

Foodways in early farming societies: microwear and starch grain analysis on experimental and archaeological grinding tools from Central China ${\rm Li,\,W.}$

Citation

Li, W. (2020, August 26). Foodways in early farming societies: microwear and starch grain analysis on experimental and archaeological grinding tools from Central China. Retrieved from https://hdl.handle.net/1887/135949

Version: Publisher's Version

License: License agreement concerning inclusion of doctoral thesis in the

Institutional Repository of the University of Leiden

Downloaded from: https://hdl.handle.net/1887/135949

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle http://hdl.handle.net/1887/135949 holds various files of this Leiden University dissertation.

Author: Li, W.

Title: Foodways in early farming societies: microwear and starch grain analysis on experimental and archaeological grinding tools from Central China

Issue Date: 2020-08-26

Foodways in Early Farming Societies:

Microwear and Starch Grain Analysis on Experimental and Archaeological Grinding Tools from Central China

Weiya Li

Faculty of Archaeology, Leiden University

Foodways in Early Farming Societies:

Microwear and Starch Grain Analysis on Experimental and Archaeological Grinding Tools from Central China

Proefschrift

ter verkrijging van

de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op woensdag 26 augustus 2020
klokke 10.00 uur

door

Weiya Li Geboren te Tongcheng, Provincie Anhui, China in 1990

Promotor:

Prof. dr. A.L. van Gijn (Universiteit Leiden)

Co-promotores:

Dr. C. Tsoraki (University of Leicester)

Dr. J.R. Pagán-Jiménez (Universiteit Leiden)

Promotiecommissie:

Prof. dr. M. van Kolfschoten (Universiteit Leiden)

Prof. dr. R.T.J. Cappers (Rijksuniversiteit Groningen)

Prof. dr. L. Liu (Stanford University)

Dr. H. Barton (University of Leicester)

This research has been made possible through the China Scholarship Council (CSC)-Leiden University joint scholarship (no. 201506340037, awarded to Weiya Li), Leiden University Fund (Mr. J.J. van Walsem Fonds, no. W19002-6-95, awarded to Weiya Li), and support from the Laboratory for Material Culture Studies at Leiden University.

Front cover: a pair of Neolithic grinding tools unearthed at the site of Jiahu, China © Weiya Li.

Acknowledgements

My deep gratitude goes first to Prof. dr. Annelou van Gijn. The communication between Annelou and I began in 2015 when I decided to apply for the joint scholarship between Leiden University and the Chinese Scholarship Council (CSC). After reading my proposal, she agreed to be my promotor and has supported me since then. As the head of the research group, she organized regular research meetings and family parties, which not only brought different people and ideas together, but also gave me a sense of belonging in Leiden. Without her trust, encouraging words, and professional guidance, my research could not have been done so smoothly.

Dr. Christina Tsoraki acted as my 'day-to-day' supervisor for nearly two years at Leiden University. She taught me how to conduct use-wear analysis step by step. Thanks to her guidance during numerous meetings and working sessions, I have developed skills in scientific research and learned the importance of being more critical, which is a vital skill for an independent scientist. After Christina got a new position and moved to the University of Leicester, she did not give up her supervision on me. I understand that means she had to sacrifice her spare time to work on my chapters and papers, which I will always appreciate.

Dr. Jaime Pagan-Jimenez is a leading researcher in starch grain analysis, which he guided me on. He recommended that I should adopt the concept of 'foodways', which enabled me to analyse and combine my research data more coherently. He also inspired me to conduct experiments to explore ancient food processing techniques, which were further developed into a paper in this dissertation.

Dr. Michael Field also played a role in my supervising team, especially during the first two years. Through many talks with him, I have learned that there should be something else in life apart from doing a PhD. During the botanic excursions that he led, I was amazed by his knowledge and passion for plants and would like to learn more from him in the future if possible.

My gratitude also goes to Prof. dr. Corrie Bakels, who has been willing to read and comment on my papers.

