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The Ones That Come Ready Made: The Identification and Use of *Sus* Tusks As Tools at Prehistoric Cave Sites in Malaysia

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ABSTRACT: Evidence for osseous technologies has featured in excavation reports from Southeast Asia for almost a century and from archaeological deposits as old as 43,000 years BP. However, in contrast to the significance that is placed on this technology in other parts of the world, until recently, Southeast Asian assemblages have drawn only very limited attention. Concentrating on evidence from Malaysia, the current paper examines one element of this inventory of tools: the deliberate modification of pig canines and the means by which such alteration can be distinguished from patterns of natural tooth wear. Particular attention is paid to the bearded pig (*Sus barbatus*), as it is one of the two species of wild boar in Malaysia whose tusks are most likely to have been used by prehistoric toolmakers. Reference is also made to wider, regional ethnographic examples of known tusk implements and their accredited uses to further assist in the identification process. Distinguishing criteria for worked tusk are formulated according to the type and extent of modification. These criteria are then applied to archaeological specimens recovered from two prehistoric cave sites in Malaysia, Gua Bintong and Niah Cave.

KEYWORDS: PIG TUSKS, NATURAL WEAR, TUSK-TOOLS, SOUTHEAST ASIA

RESUMEN: Desde hace casi un siglo los informes de excavación del sudeste asiático incorporan datos sobre tecnologías óseas en depósitos arqueológicos que alcanzan los 43.000 años A.P. No obstante, y a diferencia de la importancia que este tipo de tecnologías despierta en otras partes del mundo, hasta hace muy poco las muestras del sudeste asiático han generado muy poca atención. Centrados en evidencias procedentes de Malasia este artículo examina un elemento clave de estos inventarios de herramientas: la modificación deliberada de los caninos de suidos y los modos por los cuales tales alteraciones pueden diferenciarse de los patrones naturales de desgaste dentario. Particular atención se hace de los caninos del *Sus barbatus*, ya que se trata de una de las dos especies de jabalíes malayos cuyos colmillos parecen haber sido más ampliamente utilizados por los artesanos prehistóricos. Al mismo tiempo se recaban referencias de muestras etnográficas en un contexto regional más amplio y en donde los colmillos trabajados tienen uso conocido, lo cual permite utilizarlos como bases de inferencia en el proceso de identificación de los restos arqueológicos. Adicionalmente se ofrecen criterios diagnósticos de dichos colmillos trabajados de acuerdo con el tipo y grado de modificación que exhiben. Tales criterios son posteriormente aplicados en el análisis de especimenes arqueológicos recuperados en dos cuevas prehistóricas malayas: Gua Bintong y la cueva de Niah.

PALABRAS CLAVE: COLMILLOS DE JABALÍ, DESGASTE NATURAL, HERRAMIENTAS EN COLMILLO, SUDESTE ASIÁTICO

INTRODUCTION

Osseous technologies have appeared periodically in archaeological reports from Southeast Asian sites for almost a century. Moreover, such tools have been dated to as early as *c*. 43,000 BP (notably from the earliest levels at the Thai cave site of Lang Rongrien and the huge Niah Cave system of caverns in Sarawak, Borneo) and easily comparable with the first major appearances of such technology in Europe, during the Aurignacian. However, despite this time depth there has been, until recently, only limited investigation of the role that these technologies played in early hunting and gathering economies in the region.

Between the late-Pleistocene and the Climatic Optimum, *c*. 5,000 BP, osseous tool industries appear to have been closely associated with coastal exploitation strategies and perhaps specifically mangrove foraging (Barker *et al.*, 2002; Rabett, 2002, in press). For the most part, these industries comprise non-elaborate and generally non-standardized point- and edge-tool forms (i.e., pieces where one end of the bone is ground into a gouge-shaped or straight-bladed implement). However, an element of this tool inventory appears to involve the use of a range of implements on pig tusks and tusk fragments. In Malaysia, the focus of the current paper, such tusks are most likely to have come from either the bearded pig (*Sus barbatus*) or the Eurasian wild boar (*Sus scrofa*). In Peninsular Malaysia, both species have been present since at least the early Holocene - for example, at the rock shelter site of Gua Cha, in Kelantan, from deposits dating from before 6300±170BP (ANU2218) (Sieveking, 1954; Adi Taha, 1991). By contrast, in the Malaysian part of Borneo, the bearded pig appears to be the only indigenous species (Payne & Francis, 1998; Cranbrook & Labang, in press). Though present, the Eurasian wild boar is almost certainly an introduced species (Medway, 1973) - perhaps introduced during the expansion of Neolithic settlement of the region *c*. 4000 BP (Bellwood *et al.*, 1992). Unsubstantiated reports exist of other varieties of wild pig in Borneo, though these remain isolated incidents and may well represent members of a feral domestic stock (Medway, 1978).

To discount forms of naturally occurring modification, reference is made to a collection of tusks from bearded pig skeletons held at the Sarawak Museum, Kuching. In addition, this paper also examines patterns of intentional modification that are found on ethnographic examples of known tusk implements from Papua New Guinea. Criteria for distinguishing anthropogenic from natural alteration of the tusk are then applied to archaeological specimens from two sites: Gua Bintong, a cave site on the west coast of Peninsular Malaysia; and Niah Cave, a huge system of caverns in northern Sarawak, East Malaysia. All microscopic analysis of the tusks in this study was conducted using either a Zenith zoom stereo STZ-4500 Trinocular light microscope (15x to 120x magnification) or an IMXT zoom stereo Trinocular light microscope (10x to 40x magnification).

