# TYPOLOGICAL TRANSFORMATION AMONG LATE PALEOLITHIC FLAKED CORE TOOLS IN VIETNAM: AN EXAMINATION OF THE PA MUOI ASSEMBLAGE

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## ABSTRACT

*This paper explores typological transformations among late Paleolithic pebble tools excavated from Pa Muoi site in the Northwestern mountainous region of Vietnam. The site contains approximately 1665 pebble choppers over an excavation area of 449 m$^2$. An attribute analysis is undertaken to examine the time-ordering of dimensional and morphological changes as reduction proceeds.*

## INTRODUCTION

Since its formation in the early 1960s, prehistoric archaeology in Vietnam has operated within a culture historical perspective that is deeply rooted in the French colonial period. A fundamental aspect of this approach is the classification of artefacts into discrete types. For example, the late Paleolithic archaeological Sonvi ‘culture’ is characterized by distinctive core tool types such as end choppers, side choppers, pointed choppers and quarter-pebble choppers (Tan, 1998; Tan, Su, & Chung, 1999). To date, no studies in Vietnam have investigated whether such artefact types truly represent discrete and immutable forms, or represent differential stages in a reduction sequence whereby tool form is responsive to factors such as raw material availability, mobility and settlement pattern, as commonly documented in other parts of the world (Andrefsky, 1994; Barton, 1990, 1991; Baumler, 1987; Marwick, 2008a, 2008b; Clarkson, 2002, 2005; Close, 1991; Dibble, 1984, 1987a, 1987b, 1988, 1995; Dong, 2006, 2007, 2008; Gordon, 1993; Hiscock, 1994, 1996, 2006; Hiscock & Attenbrow, 2005; Holdaway, McPherron, & Roth, 1996; Kuhn, 1992, 1995; McPherron, 1994, 1995; Morrow, 1995, 1996, 1997; Morrow & Morrow, 2002; Neeley & Barton, 1994; Roddam, 1997; Shott, 1989). This paper explores typological transformations in the Sonvian lithic implements at the site of Pa Muoi. We specifically investigate implement reduction and the organisation of technology at the site, or in other words, the behavioural processes of tool manufacture, use, maintenance and discard.

## DESCRIBING THE SAMPLE

The site of Pa Muoi was excavated in 2008 and is located on a range of low hills of the right bank of Da River in the Northwestern mountainous region in Chieng Bang commune, Quynh Nhai district, Son La province (Figure 1). A thick pebble seam and gravel bed occurs below the site at the bottom of the hill next to the river, serving as an abundant, accessible and available source of raw material for past occupants of the site. A single disturbed cultural

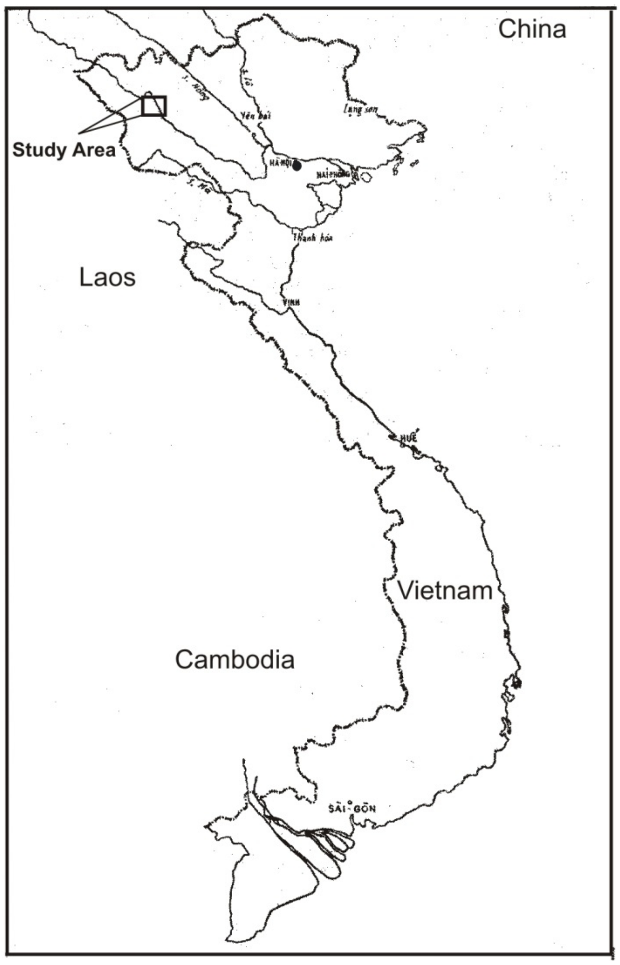



*Figure 1: The study area where Pa Muoi site is located*

layer occurs 40-50 cm below surface and includes rectangular axes, shouldered polished axes, grinding slabs, saddle querns, bronze and iron items, stoneware, ceramics and other artefact types. Artefacts typical of the Sonvian flaked pebble core tradition are most numerous at the site (Table 1).

**Table 1: Frequency of all tool types of Pa Muoi site**

| Tool name | Frequency | Percent |
|---|---|---|
| End chopper | 691 | 50.6 |
| Side chopper | 234 | 17.1 |
| Pointed chopper | 185 | 13.6 |
| Oblique chopper | 92 | 6.7 |
| Two-edge chopper | 82 | 6.0 |
| Double-end chopper | 14 | 1.0 |
| Quarter chopper | 11 | 0.8 |
| Three-edge chopper | 20 | 1.5 |
| Horse-hoof chopper | 36 | 2.6 |
| Total | 1365 | 100.0 |

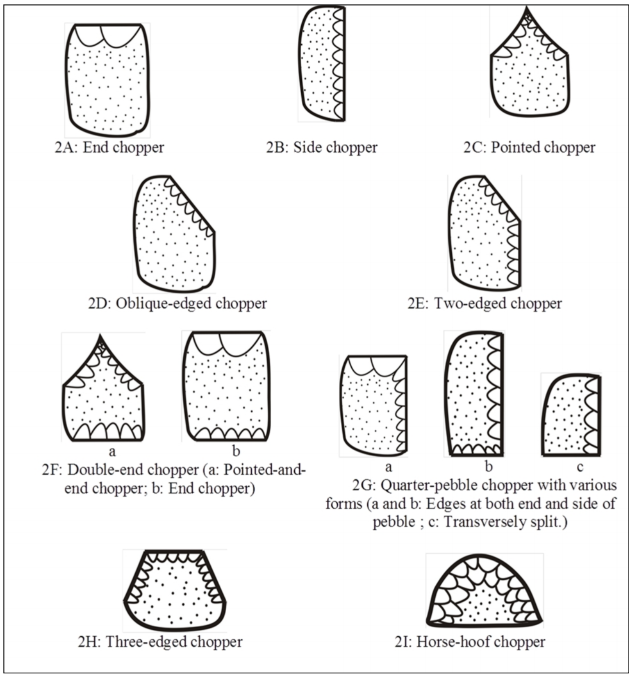



*Figure 2: Illustrations of the key types recognised in the Sonvian typology. Types are defined in the text.*

