Late Pleistocene stone artefact technology at Mau A, Yen Bai, Norther Vietnam

Quinn Habedank1,✉, and Ben Marwick2

11 February, 2022

Text of abstract

1 University of One Place  
2 University of Another Place

✉ Correspondence: [Quinn Habedank <[fl@oneoeurhg.edu](mailto:fl@oneoeurhg.edu)>](mailto:fl@oneoeurhg.edu)

Keywords: keyword 1; keyword 2; keyword 3

Highlights: These are the highlights.

# 1 Abstract

Flaked stone artefacts from Southeast Asia typically lack visually distinctive and strongly patterned forms, which can make them challenging to analyze and interpret. As a result, many of the cultural dynamics of Pleistocene hunter-gatherers of this region are poorly understood. We use 2D shape data to hypothesize a relationship between unretouched flake shape and assemblage reduction intensity at Mau A, an early Holocene archaeological site in northern Vietnam. We apply a Principal Components Analysis to the flake outlines to investigate shape variation throughout the reduction sequence (measured by dorsal cortex coverage). We find that flake shape varies by reduction stage, primarily through differences in flake length and width. Our results suggest that flake shape is sensitive to assemblage reduction intensity, and may give useful comparative insights when other attributes show little variation. These results are important for understanding stone artefact assemblages from Southeast Asia which often yield little variation when analysed with traditional approaches.

## 1.1 Introduction

* Stone tools from South East Asia tend to lack distinctive typological categories (Mijares 2008; Borel et al. 2013; Borel et al. 2017)
* The purpose of this study was to examine the relationship between flake shape and reduction intensity
* Approach used in the paper is a response to the lack of traditional typological categories in South East Asia

Here is a citation (Marwick, 2017)

## 1.2 Excavations at Mau A

Mau A is an open air archaeological site located on the banks above 5 m above the Red River in Yen Bai Province, Northern Vietnam, at the confluence of a small stream entering the river. Excavations were conducted in 2015 by a collaboration including researchers from the University of Washington, the Yen Bai Provincial Museum, the Institute of Archaeology in Hanoi, and the Vietnam National University - Social Sciences and Humanities University. An area of 2 x 2 m was excavated in 13 units of ten centimeters deep, through dense silty clay deposits to a depth of about 1.3 m below the surface. Subtle changes in stratigraphy indicated a slightly sloping deposit with four layers, consistent with reports of excavations in this location in the 1980s. A small amount of plastic and modern ceramics were found in the uppermost 0.1 m of deposit. The most striking feature identified during our excavations was the third layer, which is distinctive as very dense layer of flaked stone artefacts at about 0.6-1.1 m below the surface. No other features were identified during excavation.

This dense lithic layer contained the majority of stone artefacts recovered from the site. The chaîne opératoire of Mau A lithic technology is composed of unifacial shaping on long cobbles to produce sumatraloids (sumatralith-like pieces). The chaîne opératoire also involved the shaping of thick ovoid cobbles for the production of choppers or chopping-tools and half-cobbles (longitudinally split) that are shaped into tools with transverse cutting edges. Flake scar surfaces and edges are fresh and unweathered, indicating *in situ* production and limited post-depositional movement. While previous work has claimed the Mau A assemblage is Son Vian (a precurser to Hoabinhian technology, characterised by unifacial flaking of blocky, cubic cobbles)

Four radiocarbon ages were obtained from isolated charcoal fragments in the deposit. The charcoal was sampled to bracket the upper and lower boundaries of the dense lithic layer. The ages indicate a rapid accumulation process for this layer at the terminal Pleistocene.