NATURAL DAMAGE AND WEAR PATTERNS

An essential objective in the study of osseous technology is the ability to distinguish micro-morphological features caused by human modification, through manufacture and utilization, from features that were more likely to have been caused by natural processes, be they taphonomic or, in particular instances, formed *in vivo*, i.e., during the life activities of the animal itself. In the latter case, we are concerned predominantly (though not exclusively; see, for example, d'Errico, 1993) with those body elements that come into contact with the external environment - antler, horn and claws, and teeth - and with the range of identifiable traces that this contact leaves on the material itself.

In a study with direct bearing on this matter, Olsen (1989) reported on the development of natural polish to discrete areas of deer antler, namely to the tines and parts of the beam, that could also be misinterpreted as technological use-wear. Under an SEM, the polished and rounded surface of the tine was also seen to be covered with fine abrasive striations, caused through the action of the animal's rubbing its antlers against the ground surface or vegetation. This may proceed even to such an extent as to produce a wear facet. Another feature identified by Olsen was the existence of terminal impact fractures - the removal of longitudinal flakes of material - from the tips of tines. The appearance of this, especially in combination with localized polishing to this same area, could well be mistaken for tool use-wear damage.

Careful consideration of the kind and patterns of wear sustained during life is also crucial in any study that seeks to identify and examine the way pig tusks were used as implements in the past. For this study, the range of natural modification was determined by examining naturally abraded tusks from the bearded pig (*Sus barbatus*) in the keeping of the Sarawak Museum, Kuching, and unworked specimens of unknown species from the Papua New Guinea collection of ethnographic material at the University of Cambridge Museum of Archaeology and Anthropology; these studies were supplemented by work carried out on Medieval specimens of wild boar (*Sus scrofa*) held in the reference collection of the zooarchaeology laboratory at the School of Archaeology and Ancient History, University of Leicester (Table 1).

Tusk no.	Catalogue no.	Collection	Max. length terminal facet (mm)
1	Wiru 68.320(2)	CUMAA	27
2	Wiru 68.322(1)	CUMAA	18
3	Wiru 68.322(3)	CUMAA	14
4	Forowan 1908.70.40	PRMO	15
5	BS/2/2[L]	SM	40,9
6	BS/2/2[R]	SM	38,74
7	BS/2/3[L]	SM	53,56
8	BS/2/9[L]	SM	40,22
9	BS/2/9[R]	SM	48,42
10	BS/2/10[L]	SM	64,88
11	BS/2/10[R]	SM	38.38*
12	BS/2/14[L]	SM	39,96
13	BS/2/14[R]	SM	45,06
14	BS/2/16[L]	SM	50,67
15	BS/2/16[R]	SM	45.65*
16	Piper1[L]	SM	32,03
17	Piper1[R]	SM	29,12
18	Unprovenanced	SAAHUL	-
19	305.1962 AF [L]	SAAHUL	32,98
20	305.1962 AF [R]	SAAHUL	28,64

TABLE 1

Maximum length of the terminal facet to unworked specimens of male *Sus sp.* and *Sus barbatus* from Cambridge University Museum of Archaeology and Anthropology (CUMAA); Pitt-Rivers Museum, Oxford (PRMO); Sarawak Museum, Kuching (SM); and School of Archaeology and Ancient History, University of Leicester (SAAHUL). Note: '*' designates a break.

A pig's canines grow throughout the animal's life, with opposing pairs of upper and lower canines meeting in an oblique occlusion (Figure 1). Malformation of the tusk through damage or deliberate husbanding - for example, where the mandibular tusks are manipulated in such a way that they grow out and back into the jaw, forming a near ring (Earl of Cranbrook, personal communication) - may introduce new variables into the development of canine wear. However, under conditions where all teeth are well formed and intact, the constant attrition to the occlusal surface between them, through jaw movement and the introduction of abrading particles, results in the creation of worn facets to the terminus of both the upper and lower canines that range from 15 mm to as much as 60 mm in length.

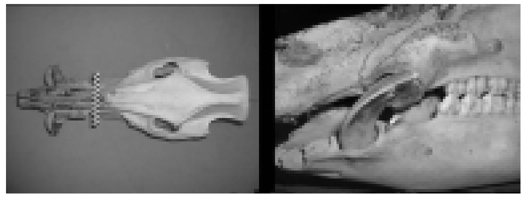

FIGURE 1

Complete skull of a modern male bearded pig (*Sus barbatus*), Specimen Piper 1, with details of the occlusal contact between the upper and lower canines.

Examination of specimens available to the author has shown that these facets may be subject to more than one form of damage, from simple rounding and polishing; or isolated short and non-aligned striations; to dense clusters of striations with varying degrees in structural uniformity, some of which appear as oblique or transverse striae. The oblique or transverse striae, in particular, could easily be mistaken as the traces of deliberate working (Figure 2). To help decide whether modification to a specimen was the result of natural or of anthropogenic processes it is useful to study ethnographic evidence of known tusk-tools.