A total number of 1665 stone artefacts are found at the site. Of these, 163 are flakes, including 24 primary flakes, 133 secondary flakes and 6 tertiary flakes (Dong, 2009). Of the retouched implements, a sample of 1365 unbroken core tools, excluding too very large ones (weight ≥ 900 gr), is selected for analysis. The sample contains all types characteristic of the Sonvian culture, namely end choppers, side choppers, pointed choppers, oblique-edge choppers, two-edge choppers, horse-hoof choppers, three-edge choppers, double-end choppers, and quarter-pebble choppers (Table 1, Figures 2 and 3).

*End Choppers* are defined as those with a single flaked edge that is perpendicular to the long axis of the pebble (Figure 2A). *Side Choppers* are defined as those with one flaked edge that is parallel to the long axis of the pebble (Figure 2B). *Pointed Choppers* have a pointed tip created by convergent percussion (Figure 2C). *Oblique-Edged Choppers* have a flaked edge that is oblique (transverse) to the long axis of the pebble (Figure 2D). *Two-Edged Choppers* are less precisely defined, and may have either two adjacent or non-adjacent flaked edges on a pebble (Figure 2E). *Double-Ended Chopper*s have two edges located at opposed ends of the long axis of a pebble (Figure 2F). There are two variants of Double-Ended Choppers. The *Pointed-and-End Chopper,* or *Type a*, has a pointed tip at one end and a straight working edge on the other. The *Double-Ended Chopper,* or *Type b*, have two straight flaked edges on opposed ends of the long axis of a pebble (Figure 2F). *Quarter-Pebble Choppers* refer to pebbles with two edges that form an almost right angle (Figure 2G). Three sub-types are recognised. *Types a and b* have two flaked edges perpendicular to one another. *Type c* has only one flaked edge perpendicular to a non-flaked surface created by transverse splitting. The *Three-Edged Chopper* is an amorphous tool possessing three adjacent flaked edges (Figure 2H). *Horse-Hoof Choppers* have a curved flaked edge and a straight unflaked edge, resembling the outline of a horses' hoof (Figure 2I).

**Table 2: Frequency of various raw material types used for tool manufacture**

| | Raw material | Frequency | Valid Percent |
|---|---|---|---|
| Valid | Hard sandstone | 442 | 47.6 |
| | Quartzite | 253 | 27.3 |
| | Rhyolite | 43 | 4.6 |
| | Granite | 24 | 2.6 |
| | Basalt | 87 | 9.4 |
| | Argillit | 24 | 2.6 |
| | Powdered sandstone | 27 | 2.9 |
| | Dacite | 8 | 0.9 |
| | Schist | 3 | 0.3 |
| | Silicious schist | 4 | 0.4 |
| | Quartz | 2 | 0.2 |
| | Unknown | 8 | 0.9 |
| | Unknown | 3 | 0.3 |
| | Total | 928 | 100.0 |
| Missing | System | 437 | |
| Total | | 1365 | |

It is noted that the drawings reflect the most representative forms of each tool type, but do not depict all the shape variants observed in an assemblage. These stone tool types are mostly comprised of unifacially flaked sedimentary river pebbles of diverse raw material types (Table 2). Although no dates are available for these Sonvian implements, a shape comparison indicates that they resemble the early Soan industry belonging to the Second Interglacial Period in the Middle Pleistocene of Northwest India (Figure 4) (De Terra & Patterson, 1939; Movius, 1944). It is a current research priority to obtain ages for the Sonvian industry in Vietnam.

