813	3	12	8		
	11	120-130	3	5					310	1	5	1		
	12	130-145	4						2					
G5														
sc1m	1	0-14	1	22			3		7				86	
	2	14-28	2	105					3	1	1		69	

	3	28-41	2	36		38	5	6	5	9	
	4a	41-53	3	67	1	405	4	20	19		
	5a	53-63	3	81	2	708	3	18	18		worked bone fragment
	6a	63-80	3	18		325	6	1	15		
	7a	80-90	3	29		360	1	12	9		
	8	90-100	3	81	2	708	3	2	18		
	9	100-116	3	4		3	3	3	3		
	10	116-130	3			1		1			
	11	130-160	3	2		2		1			
G5											
wc1m	1	0-16	1	8		6				66	
	2	16-26	2	14	1	5		1		37	
	3	26-44	2	23		15	6	0	3	13	
	4	44-53	2	3		17			1	4	
	5	53-66	2	1		16				2	
G7											
nw1m	1	0-12	2	9		1		1	1	102	1 sherd blue and white porcelain
	2	12-22	2	4	4	4		2	1	1	
	3	22-34	2	8		15		3			
	4	34-45	2			47	3	7	7	4	
	5	45-55	2			2	5	2		1	
	6a	55-67	3a			1					
	7a	67-80	3a			1					
	8	80-95	3			1					
F6	1	0-15	2	85	9	12	2		2	317	1 tubular square green glass bead, 1 sherd blue and white porcelain
	2	15-25	2	20		3				37	
	3	25-38	2	3		10	2	7	3	6	
	4	38-51	2	2		19	5	7	9	9	
e half	5	51-62	2	1	1	15	4	7	10	4	
e half	6	62-75	2	1		11	5	6	6	3	
c half	7a	75-88	3	12	11	17	1	7	8		

TABLE 1. (continued)

SQUARE	Ex- CAVA- TION	DEPTH FROM SURFACE (CM)	SOIL LAYER	PIG BONE	PIG TEETH	DEER BONE	DEER TEETH	HUMAN BONE	SHELLS	FLAKE TOOLS	OTHER PIECES OF			OTHER
	LEVEL										FLAKES	STONE	SHERDS	
F6 (cont.)														
e half	8	88-95	3	29			1		99	1	8	11		
c half	9	95-105	3	18					31		4			
e half	10	105-116	3						1		1			
F3														
se1m	1	0-9	2	10	6				50	12	27	15	10	iron fragment
	2a	9-22	3	4					5	2	8			
	3a	22-34	3	1						2	1			
	4a	34-46	3						1					
D12														
ne1m	1	0-10	2						3				4	
	2	10-20	2											
	3	20-30	2						2				1	

G4

In the first three excavation levels, the sherds, shells, and bones were distributed fairly evenly throughout the square. But beginning with level 4 there was a distinct difference in the location of the various materials in the square, which correspond to the soil layer. In level 4, soil layer 3 was present in the southeast part of the square. Soil layer 2, which was present in all parts of levels 2 and 3, was still present in the northwest part. Much more shell was present in the soil layer 3 area, much more bone was present in the soil layer 2 area, and all of the sherds were in the soil layer 2 area. Because of these differences, I divided the square into two excavation areas and kept the excavated materials from the two areas separate. Excavation levels 4, 5, 6, and 7 are from the soil layer 2 area, and 4a, 5a, 6a, and 7a are from the soil layer 3 area.

In level 5a, soil layer 3 was somewhat more extensive than in level 4a, and by level 6a it was present in all but the northwest area of the square. During level 7a, soil layer 3 became more extensive, and the last of soil layer 2 was in the northwest corner of level 7. Level 7a contained the typical small stones of soil layer 3, but also some larger (10–15 cm) stones. By level 8 the entire square was soil layer 3. Bedrock was reached at 170–180 cm, but there were no cultural remains below level 12 (145 cm).

In the earlier time periods it seems that this area nearer the cave wall was used as a midden area, particularly for shell. Levels 12–8 and 7a–4a were deposited with heavy concentrations of shell in various areas at various times, making this area somewhat higher than the surface to the west. Then levels 7 through 1 were deposited.

G5

The shell midden area present in G4 was not present in F6. The west central one meter (wc1m) of G5 was excavated to determine more about the extent of the midden area. The northern part of the square was not excavated because there was a large stone on the surface. The southwest part was not excavated due to an area of flowstone at the north wall in the northwest part of G4. I was hoping to avoid flowstone in G5 by digging north of it. Unfortunately, the flowstone was also present in the western part of G5 and blocked excavation at a depth of 50 cm in some areas, and by 66 cm in all areas. The southeast one meter (se1m) was then excavated instead.

In the southeast one meter, soil layer 3 was present from level 4, so levels 4–7 in this square correspond to levels 4a–7a of G4. As in G4, there were no sherds in these levels, and there was much shell. This deposit forms part of the same shell midden present in G4.