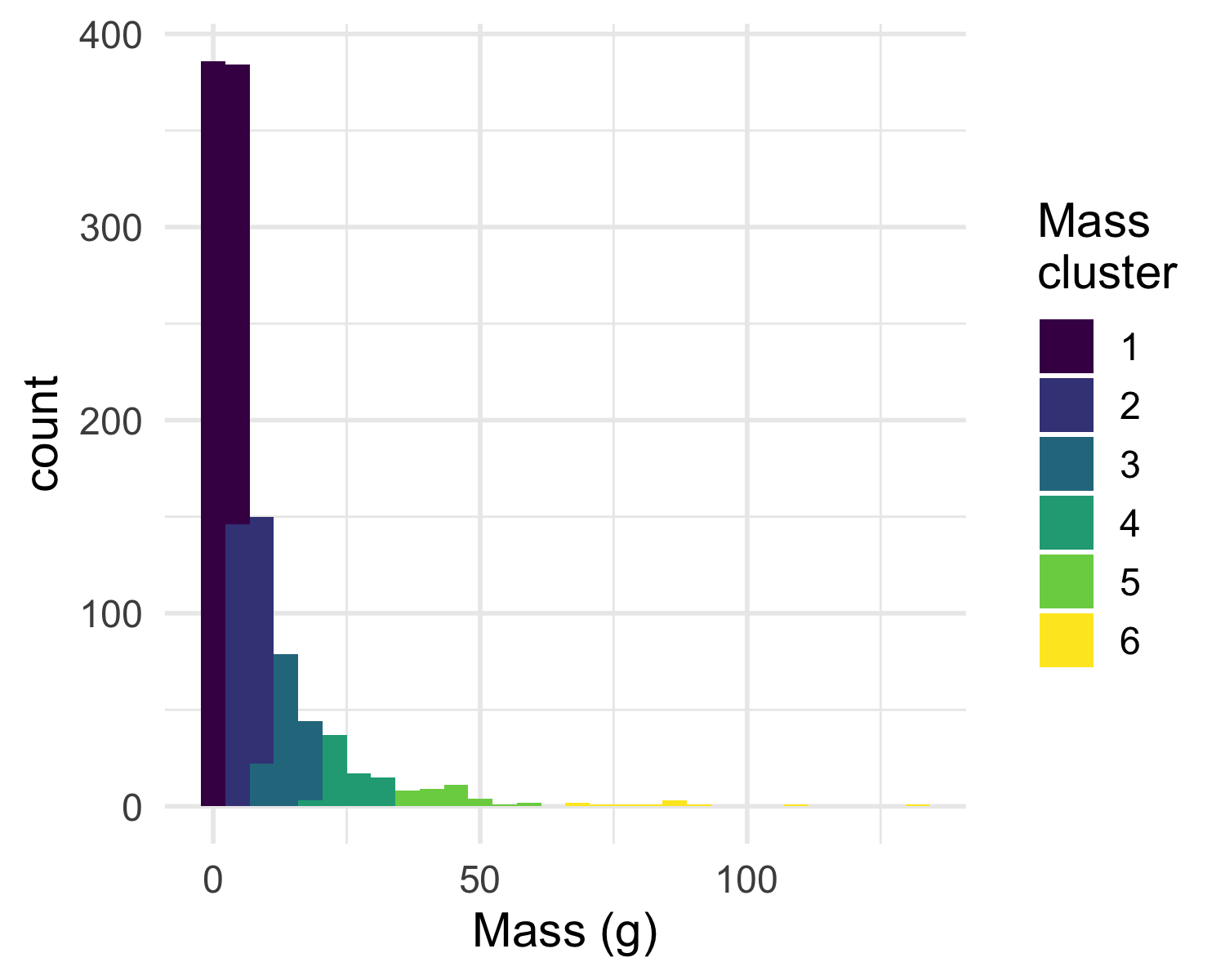
## 1.3 Methods

We initially recorded conventional linear dimension measurements, such as max dimension length and width at various points along the max dimension length, from all flakes recovered from the excavation. Then we converted these linear dimensions into landmarks points to represent the size and shape of each artefact. The specific linear measurements used to create the 2D landmarks were the top horizontal measurement, the max dimension length, width at a quarter of the maximum length, width at half of the maximum length, and width at three quarters of the maximum length.