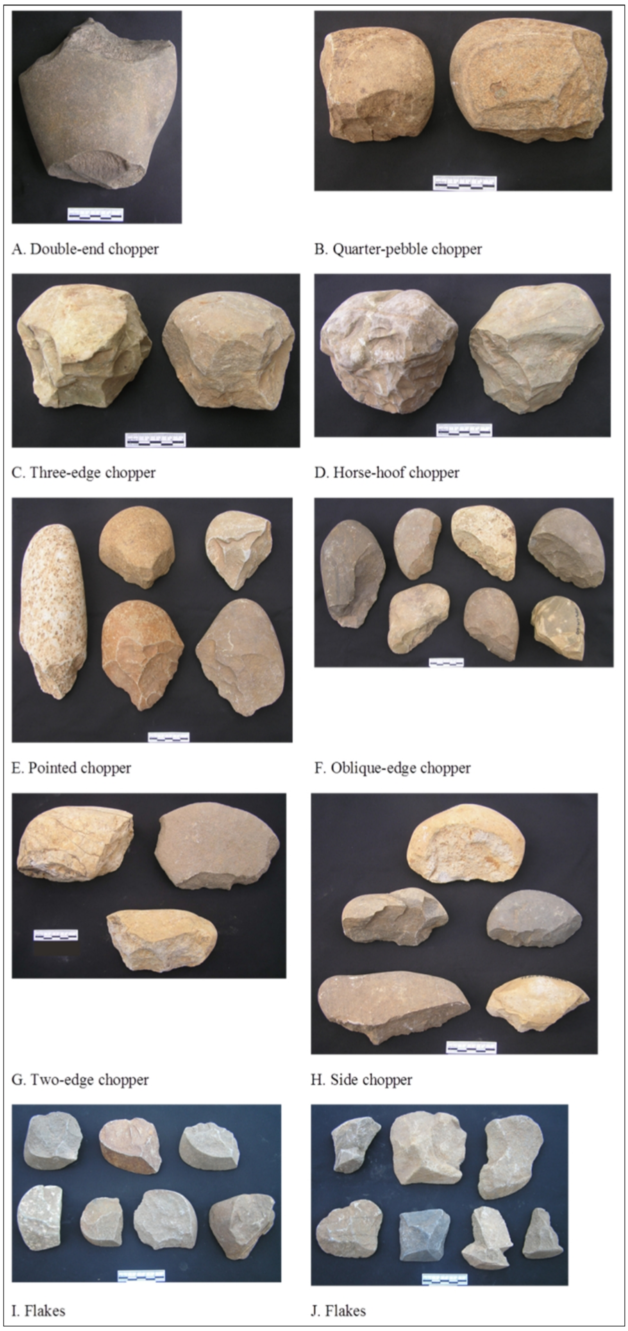



*Figure 3: Various types of choppers and flakes of the Sonvian industry*

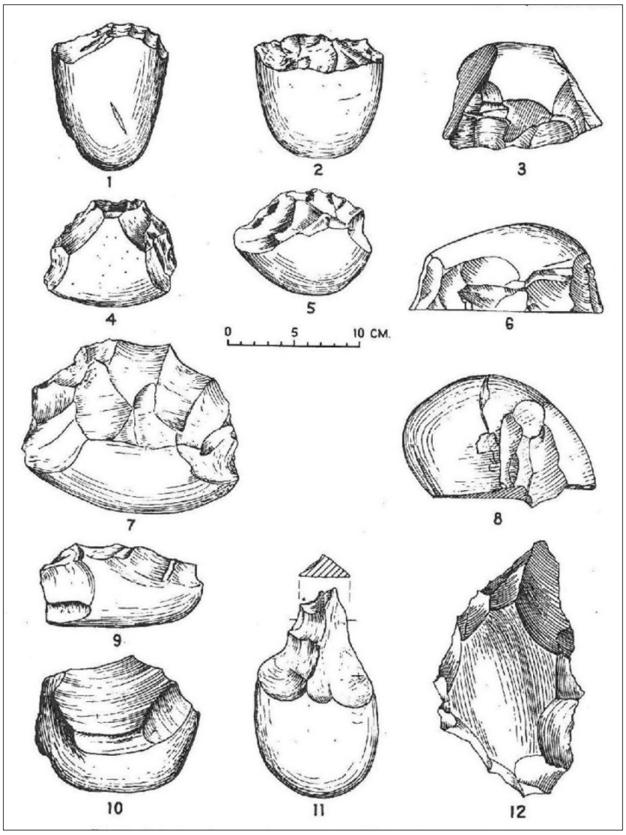


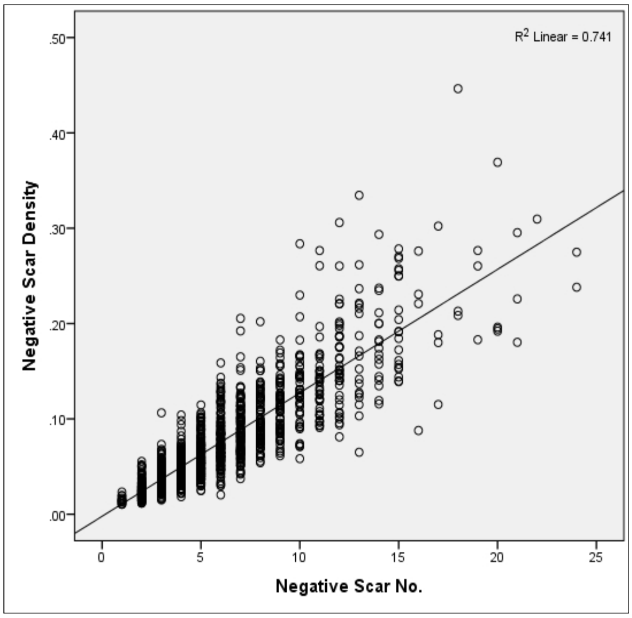

*Figure 4: Early Soan choppers and chopping tools (After Movius, 1944).*

## METHOD

A statistical based attribute analysis was undertaken on the Sonvian pebble choppers to examine the effects of reduction on implement form. The attributes include dimensions such as length, width, thickness, mass and volume (length x width x thickness), indices of shape, such as elongation (length/width), narrowness (width/thickness), and thinness (length/thickness), and measures of flaking form and intensity, such as negative scar number, flaking layer number (the number of overlapping flaking events on the same edge), edge angle and negative scar density. The variable of negative scar density is adopted as a key indication of reduction intensity, and is calculated by dividing the number of negative scars by plan surface area, calculated as length times width (Clarkson, 2013; Shipton & Clarkson, 2015). This variable is particularly suitable for Sonvian implements that are unifacially flaked. As shown in Figure 5, there is a strong and highly significant correlation between negative scar number and negative scar density for Sonvian choppers ($r = .861$, $p = <0.0005$). Extreme outliers (weight ≥ 900gr) were removed from the analysis to ensure a normal distribution of values for reliable results (Figure 6).

All measurements employed in the analysis were taken using the following procedures:

*Length* is the distance from the edge to the opposite end in the central axis of the tools.




*(r = .861, p = <0.0005)*

*Figure 5: Scatter plot shows a strong correlation between negative scar density and negative scar number*

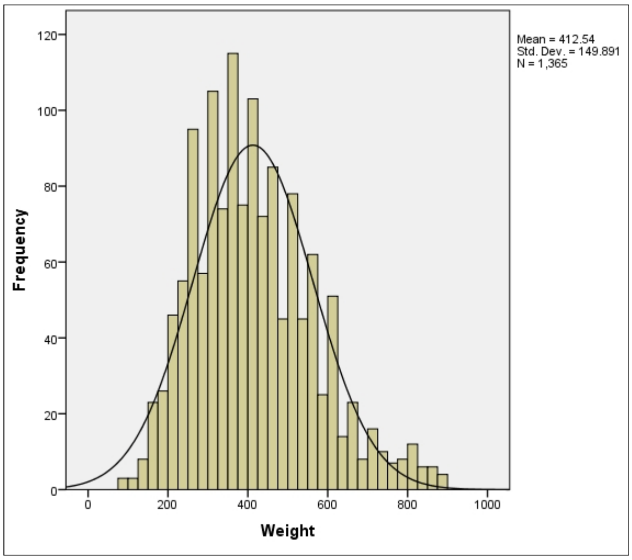



*Figure 6: Normal distribution of mass values*

*Width* was measured perpendicular to length at the mid-point.

*Thickness* was measured perpendicular to width at the intersection of length and width.

All dimensions were recorded to the nearest 0.1 millimetre.

*Edge angle* was measured in the middle of the most extensively flaked edge. For pointed choppers, edge angle was recorded right at the pointed tip.

It is recognised that the implements under examination are discarded implements, and hence may reflect later stages of use and reduction, with earlier stage morphologies modified by subsequent reduction. By ascertaining the relative degree of reduction of each artefact using the flake scar density measure described above, it is possible to explore changing artefact morphology as a factor of reduction intensity (Kuhn, 1995; Dibble 1987b).