A few very small pieces of charcoal were excavated in level 9, but not enough for a dating sample.

In the eastern part of the square the cave wall was present at 80–90 cm. It sloped to the west. Bedrock was reached in the western part of the square at 155–165 cm.

F6

There were not many artifacts in levels 2 and 3, and all the remains in level 4 were in the east half, so from level 5 on only the east half of the square was excavated. In level 7 soil layer 2 was present in the square except in the southeast corner, where soil layer 3 was starting to show. This southeast corner corresponds to level 7a of G4,

and all the artifacts in this level were in this 7a area; no artifacts were present in the rest of the square. From level 8 on, soil layer 3 was present in all areas of the square. All the remains in level 8 were in the southern one-fourth of the square. In level 9 bedrock was reached in the north part. Bedrock was reached in the south part of the square at 110–120 cm.

G7

There were some large rocks on the surface of the east part of the square, so the northwest one meter (nw1m) was excavated. No artifacts were found below level 7 (80 cm). Bedrock was reached at 107–112 cm.

F3

Only the southeast one meter (se1m) was excavated because there were many stones on the surface of this square. This square was also very stony below the surface with large and small stones. It was about four-fifths stone and one-fifth soil. All the cultural remains from this square were from the southeast corner. No remains were found below 40 cm. Large stones that could not be removed were reached at various depths in some areas. Bedrock in the remainder of the square was reached at 125–160 cm.

D2

This test square (northwest one meter) was excavated in the area outside the cave that I had been told was disturbed. There were 10 cm of stony soil in the square before reaching stone. No cultural remains were found.

D12

One square (the northeast one meter) was excavated in the back of the cave. There were five sherds and five shells in the upper 30 cm, but no other cultural remains to bedrock at 120 cm.

EXCAVATED MATERIALS

Pottery

In the upper levels of the cave 2340 sherds were excavated, though there were no whole vessels. These sherds are from approximately 62 vessels. This was determined on the basis of rim forms, colors, and excavated location. The pottery was made by paddle and anvil and has sand temper. There are three color categories. The most common (51 percent) is various shades of orange, orange brown, and light brown, the color variation being due to firing differences. Black, which includes grayish, brownish, and dull reddish black, amounted to 38 percent. This pottery is often polished and finely made. Eleven percent of the pottery is red slipped.

For descriptive purposes the pottery can be divided into three basic categories—bowls, pots, and large pots (Fig. 5). There are 21 bowls, which vary in thickness from 4 mm to 9 mm. There are 19 pots with everted or straight rims; the bodies were probably globular. The pots vary from 5 mm to 8 mm in thickness. There are 8 large pots with thicknesses of 12–18 mm. In addition, there are sherds of 14 other vessels for which form could not be determined. They are probably pots, though a