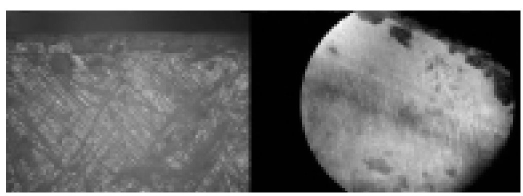

FIGURE 2

Naturally occurring surface wear to the lower canine of a male Eurasian wild boar *(Sus scrofa)* 305.1962 AF (left) and a bearded pig *(Sus barbatus)* BS/2/3 SM (right) - both images are at 40x magnification.

EVIDENCE FROM MODERN TOOL ANALOGUES

In order to examine the credibility of the archaeological specimens as tools, rather than as products of natural behavior, local ethnographic comparisons were made against implements found in the technical inventories of groups from the Highlands of Papua New Guinea (Figure 3).

FIGURE 3

Ethnographic examples of tusk-tools from Papua New Guinea. Unhafted specimens (1968.321.1-4 Wiru, Southern Highlands, Papua New Guinea.) were apparently used for scraping and planing. Photograph reprinted with the kind permission of Cambridge University Museum of Archaeology and Anthropology.

Deliberate modification of these ethnographic pig tusks appears often to have been quite intensive. The repeated appearance of chattermarks demonstrates (after Newcomer, 1974) that much of this was achieved through a longitudinal scraping action over the interior concave surface of the tusk. On occasions, this appears to have created "steps" in the surface - just visible on Figure 3 (right-most piece), Wiru 68.321(4). Grinding was employed in some instances; see, for example, Table 2, 1908.70.36, where a total of three separate longitudinal facets were created; and 1908.70.32, where a secondary facet appears to have been ground into an older worked surface (possibly a repair). The extent of modification varies from piece to piece. For example, on 68.321(3) and 68.321(4) the tip of the tusk was removed or blunted. On other tools, such as 68.322(4) or 1908.70.31, almost the entire length and width of the concave surface was worked, including the tip. However, the objective in many cases was the creation of a single sharpened edge (as marked in Figure 4) with the opposing edge almost invariably left in its natural state (compared with unworked specimens) - rounded and smooth.

In addition to these pieces, two examples of a more complex hafted tool were examined in the New Guinea collection (Figure 5). These each used two tusks (tusks 10 to 13 on Table 2) where work appears to have been concentrated intensively on the inner surface, immediately adjacent to the tip. The tusks in one of these tools are oriented at right angles to each other in separate planes, though the manner in which they were used has yet to be ascertained. Another three of the ethnographic pieces studied also exhibited this kind of modification; possibly, therefore, they were hafted or used in a similar fashion. There are no absolute

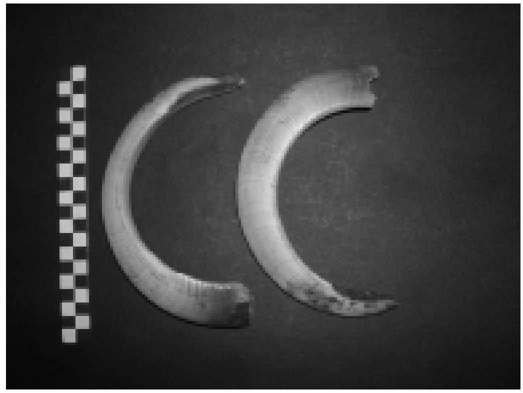

FIGURE 4

Modified *Sus* tusk (1968.320.1) (left). Principal area of working is along the interior edge (indicated on the photograph in red). Unmodified *Sus* tusk (1968.320.2) (right). Note, the tip facet on both specimens. Both items from the Wiru, Southern Highland, Papua New Guinea. Photograph reprinted with the kind permission of Cambridge University Museum of Archaeology and Anthropology. Scale at 5 mm increments.

FIGURE 5

The hafted specimen (30.351.b Sepik, Papua New Guinea) was used for cutting. Photograph reprinted with the kind permission of Cambridge University Museum of Archaeology and Anthropology. Scale at 5 mm increments.

grounds to prove this was the case, though on at least one piece (1908.70.36) part of the base of the tusk has been worked.

Turning to the question of utilization, museum records suggest that this was mainly directed at woodworking activities. Tusk 1901.65.6, a mid-section worked piece with a modified facet 111 mm in length, is labelled as having been used for “planing.” Tusks 1903.55.46 and 1903.55.47 were both described as “carving tools,” and Tusk 30.351A B161 is stated as having been used by the Sepik people of New Guinea as a “cutting instrument.” Museum labels associated with two tusk implements not listed here (namely, Z8670 OH1402 and Z8671 OH1630, both from CUMAA) relate how the artefacts were used, respectively, “for making arrow heads” and “for making spears.” Interestingly, the former shows extensive working of the concave areas behind the tip, while the latter shows much greater attention to the deep mid-section of the curve, possibly indicative of the different uses to which each of the two identified forms of tool were put; an exact association, however, between form and function has yet to be properly determined.

Only brief descriptions about the use of tusk implements surface in the wider literature, with (it has to be said) no clear distinctions being made between them. For example, Strathern writes that among the Wiru of the New Guinea Highlands, pig tusks “were used as scrapers, especially in the smoothing down of handles. Tusks were sharpened regularly on the upper inner side of the curve” (Strathern, 1969:320). Blackwood explains, in reference to the Kukukuku, also of New Guinea, that “[p]igs’ tusks are used as planes, in smoothing bows, arrows, etc., and are preferred by some workers to flint chips for such purposes” (Blackwood, 1950:33); while Williams notes that “for scrapers, the edge of a cockle shell and the thicker edge of a boar’s tusk are used [by the Orokaiva of New Guinea]” (Williams, 1930).