The outlines formed by the shape landmarks were then normalized for size, orientation, and rotation. We used Generalized Procrustes analysis to strip the flakes in the sample dataset of size, orientation, and rotation, leaving only shape data. Our methodology for carrying out the PCA on the shape landmarks was inspired by Theska et al. (2020), which also performed 2D landmark data analysis using PCA. Finally, the shape landmark values were analysed by Principal Components Analysis. PCA biplots were created to visualize differences based upon secondary categorical variables, namely flake reduction categories, excavation unit, and mass cluster. The first two primary components were then used to create biplots comparing the shape data to the flake reduction categories, excavation unit, and mass clusters, with the secondary variables being represented by colored outlines on the biplots.

Reduction categories were based upon dorsal cortex percentages were discretized based upon standard cut points. Flakes with no dorsal cortex were categorized as tertiary flakes, those with up to a dorsal cortex percentage of 50% were considered secondary and those with a dorsal cortex value greater than 50% were considered primary (Bradbury & Carr 1995). Mass clusters were generated using univariate k-means, with the end result being 6 mass clusters, with mass cluster 1 having the least mass on average and 6 having the greatest mass on average.

## 1.4 Results



# 2 Discussion

# 3 Conclusion

# 4 Acknowledgements

## 4.1 References

Borel, Antony, Richard Cornette, and Michel Baylac. 2017. “Stone Tool Forms and Functions: A Morphometric Analysis of Modern Humans’ Stone Tools From Song Terus Cave (Java, Indonesia).” Archaeometry 59 (3): 455–71. <https://doi.org/10.1111/arcm.12264>.

Borel, Antony, Claire Gaillard, Marie-Hélène Moncel, Robert Sala, Emmanuelle Pouydebat, Truman Simanjuntak, and François Sémah. 2013. “How to Interpret Informal Flakes Assemblages? Integrating Morphological Description, Usewear and Morphometric Analysis Gave Better Understanding of the Behaviors of Anatomically Modern Human from Song Terus (Indonesia).” Journal of Anthropological Archaeology 32 (4): 630–46. <https://doi.org/10.1016/j.jaa.2013.03.002>.

Bradbury, Andrew P., and Philip J. Carr. “Flake Typologies and Alternative Approaches: An Experimental Assessment.” Lithic Technology 20, no. 2 (1995): 100-15. Accessed June 11, 2021. <http://www.jstor.org/stable/23273168>.

Mijares, A. 2008. “The late pleistocene to early holocene foragers of northern Luzon.” Bulletin of the Indo-Pacific Prehistory Association 28: 99-107.

Theska, T., Sieriebriennikov, B., Wighard, S. S., Werner, M. S., & Sommer, R. J. (2020). Geometric morphometrics of microscopic animals as exemplified by model nematodes. Nature Protocols, 15(8), 2611–2644. <https://doi.org/10.1038/s41596-020-0347-z>

Marwick, B., 2017. Computational reproducibility in archaeological research: Basic principles and a case study of their implementation. Journal of Archaeological Method and Theory 24, 424–450. <https://doi.org/10.1007/s10816-015-9272-9>

### 4.1.1 Colophon

This report was generated on 2022-02-11 12:26:16 using the following computational environment and dependencies:

