THREE STYLES OF DARWINIAN EVOLUTION IN THE ANALYSIS OF STONE ARTEFACTS:

Which One to Use in Mainland Southeast Asia?

Ben Marwick

Abstract

Our understanding of flaked stone artefacts from assemblages in mainland Southeast Asia is constrained by a shortage of robust and flexible theory to generate suitable methods of analysis. I review three candidate theories derived from Darwinian evolutionary principles to identify the most suitable for investigating flaked stone artefacts from mainland Southeast Asia. The demands of the theory are compared with the evidential constraints of the assemblages. Human behavioural ecology is found to be the most suitable because of the reliable methods available to test predictions with artefact assemblages. A small case study is discussed to demonstrate the applicability of this approach.

Introduction

One of Sandra Bowdler's lesser known research interests involves Sigmund Freud and his ideas about archaeology and the past (Bowdler 1996). This paper is not about Sigmund Freud, but his work is a convenient lens through which the history of psychology in the nineteenth century may be viewed as a development away from philosophy towards biology (Young 1990). Darwin's *On the Origin of Species* was published in 1859 when Freud was two years old and was one of eight of Darwin's books that is known from Freud's library (Ritvo 1990). By the late 1890s when Freud was well established in private practice, Darwin's contributions were ubiquitous. For example, Darwinism pervaded the emerging discipline of child psychology (where Darwin was an important pioneer), reinforced the importance of sexuality in understanding psychopathology, raised the possibility of historical reductionism (where the past can be used as the key to understanding the present), and contributed concepts like fixation and regression to Freud's overall theory of psychopathology (Sulloway 1979). Darwin's significance in this shift from philosophy to biology is that he provided psychologists with two simple instinctual drives that underlie behaviour, namely the will to survive and the urge to reproduce. This paper is about the application of Darwinian concepts in archaeology to a region in which Bowdler has been especially active and provocative, Southeast Asia.

Since Freud's death, Darwinian thinking has grown substantially in complexity and influence, especially in the biological sciences. Freud's work and influence has taken a slightly different trajectory, especially since the publication of his unexpurgated correspondence with Berlin physician Wilhem Fliess that called into question Freud's scientific judgement and originality (Masson 1985; Sulloway 1991). However, since Freud and perhaps because of his own influence, the human sciences have been ambivalent about employing Darwinian analytical tools. Although parallels or analogies between biological evolution and cultural evolution have long been noted by eminent authors from diverse disciplines in the human sciences (Huxley 1955; Kidder 1932; Kroeber 1960; Popper 1979), it has only been very recently that the details of how to productively employ Darwinian thinking have begun to be realised (Mesoudi *et al*. 2006).

The aim of this paper is to pragmatically examine the usefulness of three distinctive applications of Darwinian evolutionary concepts to archaeology, in particular the analysis of flaked stone artefacts in mainland Southeast Asia. This aim is motivated by a series of brief but provocative and significant papers by Bowdler (1994a, 1994b, 2006; Bowdler and Tan 2003) on the geographical range and cultural affinities of the Hoabinhian, a distinctive flaked stone artefact technology found in mainland Southeast Asia from the late Pleistocene to the middle Holocene (Moser 2001). Bowdler's contributions in this area are notable for sidestepping the frothy debates about how to define the Hoabinhian that have characterised much of the literature. Instead she draws attention to the details of the stone artefact assemblages and focuses her analysis on salient metric and morphological variables. These approaches are likely to form the foundations of future work as hunter-gatherer archaeology in mainland Southeast Asia matures. However, few other writers are likely to bring Bowdler's combination of empiricism and creativity to mainland Southeast Asian archaeology. This paper hopes to build on Bowdler's work on flaked stone artefacts by identifying a promising evolutionary framework to interpret variation in metric and morphological variables in mainland Southeast Asian assemblages.

The reason why Bowdler's work naturally leads to a consideration of evolutionary approaches is that she eschews the typological methods that have dominated previous work in favour of consideration of a greater part of the assemblage. This replacement of typological methods by population-level methods resembles what Ernst Mayr (1970; see also Chung 2003) has identified as the key scientific contribution made by Darwin. Mayr claims that Darwin introduced into the scientific literature a new way of thinking, 'population thinking'. This approach to classification holds that phenomena cannot exist as discrete entities because they are always in the process of becoming something else. No two things are ever exactly alike because similar things do not share an essence; they are just at similar points in the process of becoming something else. The population-thinker sees individual things that are composed of unique features and when these things are grouped together they form populations that are described by statistical abstractions such as mean and measures of variation (Mayr 1959).

