พลวัตทางสังคม วัฒนธรรม และสิ่งแวดล้อมบนพื้นที่สูง ในอำเภอปางมะผ้า จังหวัดแม่ฮ่องสอน

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บทนำ

คำขอบคุณ

ภาพรวมของโครงการโบราณคดีบนพื้นที่สูงจากผลการวิจัยเชิงบูรณาการ (15)

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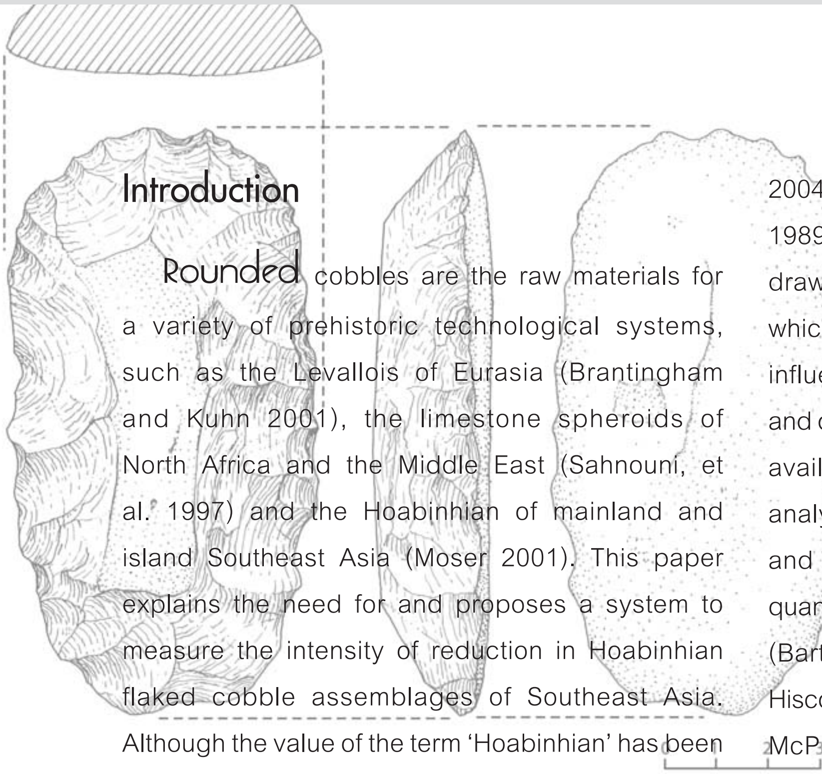
วิธีวิทยาในการศึกษาคุณลักษณะทางเทคโนโลยีของชุดเครื่องมือหินกะเทาะโหบินเนียน

บทคัดย่อ

เบน มาร์วิค *

ในบทความนี้ผู้เขียนได้ทำการวิเคราะห์ชุดเครื่องมือหินกะเทาะหัวบินเนียนที่ได้จากการทดลองเพื่อแสดงให้เห็นว่าการเปลี่ยนแปลงรูปทรงของสะเก็ดหินเป็นตัวบ่งชี้สำคัญถึงความเข้มข้นของกระบวนการผลิตชุดเครื่องมือหิน (assemblage reduction intensity) ผลการวิเคราะห์แสดงให้เห็นว่า การบันทึกข้อมูลถึงร่องรอยการต่อยกะเทาะเอาส่วนยื่นออก (overhang removal) มุมที่ต่อยกะเทาะด้านใน (interior platform angle) และจำนวนร้อยละของพื้นผิวด้านหน้าที่เหลืออยู่บนสะเก็ดหิน (percentage of dorsal cortex) จะช่วยให้ข้อมูลที่น่าเชื่อถือในการศึกษาถึงขอบเขตของกระบวนการผลิตชุดเครื่องมือหิน (the extent of assemblage reduction) ผู้เขียนยังได้นำเสนอและพิสูจน์ผลการทดลองถึงวิธีการใหม่ที่ใช้ตรวจหารูปแบบที่เปลี่ยนแปลงไปของชุดเครื่องมือหิน (detecting assemblage variation) จากตำแหน่งของพื้นผิวด้านหน้าบนสะเก็ดหิน วิธีการดังกล่าวนี้ ได้ออกแบบมาโดยใช้ประโยชน์จากตัวอย่างรูปทรงเรขาคณิตและแบบแผนกระบวนการผลิตชุดเครื่องมือหินกะเทาะโหบินเนียน การค้นพบนี้ถือเป็นการพัฒนาเครื่องมือที่ใช้ในการสร้างคำอธิบายเชิงมานุษยวิทยาเกี่ยวกับโบราณคดีโหบินเนียน