#> ─ Session info ───────────────────────────────────────────────────────────────  
#> setting value  
#> version R version 4.1.2 (2021-11-01)  
#> os macOS Catalina 10.15.7  
#> system x86\_64, darwin17.0  
#> ui X11  
#> language (EN)  
#> collate en\_US.UTF-8  
#> ctype en\_US.UTF-8  
#> tz America/Los\_Angeles  
#> date 2022-02-11  
#> pandoc 2.14.0.3 @ /Applications/RStudio.app/Contents/MacOS/pandoc/ (via rmarkdown)  
#>   
#> ─ Packages ───────────────────────────────────────────────────────────────────  
#> package \* version date (UTC) lib source  
#> assertthat 0.2.1 2019-03-21 [1] CRAN (R 4.1.0)  
#> backports 1.4.1 2021-12-13 [1] CRAN (R 4.1.0)  
#> bit 4.0.4 2020-08-04 [1] CRAN (R 4.1.0)  
#> bit64 4.0.5 2020-08-30 [1] CRAN (R 4.1.0)  
#> bookdown 0.24 2021-09-02 [1] CRAN (R 4.1.0)  
#> brio 1.1.3 2021-11-30 [1] CRAN (R 4.1.0)  
#> broom 0.7.12 2022-01-28 [1] CRAN (R 4.1.2)  
#> cachem 1.0.6 2021-08-19 [1] CRAN (R 4.1.0)  
#> callr 3.7.0 2021-04-20 [1] CRAN (R 4.1.0)  
#> cellranger 1.1.0 2016-07-27 [1] CRAN (R 4.1.0)  
#> Ckmeans.1d.dp \* 4.3.4 2022-01-31 [1] CRAN (R 4.1.2)  
#> cli 3.1.1 2022-01-20 [1] CRAN (R 4.1.2)  
#> colorspace 2.0-2 2021-06-24 [1] CRAN (R 4.1.0)  
#> crayon 1.4.2 2021-10-29 [1] CRAN (R 4.1.0)  
#> DBI 1.1.2 2021-12-20 [1] CRAN (R 4.1.0)  
#> dbplyr 2.1.1 2021-04-06 [1] CRAN (R 4.1.0)  
#> desc 1.4.0 2021-09-28 [1] CRAN (R 4.1.0)  
#> devtools 2.4.3 2021-11-30 [1] CRAN (R 4.1.0)  
#> digest 0.6.29 2021-12-01 [1] CRAN (R 4.1.0)  
#> dplyr \* 1.0.7 2021-06-18 [1] CRAN (R 4.1.0)  
#> ellipsis 0.3.2 2021-04-29 [1] CRAN (R 4.1.0)  
#> evaluate 0.14 2019-05-28 [1] CRAN (R 4.1.0)  
#> fansi 1.0.2 2022-01-14 [1] CRAN (R 4.1.2)  
#> farver 2.1.0 2021-02-28 [1] CRAN (R 4.1.0)  
#> fastmap 1.1.0 2021-01-25 [1] CRAN (R 4.1.0)  
#> forcats \* 0.5.1 2021-01-27 [1] CRAN (R 4.1.0)  
#> fs 1.5.2 2021-12-08 [1] CRAN (R 4.1.0)  
#> generics 0.1.2 2022-01-31 [1] CRAN (R 4.1.2)  
#> ggplot2 \* 3.3.5 2021-06-25 [1] CRAN (R 4.1.0)  
#> glue 1.6.1 2022-01-22 [1] CRAN (R 4.1.2)  
#> gtable 0.3.0 2019-03-25 [1] CRAN (R 4.1.0)  
#> haven 2.4.3 2021-08-04 [1] CRAN (R 4.1.0)  
#> here 1.0.1 2020-12-13 [1] CRAN (R 4.1.0)  
#> highr 0.9 2021-04-16 [1] CRAN (R 4.1.0)  
#> hms 1.1.1 2021-09-26 [1] CRAN (R 4.1.0)  
#> htmltools 0.5.2 2021-08-25 [1] CRAN (R 4.1.0)  
#> httr 1.4.2 2020-07-20 [1] CRAN (R 4.1.0)  
#> jsonlite 1.7.3 2022-01-17 [1] CRAN (R 4.1.2)  
#> knitr 1.37.4 2022-01-29 [1] https://yihui.r-universe.dev (R 4.1.2)  
#> labeling 0.4.2 2020-10-20 [1] CRAN (R 4.1.0)  
#> lifecycle 1.0.1 2021-09-24 [1] CRAN (R 4.1.0)  