Tusk no.	Catalogue no.	Collection	Max. length of facet (mm)
1	Wiru 68.320(1)	CUMAA	114
2	Wiru 68.321(1)	CUMAA	106
3	Wiru 68.321(2)	CUMAA	82
4	Wiru 68.321(3)	CUMAA	103
5	Wiru 68.321(4)	CUMAA	91
6	Wiru 68.322(2)	CUMAA	81
7	Wiru 68.322(4)	CUMAA	97,5
8	Wiru 68.322(5)	CUMAA	110,5
9	68.323(1)	CUMAA	98
10	30.351.A.B161‡	CUMAA	33,7
11	30.351.A. B162‡	CUMAA	46,88
12	30.351.B[a] ‡	CUMAA	50,16
13	30.351.B[b] ‡	CUMAA	53
14	Forowan 1908.70.30	PRMO	46
15	Forowan 1908.70.31	PRMO	109
16	Forowan 1908.70.32	PRMO	120
17	Forowan 1908.70.33	PRMO	116
18	Forowan 1908.70.34	PRMO	88,5
19	Forowan 1908.70.35	PRMO	97,25
20	Forowan 1908.70.36	PRMO	78
21	Forowan 1908.70.37	PRMO	83,5
22	Forowan 1908.70.38	PRMO	84,5
23	Forowan 1908.70.39	PRMO	85,25
24	BII 36.1901.65.6	PRMO	111
25	BII 36.1903.55.46	PRMO	49
26	BII 36.1903.55.47	PRMO	49

TABLE 2

Maximum length of the worked facet on ethnographic specimens of male *Sus sp*. From Cambridge University Museum of Archaeology and Anthropology (CUMAA) and Pitt-Rivers Museum, Oxford (PRMO). Note: ‘‡’ denotes elements of hafted tools.

IDENTIFICATION CRITERIA

A review of examples of both naturally occurring and deliberate human modification shows that we can identify two criteria by which to distinguish them:

1) In most ethnographic cases (85%), the method of preparation, whether covering large sections of the curved internal surface of the canine or concentrated in the area immediately behind the tip, was by scraping in a longitudinal fashion, probably outwards towards the tip. This action produced the distinctly banded striation pattern seen on most pieces (caused by micro-irregularities along the edge of the stone tool) and, on occasion, clear chattermarks, further testament to this kind of working. These marks differ from the naturally worn facets, which are predominantly abraded and show only rare evidence of any longitudinal alignment to striations (see the single scrape mark running along the tusk in Figure 2). Oblique and transverse striations do sometimes occur on the worked specimens. Over the 26 worked specimens analyzed, 9 display some evidence that manufacturing strokes were delivered at an oblique angle; 4 show transverse working. In

only two cases, however, do either of these forms occur on their own; in general they appear as part of a more complex pattern characterized by longitudinal striations.

2) All of the tools on which the middle of the inner curve of the tusk was worked show the length of the manufactured surface to be invariably much longer than that of even the largest recorded natural wear facet (Figure 6). Natural variability in the pattern of the wear to the lower canine may result from alterations in the extent of the contact surface with the upper canine over time, but whether this has the potential to influence the length of the terminal facet is not presently known (Gouldwell, personal communication). The pronounced dental wear apparent on several of the specimens in the Sarawak Museum collection clearly implies advanced age. It is therefore felt unlikely that, on the basis of the analysis conducted so far, any specimen exhibiting a facet length in excess of 70 to 80 mm will be of a natural origin. The only possible exception involves instances in which the animal was husbanded in such a way that its tusks curved back into the jaw. Under those circumstances, the author has noted that the interior of the curve could become extensively worn, extended, and thinned in a fashion reminiscent of the right-most tool in Figure 3. However, the surface is predominantly polished, with few indications of striations. Furthermore, under such extreme conditions, the pig becomes almost entirely dependent on humans, with a very limited ability to feed itself, a situation unlikely to occur naturally.

The potential for misidentification becomes greater when the tusk facet is 60 mm or less in length. Although the ethnographic evidence presented here shows that worked tusks can carry a comparatively small facet, this degree of modification can also be generated easily through the natural process of tusk attrition. Identification of a genuine tool under these circumstances becomes more problematic, especially if the tusks show the kind of regular oblique or transverse abrasion pattern that can also occur naturally. The status of the following archaeological specimens is considered on the basis of these criteria.