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In archaeology there are three distinct results of this way of thinking about analysing stone artefacts: selectionist archaeology, dual inheritance theory and human behavioural ecology (Preucel 1999; Smith 2000). In the last 10 years a voluminous literature of programmatic statements from proponents of these approaches has appeared (e.g. Boone and Smith 1998; Lyman and O'Brien 1998; O'Brien and Lyman 2002; Winterhalder and Smith 2000). Each of these approaches is based on two elements of Darwinian evolution. The first is a population-thinking approach to stone artefact assemblages and the second is a universal or generic Darwinist perspective of cultural change, where culture is argued to exhibit variation, competition, inheritance, and the accumulation of successive modifications over time (Mesoudi *et al.* 2004). Despite these shared perspectives, the three approaches differ in their explanatory aims and in their definitions of key details such as where variation comes from, what is under selection and how selection occurs. The operational details of the three styles have important implications for their suitability as conceptual frameworks for mainland Southeast Asian lithic analysis because of the specific character of the evidence.

Selectionist Archaeology and Stone Artefact Analysis

Selectionist archaeologists hold that artefacts are subject to evolutionary processes just like organic parts of the phenotype, such as eyes, hair, skin etc. O'Brien *et al.* (2001) aim to use cladistic methods to develop hypotheses about the historical relationships between different kinds of stone points. While information about the organic parts is transmitted via genes, information about the artefacts is transmitted via culture (for example, social contexts of teaching and learning). Continuity of transmission results in the inheritance of artefact forms, over time this leads to the tool traditions or lineages. The source of new kinds of artefacts is errors in the transmission of information. They note that they are unsure how to distinguish unintentional random variation from variation directed by deliberate attempts by people to solve problems (Lyman and O'Brien 1998). In the case of stone artefacts, the foci of selection are the functional traits of the implements (O'Brien and Lyman 2000:375). Selectionists claim that functional traits are those under selection because they directly affect the Darwinian fitness of the populations that are transmitting the trait (Dunnell 1978).

There are two problems that limit the usefulness of selectionism. First, the link between changes in functional traits of the implement and changes in the fitness of the makers is not made; it rests on unstated and undemonstrated assumptions about how technological change affects human reproductive fitness (Preucel 1999; Wylie 1995). Second, the selectionist approach is problematic because it does not make any claims about human behaviour in the past. This is not an accidental omission but a deliberate epistemological gambit by selectionists. As part of their claim to be uniquely scientific, they state that inference from archaeological to behavioural contexts is fatally insecure because past behaviours are inaccessible to archaeologists. Epistemic security can only be ensured for identifying variability in the archaeological record and monitoring it over time; selectionists are interested in the material of the archaeological record, not in the behaviours that contributed towards its formation (Dunnell 1978, 1980, 1989:45). Wylie (1995:208) notes that this is paradoxical because in order to provide compelling explanations for the adaptive advantages of specific variations in artefact design, selectionists must depend on behavioural reconstruction to establish exactly how a specific variation favoured human reproduction under specific conditions.

Dual Inheritance Theory and Stone Artefact Analysis

A more coherent application of evolutionary principles to archaeological explanation can be found in case studies that employ Boyd and Richerson's (1985) dual inheritance theory (DIT). This theory asserts that there are Darwinian evolutionary forces acting on the cultural transmission of information that are unique and independent of genetic evolution. DIT holds that there are biases arising from human psychology that can affect cultural transmission at the population level. These include directed or content-based bias (when the content of one variant is easier to learn, remember and transmit than another variant), frequency-based bias (when the commonness or rarity of a variant is the criteria determining its transmission), model-based bias (when a variant is transmitted because of its association with a suite of other attributes associated with individuals exhibiting the variant) and guided variation (when individuals copy existing behaviours and modify them by trial and error) (Boyd and Richerson 1985).

For stone artefact assemblages the effects of different biases of cultural transmission can be explored in metric variability (Bettinger and Eerkens 1997, 1999). For example, guided variation (resulting in high metric variation and low correlation between different metric attributes) and content-based bias will be important during times of low population densities and low techno-organisational complexity because competing variants are easily compared by field testing and individual experience. When the population grows and/or technology becomes more complex, frequency-based and model-based biases (resulting in low metric variation and high correlation between different metric attributes) are expected to be more important because individual field testing of variants is inefficient compared to relying on social transmission of pre-tested variants.