* *นักศึกษาปริญญาเอก คณะโบราณคดีและประวัติศาสตร์ธรรมชาติ ภาควิชาวิจัยภูมิภาคแปซิฟิกและเอเชีย มหาวิทยาลัยแห่งชาติ-ออสเตรเลีย*



Introduction

Rounded cobbles are the raw materials for a variety of prehistoric technological systems, such as the Levallois of Eurasia (Brantingham and Kuhn 2001), the limestone spheroids of North Africa and the Middle East (Sahnouni, et al. 1997) and the Hoabinhian of mainland and island Southeast Asia (Moser 2001). This paper explains the need for and proposes a system to measure the intensity of reduction in Hoabinhian flaked cobble assemblages of Southeast Asia. Although the value of the term 'Hoabinhian' has been under debate for some time (Pookajorn 1988; Shoocongdej 2000) it is used here to refer specifically to Southeast Asian lithic assemblages from the terminal Pleistocene and Holocene characterised by unifacial, centripetal and circumferential cobble reduction and resulting flakes and debitage.

Measuring lithic reduction intensity has become an important approach in anthropological archaeology but has yet to be applied to mainland Southeast Asian assemblages. One of the most productive recent developments in huntergatherer anthropology has been research exploring the relationship between technology, mobility and economic risk (Bamforth 1986, 1991; Bamforth and Bleed 1997; Bleed 1986; Fitzhugh 2001; Hiscock 1994; Hiscock 1996; Kelly 1992; Kuhn 1992; 1995; 2004; Nelson 1991; Parry and Kelly 1987; Shott 1986; 1989; Torrence 1983; 1989). This research usually draws on models of human behavioural ecology which predict that artefact assemblages are strongly influenced by residential mobility, resource density and quality, as well as risk and uncertainty in resource availability (Winterhalder and Smith 2000). For the analysis of lithic assemblages, the most powerful and robust tests of these models have come from quantifying variation in the extent of artefact reduction (Barton 1988; Clarkson 2002a; 2002b; Dibble 1995; Hiscock and Attenbrow 2003; Law 2005; Mackay 2005; McPherron 1999; Shott 2005)

Quantifying Lithic Reduction

Numerous studies have documented general measures of core reduction in assemblages showing that core reduction exerts considerable influence upon various attributes of lithic assemblages (Dibble, et al. 1995). Analysis of Eurasian assemblages show that as core reduction increases, the number of blanks per core and extent of core preparation also increase (Bar-Yosef 1991; Marks 1988; Montet-White 1991; Munday 1977). Similarly, as core reduction increases in Eurasian assemblages, average core size, flake size, flake platform area, and cortex decrease (Henry 1989; Marks, et al. 1991; Newcomer 1971; Stahle and Dunn 1982). Studies of Hoabinhian assemblages

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Ben Marvick (เบน มาร์วิค)

make limited use of these general indicators of core reduction intensity (Reynolds 1989; 1992; Shoocongdej 2000; White and Gorman 2004). These indicators are used only as assemblage descriptors while the overall assemblage interpretation is still based on typological analyses (Shoocongdej 1996b). The limited use of these core reduction indicators in Hoabinhian assemblages may be because there has been little experimental work to demonstrate their relevance.

In addition to measuring core reduction, a variety of methods have been developed for quantifying flake reduction for assemblages around the world (Barton 1988; Clarkson 2002b; Dibble 1987; Dibble and Pelcin 1995; Kuhn 1990). These methods are based on flake cross-section geometry, flake retouch perimeter, flake retouch height, flake retouch invasiveness, flake allometry and typological comparisons. These methods have been examined in detail by Hiscock and Clarkson and they conclude that the flake retouch height and invasiveness measurements are the most effective metrics (Clarkson 2002b; Hiscock and Clarkson 2005a; 2005b). Unfortunately most of these methods are poorly suited for analysing Hoabinhian assemblages because these assemblages typically have low proportions of retouched flakes and few or no artefact forms with clear morphology and

size discontinuities (Matthews 1964; Reynolds 1989; 1992; Shoocongdej 1996a; White and Gorman 2004). A customised and standardised method for measuring reduction in Hoabinhian assemblages would provide the necessary data for comparing relative reduction intensity within and between assemblages from different contexts.