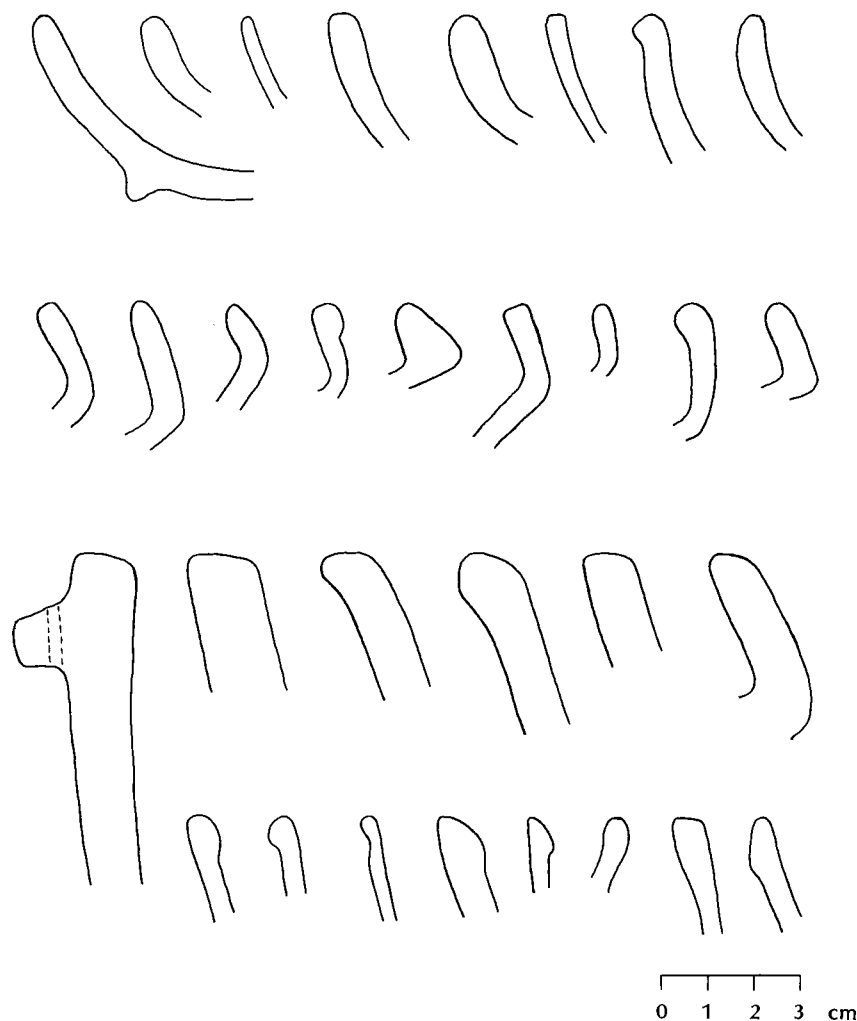


Fig. 5. Pottery rim forms. Top row, bowls; second row, pots; third row, large pots; bottom row, probable pots.

few could be bowls. Twelve sherds of ring feet were also excavated. Six sherds of blue and white porcelain were excavated in level 1.

Stone Tools

There were 1172 flakes excavated; 410 were used as tools. These are all small (95 percent are 1–5 cm in length or width), amorphous tools with no recurrent forms, so the tools cannot be divided into morphological “types.” Fewer than 3 percent of the tools are retouched. Seventy-one percent are made of chert, and the remainder are andesite, basalt, agate, jasper, and jade.

An edgewear analysis was conducted on the tools to determine their functions,

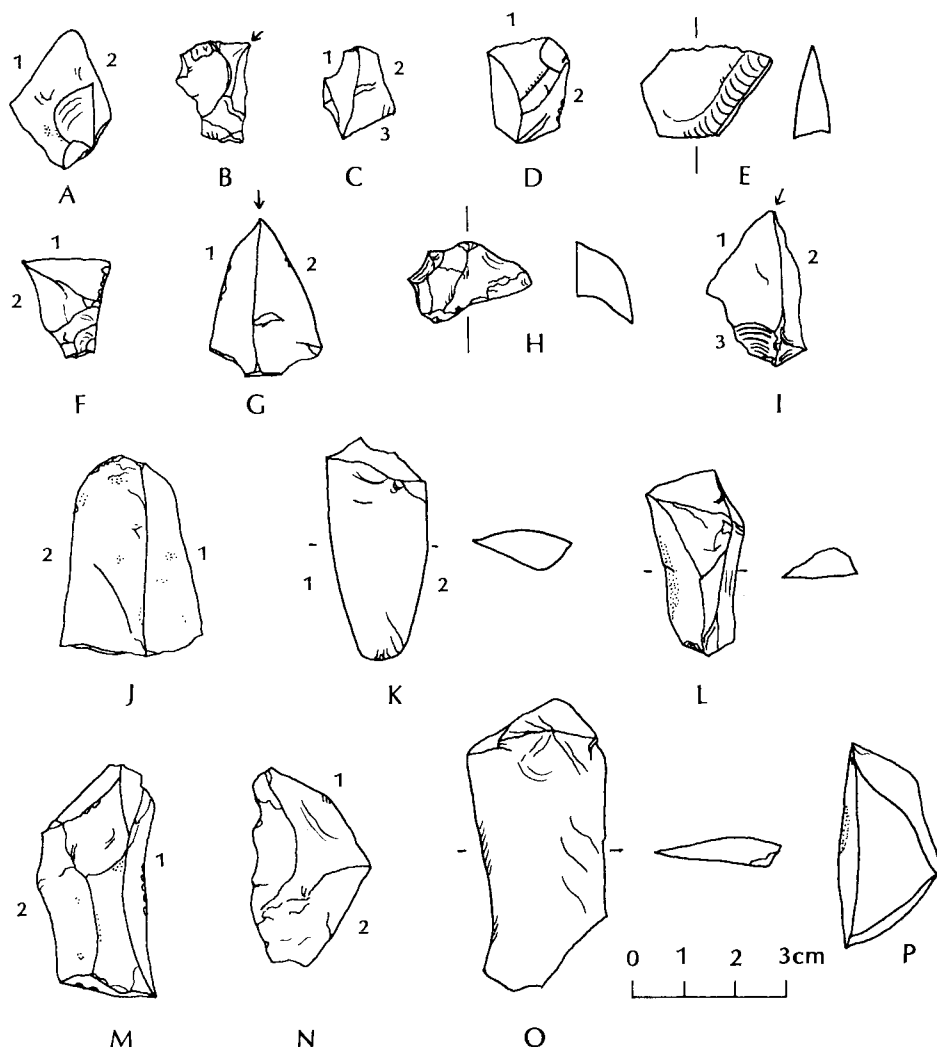


Fig. 6. Flake tools. Stippling shows areas of sheen: A, edges 1 and 2 used for whittling on wood and bamboo; B, point is bone graver; C, woodworking, 1 spokeshave, 2 cutting, 3 scraper; D, bamboo working, 1 cutting edge, 2 scraper; E, upper edge is a retouched wood saw; F, edges 1 and 2 used for wood cutting; G, point used as drill, edges 1 and 2 for cutting wood; H, upper edge used for hide scraping; I, woodworking, point is graver, edges 1 and 2 are scrapers, 3 for cutting; J, bamboo working, 1 cutting edge, 2 scraper; K, edges 1 and 2 used for butchering; L, grass cutting; M, edges 1 and 2 are scrapers on wood and bamboo (made of jade); N, edges 1 and 2 used for cutting bone; O, wood whittling; P, grass cutting.