#> lubridate 1.8.0 2021-10-07 [1] CRAN (R 4.1.0)  
#> magrittr 2.0.2 2022-01-26 [1] CRAN (R 4.1.2)  
#> memoise 2.0.1 2021-11-26 [1] CRAN (R 4.1.0)  
#> modelr 0.1.8 2020-05-19 [1] CRAN (R 4.1.0)  
#> munsell 0.5.0 2018-06-12 [1] CRAN (R 4.1.0)  
#> pillar 1.7.0 2022-02-01 [1] CRAN (R 4.1.2)  
#> pkgbuild 1.3.1 2021-12-20 [1] CRAN (R 4.1.0)  
#> pkgconfig 2.0.3 2019-09-22 [1] CRAN (R 4.1.0)  
#> pkgload 1.2.4 2021-11-30 [1] CRAN (R 4.1.0)  
#> prettyunits 1.1.1 2020-01-24 [1] CRAN (R 4.1.0)  
#> processx 3.5.2 2021-04-30 [1] CRAN (R 4.1.0)  
#> ps 1.6.0 2021-02-28 [1] CRAN (R 4.1.0)  
#> purrr \* 0.3.4 2020-04-17 [1] CRAN (R 4.1.0)  
#> R6 2.5.1 2021-08-19 [1] CRAN (R 4.1.0)  
#> rbibutils 2.2.7 2021-12-07 [1] CRAN (R 4.1.0)  
#> Rcpp 1.0.8 2022-01-13 [1] CRAN (R 4.1.2)  
#> Rdpack 2.1.3 2021-12-08 [1] CRAN (R 4.1.0)  
#> readr \* 2.1.2 2022-01-30 [1] CRAN (R 4.1.2)  
#> readxl 1.3.1 2019-03-13 [1] CRAN (R 4.1.0)  
#> remotes 2.4.2 2021-11-30 [1] CRAN (R 4.1.0)  
#> reprex 2.0.1 2021-08-05 [1] CRAN (R 4.1.0)  
#> rlang 1.0.1 2022-02-03 [1] CRAN (R 4.1.2)  
#> rmarkdown 2.11 2021-09-14 [1] CRAN (R 4.1.2)  
#> rprojroot 2.0.2 2020-11-15 [1] CRAN (R 4.1.0)  
#> rstudioapi 0.13 2020-11-12 [1] CRAN (R 4.1.0)  
#> rvest 1.0.2 2021-10-16 [1] CRAN (R 4.1.0)  
#> scales 1.1.1 2020-05-11 [1] CRAN (R 4.1.0)  
#> sessioninfo 1.2.2 2021-12-06 [1] CRAN (R 4.1.0)  
#> stringi 1.7.6 2021-11-29 [1] CRAN (R 4.1.0)  
#> stringr \* 1.4.0 2019-02-10 [1] CRAN (R 4.1.0)  
#> testthat 3.1.2 2022-01-20 [1] CRAN (R 4.1.2)  
#> tibble \* 3.1.6 2021-11-07 [1] CRAN (R 4.1.0)  
#> tidyr \* 1.2.0 2022-02-01 [1] CRAN (R 4.1.2)  
#> tidyselect 1.1.1 2021-04-30 [1] CRAN (R 4.1.0)  
#> tidyverse \* 1.3.1 2021-04-15 [1] CRAN (R 4.1.0)  
#> tzdb 0.2.0 2021-10-27 [1] CRAN (R 4.1.0)  
#> usethis 2.1.5 2021-12-09 [1] CRAN (R 4.1.0)  
#> utf8 1.2.2 2021-07-24 [1] CRAN (R 4.1.0)  
#> vctrs 0.3.8 2021-04-29 [1] CRAN (R 4.1.0)  
#> viridisLite 0.4.0 2021-04-13 [1] CRAN (R 4.1.0)  
#> vroom 1.5.7 2021-11-30 [1] CRAN (R 4.1.0)  
#> withr 2.4.3 2021-11-30 [1] CRAN (R 4.1.0)  
#> xfun 0.29 2021-12-14 [1] CRAN (R 4.1.0)  
#> xml2 1.3.3 2021-11-30 [1] CRAN (R 4.1.0)  
#> yaml 2.2.2 2022-01-25 [1] CRAN (R 4.1.2)  
#>   
#> [1] /Library/Frameworks/R.framework/Versions/4.1/Resources/library  
#>   
#> ──────────────────────────────────────────────────────────────────────────────

The current Git commit details are:

#> Local: master /Users/bmarwick/Desktop/maualithicspaper  
#> Remote: master @ origin (https://github.com/benmarwick/maualithicspaper)  
#> Head: [cf27ca8] 2022-02-11: add in code block that does the univariate k-means