DIT differs from selectionism because it gives the primary selective role to transmission biases and decouples selective processes and the biological fitness of the artefact makers. Transmission bias 'is a culling process analogous to natural selection' acting on socially transmitted information (Richerson and Boyd 1992:67). Selection resulting from transmission bias may not always optimise genetic fitness, since genetic reproduction is not required for cultural reproduction (for example, information can be transmitted to non-kin) (Richerson and Boyd 1992:75-85). The most important advantage of DIT over selectionism is that it links people and their behaviour to their stone artefacts. Dual inheritance theory provides description and explanation that include details of artefact design, reconstruction of cultural behaviours (such as contexts of learning) and incorporates historically specific conditions known from other sources.

Human Behavioural Ecology and Stone Artefact Analysis

Human behavioural ecology (HBE) is a field of study applying theory from evolutionary ecology to anthropological questions. Evolutionary ecology examines how the evolutionary history of organisms influences their responses to selective pressures in the environment. This theory developed from ethological studies that asked why certain patterns of animal behaviour emerged and persist and sought answers from the ecological contexts of these behaviours (Shennan 2002a). The role of evolutionary processes in HBE is quite different from selectionist and DIT approaches that explicitly refer to selection and transmission as controls on artefact variation. The role of selection here is to produce a phenotype with the cognitive flexibility to weigh the costs and benefits of particular strategies. Behavioural strategies are general decision categories (e.g. what prey? which location?) that are distinct from behavioural tactics that specify the particular techniques of foraging. The strategies themselves, or the information that generates them, are not considered to be under strong selection. Instead, the most important selection remains at the lowest levels as defined for biological evolution; a process that acts on genotype variation (Cronk 1991:28). Natural selection maximises gene survival, and individuals, as temporary vehicles for genes, should behave in ways that maximise reproductive fitness. So natural selection supplies the capacity to generate a range of behavioural strategies, but the particular strategy employed depends on the specific environment. Variation in behavioural strategies results from environmental variation because natural selection has produced a phenotype with sufficient flexibility to track environmental variation optimally (Boone and Smith 1998:145).

One of the key differences between behavioural ecology and other evolutionary approaches to archaeology is that behavioural changes result mostly from phenotypic flexibility rather than selective processes. There is room for some selective processes because in addition to genes, culture is another system of inheritance that affects behavioural strategies (Jeffares 2005). This means that there could be a role for DIT in HBE as 'rules of thumb' to improve the efficiency of information processing (Jochim 1983) or as a source of alternative hypotheses when adaptive predictions are not satisfied, because cultural transmission biases can result in non-adaptive behaviours (Shennan 2002b). In this way, HBE is not a simple borrowing of animal ecology models, but is also capable of incorporating cultural information. In any case, the priority of HBE is to focus on behavioural adaptation without having to tackle the hard problem of demonstrating and explaining heritability in material culture.

Although optimality models allow the heritability problem to be sidestepped there are two problems that it raises when applied to human behaviour and by extension, stone artefact analysis. Sterelny (2004) has suggested that the good fit between animal behaviour and evolutionary ecology predictions is because animals have simple heuristics with low decision loads that lead to near-optimal behaviour. Humans are different because the trade-offs relating to our existence are far more complex and have much higher decision loads resulting from our psychological, social and political contexts. Consequently, HBE predictions relating to stone artefact assemblages might receive only equivocal support because of difficult-to-measure psychological, social and political influences. A second problem is that the incompleteness of the archaeological record and ambiguities involved in reconstructing behavioural strategies mean that HBE models can only be tested for qualitative consistency with the predicted behaviours (Sterelny 2004:253). In other words, we do not know the 'recommended daily intake' for stone artefacts or how such a thing could be accurately measured (Shea 1991).

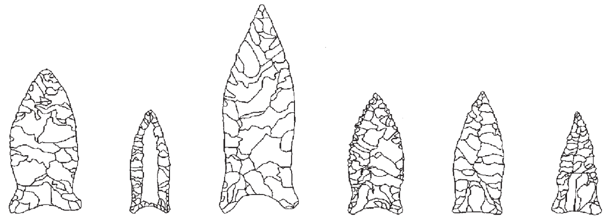

Figure 1 Some of the Palaeoindian point forms from the Southeastern United States used by O'Brien *et al.* (2001) in their cladistic analysis. Reprinted from *Journal of Archaeological Science*, 28, M.J. O'Brien, J. Darwent and R.L. Lyman, Cladistics is useful for reconstructing archaeological phylogenies: Palaeoindian points from the southeastern United States, pp.1115-1136, 2001, with permission from Elsevier.