though functions could not be determined for all of the tools. (For methods used in the analysis, see the Appendix.) The tools (Fig. 6) were used as scrapers on wood, bamboo, and bone, and a few on leather; knives for whittling on wood, bamboo, and bone; gravers on bone and wood; chisels on wood and bone; animal butchering; drills or awls on wood, bone, and possibly leather; spokeshaves; saws on wood, bamboo, and bone; and grass cutting. Twelve percent of the tools are composite, for

example, one flake with two or more working edges, one edge used as a knife and one or more other edges used as a scraper or graver. These composite tools were used on wood, bamboo, or bone, and some on both wood and bamboo.

In addition to the flakes, other pieces of stone were also excavated. These are generally small angular chunks of stone, including chert, andesite, jasper, shale, basalt, dacite, and quartzite. One small fragment of a ground stone tool was also excavated.

Metal

One brass needle was excavated (Fig. 7H). It is 39 mm long and 1 mm in diameter. It is slightly curved and is broken through the eye. It contains 72 percent copper, 10 percent zinc, and lesser amounts of lead, tin, and iron. The metals are present in percentages contained in some naturally occurring copper oxide ores, such as azurite and malachite (Patterson 1971). Therefore, the needle may have been made from a naturally occurring alloy. If it was made from a naturally occurring copper oxide ore, it must have been reduction smelted (Craddock 1978). The metals also could have been melted separately under reducing conditions and mixed.

Two iron fragments were excavated, both in level 1. The one from G4 is a small fragment only 1 mm thick (Fig. 7G). The one from F3 is an irregular fragment, 65 × 21 mm, but flat (8–9 mm thick) (Fig. 7L).

Ornaments

Four glass beads and one stone bead were excavated from levels 1 and 2 (Fig. 7A–D). The stone bead is ground red chert. The glass beads are all of different types. One is a small turquoise bead, and the other three are made of green glass. One is spherical (6 mm), one is a 16 mm long tubular bead and is square in cross-section. The third is a 5 mm long fragment of what seems to be a tubular bead with a round cross-section.

Two fired clay earrings excavated from levels 3 and 4 (Fig. 7E–F) have broken tops. The spherical one has the projections of the *lingling-o* type (Loofs-Wissowa 1980–1981; Solheim 1982–1983), though the other one is plain.

A fragment of a shell bracelet was also recovered, and nine small fragments of a boar tooth. The tooth fragments fit together, revealing a drilled hole, a possible pendant.

Bone

The excavated bone can be divided into four categories—bone points, a fragment of worked bone, animal bone from food refuse, and human bone.

Three bone points were excavated. They are all finely ground and have a similar shape (Fig. 7I–K). The worked bone fragment is 16 mm long, 6–8 mm wide, and 2–3 mm thick. It looks as though it was partially sawn, and then snapped to cut it to this length.

The animal bone is all fragmentary (except for a few small bones that were whole), generally in small fragments, and it is impossible to tell how many animals are represented. The great majority (over 98 percent) is from wild pig (*Sus* sp.). There is also some deer (*Cervus* sp.) bone, some pig and deer teeth, and three bird vertebrae from a bird of wild chicken size.

