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Issues and directions in phytolith analysis

Thomas C. Hart

Anthropology Department, University of Texas at Austin, Austin, TX 78712, USA

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ABSTRACT

This special issue examines new trends in phytolith scholarship and assesses the future direction of this field of research. The papers presented represent a broader shift in phytolith research into a new phase called the “Period of Expanding Applications”. It is characterized by 1) a rapid increase in the number of phytolith publications; 2) a diversification of research topics; 3) a reassessment of the use of radiocarbon and other isotopes in phytoliths; 4) the development of digital technologies for refining and sharing phytolith identifications; 5) renewed efforts for standardization of phytolith nomenclature and laboratory protocol; and 6) the development of the field of applied phytolith research. This paper argues that interdisciplinary collaborations and a continued effort to understand the basics of phytolith production patterns are essential for the growth of the discipline and its application in archaeological studies.

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1. Introduction

Exploring how phytoliths are produced in plants, and what they can tell us about human activities in the past, has been the main focus of phytolith scholarship for more than 180 years. With the explosion of phytolith research across the globe starting around the year 2000, phytolith scholarship has entered a phase titled the “Period of Expanding Applications”. In this paper I review the historical trends in phytolith analysis leading up to and including this new era, discuss how the papers presented in this special edition fit into these trends, and offer some suggestions and cautionary notes about the direction of phytolith research in archaeology going forward.

2. History of phytolith research

The history of phytolith research is a tale of dueling interests. Since the discovery of phytoliths, researchers have alternated between the need to do botanical research and the application of phytoliths to environmental and anthropological research questions. The first phytolith publication, during what Piperno (1988, 2006, p. 2) terms the “Discovery and Exploratory Phase-1835–1895”, examined phytolith production in living plant tissues (Piperno, 1988, 2006; Struve, 1835). Scholars in Germany were quick to realize that phytoliths could be used in environmental

reconstructions (Ehrenberg, 1841, 1854; Piperno, 1988, 2006). From 1895 to 1936, during the “Botanical Phase of Research” (Piperno, 1988, 2006, p. 2), phytolith scholarship was centered on understanding comparative plant physiology and phytolith formation. The first archaeological applications occurred in the early twentieth century of this period (Netolitzky, 1900, 1914; Schellenberg, 1908). In the “Period of Ecological Research” from 1955 to 1975 soil scientists, ecologists, agronomists, and botanists continued to conduct botanical research but also conducted some of the first paleobotanical and paleoecological studies of ancient sediments (Piperno, 1988, 2006). The paper by Rovner (1971) is widely credited with bringing wider attention to the use of phytoliths for palaeoethnobotanical and archaeological research (Piperno, 1988, 2006).

In the “Modern Period of Archaeological and Paleoenvironmental Research” (1978–2000) phytolith scholarship really established itself as an independent, important area of archaeology (Piperno, 1988, 2006). This period saw the first major expansion of archaeological phytolith research across the globe with a large number of projects focusing on reconstructing past environments and uncovering the origins and intensification of agriculture (Pearsall, in press). The International Society of Phytolith Research, now known as the International Phytolith Society, was founded in 1996. At the biennial conferences phytolith experts focus on the finer points of phytolith method and theory (e.g., Madella et al., 2005). Phytolith papers now regularly appear in a wide variety of journals ranging from publications with broad audiences like *Science* to the specialist reports in *The Phytolitherian*.

E-mail address: Thomas.Hart@utexas.edu.<http://dx.doi.org/10.1016/j.jas.2016.03.001>

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3. The period of expanding applications, 2001 – present

Since the turn of the century, the coalition of a number of factors has been leading us into a new phase of phytolith scholarship which I have termed the “Period of Expanding Applications.” It is characterized by 1) a rapid increase in the number of phytolith publications; 2) a diversification of research topics; 3) a reassessment of the use of carbon 14 and other isotopes in phytoliths; 4) the development of digital technologies for refining and sharing phytolith identifications; 5) renewed efforts for standardization of phytolith nomenclature and laboratory protocol; and 6) the development of the field of applied phytolith research. The papers in this special edition represent current topics of interest in phytolith research and point the way to the future.

3.1. Increase in the number of phytolith publications

The first indication that we were entering a new period of phytolith research is the overall increase in number of phytolith publications since 1996. A basic English language search of the databases of the five major international publishing companies, Reed-Elsevier, Springer, Wiley-Blackwell, Taylor & Francis and Sage using the term “phytolith” in the publication title reveals an increase in the number of phytolith publications from around 1997 (Fig. 1).