Evidential Constraints in Mainland Southeast Asian Stone Artefact Assemblages

To date, applications of selectionist and DIT methods have been on stone artefact assemblages with large numbers of highly distinctive forms, such as Palaeoindian projectile points and flaked stone arrowheads (Figure 1; Bettinger and Eerkens 1997, 1999; Buchanan and Collard 2007; O'Brien *et al.* 2001; Shott 1997). Similarly distinctive forms are rare in mainland Southeast Asian flaked stone artefact assemblages (Figure 2). For example, in my analysis of the assemblage at Tham Lod Rockshelter in northwest Thailand, I found that only 35 artefacts out of 2714 (1.3%) could be identified as one of Colani's (1927) 28 visually distinctive Hoabinhian types. To focus the analysis on these 35 artefacts, as a selectionist or dual inheritance theorist would have to, would result in unreliable conclusions, given the small sample size as well as a very inefficient use of evidence, given the high percentage of artefacts excluded from the analysis.

To overcome this constraint, Bowdler and Tan (2003:42) suggest that some technological attributes of the informal components of mainland Southeast Asian assemblages are 'just as likely to be influenced by cultural factors as pragmatic ones'. This assumes that similarities between assemblages can be interpreted as being phylogenetically homologous (i.e. due to common technological ancestry via cultural transmission) as opposed to being homoplasic (i.e. due to convergent technological evolution via adaptation). In favour of the idea of convergent technological evolution, there is an extensive body of literature demonstrating that morphological variation in retouched stone artefacts is most strongly related to the amount of reduction that the artefact has undergone (Bamforth 1986; Clarkson 2004, 2007; Hiscock 2006; Hiscock and Attenbrow 2005; Kuhn 1994, 1995). This view holds that the shapes and sizes of artefacts are controlled by processes of edge and tool maintenance in addition to a desire by the knapper to produce discrete shapes. Much of the degree of maintenance can be explained in terms of the performance of the artefact within the economic context in which the ancient foragers operated. This model leaves only