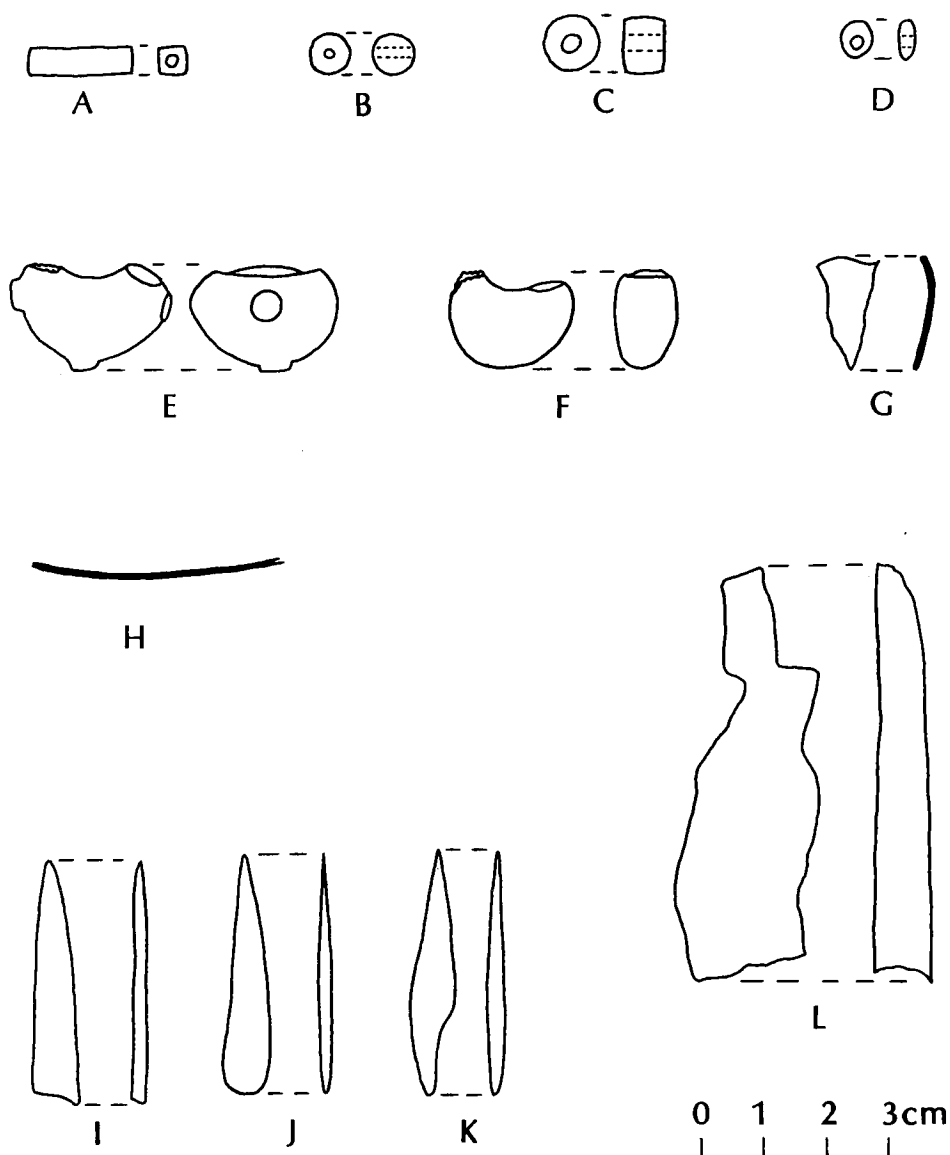


Fig. 7. Excavated artifacts. A, tubular square green glass bead; B, spherical green glass bead; C, ground red chert bead; D, turquoise glass bead; E, F, fired clay earrings (top parts broken); G, L, iron fragments; H, brass needle; I, J, K, bone points.

There were 78 human bones and fragments excavated, from at least two adults. Represented are bones from two right hands, two left hands, one right foot, and also four skull fragments, five vertebrae, one ulna, one radius, and three patellae. They were not placed in any type of burial areas, but were found scattered, mostly in the upper levels of G4.

Shell

Several thousand shells from the edible gastropod *Thiara scabra* were excavated. These shellfish grow in the river near Musang Cave and were probably collected there by the prehistoric inhabitants of the cave. These shells in the cave are undoubtedly from food refuse.

Four cowrie shells were also excavated.

CULTURAL INTERPRETATION

Cultural Levels

On the basis of soil types and artifact types, the materials in the cave can be grouped into two cultural levels. These represent somewhat different use patterns of the cave, and show that the prehistoric users of the cave had different artifact types during the two time periods. The earlier one, Cultural Level I, consists of the materials in soil layers 3 and 3a. These are from G4 levels 8–12 and 4a–7a, G5 se1m levels 4a–11, G7 levels 6a–8, and F6 levels 7a–10. Cultural Level II consists of the materials in soil layers 1 and 2. These are from G4 levels 1–7, G5 se1m levels 1–3, G5 wc1m levels 1–5, G7 levels 1–5, F6 levels 1–6, F3 levels 1–4, and D12 levels 1–3.

The materials from Cultural Level I are flake tools, shells, and animal bone. Almost all of these materials are from the shell midden area in squares G4 and G5. Over 98 percent of the shell and most of the bone and stone tools were in this area. Excavation levels 9, 10, and 11 contained shell concentrations at various places in the midden area. Levels 8–4a contained much more shell distributed more evenly throughout the midden, though there were some areas with heavier concentrations. A total of 303 flake tools were in Cultural Level I. They show all of the uses already discussed.