Similarly, in order to examine the typological transformation among different tool types found at Pa Muoi site, we first examine changes in tool size and shape as reduction intensity increases. Next, the relative positions of different tool types and subsequently stages of reduction along the reduction intensity scale will be explored. Finally, a hypothetical transformational model for chopper tool types is proposed.

## RESULTS

### Changes in tool size in response to reduction intensity

Figure 7 indicates that length, width, mass and volume of choppers decrease as reduction intensity increases. The exception is thickness, which increases with reduction. Furthermore, only weak/very weak (though still significant) correlations exist between negative scar density and almost all tool dimensions, except for length, which shows a moderately strong correlation. Thus almost all implement dimensions decrease as reduction intensity increases, and in particular, tool length. Tool thickness is not heavily affected by continued reduction. This might reflect relatively steep retouch that was rarely ever invasive enough to reduce the thickness of implements. Furthermore, the results shown for thickness in Figure 7C suggest that progressively thicker pebbles tended to be selected for higher levels of reduction – a pattern observed in many parts of the world. However, the most intensively flaked implements in the sample do show lower than average thickness.

### Changes in tool shape in response to reduction intensity

Figure 8 indicates a consistent decrease in tool elongation (length relative to width), narrowness (width relative to thickness) and thinness (thickness relative to length) as reduction intensifies, and that there are weak and highly significant correlations between negative scar density and elongation ($r = -.304$, $p = <0.0005$), and narrowness ($r = -.264$, $p = <0.0005$), but a moderate correlation with thinness ($r = -.436$, $p = <0.0005$). Thus a consistent change in tool shape takes places as implements are more intensively reduced.

### Types as Relative Points in the Reduction Sequence

The relative positions of various tool types can be ascertained by determining the average extent of reduction for each tool type. The mean of negative scar density is treated as indicative of the central tendency of variation in reduction intensity for artefacts classified in each tool type (Table 3). The mean values are then sorted from the lowest to the highest with a view to establishing a relative time-ordering of different tool types in a reduction sequence from early to late stages (Figure 9). It can be observed that same trend in relative position of each tool type with respect to scar density exists for the mean, the median and the minimum values (Figure 10). This suggests a consistent typological transformation takes place as pebbles are increasingly reduced.

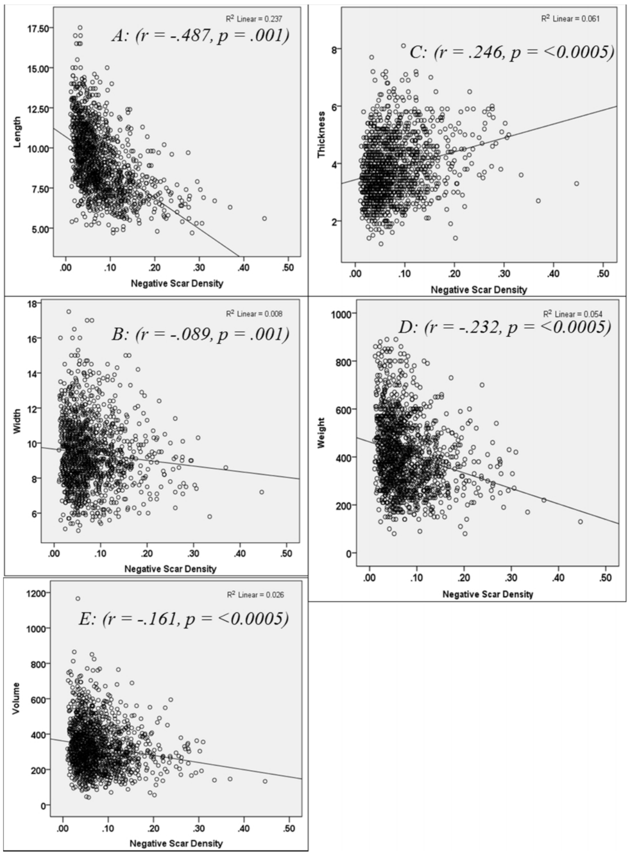



*Figure 7: Scatterplots show the trend of length (A), width (B), thickness (C), weight (D), volume (E) as a function of negative scar density and their correlations*

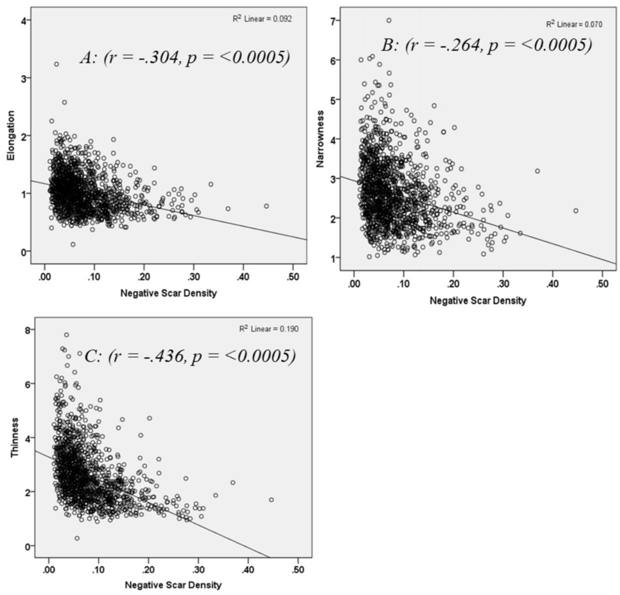
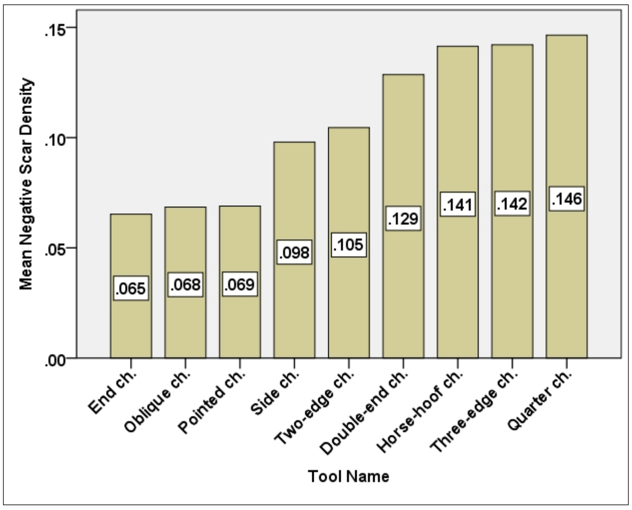