An Experimental Approach to Quantifying Hoabinhian Reduction

Shoocongdej (1996a) has noted that the lack of systematic lithic production experiments using river cobble material in Southeast Asia makes it difficult to measure assemblage reduction with confidence. In an attempt to help assuage this problem, the experiment described here was designed, following Amick et al. (1989), with two objectives in mind. First, to observe how a large number of flake variables change over the course of core reduction, and second, to identify the most responsive variables for use in archaeological analysis.

A simple experiment was designed to record changes in 28 metric and technological variables of flakes struck by the author from 30 river cobbles by hardhammer percussion. Cobbles of a variety of different sizes and shapes were collected from the Lang River, adjacent to the Tham Lod rockshelter archaeological site in northwest Thailand (Shoocongdej 2004). The raw materials of the cobbles were orthoquartzite (n = 25), sandstone (n = 3) and andesite (n = 2). These raw materials have similar mechanical properties and were not separated for analysis. Detached pieces over 5 mm with unambiguous positive scars (having evidence of a bulb of percussion or bending initiation) were recorded as flakes. The order of each flake was recorded as they were struck and flaking continued until flakes could no longer be detached using freehand percussion. Although the cores are not discussed here, core mass was recorded after each flake detachment and the final state of the core was also recorded. The experimental cobble reduction was carried out in order to create a variety of typical Hoabinhian typological forms (cf. Colani 1927; Forestier, et al. 2005), simulating a range of possible reduction sequences, until the cobble could no longer be held for flaking. After a core was completely reduced, every flake was given an individual percentile ranking reflecting its position in the sequence of all flakes removed from that core. To analyse the data, flakes from all 30 cores were ordered together by their individual percentile ranking and then arbitrarily divided into ten classes to form a continuum of reduction intensity from early reduction (1) to late reduction (10).

Results

The thirty cobbles produced a total of 625 flakes and 159 non-flake pieces. The average number of flakes per cobble is 21 with a maximum of 72 and most cobbles producing less than 30 flakes (Figure 1). The patterns of variation in the measured variables are complex, as indicated by the results of a principle components analysis that shows a high number of components (12) are necessary to explain 80% of variance. As a first step to understanding how flake morphology and attributes vary through the reduction sequence, a series of basic attributes are examined here. With the exception of mass, these variables are the most sensitive to changes in the extent of core reduction. For convenience, a 'sensitive' variable is defined here as a variable that has a statistically significant correlation with reduction intensity of greater than |.300|.

Mass

Flake mass is used as a general measure of flake size and has been observed as reliable indicator of reduction for biface manufacture (Amick, et al. 1988; Magne and Pokotylo 1981). For this experiment, flake mass does not significantly vary according to the extent of reduction (r = .017 p = .663, Kruskal-Wallis _2 = 5.691, df = 9, p = .770) and is not a useful reduction indicator. Maudlin and Amick (1989) also observed that size variables were poor indicators of reduction and suggested it was probably because of the small flakes that are continuously produced throughout the reduction process. For this Hoabinhian experiment, the poor correlation of size and reduction may be because the oblate spheroid geometry of most of the cobb les results in short early reduction flakes made by acute, glancing blows on the perimeter of the cobble, followed by mid-reduction flakes that are as long as the maximum thickness of the cobble and finally by late-reduction flakes that are small because most of the mass of the cobble has been already removed.