Four ^{14}C dates were obtained on shell from Cultural Level I: 9850 B.C. (calibrated date, see Table 2) (ISGS-496) from G4 level 10; 7730 B.C. (GaK-7046) from G5 level

TABLE 2. RADIOCARBON DATES^a

LAB NO.	SQUARE	EXCAVA-	CUL-	UNCORRECTED DATE B.P. ^d	CALIBRATED DATE ^e	TWO SIGMA RANGE
		TION LEVEL	TURAL LEVEL			
GaK-7043 ^b	G5 wc1m	3	II	4110 ± 130	2680 B.C.	3040–2320 B.C.
GaK-7044	G5 wc1m	5	II	4980 ± 150	3740 B.C.	4095–3385 B.C.
ISGS-497 ^c	G4	6a	I	10,750 ± 150	9120 B.C.	9920–8320 B.C.
GaK-7045	G5 se1m	7a	I	9670 ± 220	8010 B.C.	8810–7210 B.C.
GaK-7046	G5 se1m	8	I	9390 ± 280	7730 B.C.	8530–6930 B.C.
ISGS-496	G4	10	I	11,450 ± 170	9850 B.C.	10,650–9050 B.C.

^aAll dates are on shell.

^bGaK = Gakushuin University.

^cISGS = Illinois State Geological Survey.

^dUncorrected dates are based on Libby half-life of 5568 years.

^eCalibrated dates are according to Klein et al. 1982. Klein et al. give two sigma ranges. The single calibrated dates given here are halfway between the two sigma range dates. These dates are slightly different from those in Thiel 1980 because they are calibrated differently.

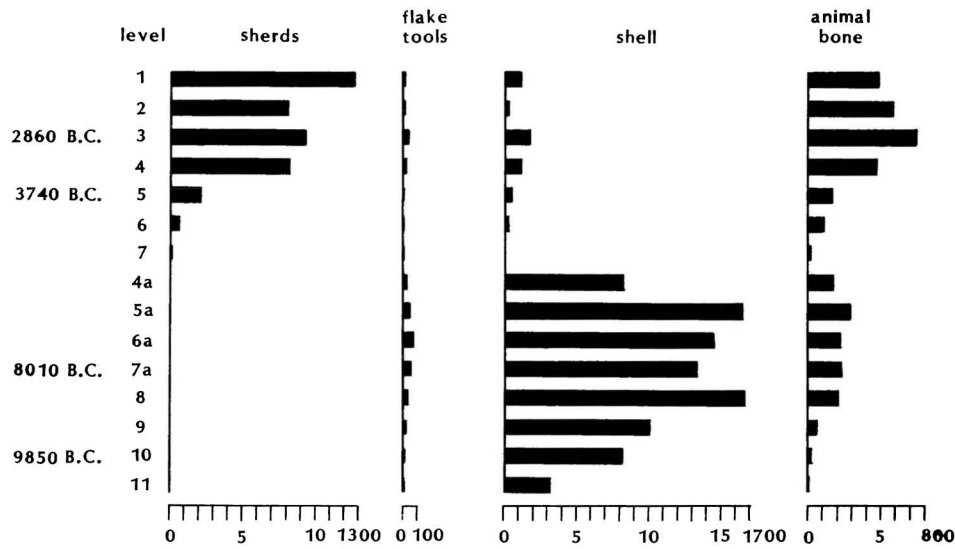


Fig. 8. Amount of material excavated in counts per excavation level for all excavated areas. The animal bone is fragmentary, so these counts do not give the number of whole bones or animals, but represent the proportional amount of bone per level. Levels 4a through 11 are Cultural Level I, 1 through 7 are Cultural Level II.

8; 8010 B.C. (GaK-7045) from G5 level 7a; and 9120 B.C. (ISGS-497) from G4 level 6a. The last three dates are in reverse age from their stratigraphic position and deserve comment. The 7730 and 8010 dates are both from G5. The deeper date is younger, but only by 280 years; they overlap in the one standard deviation range. Both of these dates are on shell from the northern edge of the shell midden and therefore may be slightly younger than shell from the center of the midden of a slightly shallower depth. This is where the 9120 (G4 level 6a) date was obtained. All three dates are younger than the deepest date, 9850 (G4 level 10), and all three dates are within a time range of 1390 years. Within the two standard deviation range the level 8 date can be earlier than the level 6a date, 8530 B.C. and 8320 B.C. respectively. Also, the dates were processed at two different laboratories. The ISGS dates were checked for calcite content, and these dates were obtained on pure aragonite. The GaK dates were not checked for calcite content. This may cause a slight difference in the ages. Considering all these factors, the dates are in reasonable agreement. These three dates represent a range of dates for the middle depths of the midden. The upper depths are probably several hundred to a few thousand years younger.

Cultural Level II contained shells, animal bone, and flake tools, as in Cultural Level I, but this level also contained pottery and other artifacts. These materials were deposited more or less evenly throughout the front part of the cave, and were not confined to a midden as in Cultural Level I. There was only a small amount of shell compared to Cultural Level I, but there was over twice as much animal bone. Some 157 flake tools were excavated in Cultural Level II, only about half as many as in Cultural Level I, but they show the same uses (Fig. 8).