*Figure 8: The effects of reduction intensity on shape: Elongation (A), narrowness (B) and thinness (C).*

**Table 3: Mean and variation of negative scar density for all tool types**

| Tool Name | Mean | N | Std. Deviation |
|---|---|---|---|
| End chopper | 0.065 | 667 | 0.046 |
| Oblique chopper | 0.068 | 89 | 0.039 |
| Pointed chopper | 0.069 | 178 | 0.038 |
| Side chopper | 0.098 | 218 | 0.056 |
| Two-edge chopper | 0.105 | 79 | 0.053 |
| Double-end chopper | 0.129 | 14 | 0.098 |
| Horse-hoof chopper | 0.141 | 36 | 0.083 |
| Three-edge chopper | 0.142 | 20 | 0.086 |
| Quarter chopper | 0.146 | 11 | 0.055 |
| Total | 0.078 | 1312 | 0.054 |




*(ANOVA, df = 8, F = 29.732, p =0..0005)*

*Figure 9: Mean negative scar number of various tool types presented from the lowest to the highest values.*

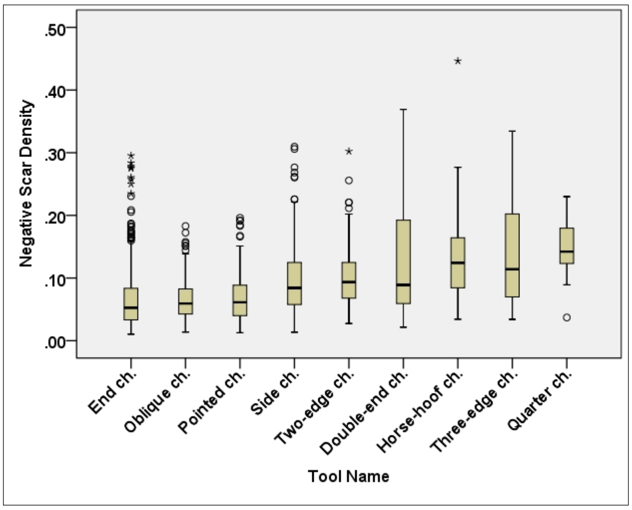



*Figure 10: Boxplot shows variation within each tool type, the increased median and lowest values and the overlapping values among tool types.*

Figure 9 indicate that the three types with the least reduction exhibit only one retouched edge, these being end choppers, oblique-edged choppers and pointed choppers, with mean scar density values of 0.065, 0.068 and 0.069 respectively. A jump in scar density is indicated by side choppers and two-edged choppers which have mean scar densities of 0.098 and 0.105 respectively. A final jump in mean values is associated with four tool types: double-end choppers, horse-hoof choppers, three-edge choppers and quarter-pebble choppers, which have means values of 0.129, 0.141, 0.142 and 0.146 respectively. These types exhibit two to three flaked edges.

The above hypothesis is better demonstrated by contrasting the frequency of tool types at the earliest stage of reduction (1-2 negative scars) that is defined by more than one standard deviation from the mean, and the latest stage of reduction (≥ 14 negative scars) that is ascertained by more than two standard deviation from the mean (Figures 11 and 12). Figure 11 indicates that 1-2 negative scars are absent from the four most heavily reduced tool types, namely quarter-pebble choppers, double-ended choppers, three-edged choppers and horse-hoof choppers, while they are seen with highest percentage in the three most lightly worked tool types, i.e., end choppers, pointed choppers and oblique-edged choppers. This pattern in scar number and positioning of types confirms a sequence of reduction took place from a single edge to two or more edges. The most heavily worked choppers also represent the most exhausted morphologies observed in the tool assemblage in that they possess a highest frequency of flake scars which might prevent further percussions. They occur at the lowest frequency in the assemblage, suggesting that they are uncommon types that were more extensively worked than most pebbles in the assemblage (Table 1).

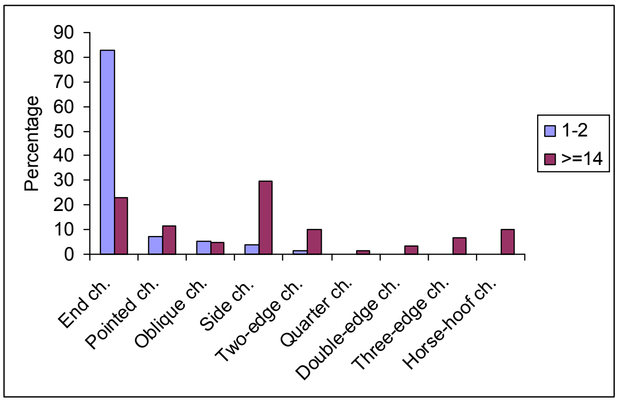



*Figure 11: Contrasting frequency of choppers with 1-2 and ≥ 14 negative scars.*

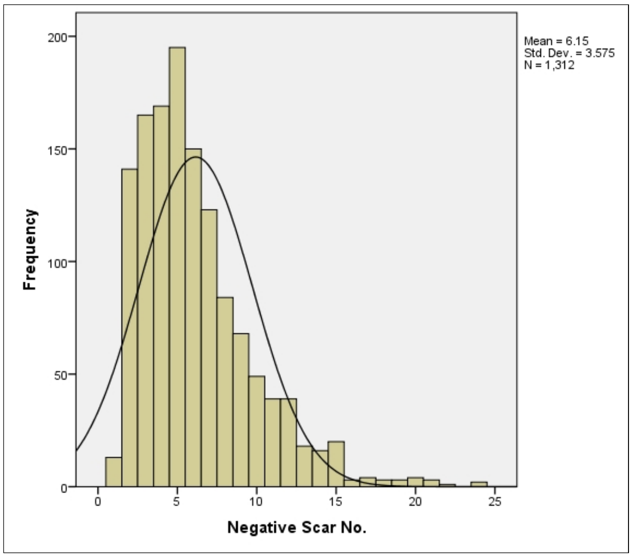
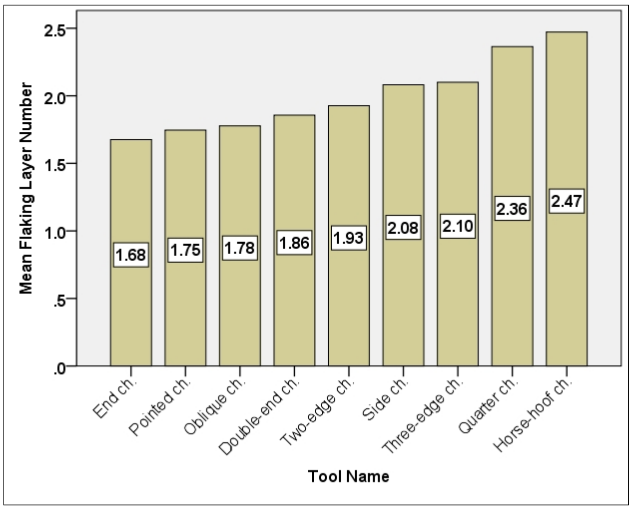