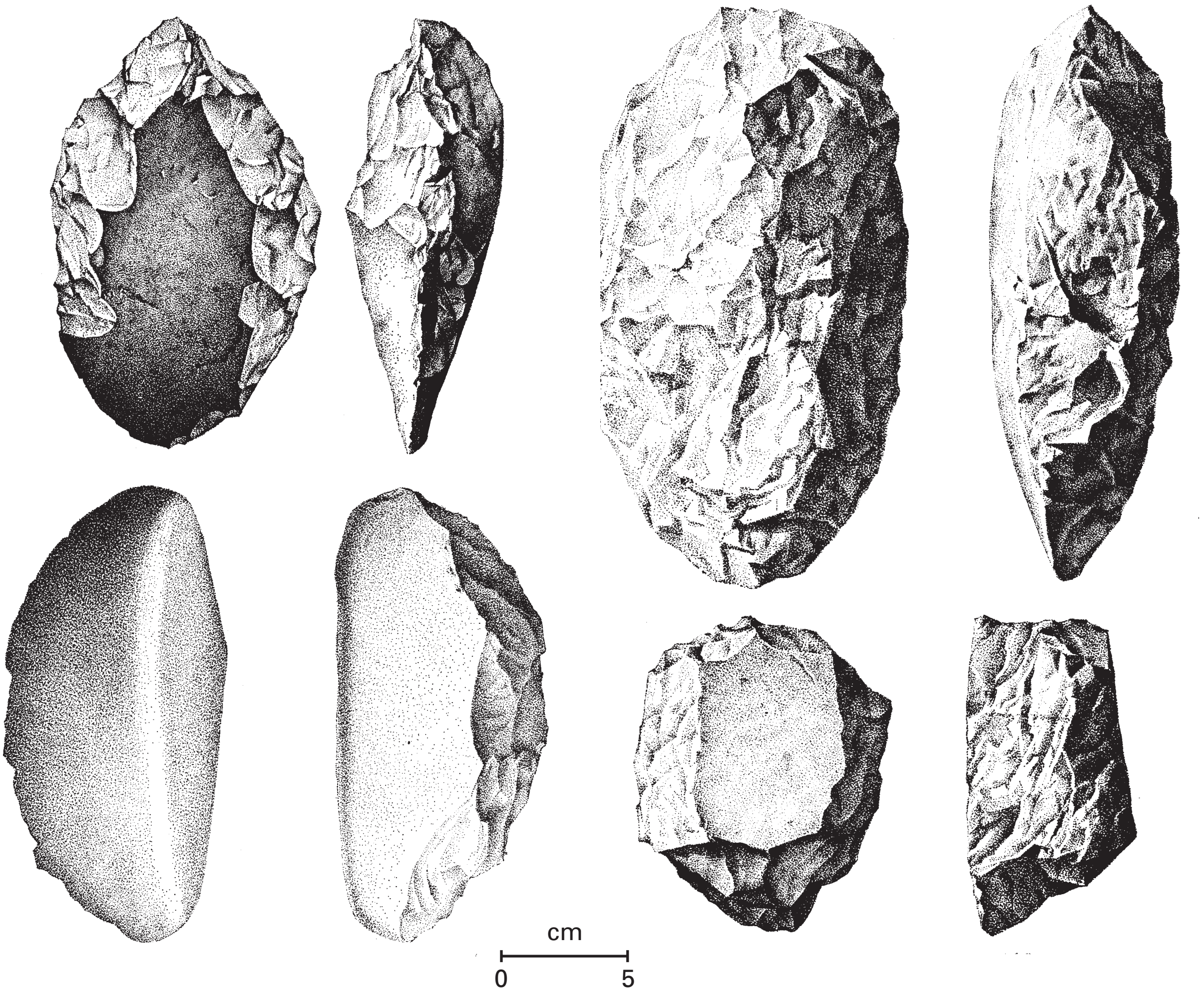

Figure 2 Typical core forms in Hoabinhian assemblages. Reprinted from van Heekeren, H.R. and E. Knuth, *Archaeological Excavations in Thailand: Sai Yok: Stone-Age Settlements in the Kanchanabur Province*, pp.30-31, 34, 1967, with permission from Wiley-Blackwell and *Journal of Archaeological Science*, 35, B. Marwick, What attributes are important for the measurement of assemblage reduction intensity? Results from an experimental stone artefact assemblage with relevance to the Hoabinhian of mainland Southeast Asia, pp.1189-1200, 2008, with permission from Elsevier.

a small amount of variability available for explanation by non-economic factors such as Bowdler and Tan's cultural factors or the errors in transmission and transmission biases proposed by some evolutionary theorists. This implies that although a signal of cultural factors and transmission effects is likely to influence artefact morphology, its influence on morphological variation may be difficult to measure reliably.

The key here is the central theme of HBE: adaptation; these flake attributes appear to be more sensitive to variation in adaptive responses to economic conditions than anything else. In contrast to the problematic methods of selectionist and dual inheritance theorists, robust methods exist for testing hypotheses derived from HBE about how stone artefact attributes are structured by situational variables that encouraged people to employ certain techniques (Yesner 1981). For example, Kuhn's (2004) well-known continuum of place and individual provisioning has proven to be a very versatile system for testing predictions about adaptation to landscapes using retouched and unretouched artefacts (Clarkson 2006, 2007). Clarkson (2006) links these two strategies to the problem of maintaining a constant supply of effective tools under conditions where mobility and the abundance and predictability of resources vary. Individual provisioning represents a response to ecological contexts requiring high mobility and contingency planning due to the unpredictability of resources. Place provisioning is a more adaptive strategy when the location and timing of activities to be performed in the future is predictable and mobility is low.

To link Kuhn's system to assemblage-level analysis of only unretouched flakes I conducted an experiment that produced 625 flakes from 30 cores. The experiment was designed to investigate how technological attributes of flakes changed according to the extent of core reduction, with less extensive reduction a proxy for place provisioning and more extensive reduction a proxy for individual provisioning. Strong correlations were found between the presence of overhang removal, the size of the interior platform angle, the percentage of dorsal cortex, the number of dorsal flake scars, the location of dorsal cortex and the position of a flake in the sequence of core reduction (Marwick 2008a). For example, the more extensively a core is worked, the greater the proportion of flakes with overhang removal, with high interior platform angles, with small percentages of dorsal cortex and high numbers of dorsal flake scars. The extensiveness of core reduction is most productively and parsimoniously linked to supply of materials for making artefacts and the demand for artefacts (Marwick 2008a). A limited supply or high demand, or both, will result in more extensive core reduction as people adapt their technology to the situation.