Two ¹⁴C dates were obtained for Cultural Level II: 3740 B.C. (GaK-7044) from G5 wc1m level 5, and 2680 B.C. (GaK-7043) from G5 wc1m level 3. Both dates are asso-

ciated with pottery. The pottery at 3740 B.C. is some of the earliest dated pottery from anywhere in the Philippines. Since there is also pottery from levels 6 and 7, the earliest pottery at the site may be older than 4000 B.C.

The 2680 B.C. date is particularly important because it is from the same excavation level as the brass needle. This is the earliest date associated with metal from anywhere in the Philippines. However, the needle was from the southwest area of G4, so it was separated from the dated shell sample by more than 2 m horizontally. Also, because of its small size, the needle may have settled downward from a shallower depth, and may not actually be as old as the date. It is probably best to reserve judgment on the date of early brass in the region until an item is excavated at another site from a better dated context.

Interpretation

The excavated materials from the cave can be interpreted to present a cultural sequence of use of the cave that extends for approximately 12,000 years (Fig. 8). The earliest date, 9850 B.C., comes from a small concentration of shell near the bottom of the midden area. There are also a few concentrations of shell in various parts of the midden at lower depths, and they are possibly a few hundred years older. The earliest use of the cave was probably about 10,000 B.C. or slightly earlier. This is the beginning of Cultural Level I. A few flake tools and pig bones were also recovered from the areas with the shell. At this early time the cave seems to have been used sporadically by hunters and gatherers as a frequentation site for shellfish gathering in the river, and also for hunting.

By the middle levels of Cultural Level I, 9100–7700 B.C., there was a dense, continuous shell midden in the southeast area of the cave. This shows a more intensive use of the cave, but for the same purposes. The flake tools show uses for woodworking, bamboo working, bone working, and grass cutting. These could be related to subsistence and also to other activities.

This use pattern of the cave continues, and the shell, flake tool, and bone deposits become even more dense in the upper levels of Cultural Level I, though they decrease somewhat in the uppermost level (Fig. 8). It is difficult to determine exactly when Cultural Level I ended. It may have been about 6500–7000 B.C., though it could have been as late as 4000–4500 B.C.

It is also difficult to tell when Cultural Level II began. The earliest date, from level 5, is 3740 B.C., with a range of 3385–4095. The materials from levels 6 and 7 are undoubtedly older, though they are probably no older than 4000–4500 B.C. This is the beginning of the new use pattern of the cave. Cultural remains are found to the surface of the cave, and sherds of blue and white porcelain are present in level 1, so the cave was probably used until very recently.

There are two primary differences between Cultural Levels I and II. One is the introduction of new artifact types, the pottery and various other items. The second is the change in subsistence remains. Almost three times as much animal bone was in Cultural Level II compared to Cultural Level I, indicating more hunting. But what is most striking is the drastic reduction in the amount of shell (Fig. 8). Cultural Level II contains only about 5 percent of the amount of shell in Cultural Level I. Nearly equal volume was excavated of the two levels (Cultural Level I represented 47 percent of the area excavated, Cultural Level II 53 percent), so these differences are significant

and show a definite change in the use of the cave. During Cultural Level I the cave was used primarily as a campsite associated with shellfish gathering. In Cultural Level II this no longer seems to be the case.

Several possible interpretations of this change in subsistence remains come to mind. During later times the people may have chosen to use their time more for hunting than shellfish collecting. Or they may have continued to collect them but deposited the shells elsewhere. The cave may have been used by new people with a different subsistence pattern who moved into the area. Or the shellfish may no longer have been as available to the Musang Cave people because now they were also collected by other people who had moved into the area. There are other possible interpretations, but additional excavation and research are needed to determine which is the most likely.

However, some data show that the shellfish were collected more intensively through time. This comes from the shells at Musang Cave. The size of the shells shows that they were collected more during Cultural Level II than Cultural Level I. When I measured a random sample of shell from each excavation level, the largest shells were seen to come from levels 10 and 11, with an average length of 50 mm (range 40–71 mm). From levels 9–6a, a period of heavy use of the cave (Fig. 8), the shells decrease in size, with average length 46 mm (range 33–67 mm), showing that they were collected more intensively (the shellfish did not have time to grow as large). In levels 5a and 4a they are even smaller, with average length 43 mm (range 28–62 mm). This small size continues during Cultural Level II. The smallest size is during level 4, with an average length of 40 mm (range 24–55 mm), though by level 3 they were again slightly larger, average length 44 mm (range 33–58 mm).

Even though very few shells are in the cave in Cultural Level II, the shells that are there are small, showing that they were collected more intensively than in Cultural Level I. Apparently, either the Musang Cave people were still collecting them but depositing the shells elsewhere, or other people in the area were also collecting them, so they were no longer as available to the Musang Cave people. This may have led to an increase in hunting, as represented by the increase in animal bone in Cultural Level II.