Overhang removal

Overhang removal (OHR), also known as platform trimming or platform preparation, is defined here as the presence of a series of overlapping small (an arbitrary scar length of <15 mm is used here) step-terminated flake scars initiated from the platform surface onto the dorsal surface of a flake

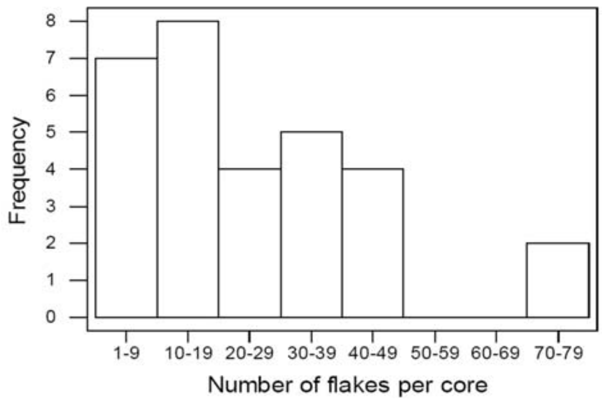

Figure1 . Frequency distribution of flakes per core in the experimental assemblage.

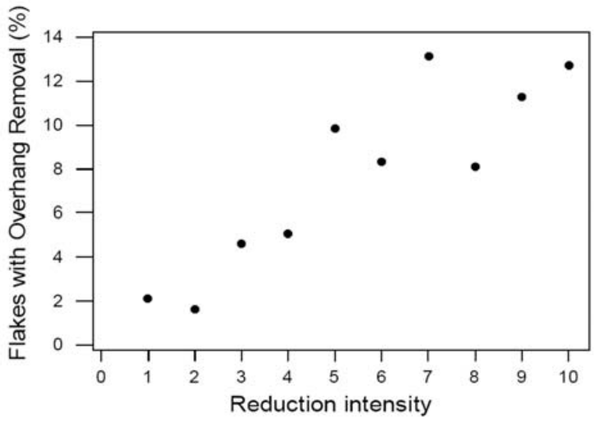

Figure 2. Plot of changes in the percentage of flakes with overhang removal and increasing reduction.

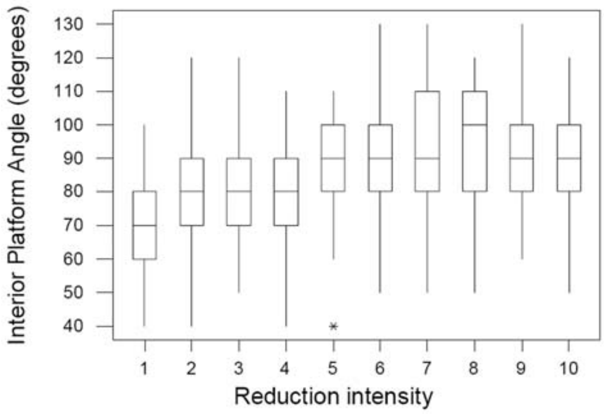

Figure 3. Plot of changes in flake interior platform angle with increasing reduction.

(Clarkson and O'Connor 2005; Holdaway and Stern 2004; Newcomer and Karlin 1987; Phagan 1985). These scars are often interpreted as the removal of a lip left on the platform by earlier flake removal and are presumably generated to maintain a certain core morphology for the predictable removal of flakes as core size decreases and platform angles increase (Clarkson and O'Connor 2005). This experiment shows a strong and significant positive correlation between the presence of OHR and increasing intensity of cobble reduction ($r = .892$ $p = .001$, Figure 2).

Interior platform angle

The increase in the percentage of flakes with OHR is probably a result of adapting to decreases in core size and changes in platform angle. Interior platform angle (IPA) was measured as the angle between the striking platform and the ventral surface with a goniometer. Despite a number of studies of platform angles showing that it is difficult to measure reliably (Andrefsky 1998; Dibble and Bernard 1980), in this experiment there is a significant correlation between IPA and extent of reduction ($r = .307$ $p < .05$). The IPAs of the early reduction flakes are typically less than 90 and then in the later stages of reduction the values cluster around 90-100 (Figure 3). The 90-100 values are probably asymptotic because it is difficult to remove flakes at higher angles without risking aberrant hinge and step terminations that alter the morphology of the core's free face and reduce its useful life (Macgregor 2005; Whittaker 1994). In this experiment the increasing percentage of OHR and the increasing IPA are probably directly linked because increases in flake IPA result in more acute platform angles on the core, creating lips on the platform that are removed when the core is prepared for another flake removal, leaving traces of OHR.