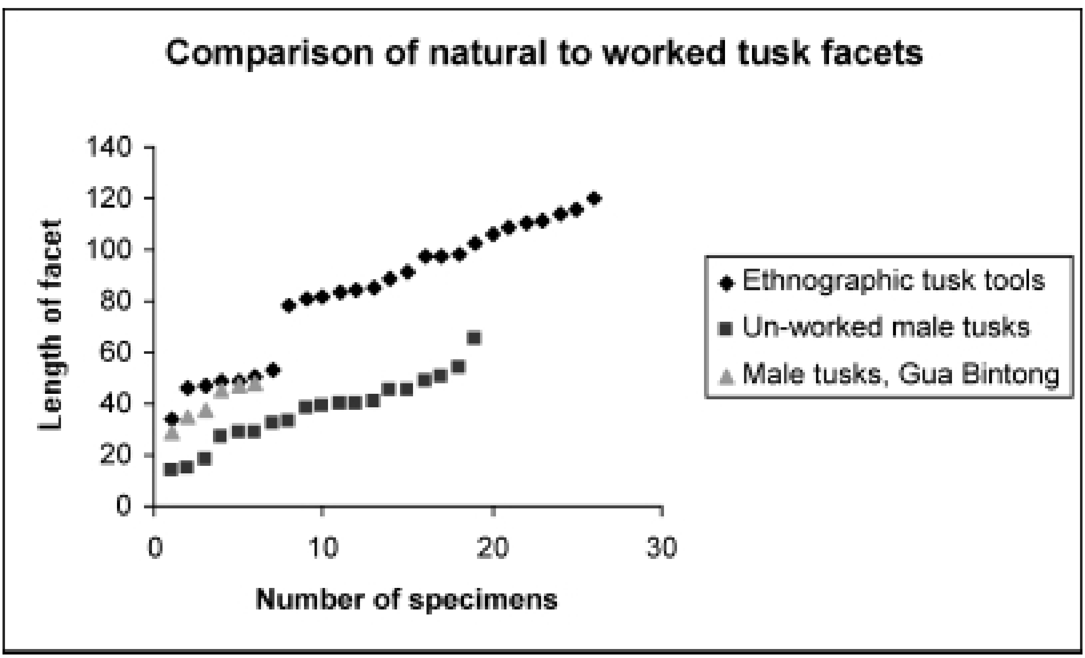

FIGURE 6

Chart comparing the length of male tusks terminal facets from ethnographic worked and unworked specimens, together with values for the length of terminal facets from the male pig specimens from Gua Bintong, Peninsular Malaysia.

ARCHAEOLOGICAL EVIDENCE

Gua Bintong

Gua Bintong is a small cave site situated approximately 16 km inland, near the base of Bukit Chuping, one of several limestone massifs that rise above the otherwise flat alluvial landscape of the northwest province of Perlis (Figure 7). It is the only site thus far discovered in Peninsular Malaysia to yield a large component of osseous tools. The Gua Bintong archaeological assemblage is currently undated; however, a marine terrace 3 m above the current sea level in a neighbouring cave within the same massif has been dated to 5200±200 BP (Haile, 1971). This would appear to place occupation of the site around the beginning of the mid-Holocene coastal inundation and mangrove expansion in this part of the region, which is known to have been around 4900-4500 BP (Woodroffe, 1993).

A total of 47 bone and antler implements - consisting of unadorned points, gouges, and straight-bladed (chisel-like) pieces – were recorded by the original excavator, Collings, in 1937. A limited reexamination by the current author of the five bags of faunal material, held at the National Heritage Board’s Central Repository, Singapore, that still remain from that excavation revealed 13 tusk fragments that constitute potential tools. Unfortu-