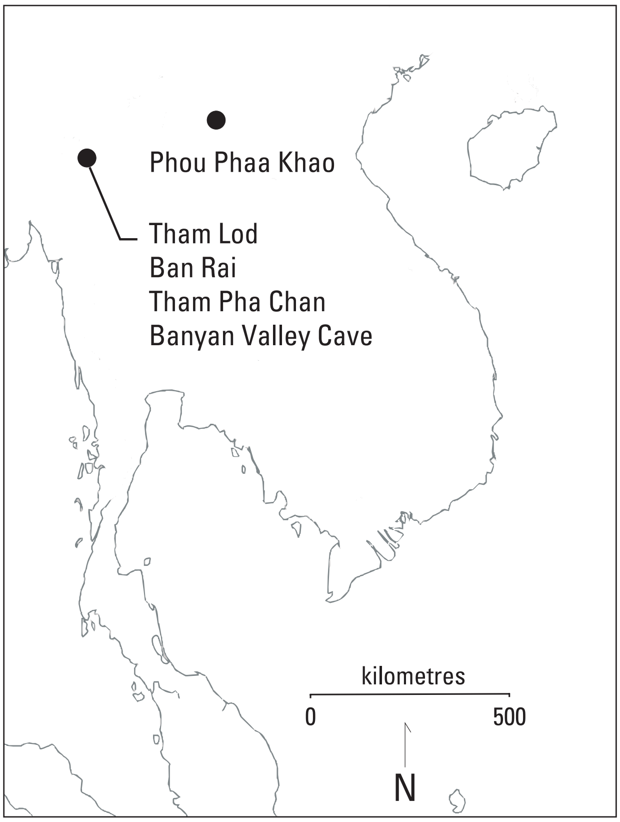

Figure 3 Locations of excavated sites in Thailand and Laos discussed in the text.

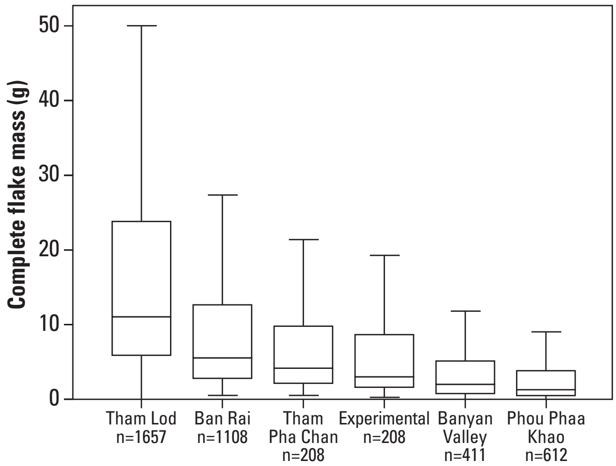

Figure 4 Box plots showing medians and distributions of complete flake mass values for six assemblages with Hoabinhian affinities.

This does not mean that HBE is an instant panacea for understanding stone artefact assemblages in mainland Southeast Asia. The variables I discussed in my experiment have been recognised by stone artefact analysts for a long time, but curiously only appear in one previous publication on Hoabinhian stone artefacts, and under slightly different names (White and Gorman 2004). A lack of consensus in data collection strategies and standards of reporting means that meta-analysis, or combining the results of disparate independent studies for hypothesis testing, is currently unlikely to produce useful or reliable results. Similarly, definitions of attributes used by analysts are rarely given in the literature so it is difficult to know if measurements are comparable between researchers. This is particularly important for understanding assemblage taphonomy, since different rates of flake breakage can alter the identification and counts of artefacts (Hiscock 2002). If HBE-motivated analyses become popular it will be a slow process because this kind of systematic and precise attribute analysis is relatively time consuming and requires some investment in developing a theoretical grounding customised for the specific environment of the site.