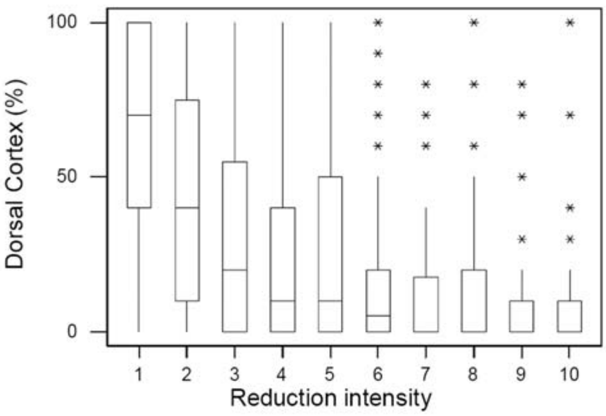

Figure 4. Plot of changes in flake dorsal cortex percentage with increasing reduction.

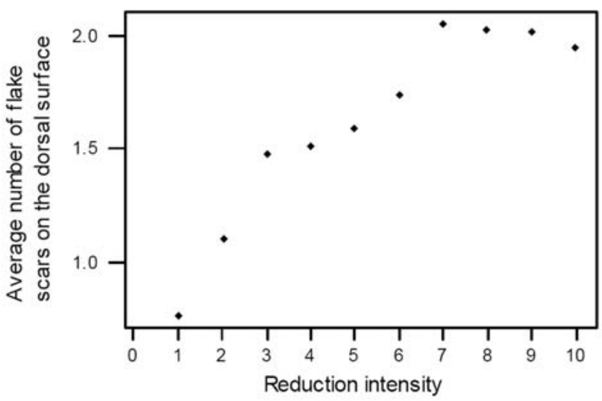

Figure 4. Plot of change in the average numbers of flake scars on the dorsal surface with increasing reduction.

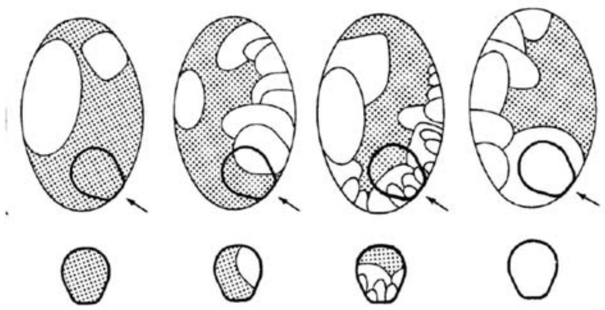

Figure 5. Four classes of dorsal cortex location identified by Nishimura (2005)

Percentage of dorsal cortex

The amount of cortex (the skin on the outer surface of the cobble formed with chemical or mechanical weathering) on the dorsal surface of a flake is another important indicator of an assemblage's extent of reduction (Andrefsky 1998; Blades 1999; Cowan 1999; Morrow 1984; G.H. Odell 1989; 1989). The popularity of this variable is based on the simple assumption that flakes with a high percentage of cortex come from the outer surface of the core and once that outer surface has been completely removed, all subsequent flakes will be noncortical. Thus, the more extensive the core reduction, the higher the proportion of noncortical flakes in an assemblage (Dibble, et al. 2005). In this experiment the percentage of flake dorsal cortex (measured in intervals of ten percent for each flake) is significantly correlated with the extent of cobble reduction ($r = -.491$ $p < .05$). Although there is a good statistical correlation for the overall reduction sequence, Figure 4 shows that dorsal cortex is most sensitive to variation in the early stages of core reduction. In the later half of the reduction process the average percentage of dorsal cortex is low but the numerous outlying values suggest the influence of some stochastic effects. These results corroborate those of earlier studies suggesting that cortex percentage is most useful as an indicator of early reduction (Dibble, et al. 2005; Dibble, et al. 1995; Magne 1985; Magne and Pokotylo 1981; Mauldin and Amick 1989).