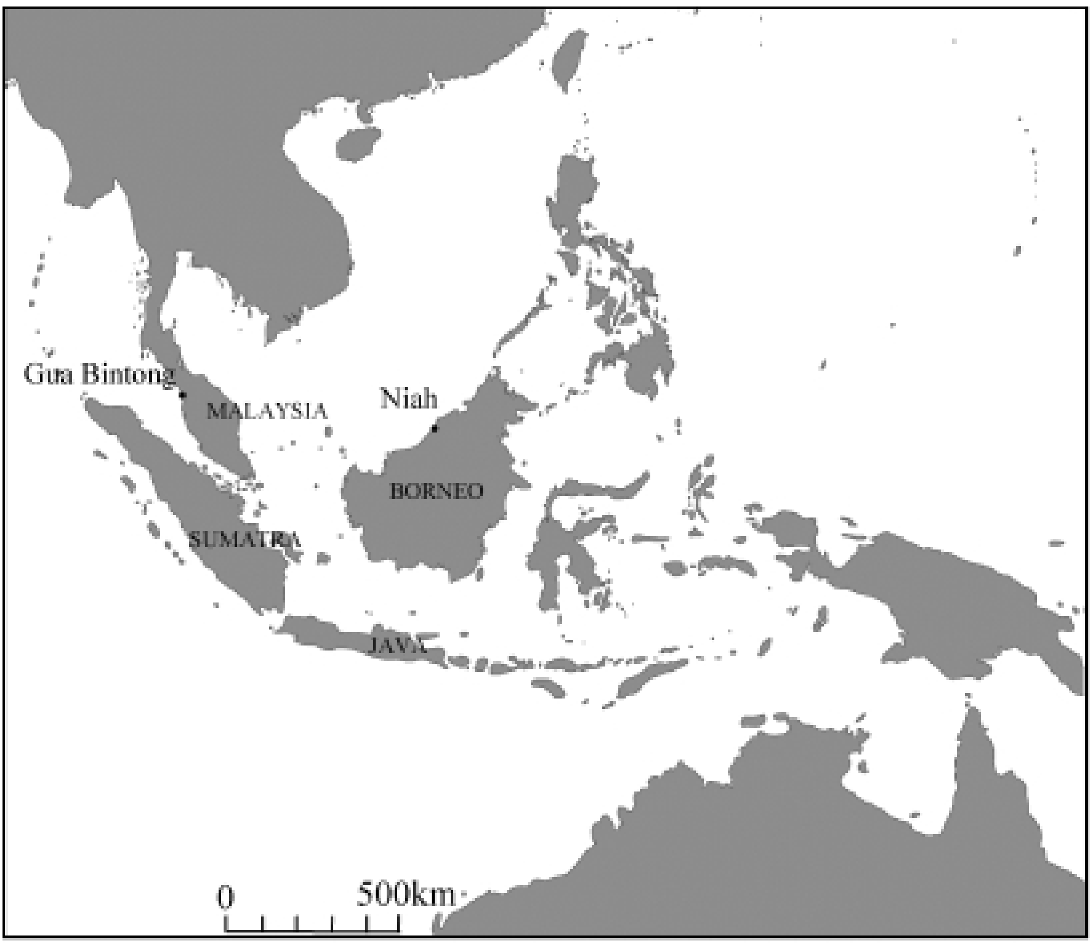

FIGURE 7

Southeast Asia (sea level at modern values), with the locations of the two sites mentioned in the text. (Adapted from Voris 2000, Field Museum of Natural History, Chicago www.fieldmuseum.org).

nately, the lack of contextual information means that in no instance is it possible to determine any details about the location of these pieces or the original finds.

Examination of the eight male tusks (Table 3) shows that these were subject to invasive modification, extending from the tip backwards, leading to the creation of a carved terminal facet (Figure 8). In most cases where the surface of the facet is discernable, i.e., un-encrusted, it is marked by regular concentrations of oblique or occasionally transverse striations such as are shown in Figure 9. The incised appearance of these marks suggests that abrading rather than scraping figured in their creation. The regular nature of these striations is suggestive of deliberate working, but cannot be taken as indicative of anthropogenic origin since, as shown above, very similar patterns can occur under natural conditions. In unbroken specimens (n = 6) the length of the facet falls in the range below 50 mm (Figure 6), also making their clear identification as implements problematic by these means. Therefore, although these may indeed represent tools - some ethnographic implements do exhibit such characteristics - additional lines of investigation would be necessary to demonstrate this categorically. Under the current criteria, their technical status is unproven.

The second set of archaeological artefacts recovered from the faunal remains consisted of five lower canines from female pigs (Figure 10; Table 4). Each piece has (to varying degrees of invasiveness) a stepped inset at its terminus, which

Artefact no.	Catalogue no. (faunal bag no.)	Max length terminal facet (mm)
1	A0182	48
2	A0182	37
3	A0182	5*
4	A0182	45
5	A0182	29
6	A0182	47
7	A0182	15*
8	A0182	35

TABLE 3

Maximum length of the terminal facet of male pig lower canines recovered during reexamination of remaining faunal material from Gua Bintong, Peninsular Malaysia.

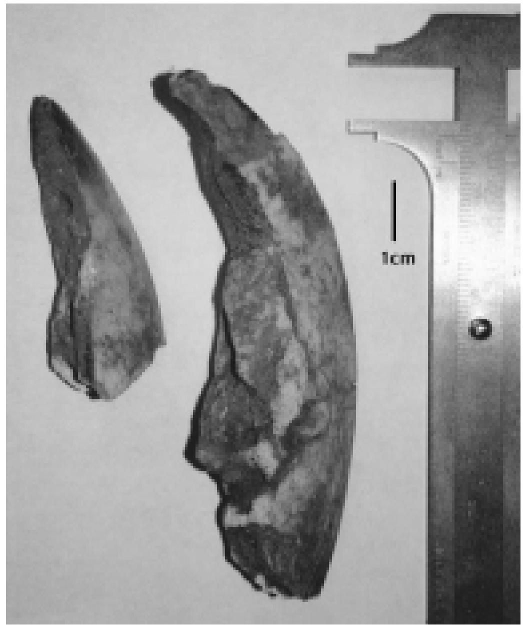

FIGURE 8

Male pig lower canines recovered during reexamination of remaining faunal material from Gua Bintong. Photograph reprinted courtesy of the Asian Civilisations Museum, Singapore.

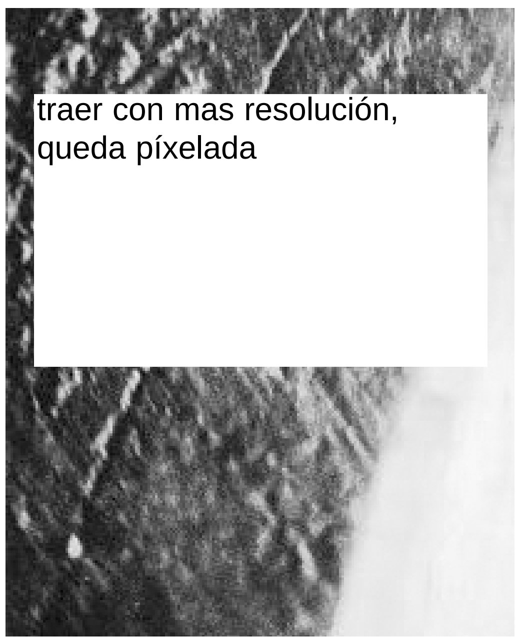

FIGURE 9

Microscope photograph of the regular obliquely aligned striations appearing on the terminal facet of tusk no. 4 (magnification 24x).remaining faunal material from Gua Bintong. Photograph reprinted courtesy of the Asian Civilisations Museum, Singapore.