*Figure 12: Distribution of negative scar frequency of all stone tools in the assemblage.*

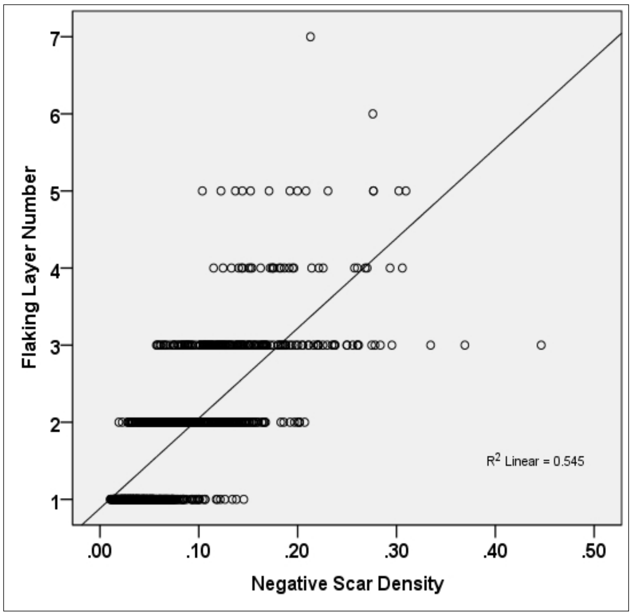
The same pattern of typological transformation is evident when another variable is examined - flaking layer number. End choppers, pointed choppers and oblique-edged choppers all have the fewest flaking layers, with means of 1.67, 1.74 and 1.78 respectively, consistent with their having only low intensity reduction. The three-edged choppers, quarter-pebble choppers and horse-hoof choppers all exhibit much more numerous flaking layers, with means of 2.10, 2.33 and 2.47 respectively (Figure 13). However, some departures from the overall trend exist, with side choppers have an equally high number of flaking layers to choppers with two flaked margins (i.e. double-ended and two-sided choppers).

The statistics indicates that there is a strong and highly significant correlation between flaking layer number and negative scar density ($r = .738$, $p = <0.0005$) (Figure 14).



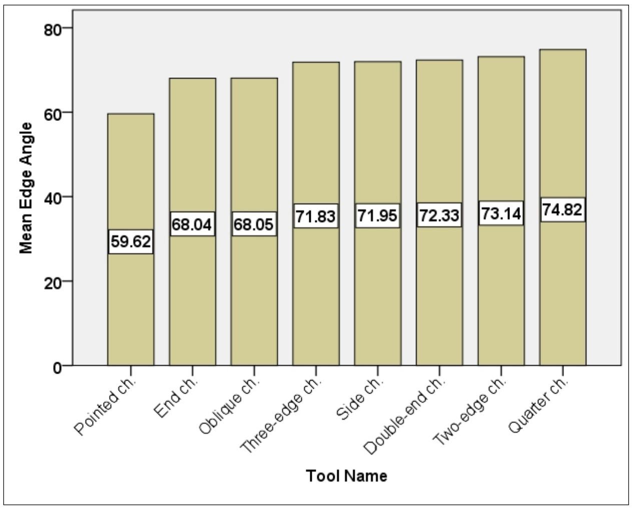

*(ANOVA, df = 8, F = 9.085, p = <0.0005)*

*Figure 13: Mean values of flaking layer number for various tool types.*




*(r = .738, p = <0.0005)*

*Figure 14: Scatterplot shows the flaking layer number as a function of negative scar density and their correlation.*




*(ANOVA, df = 7, F = 16.383, p = <0.0005)*

*Figure 15: Mean edge angle for all tool types sorted from lowest to highest values.*

The edge angle of tools often indicates a threshold at which prehistoric people discarded their tools, whether due to difficulties encountered in further flaking an edge as it approaches 90 degrees, or due perhaps to the changing functional efficiency of edge for certain tasks (Connell and Clarkson 2011). Interestingly, Figure 15 indicates that the ordering of chopper types is somewhat different for edge angle as reduction intensity increases. While tools with a single flaked margin once again show lower values of edge angle, several chopper types with two margins have higher edge angles than those with three flaked margins. This may indicate that past knappers made choices about whether to continue flaking one or two edges, or alternatively, expand flaking onto a third margin. Adding a third margin may have resulted in maintaining overall edge angles at lower values, whereas continuing to flake a single or two edges will drive up edge angles with each flaking event.

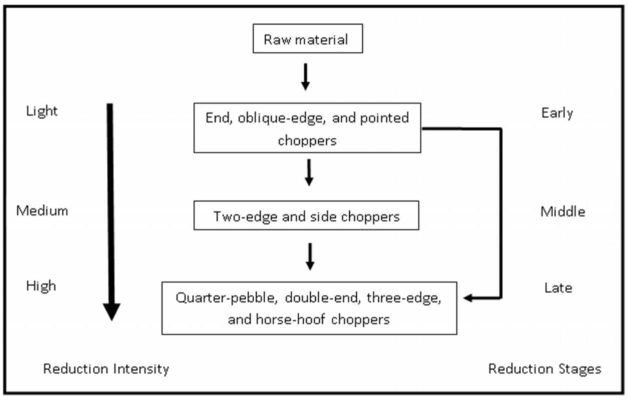



*Figure 16: Proposed model of typological transformation under the influence of reduction intensity at Pa Muoi site.*

Given the above analyses, a hypothetical model of typological transformation is proposed in Figure 16. In this model, the various tool types are viewed as points or stages along a trajectory of continued reduction, rather than as discrete or separate types as in a segmented and discontinuous scheme. The transformational process is described to begin with a pebble selected for tool manufacture. The first knapping always targets either the end, side or corner of the pebble, creating an end chopper, oblique-edged chopper or a pointed chopper. In the analyses presented above, these tool types all exhibit only light reduction. During the process of use, any of them can be discarded at any time when reaching an edge angle threshold of around 60 degrees or greater. Only some of the items are chosen for further modification and reuse. This further transforms them into different tool types through more extensive reduction. Specifically, the process might have resulted in transforming any tool type into a two-edged chopper or a side chopper, depending on whether a single side was reused or new edges were added around the perimeter of the pebble. Likewise, side and two-edged choppers might then be further reduced and reshaprened into quarter-pebble choppers, double-ended choppers, three-edged choppers and horse-hoof choppers as more edges are added and continue to be resharpened, resulting in types with the highest reduction intensity overall. In each scheme maintenance and reuse play a potentially important role in the typological transformational process.