There are some data to show that other people, agriculturalists, were present in the area during Cultural Level II. This is provided by Arku Cave, a burial site 1.5 km upriver from Musang Cave. Arku Cave was used for burials from approximately 2200–50 B.C. The cave contained a large quantity and variety of grave goods, including pottery, shell, stone, fired clay earrings, shell beads and bracelets, spindle whorls, ground stone adzes, a barkcloth beater, flake tools, bone points, and other artifacts (Thiel 1986–1987).

The people who used Arku Cave for burials were undoubtedly agriculturalists, and probably lived in a nearby village. The fired clay earrings from Musang are similar to some from Arku. The pottery from the two sites is of the same types, manufacturing techniques, temper, and colors, and looks as though it comes from the same source.

In addition to the change in subsistence remains, the other primary difference between Cultural Levels I and II is the introduction of the pottery, ornaments, and other items. There are two likely interpretations for this. One is that new people, such as the agriculturalists who used Arku Cave, were now using Musang Cave periodically, and they were responsible for the Cultural Level II remains in the cave.

A second interpretation is that the cave continued to be used by the hunters and gatherers, but they obtained the pottery and other items in trade from the agriculturalists. Some data support this interpretation. The flake tools from the site are the same throughout both cultural levels, indicating cultural continuity. Also, trade between hunters and gatherers and agriculturalists is a pattern found today in the Philippines, including the area in the mountains east of Musang Cave, as well as in other parts of northern Luzon (Peterson 1978). This type of trade is also present in other parts of Southeast Asia, and seems to have considerable time depth. Additional research is needed, but this interpretation is likely.

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APPENDIX

Lithic Use-Wear Analysis

All of the flakes were checked for evidence of use. Those that did show use-wear were analyzed to try to determine the functions of the tools. For methods that are used in various types of use-wear analyses, see Hayden (1979), Honea (1983), Keeley (1980), Semenov (1964), and Sinha and Glover (1984). I was interested in determining the use pattern and also the material on which it was used. The tools were examined with the naked eye, and with 2×, 10×, and 20× hand lenses.

When a stone flake or core is used as a tool, tiny flakes are removed from the utilized edge. This works on the same principle as pressure flaking in the manufacture of a tool, but on a much smaller scale. Tiny flakes are removed from the tool as a result of pressure from the material on which the tool is used. The specific type of use results in certain patterns of flake removal. Particular materials also produce other alterations of the edge, such as polish, gloss or sheen, staining, or rounding. These patterns can help identify the type of use.

All the tools were analyzed, but I could not determine the use of approximately 10 percent of the tools. The use determinations made are probably not correct in every single case, but they definitely show categories of use patterns. The largest category of tools is scrapers used on wood or bamboo. Knives used on wood are the next most common. Many of the tools are composite tools with one or more working edges used as scrapers or knives. The use determinations were made by the following criteria.

Scraper. A scraper is drawn across the surface of the material being worked in one direction to remove some of the surface of the material. A fairly high edge angle is needed on the tool so the edge will not snap off during use. However, the angle is quite variable and can range from 30° to 120°, but usually is between 45° and 90°. Because scrapers are drawn across the material in only one direction, this removes flakes from only one side of the edge being used. The other side is generally unaltered. In addition to the removal of flakes, scraping sometimes produces other

alterations on the tool, which depend on the kind of material being worked. Wood is the commonest material on which scrapers are used. Most wood produces only the flakes. Very hard wood and bone also produce polish on the tool. Use of a scraper on bamboo produces the same type of flake removal as on wood, but in addition glossy patches are produced on the tool from the silica in the bamboo. The patches can occur on the edge of the tool, and on ridges and the body of the tool. Hide scraping produces flakes, rounding of the edge, and possible striations.

Spokeshave. A spokeshave is a particular type of scraper, usually having an edge angle from 50° to 90°. It has a distinctive concave cutting edge. The same type of edge damage occurs on a spokeshave as on a wood scraper.

Knife. To be an effective cutting tool a knife must be much thinner than a scraper. Edge angles on knives vary from 10° to 35°. Knives are used in a downward motion to the material being cut, so flakes can be removed from both sides of the cutting edge. Use on bone or very hard wood also can produce a polish on the edge. Use on bamboo produces glossy patches near the edge and on ridges of the tool farther back from the edge.

Grass-cutting blade. These are knife-like tools with edge angles from 35° to 60°. The silica in the grass produces a very distinctive lunate-shaped glossy area at the edge of the tool that is visible to the naked eye. Grass cutting may also remove flakes from both sides of the edge, producing a slight rounding of the edge, or striations perpendicular to the cutting edge.

Graver. Gravers have a sharp, small point for engraving bone or wood. Edge angles vary from 40° to 80°. Flakes may be removed during use. Use on hard wood or bone may produce polish at the point.

Drill. A drill has a long, narrow point. Flakes and striations are produced perpendicular to the length of the drill. Hard wood and bone can also produce polish on the drill.

Saw. A saw has an edge angle of 20° to 30°, and a retouched denticulate edge. Use produces flakes from both sides of the edge, and usually also some rounding and polishing of the edge and striations parallel to the edge.

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