At Leiden University, a lot of help was also offered by people from the Laboratory for Material Culture Studies and the Laboratory for Archaeobotanical studies. They are Eric Mulder, Loe Jacobs, Annemieke Verbaas, and Erica van Hees. I also thank other staff members in the Faculty of Archaeology for their valuable advice during the annual PhD events, including Prof. dr. Ann Byrsbaert, Prof. dr. Marie Soressi, Prof. dr. Miguel John Versluys, Dr. Amanda Henry, Dr. Andrew Sorensen, Dr. Geeske Langejans, Dr. Victor Klinkenberg, Dr. Roswitha Manning, Dr. Andrzej Antczak, and Dr. Noa Corcoran-Tadd. The people who shared the office with me

included Dr. Ben Chan, Alex Brandsen, Kinga Winnicka, Marie Kolbenstetter, Paul Kozowyk, Valerio Gentile, and Wouter Verschoof, who are all outstanding archaeologists and have inspired me daily. My thanks also go to the many other PhD fellows and friends in the faculty, for creating such a friendly research environment, including Dr. Tom Breukel, Dr. Joseph Sony Jean, Andy Ciofalo, Catarina Guzzo Falci, Dr. Daniel Turner, Katarina Jacobson, Matilda Siebrecht, Martina Revello Lami, Natalia Donner, Riia Timonen, Simone Casale, Yannick Boswinkel and many more.

Outside Leiden, Prof. Juzhong Zhang and Prof. Yuzhang Yang from the University of Science and Technology of China helped me to obtain the study materials in China. Prof. Li Liu from Stanford University and Dr. Hsiao-chun Hung from Austrian National University inspired me to write my PhD proposal through their expertise in Chinese archaeology. Prof. Danny Rosenberg at University of Haifa, Dr. Tobias Richter at the University of Copenhagen, Dr. Emanuela Cristiani at Sapienza University of Rome, and many other scholars are thanked for sharing ideas during the conferences or giving suggestions for my future career development. I am also keen to thank the young Chinese archaeologists such as Dr. Chao Huang, Dr. Juan Wang, Dr. Jiajing Wang, Dr. Ling Yao, Dr. Wangli Lan, Dr. Wuhong Luo, Dr. Xiujia Huan, Dr. Zhijie Cheng, and Fang Fang, who were always supportive whenever I need their help.

A group of friends also brought me a lot of happy memories in Europe. They are David, Hongchan, Hao, Heidi, Jan, Jing, Montse, Vincent, Weijuan, Wangyang, Xiao, Xiangyu, and Yandi. Thank you all for sharing drinks, meals, or trips with me.

Finally, I want to specially thank my parents, sisters and other family members for their unconditional love and support all the time.

Contents

Illustrations	XII
Tables	XIV
Chapter 1 Introduction	1
1.1 The research region	
1.2 A brief introduction to Chinese archaeology and the Neolithic archaeology	
cultures in the research region	5
1.2.1 Development of Chinese archaeology	6
1.2.2 Neolithic Cultures in the Central Plain of China	6
Peiligang Culture (c. 7000-5000 BC)	6
Jiahu Culture (c. 7000-5500 BC)	7
Yangshao Culture (c. 5000-3000 BC)	8
Longshan Culture (c. 3000-2000 BC)	8
1.3 Overview of previous studies and research questions	9
1.4 Case studies	12
1.5 Methodological framework	14
1.5.1 A brief introduction to the analytical methods	14
1.5.2 Microwear analysis for the study of experimental and archaeologic	al grinding
tools	18
1.5.3 Starch grain analysis in this research	
1.6 Dissertation outline	21
References	23
Chapter 2 New insights into the grinding tools used by the earliest	farmers
in the central plain of China	
· ·	
2.1 Introduction	
2.2 Materials and methods	
2.3 Results	
2.4 Discussion	
2.5 Conclusion	
References	49
Chapter 3 Cereal processing technique inferred from use-wear ana	lysis at
the Neolithic site of Jiahu, Central China	53
3.1 Introduction	
3.2 Archaeological background of Jiahu	
3.3 Material and methods	
3.4 Results	
3.5 Discussion	
3.6 Conclusion	
References	

Chapter 4 The Influence of grinding on the preserva	ation of starch grains
from rice	71
4.1 Introduction	73
4.2 Materials and Methods	76
4.3 Results	77
4.3.1 Rice	77
4.3.2 Foxtail millet	78
4.3.3 Job's tears	80
4.3.4 Barley	80
4.4 Discussion	82
4.5 Conclusion	85
References	89
Chapter 5 Plant foods and different uses of grinding	g tools at the Neolithic
site of Tanghu in Central China	95
5.1 Introduction	97
5.2 The grinding tool assemblage from the site of Tangh	u98
5.3 Methods	100
5.4 Results	103
5.5 Discussions	107
5.6 Conclusion	108
References	110
Chapter 6 Foodways of the earliest farmers in the I	Huai River Basin, China
	115
6.1 Food procurement: plants, animals, and tools	115
6.1.1 Plants	
6.1.2 Animals	117
6.1.3 Tools used in food procurement	119
6.2 Food processing	124
6.2.1 Rice Processing	125
De-husking	125
Grinding	125
Fermenting	126
6.2.3 Acorn processing	127
6.2.4 Processing of underground storage organs (USO	s)127
6.2.5 Tools used for food processing	128
6.3 Storage of food	129
6.4 Cooking and serving	130
6.5 Consumption and human diet	
6.6 Discard and recycling of food remains	
6.7 Foodways at Jiahu: chronological trends	
6.8 Conclusion	
References	138
Chapter 7 Conclusion	143