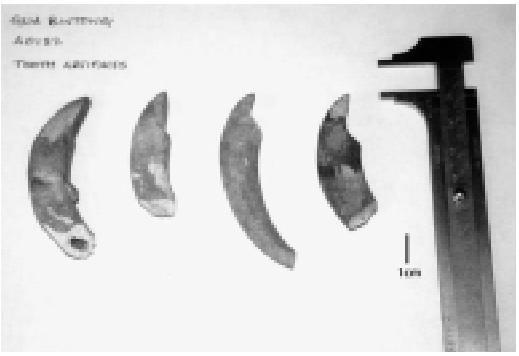

FIGURE 10

Female pig lower canines recovered during reexamination of remaining faunal material from Gua Bintong. Photograph reprinted courtesy of the Asian Civilisations Museum, Singapore.

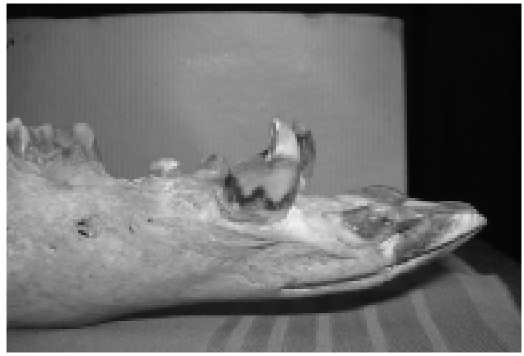

FIGURE 11

Mandible of female bearded pig (*Sus barbatus*) showing deeply incised terminal facet to lower canines (BS/2/18). Image reproduced courtesy of the Sarawak Museum, Kuching.

Tusk no.	Catalogue no. (faunal bag no.)	Max. Length (mm)	Max. Width (mm)	Max. Breadth (mm)
1	A0182	63,25	9,25	13,5
2	A0182	47,5	10	15,25
3	A0182	44,25	11	13,75
4	A0182	56,5	-	14,25
5	A0182	81,25	-	15,75

TABLE 4

Dimensions of tusks belonging to female *Sus sp.* from Gua Bintong, Peninsular Malaysia.

exhibits an obliquely aligned base with striae running across it in a transverse fashion. Examination of specimens at the Sarawak Museum, Kuching (and at the Natural History Museum, London) shows that very similar stepped facets appear quite naturally (Figure 11). This suggests that the pattern of damage is almost certainly not anthropogenic, meaning that, of the pieces studied from this site, none can be allocated confidently to tool status, despite what might, in isolation, appear to be promisingly anthropogenic characteristics.

Niah Cave

The Niah cave complex consists of six principal caverns set within the Gunung Subis, a limestone massif that rises above the sub-coastal plain of northern Sarawak approximately 16 km inland from the South China Sea (Figure 6). The archaeological potential of the caves was recognized as early as the 1860s, but systematic investigation did not take place until the then curator of the Sarawak Museum, Tom Harrisson, began major excavations in the 1950s and 1960s.

The largest cavern, the West Mouth, is 49 m above average sea level and has a ground area of about 10.5 hectares. It is 61 m high floor to ceiling, and in excess of 244 m wide at the entrance, opening into a narrow gorge with sheer limestone cliffs to over 300 m. Previous examination and cataloguing of the bone and tooth artefacts (Harrisson & Medway, 1962; Medway, 1966) showed that most of the artefacts were coming from deposits in the West Mouth and from two other cave mouths within Gunung Subis: the south east-facing Gan Kira and east-facing Lobang Angus. Between them Harrisson & Medway, 1962, and Medway, 1966 classified 257 artefacts. The authors considered 167 of these to be "tools," while the remaining 90 pieces were "more elaborate" decorative items, such as carvings and beads. None of the pieces in this collection of osseous tools has been dated directly. However, recent limited excavation of a new location within the West Mouth (Area D) has yielded new comparable specimens in contexts that can be bracketed with confidence to between 10,000 and 8,000 years BP (Barker *et al.*, 2002; Piper, personal communication).

Pieces of largely complete, modified pig tusk that have been classified as implements were recovered from a range of depths during the original excavation of the West Mouth, though they appear to have been concentrated in the region half a meter to a meter below the surface (Harrisson & Medway, 1962). Unfortunately, none of the implements from this original publication can presently be located and will have to be covered by a future report. However, six modified tusk fragments have been found among the excavated assemblage and examined by the present author. Four of these (Figure 12) were found in the Lobang Angus entrance to Niah in 1965; the fifth (made up of fragments 5 and 6, in Table 5) and sixth are from excavation in Area D of the West Mouth entrance in 2002 (Barker *et al.*, 2002). In each of these cases, it is apparent that the original tusk was split in half longitudinally. The convex edge of the inside surface appears to have been subsequently worked to form a sharp edge; the outer enamel surface was not modified in any way. These artefacts appear to meet the description of tusk "knives" as defined by Harrisson & Medway, 1962 in their original analysis of the bone and tooth artefacts from Niah.

Microscopic analysis of these pieces reveals clear bundles of fine, banded striations, immediately characteristic of scraping. These run either

FIGURE 12

Examples of the split tusk implements from Lobang Angus, Niah (artefact nos. 1, 3, and 4, Table 5). Image reproduced courtesy of the Sarawak Museum, Kuching. Scale at 5 mm increments.