Dorsal flake scars

Closely related to the percentage of dorsal cortex is the number of flake scars on the dorsal surface of flakes. In this experiment the number of flake scars is significantly correlated with reduction intensity ($r = .308$ $p < .0001$, Figure 5). However, as Maudlin and Amick (1989) note, dorsal flake scars can also be highly correlated with flake size and in this case the correlation with flake mass is stronger ($r = .424$ $p < .0001$) than the correlation with reduction intensity. Figure 5 suggests that this variable becomes asymptotic as reduction increases, probably because the constant size of flakes limits the maximum number of visible flake scars to about two. These qualities suggest that the number of dorsal flake scars may be a less reliable indicator of reduction intensity than the other variables discussed here.

Dorsal cortex location

Nishimura (2005) has suggested that the location of dorsal cortex in flakes in Hoabinhian assemblages in northern Vietnam may indicate stages of tool making. He noted that early stages are characterised by flakes with 100% dorsal cortex (primary flakes) and flakes with a crescent-shaped distribution of dorsal cortex (cortex extending from the platform, around one margin and contacting the distal end). He notes that the later stages of 'resharpening or otherwise rejuvenating an edge [on a core tool]' results in flakes with cortex on the distal end of the flake and flakes without any dorsal cortex (tertiary flakes) (cf. Jeremie and Vacher 1992; Nishimura 2005). This cobble reduction experiment demonstrates that Nishimura's four classes (Figure 6) are an exhaustive classification because they describe 98% of flakes (Figure 7).

Cortex location has been used to distinguish between multidirectional core reduction, bifacial reduction and dart production (Tomka 1989) but does not appear to have been systematically investigated as an indicator of reduction intensity. This experiment shows that numbers of flakes with 100% cortex and crescent patterned cortex significantly decrease as reduction continues while numbers of flakes with distal cortex and no cortex increase significantly (Table1). Table 1 also shows that the four classes are relatively insensitive to flakesize, making them more reliable indicators of reduction than counts of dorsal flake scars. Figure 8 shows how the majority of flakes change from primary to tertiary very early in the reduction process, supporting the earlier observation that major changes in dorsal cortex occur during the early stages of reduction. The important detail in this figure is that it shows the middle stages of reduction can be identified in the region with <10% crescent-pattern flakes and >20% distal-patterned flakes. The usefulness of these two flake classes as indicators of mid-reduction is also indicated by their good correspondence with two other reliable indicators of reduction intensity, dorsal cortex percentage (Figure 9) and IPA (Figure 10).

The reason that these flake classes are good indicators of reduction is probably because unifacial cobble reduction typically begins with removal of primary and crescent-patterned flakes as flakes are removed from the circumference of the cobble, followed by the appearance of distal-pattered flakes as flake removal begins to overlap previous scars around the circumference of the cobble and invade towards the centre of the cobble. Distal-patterned and tertiary flakes become more abundant when flake removal is increasingly invasive and core rotation increases so that flake scars intersect with previous scars.

Although this four class system has yet to be used to interpret any archaeological assemblages, it can be shown to have some advantages over other methods of recording dorsal cortex. Firstly, the four class system has stronger correlations with reduction intensity and weaker correlations with flake size than the popular primary-secondary-tertiary system (secondary flakes and reduction intensity: $r = -.232$, $p < .001$, secondary flakes and flake mass: $r = .265$, $p < .001$).

Secondly, Sullivan and Rosen (1985) note that

Table 1. Correlations of four classes of dorsal cortex location with reduction intensity and flake mass.

Class	Reduction		Mass	
	r	*p*	*r*	*p*
Primary	-.313	<.0001	.015	.700
Crescent	-.317	<.0001	.056	.159
Distal	.059	<.0001	.287	<.0001
No Cortex	.375	<.0001	-.271	<.0001

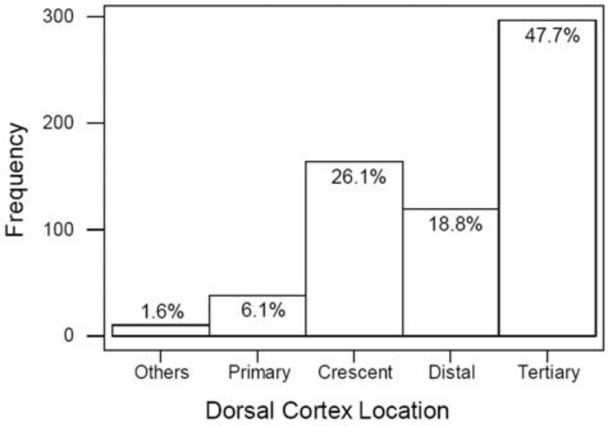

Figure 7. Frequency distribution of the four calsses of dorsal cortex location.