The average number of phytolith publications published per year from 1971 to 1996 was 1.03 (std \pm 1.61). This increased dramatically between 1997 and 2015 (Fig. 1) to 13.58 (std \pm 8.71) publications per year. In addition, the average number of journals that published articles with the word “phytolith” in the title also increased from 0.88 (std \pm 1.34) per year before 1997 to 8.37 (std \pm 5.09) journals per year (Fig. 2).

These are likely to be conservative estimates because this search was limited to papers that only include the word “phytoliths” in the title of English language journals and does not reflect the diversity and growth of phytolith scholarship in other languages. This search

is also a conservative estimate because many papers involve phytolith research without explicitly stating so up front. While much of the increase in publications and journals can be attributed to the overall growth of the global economy and the development of new research facilities, it still represents a sizable change in the quantity of phytolith scholarship.

3.2. Diversification of research topics

The second indication that we are entering a new period of research is the expansion and diversification of research topics. New areas in which phytoliths have contributed to archaeological research include plant use by early *Homo sapiens* and other hominins; ritual and burial practices; study of agricultural fields and paleosols; measures of anthropogenic burning; identification of beverages and spices; hunter-gatherer food ways; and agricultural and herding food traditions; (Pearsall, 2015, pp. 266–267). While artifact and dental calculus analyses are not entirely new lines of research, there has been a substantial increase in the number of studies as well as a concentrated effort to refine methodological and taphonomic issues (García-Granero et al., 2016; Hart, 2011; Henry et al., 2011; Henry and Piperno, 2008; Raviele, 2010, 2011).

Scholars have expanded the pool of research topics that can be studied through phytolith analysis by examining phytolith production in previously untested, yet potentially important plant taxa. Prior to the Period of Expanding Research Applications, some of the most important comparative phytolith work focused on the origins and intensification of agriculture. This research was largely limited to the Lowland Neotropics (Piperno and Pearsall, 1998), Southwest Asia (Rosen, 1992) and, to a lesser extent, East Asia (Fujiwara, 1976, 1993), Southeast Asia (Wilson, 1985), and Africa (Alexandre et al., 1997). Research in the new millennium has refined some of these identifications such as bananas (Ball et al., 2006; Lentfer, 2009) and expanded to new crops such as *Setaria* and *Panicum* millets (Lu et al., 2009).

For this special issue many of the leading experts in the field

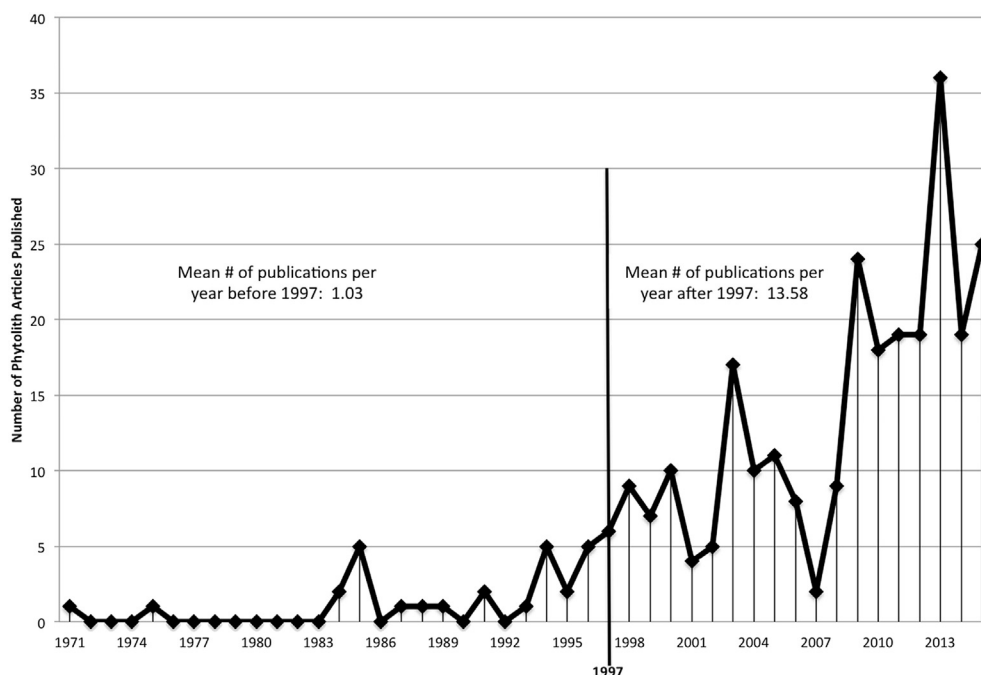


Fig. 1. Number of papers with the word “phytolith” in the title when searching Reed-Elsevier, Springer, Wiley-Blackwell, Taylor & Francis and Sage publication companies. Note the dramatic rise in the number of publications after 1997.

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