Figure 17 illustrates the model above considering three possible reduction pathways as follows:

Sequence 1: raw material → end chopper → quarter-pebble chopper/double-end chopper → three-edge chopper → horse-hoof chopper.

Sequence 2: raw material → pointed chopper → three-edge chopper/end chopper/double-end chopper → horse-hoof chopper/quarter-pebble chopper.

Sequence 3: raw material → oblique-edge chopper → two-edge chopper → side chopper → quarter-pebble chopper.

Figure 17 illustrates not only the typological transformation among tool groups with different degree of reduction, but also within a single tool group with the same reduction intensity, for instance, from quarter-pebble chopper to three-edge chopper and subsequently to horse-hoof chopper or from double-ended chopper to three-edged chopper in the sequence 1; from pointed chopper to end chopper in the sequence 2; and from two-edged chopper to side chopper in the sequence 3.

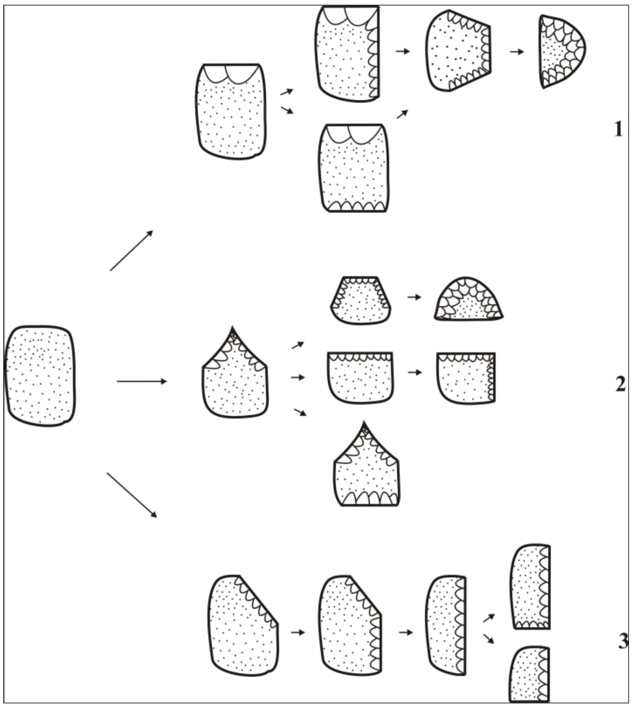



*Figure 17: Illustration of proposed model of typological transformations at Pa Muoi site.*

The model suggests that typological transformations occur as reduction expands from one working edge to another, and that the more extensively worked tools are the more frequently they are seen with more than one working edge. Thus, different tool types evidently do not reflect the functional and economic nature of the tools, but may still serve the purposes of communication and general description of variability of lithic artifacts in the scale of intra-site, inter-sites or inter-regions.

## CONCLUDING REMARKS

The paper has analysed and presented evidence for typological transformations among Late Paleolithic core tools using the data excavated from Pa Muoi site of Vietnam. It has been demonstrated that the transformational process takes place from lightly reduced tool types to more heavily worked ones as a result of increasing reduction intensity resulting from behavioural processes of tool manufacture, use, maintenance and discard. As a start, the first knapping is applied on one end, side or corner of a pebble to produce early-stage choppers such as end choppers, pointed choppers and oblique-edged chopper. As the process of use and maintenance continues, edges on side choppers are further reduced, or new edges are added, producing a diverse array of types at middle and late stage of reduction.

The paper is the first attempt to examine the effects of reduction intensity on typological variation in the Sonvi Industry of Late Palaeolithic Vietnam. Having demonstrated a reduction sequence for choppers, other factors such as environmental, economic and social factors should be paid more attention in the future in an attempt to explain and interpret the morphological variability of stone artefacts at an intra-site, inter-site and inter-regional scale, as well as reconstruct the organization of lithic technology over space and through time.

## ACKNOWLEDGEMENTS

This paper is based on the results of data collected by DN in 2008-2009 following excavations at Son La hydro-electric power plant conducted by the Vietnamese Institute of Archaeology. DN would also like to extend his sincere thanks to the Endeavour Foundation for granting a post-doctoral scholarship at the University of Queensland in 2012 to undertake this research.

## BIBLIOGRAPHY

Andrefsky, W. (1994). Raw-Material Availability and the Organization of Technology. *American Antiquity, 59*(1), 21-34.

Barton, C. M. (1990). Beyond Style and Function: A View from the Middle Paleolithic. *American Anthropologist, 92*(1), 57-72.

Barton, C. M. (1991). Retouched tools: Fact or Fiction?. Paradigms for interpreting Paleolithic chipped stone. In G. Clark (Ed.), *Perspectives on the past*, 143-163. Philadelphia: University of Pennsylvania Press.

Baumler, M. F. (1987). *Core Reduction Sequences: An Analysis of Blank Production in the Middle Paleolithic of Northern Bosnia (Yugoslavia).* Unpublished Ph.D, The University of Arizona.

Clarkson, C. (2002). Holocene Scraper Reduction, Technological Organization and Land Use at Ingaladdi Rockshelter, Northern Australia. *Archaeology in Oceania, 37*(2), 79-86.

Clarkson, C. (2005). Tenuous Types: 'Scraper' Reduction Continuums in Wardaman Country, Northern Australia. In C. Clarkson & L. Lamb (Eds.), *Rocking the Boat: New Approaches to Stone Artefact Reduction, Use and Classification in Australia*: British Archaeological Reports International Monograph Series. Oxford: Archaeopress.

Clarkson, C. (2013). Measuring core reduction using 3D flake scar density: a test case of changing core reduction at

Klasies River Mouth, South Africa. *journal of Archaeological Science, 40*, 4348-4357.

Close, A. E. (1991). On the Validity of Middle Paleolithic Tool Types: A Test Case from the Eastern Sahara. *Journal of Field Archaeology, 18*, 256-264.