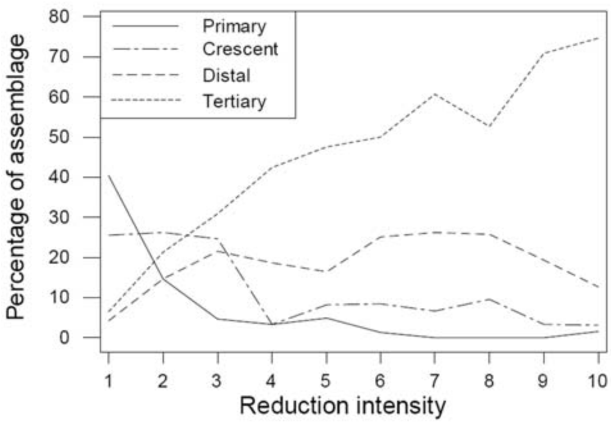

Figure 8. Changes in the proportions of the four calsses of dorsal cortex distribution with increasing reduction.

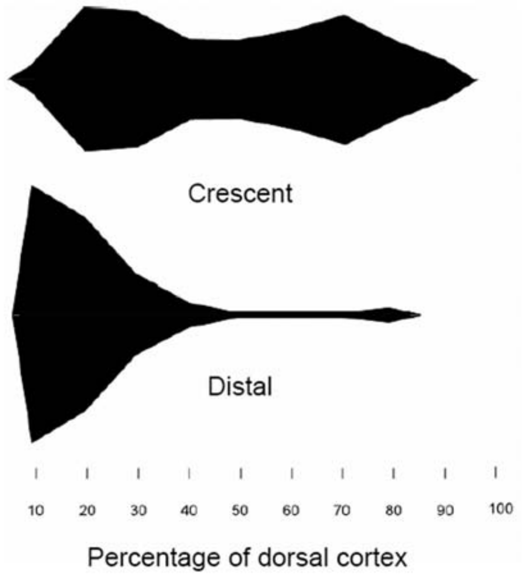

Figure 9. The relationship of dorsal cortex location to percentage of dorsal cortex.

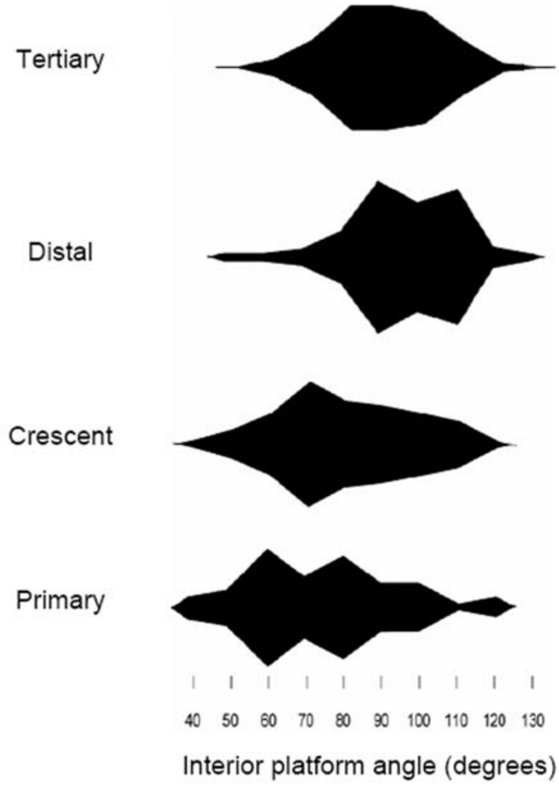

Figure 10. The relationship of dorsal cortex location to interior platform angle.

the primary-secondary-tertiary system is problematic because of false assumptions and inconsistent definitions across different analysts. To assess the level of inter-observer reliability available with the four flake classes a series of simple blind tests were undertaken. Ten people with a range of experience in lithic analysis classified thirty flakes into the four cortex classes plus an 'other' category. Their results were compared to the author's and the average difference was 10.6%. Two of the more experienced participants had no errors in their classification, suggesting that with more training and familiarity, error levels can be very low or zero. These results mean that inter-observer errors in the use of these four classes are relatively low (cf. Clarkson 2002b) and unlikely to be greater than other measurements (Fish 1978).