To show some of the demands of an analysis motivated by HBE and the challenges involved in comparing disparate assemblages, I present a brief case study of an examination of complete flake mass in six assemblages (Figures 3-4). A complete flake is defined as a piece with unambiguous positive conchoidal scars, having evidence of a bulb of percussion or bending initiation but no evidence of longitudinal or lateral breaks (Marwick 2008a). Figure 4 shows the distribution of complete flake mass for six assemblages with Hoabinhian affinities in mainland Southeast Asia. Tham Lod, Ban Rai, Banyan Valley Cave and Tham Pha Chan are all rockshelters in Mae Hong Son Province, northwest Thailand (Figure 3; Gorman 1971; Shoocongdej 2006; Treerayapiwat 2005). Tham Lod and Ban Rai were excavated by the Highland Archaeological Project in Pangmapha, directed by Rasmi Shoocongdej. Banyan Valley Cave and Tham Pha Chan were excavated by Chester Gorman as part of PhD fieldwork. The experimental assemblage is the one referred to above (made to reproduce typical Hoabinhian forms) and Phou Phaa Khao is a rockshelter near Luang Prabang, Laos, excavated by the Middle Mekong Archaeology Project (Figure 3; White 2007; White and Bouasisengpaseuth 2007). Control over variation in the identification of flakes has been achieved by my analysis of the Tham Lod, Ban Rai, experimental and Phou Phaa Khao assemblages, and Olivia Given analysing the Banyan Valley Cave assemblage using the same protocols described in Marwick (2008a). Given also created a concordance of White's Tham Pha Chan data (White and Gorman 2004) so that wherever possible White's variables could be directly compared with Marwick's. Although some information about these sites has been previously published, the metric data are presented here for the first time.

It is likely that the distribution of complete flake mass in these assemblages is influenced in complex ways by a large number of variables and space limitations prevent a full exploration here. That said, it is possible to survey some of the most likely candidate variables. Analysis of the experimental assemblage showed that flake mass has a very weak relationship to extent of core reduction (r=0.017), so it is unlikely that differences in core reduction contribute substantially to the differences between these assemblages (Marwick 2008a). On the other hand, a moderate positive correlation was observed in the experimental assemblage between the initial core mass and the average mass of flakes produced by that core (rho=0.400; Figure 5). This suggests that the initial size of the cobble contributes to the upper range of flake sizes in an assemblage, as might be expected. For the six assemblages together, there is a moderate correlation between sample size and median mass, with large samples typically having higher median flake mass values (rho=0.460; Figure 6). This correlation indicates that larger samples are more likely to include rare larger flakes, although the small number of assemblages considered limits the reliability of this correlation.

However, this still leaves considerable variation in flake mass unexplained. Sieve sizes were relatively similar across the

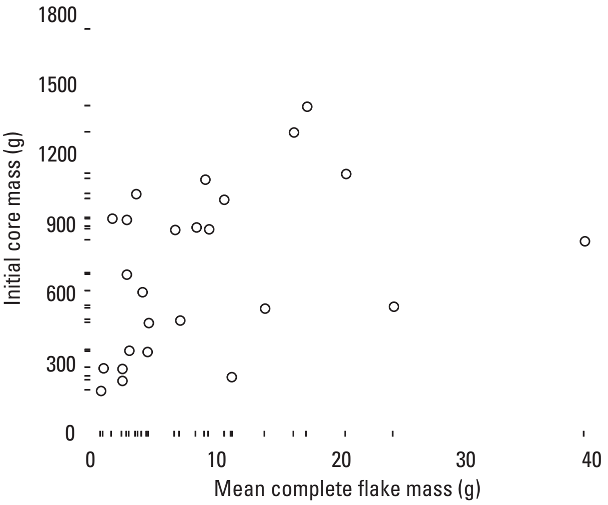

Figure 5 Scatterplot showing relationship between initial core mass and mean complete flake mass from the experimental assemblage described in Marwick (2008b).

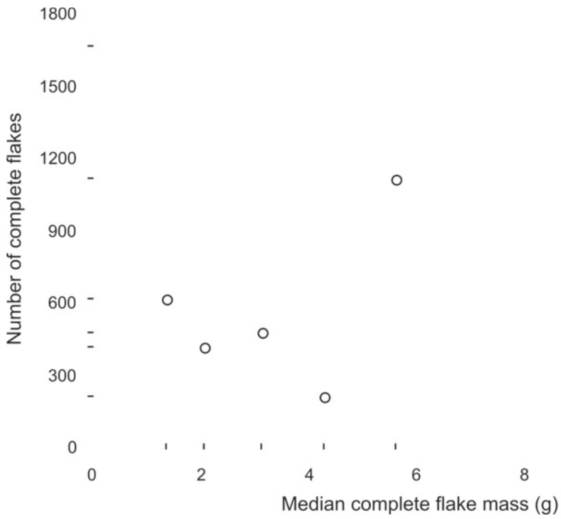

Figure 6 Scatterplot showing relationship between the number of complete flakes in each assemblage and median complete flake mass for the six assemblages discussed in the text.