Connell, K. and C. Clarkson 2011 Scraper reduction continuums and efficient tool use: A functional analysis of scrapers at different stages of reduction. Marwick, B and A. Mackay (eds) *Keeping your Edge: Recent Approaches to the Organisation of Stone Artefact Technology*. Pp.45-56. British Archaeological Reports S2273. Oxford: Archaeopress.

De Terra, H., & Patterson, T. T. (1939). Studies on the Ice Age in India and Associated Human Cultures. Washington, D. C. The Carnegie Institution of Washington.

Dibble, H. L. (1984). Interpreting Typological Variation of Middle Paleolithic: Functions, Style, or Sequence of Reduction? *Journal of Field Archaeology, 11*(4), 431-436.

Dibble, H. L. (1987a). The Interpretation of Middle Paleolithic Scraper Morphology. *American Antiquity, 52*(1), 109-117.

Dibble, H. L. (1987b). Reduction Sequences in the Manufacture of Mousterian Implements of France. In O. Soffer (Ed.), *The Pleistocene Old World: Regional Perspectives*, 33-45. New York: Plenum.

Dibble, H. L. (1988). Typological Aspects of Reduction and Intensity of Utilization of Lithic Resources in the French Mousterian. In H. Dibble & A. Montet-White (Eds.), *Upper Pleistocene Prehistory of Western Eurasia, 1,* 181-197. Philadelphia: University Museum Monograph 54, University Museum Symposium Series.

Dibble, H. L. (1995). Middle Paleolithic Scraper Reduction: Background, Clarification, and Review of the Evidence To Date. *Journal of Archaeological Method and Theory, 2*(4), 299-368.

Dong, N. T. (2006). Transecting the Bai Ben site by the reduction model. *Journal of Archaeology 3*, 64-81. (In Vietnamese).

Dong, N. T. (2007). *A Technological Analysis at a Neolithic Lithic Workshop at Bai Ben, Vietnam*. PhD Thesis. The University of Queensland, Brisbane.

Dong, N. T. (2008). Transecting the Bai Ben site - Model and testing model. *Journal of Archaeology 2*, 72-86. (In Vietnamese).

Dong, N. T. (2009). *Preliminary report on the excavation result of the Pa Muoi site*. Institute of Archaeology, Hanoi. (In Vietnamese).

Gordon, D. (1993). Mousterian Tool Selection, Reduction, and Discard at Ghar, Israel. *Journal of Field Archaeology, 20*(2), 205-218.

Hiscock, P. (1994). The End of Points. In M. Sullivan, S. Brockwell & A. Webb (Eds.), *Archaeology in the North*, 72-83). North Australia Research Unit: Australian National University.

Hiscock, P. (1996). Transformations of Upper Palaeolithic Implements in the Dabba industry from Haua Fteah (Libya). *Antiquity, 70*, 657-684.

Hiscock, P. (2006). Blunt and to the Point: Changing Technological Strategies in Holocene Australia. In I. Lilley (Ed.), *Archaeology in Oceania: Australia and the Pacific Islands*, 69-95). Blackwell.

Hiscock, P., & Attenbrow, V. (2005). Reduction Continuums and Tool Use. In C. Clarkson & L. Lamb (Eds.), *Lithics 'Down Under': Recent Australian Approaches to Lithic Reduction, Use and Classification*, 43-55. Oxford: Archeopress.

Holdaway, S., McPherron, S., & Roth, B. (1996). Notched Tool Reuse and Raw Material Availability in French Middle Paleolithic Sites. *American Antiquity, 61*(2), 377-387.

Kuhn, S. L. (1992). Blank Form and Reduction as Determinants of Mousterian Scraper Morphology. *American Antiquity, 57*(1), 115-128.

Kuhn, S. L. (1995). *Mousterian Lithic Technology: an Ecological Perspective.* Princeton: Princeton University Press.

Marwick, B. (2008a). Beyond Typologies: The Reduction Thesis and Its Implications for Lithic Assemblages in Southeast Asia. *Bulletin of the Indo-Pacific Prehistory Association*, 28, 108-116.

Marwick, B. (2008b). Stone Artefacts and Human Ecology at Two Rockshelters in Northwest Thailand. Australian National University. PhD thesis, Canberra.

McPherron, S. P. (1994). *A Reduction Model for Variability in Acheulian Biface Morphology.* Ph.D Thesis, University of Pennsylvania.

McPherron, S. P. (1995). A Re-examination of the British Biface Data. *Lithics, 16*, 47-63.

Morrow, J. E. (1995). Clovis Projectile Point Manufacture: A Perspective from the Ready/Lincoln Hills Site, 11JY46, Jersey County, Illinois. *Midcontinental Journal of Archaeology, 20*(2).

Morrow, J. E. (1996). *The Organization of Early Paleoindian Lithic Technology in the Confluence Region of the Mississippi, Illinois, and Missouri Rivers.* Ph.D Dissertation, University of Washington.

Morrow, J. E. (1997). End Scraper Morphology and Use-Life: An Approach for Studying Paleoindian Lithic Technology and Mobility. *Lithic Technology, 22*, 70-85.

Morrow, J. E., & Morrow, T. A. (2002). Exploring the Clovis-Gainey-Folsom Continuum: Technological and Morphological Variation in Midwestern Fluted Points. *Lithic Technology, 2*, 141-157.

Movius, H. L. (1944). Early Man and Pleistocene Stratigraphy in Southern and Eastern Asia. Cambridge, Massachusettes, U.S.A.: Museum.

Neeley, M. P., & Barton, C. M. (1994). A New Approach to Interpreting Late Pleistocene Microlith Industries in Southwest Asia. *Antiquity, 68*, 275-288.

Roddam, W. (1997). *Like, --But Oh How Different: Stone Point Variability in the tip End, Northern Territory*. Darwin: Northern Territory University.

Shipton, C., & Clarkson, C. (2015). Flake scar density and handaxe reduction intensity. *journal of Archaeological Science, Reports 2*, 169-175.

Shott, M. J. (1989). Technological Organization in Great Lakes Paleoindian Assemblages. In C. J. Ellis & J. C. Lothrop (Eds.), *Eastern Paleoindian Lithic Resource Use*, 221-237. Westview Press.

Tan, H. V. (1998). *Vietnamese Archaeology. Volume I: The Stone Age of Vietnam*. Publishing House of Social Sciences, Hanoi. (In Vietnamese).

Tan, H. V., Su, N. K., & Chung, T. N. (1999). *The culture of Son Vi*. Publishing House of Social Sciences, Hanoi. (In Vietnamese).