Finally, the distal cortex class provides valuable resolution for the later stages of the reduction process. Although flakes with distal cortex have a low correlation with overall reduction (Table 1), they are useful markers of intensive reduction because they are most abundant in the second half of the reduction process, compared to tertiary flakes that become abundant relatively early in the reduction process. This feature of the distal cortex flakes is especially relevant in assemblages where flakes are transported out of the assemblage or partially worked cores are introduced and reduced further so that the proportions of primary and tertiary flakes no longer accurately represent the extent of reduction occurring at the site.

Discussion

This experiment was designed to reproduce the particular qualities of Hoabinhian assemblages, especially the unifacial circumferential, centripetal reduction of rounded cobbles (Forestier 2000). The results presented here suggest that there are a number of simple technological attributes of flakes that are robust indicators of the intensity of reduction in Hoabinhian lithic assemblages. Analysis of the experimental data showed that the most important variables for measuring reduction intensity are the presence of overhang removal, interior platform angle and percentage of dorsal cortex. These attributes have the advantages of being well understood and widely used by lithic analysts as well as being easily recognisable, allowing rapid and accurate data collection. In addition to these familiar attributes a new method of classifying flakes according to dorsal cortex location has been proposed. This new method was shown to be similarly useful for measuring assemblage reduction intensity and its reliability is demonstrated by relatively low inter-observer error.

A further advantage of the attributes discussed here is that they can be used to produce summary ratios to describe and compare assemblages. These ratios represent a continuous measurement of assemblage variation without imposing arbitrary stages or events onto the reduction process. Summary ratios of flake attributes can be used to describe the extent of cobble reduction even when cores have been removed from the assemblage. It is also notable that the number of flake scars on a core at the end of the reduction process has no significant correlation with the number of flakes removed from that core (r = .251, p = .226) (cf. Braun, et al. 2005). This highlights the importance of data from flakes in accurately understanding lithic reduction in Hoabinhian assemblages.

Limitations and potential sources of error

Shott (1996) has noted that it is not easy to design experiments that depict how ancient stoneworking actually proceeded. This experiment has tried to simulate the defining characteristics of Hoabinhian assemblages, such as unifacial, centripetal and circumferential cobble reduction. However, it is likely that Southeast Asian lithic assemblages represent a range of core reduction strategies (Forestier, et al. 2005; White and Gorman 2004). Until future work describes these different reduction strategies we cannot know how well this experiment approximates the range of variation in the Hoabinhian. Nevertheless, most of the variables identified here are reliable indicators of reduction in a range of technological systems, including biface manufacture, so the variation within Hoabinhian technologies is unlikely to compromise the robustness of these measures.

Conclusion

The purpose of this paper has been to present some features of a robust system for measuring the intensity of flaked stone artefact assemblage reduction for Hoabinhian assem-blages of Southeast Asia. Nearly all Hoabinhian lithic assemblages contain flakes but it can be difficult to know what variables will be the most meaningful to record, especially when the assemblage has many amorphous cores and very few retouched pieces. Analysis of the experimental assemblage has shown that record-ing the presence of overhang removal, interior platform angle, percentage of dorsal cortex and dorsal cortex location will provide robust data on the extent of assemblage reduction. By comparing these data between different sites and different periods we can investigate questions of human behaviour and ecology, such as the relationships between technology, mobility and economic risk.

Much work on lithic assemblages from mainland Southeast Asia focuses on description without producing generalised interpretations presented in anthropological frameworks (Glover 2001; Miksic 1995). While making important contributions to understanding individual sites, this descriptive approach to lithics is limited in what it can say about the major questions of culture history and process in mainland Southeast Asia (but see Shoocongdej 2000 for an exception). This paper has outlined some basic and reliable methods to help archaeologists liven up lithic analysis in mainland Southeast Asia and give lithic assemblages the important role they deserve in contributing towards our understanding of globally significant issues of past human behaviour.

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