excavations, with Shoocongdej using 1.5mm, Gorman 1.5mm and White 2mm. The experimental assemblage was not sieved but all complete flakes over 5mm were analysed (Marwick 2008a). So the recovery instruments probably had little effect on differences in central tendencies of flake mass. One possibility for the smaller flakes found at Phou Phaa Khao is that the operators all had previous experience in detailed technological analyses of Hoabinhian assemblages. This factor may have contributed to an increased yield of smaller flakes because of a greater familiarity in identifying flake attributes under a wider range of conditions. This might explain the lower median flake mass compared to the other sites. However, it does not explain the small range of mass values at Phou Phaa Khao relative to the other assemblages and why larger flakes seem to be missing from this assemblage. This could be explained by a central place model – a model that is frequently employed by behavioural ecologists. This model predicts that processing and transporting of resources will tend to be more extensive when source is distant (Bird and O'Connell 2006). In this case, core reduction appears to have been relatively more intensive at Phou Phaa Khao compared to the other assemblages, perhaps reflecting a strategy of individual provisioning as an adaptation to the absence of any local stone sources. Other likely variables that might be relevant include distance to reliable water, quality of raw materials, population size and biomass availability. Unfortunately little data is currently available for these variables on these sites, but these variables are likely to be important in future explanations of stone artefact variability in mainland Southeast Asia.

Taking this comparison further is risky because of differences in the periods of time represented by each assemblage and conflation of important effects relating to technological change occurring over long periods of time (for example, the Tham Lod assemblage represents 35,000 years). The main point from this brief example is that interpreting even a simple attribute such as complete flake mass is complicated and potentially influenced by factors that are not currently recorded (such as unworked cobble sizes) or unrelated to the conditions of original assemblage formation. This is not a novel observation for archaeology in general, but one that is yet to receive much attention in the Hoabinhian literature. Ideally, interpretations of assemblages are dependant on data that are carefully and consistently collected from a series of other metric and technological variables. As with any reliable method, these variables should satisfy two conditions. First, they must be explicitly defined to ensure that different analysts are recording the same thing in the same way. My experimental study offers some definitions towards satisfying this condition (Marwick 2008a). Second, verification of the variables must be undertaken to separate effects of the situation that influenced how the assemblage was originally produced (these are the effects of interest in most cases) and effects of taphonomy and recovery methods. These details have largely been worked out in archaeological analysis of fauna, with relatively standardised methods for describing bone breakage and quantifying faunal assemblages. While stone artefact analysts are making progress with these topics (Hiscock 2002), these concerns are not yet consistently addressed in the Hoabinhian literature.

Conclusion

The purpose of this paper has been to examine Darwinian approaches to stone artefact analysis and identify the most promising one for mainland Southeast Asian assemblages. A strict adherent to scientific method would have derived methods from each theory and demonstrated each one with an assemblage, and then ranked the results in order of how completely the theory explains the state of the assemblages. I have taken a more pragmatic and reflexive approach, looking back from the available evidence to the requirements of each theory. I have argued that of the three Darwinian approaches currently in use, human behavioural ecology is the most promising because of robust links between its theory of adaptation and assemblage measurement. A comprehensive demonstration of the applicability of this approach is limited by the previously published data, but a more in depth study is presented in Marwick (2008b). The other two Darwinian approaches, selectionism and dual inheritance theory, have very limited potential in mainland Southeast Asian flaked stone artefact assemblages because they focus on transmission of information and this is very difficult to reliably measure in unretouched flaked stone artefact assemblages.

As a minor point, I have highlighted the need for explicit and consistent definitions for flake attributes and careful attention to the influence of recovery techniques on analytical results. This is more than simply muddying the waters to declare them deep; improvements in methods will benefit archaeologists in mainland Southeast Asia regardless of their theoretical orientations, especially those who do not openly profess one. Maynard Keynes (1964:383) famously wrote (and Sandra Bowdler frequently paraphrased), 'practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist', indicating that no-one really works in a theoretical vacuum, even if their writing does not acknowledge a theoretical foundation (in this case 'people' should be substituted for 'men' and 'archaeologist' for 'economist'). If a sharper focus on explicit theorising could be achieved, a more unified and persuasive direction could be given to much work in mainland Southeast Asian archaeology.

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Papers to Celebrate the Career of Sandra Bowdler

Jane Balme and Sue O'Connor (eds)

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