Artefact no.	Trench no. (small find no.)	Max. length (mm)	Max. width (mm)	Max. thickness (mm)
1	US/27	57,75	18,75	7
2	US/13	35	13,5	5
3	US/19	48.25*	21,25	7
4	US/19	48.25*	18*	6
5	113	24,28	11,67	6,04
6	108	31,33	19,94	7,34
7	107	35,66	12,55	4,21

TABLE 5

Dimensions of split-tusk implements from Lobang Angus and the West Mouth entrances to Niah Cave, Sarawak.

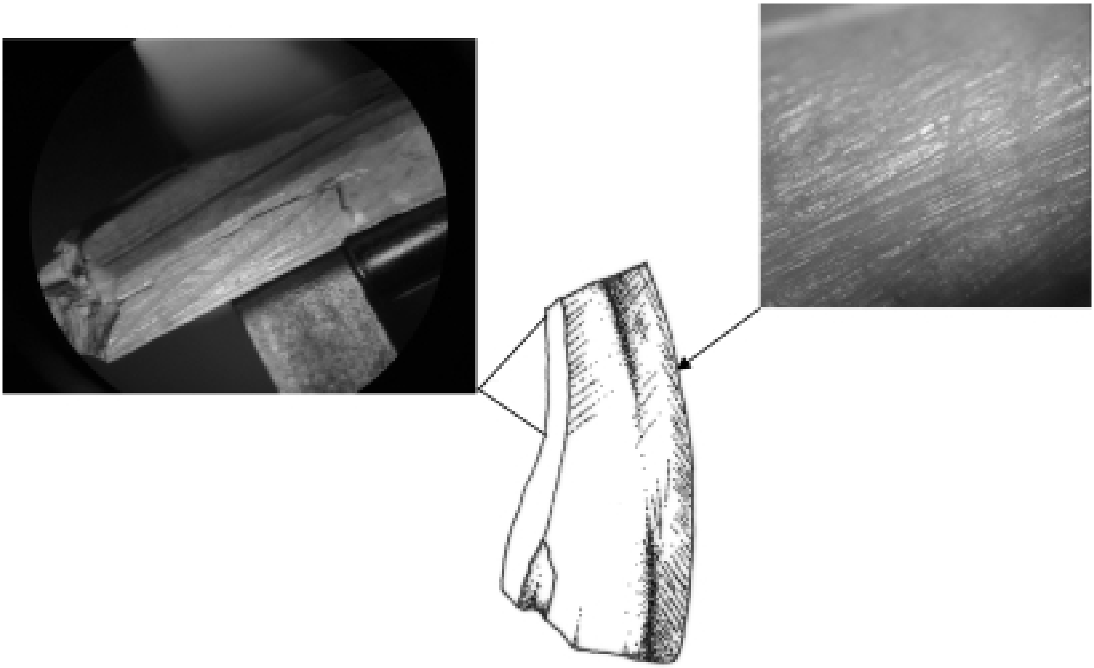

FIGURE 13
A split-tusk implement from Lobang Angus, Niah (artefact no. 3, Table 5) showing scraped modification parallel to the edge (magnification 40x) and longitudinal scraping of the interior curved surface of the tusk (magnification 10x). (Drawing by Ryan Rabett.)

obliquely to or parallel with what would likely have been the working edge, such as can be seen on artefact LA US/19 (Figure 13). Significantly, examination of what remains of the inner curve of the canine on this same artefact shows that this was also subject to modification through longitudinal scraping (Figure 13). On the basis of the criteria set out above, both these features strongly suggest that these pieces were deliberately worked implements and not the result of natural processes.

DISCUSSION

This paper has endeavored to provide a robust way for distinguishing intentional tooth modification from naturally occurring patterns of wear on pig canines. Two criteria for accomplishing this have been proposed after considering the extent and form of natural tusk attrition and with reference to an ethnographic collection of tusk implements. These criteria relate to the character of the striations themselves and their alignment, and to the linear extent of the carved terminal facet found both on naturally worn tusks and tusk-tools. Clear differences were observed between anthropogenic and natural agencies. However, this process was at its most problematic in those instances where the kinds of traces left behind were morphologically almost identical. As a consequence of falling in this area, the status of the specimens of male pig tusk from Gua Bintong remains unresolved, while that of the female tusks can almost certainly be assigned as natural. By contrast, though, using the criteria it was possible to allot the examples from Niah Cave to tool-status with a much greater degree of confidence. Further research should help clarify the current area of ambiguity. It may be possible, for example, to identify subtle differences in the make-up of the striation signature between anthropogenic and non-anthropogenic processes. This may involve variance in the degree of non-aligned striations, wear that occurs naturally being perhaps more prone to this characteristic than when facet preparation and maintenance is deliberate and controlled. The use of higher magnifications than those available in this study may also reveal clearer distinctions between the two agencies and may perhaps confirm the actual uses to which tusk-tools were applied in the past. By analogy to modern analogues, the presence of pig tusk-tools from prehistoric site inventories in Southeast Asia may be linked to some form of on-site manufacturing, possibly of wooden implements such as spears and arrows. Thus, their presence may form a new line of indirect evidence for the use of projectile hunting techniques in prehistoric contexts. Such evidence would be of some value in an archaeological region that, compared with Eurasia, has few other lines of preserved evidence relating to such technology, given the limited use of lithic points. The presence or absence of verifiable tusk implements from archaeological assemblages may also inject some welcome debate about the nature of inter-site functionality, which in the case of early rainforest foraging has tended to be characterized as homogeneously opportunistic and unspecialized.

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