7.1 Correlation between tool type and function	143
7.2 Choices of food processing techniques in the past	145
7.3 Rice processing in the early rice agricultural societies	146
7.4 Foodways in different Neolithic communities	147
7.5 Limitations and future directions	149
References	151
Appendix I Explanations of the variables used for describing microwear	
traces on grinding tools	. 155
1.1 Micro-striations	155
1.2 Micro-polish	155
References	
Appendix II Supporting data for Fig. 4.3b in Chapter 4	. 165
English Summary	. 177
Samenvatting	. 179
Curriculum vitae	. 181

Illustrations

Figure 1.1 The location of the sites attributed to the Jiahu and Peiligang Culture sites2
Figure 1.2 A grinding scene depictured in the chapel of a tomb during the Old Kingdom (2592-2120 BC) in Egypt4
Figure 1.3 Well-manufactured grinding slab and roller from the Neolithic site of Jiahu in the upper catchment of the Huai River10
Figure 1.4 Morphological features on the starch grains from potato (Solanum tuberosum L.)
Figure 1.5 Residues on an experimental grinding tool that was used to process cereals
Figure 2.1 The site of Jiahu in the central plain of China35
Figure 2.2 Grinding tools from the site of Jiahu with different morphologies37
Figure 2.3 Reference collection of use-wear associated with processing different kinds of materials41
Figure 2.4 Different types of use-wear distributed on the grinding tools from the
site of Jiahu42
Figure 2.5 Quantitative analysis of starch grains at the site of Jiahu44
Figure 2.6 Polish with a rough texture found on the edges of the grinding slab with
feet46
Figure 2.7 Starch grains discovered in the Jiahu grinding tool assemblage47
Figure 3.1 The site location of Jiahu and the previous archaeological findings57
Figure 3.2 Use-wear traces on experimental grinding stone tools under the magnification of 200x and 500x61
Figure 3.3 Soaked rice flour forms the "noodle shapes" during wet-grinding62
Figure 3.4 Use-wear traces associated with dry-grinding of cereals on Jiahu grinding tools under different magnifications
Figure 4.1 The archaeological sites mentioned in the text
Figure 4.2 Morphological changes of starch grains from rice after dry- and wet-
grinding
Figure 4.3 The size of starch grains from the unprocessed, dry-grinding (in red
colour) and wet-grinding samples
Figure S4.1 Morphological changes of starch grains from foxtail millet after dry- and wet-grinding86
Figure S4.2 Morphological changes of starch grains from Job's tears after dry- and wet-grinding
Figure S4.3 Morphological changes of starch grains from barley after dry- and wet-
grinding88

Figure 5.1 The location and archaeological findings at the site of Tanghu and th nearby sites10
Figure 5.2 Microwear traces and starch grains on the grinding tools from Tanghu
Figure 5.3 Microwear traces from the experimental grinding tools
Figure 6.3 Three different types of phytoliths from rice
Figure 6.6 Examples of the potteries from the site of Jiahu

Tables

Table 1.1 Chronology, dating, and some key findings in the Neolithic cultures
mentioned in this chapter9
Table 2.1 Overview of the artefacts and the processed material suggested by use-
wear traces38
Table 2.2 Ancient starch grains extracted from 9 of the studied Jiahu grinding tools
40
Table 4.1 Information on the grinding experiments75
Table 4.2 Characteristics of starch grains before and after grinding84
Table 5.1 Processed materials on the grinding tools inferred by microwear analysis
99
Table 5.2 Starch grains identified on the grinding tools at the site of Tanghu103
Table 6.1 Animal remains from fish, mammals, reptiles, birds, and shellfish during
different phases at the site of Jiahu117
Table 6.2 Percentage of NISP and MNI of pigs and deer among the total identified mammal remains from the site of Jiahu119
marifical remains from the site of stand