Available online at www.sciencedirect.com
ScienceDirect
Palaeogeography, Palaeoclimatology, Palaeoecology 246 (2007) 454–470
PALAEO
www.elsevier.com/locate/palaeo

Comparative study of modern phytolith assemblages from inter-tropical Africa

Doris Barboni *, Laurent Bremond [1], Raymonde Bonnefille

CEREGE, CNRS-UAMIII / UMR 6635, B.P. 80, F13545 Aix-en-Provence Cedex 04, France

Received 10 March 2006; received in revised form 8 September 2006; accepted 18 October 2006

Abstract

We present a synthesis of modern phytolith studies from Africa, to infer the potential and limitations of phytolith assemblages to reconstruct vegetation and tree cover density. The modern dataset includes 149 phytolith assemblages of surface soil samples from 10 phytogeographical zones and sub-zones from East and West Africa, as well as 500 m-resolution satellite estimates of the percent tree cover at the sampling sites. To test the potential of phytolith assemblages to discriminate vegetation types we used principal component analysis. For each phytogeographical zone and sub-zone, we also provided the mean values, standard errors, and 95% confidence intervals for the means obtained on the modern African dataset for the abundance of the 13 most common phytolith types preserved in soil samples, and for four phytolith indices.

Results from the modern African dataset show that 1) the relative abundances of 11 (out of 13) phytolith types allow discrimination of all vegetation zones but the Somalia–Masaï steppe region, which at elevation <600 m asl, exhibits a high proportion of rondel and trapeziform short cell phytoliths, like in the Afromontane region; 2) the co-occurrence of rondels and trapeziform polylobates characterises zones above 1900 m asl and/or current annual temperatures <19 °C; 3) the relative abundance of globular phytoliths (granulate, smooth, and echinate) is better correlated to 500 m-resolution satellite estimates of the tree cover ($R^2=0.60$ for $n=149$, and $R^2=0.57$ for $n=85$, $p<0.005$) than is the abundance of arboreal pollen ($R^2=0.42$, $p<0.005$, only for $n=85$). The tree cover, however, is largely under-estimated in the Afromontane zone, where globular phytoliths do not trace high-elevation forests.

Limitations in our interpretation do exist, but could be overcome in the future through additional studies along an elevation/temperature gradient in the Somalia–Masaï region of East Africa, and with more precise identifications of phytolith types and sub-types.

Keywords: Hominids; Palaeo-anthropological sites; Silica bodies; PCA; Tree density; MODIS; Africa

1. Introduction

In Africa, reconstructing past vegetation, especially past tree cover density at early hominid sites, is an important focus of palaeoenvironmental studies because theories on evolution often imply the influence of the environment on human evolution, especially the emergence of bipedalism in early hominids. For some sites, such as the *Ardipithecus ramidus* localities of Aramis, Kuseralee Dora, and Sagantole (White et al., 1994; Wolde Gabriel et al., 1994) in the Middle Awash Valley, Ethiopia, fossil pollen are poorly preserved, and fossilized wood does not show diagnostic anatomical

* Corresponding author. Fax: +33 4 42 97 15 40.
E-mail address: barboni@cerege.fr (D. Barboni).
[1] Present address: Center of Bio-Archaeology and Ecology (UMR5059 CNRS/USTL/EPHE), Institut de Botanique, Université Montpellier 2, 163 Rue Broussonet, F-34090 Montpellier, France.

0031-0182/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.palaeo.2006.10.012

features necessary for identification. Because of these limitations, phytolith studies were undertaken in an effort to clarify the environment inhabited by the hominids and other mammals from these localities. Being preserved in oxidizing environments, phytoliths (opal-A particles that precipitate in plant cells) may compensate for the lack of other plant remains, as shown by a preliminary phytolith study at Middle Awash (Barboni et al., 1999) and at other palaeoanthropological sites in East Africa (Albert et al., 2006). The field of phytolith studies still is in its infancy, and uncertainties regarding the interpretations of phytolith data can still be controversial (Pearsall et al., 2004). However, it is now well established that phytoliths can seldom relate to certain groups of plants. Phytolith assemblages obtained from soil samples proved to be good indicators of the grass cover in many tropical and temperate regions (see Strömberg, 2004, for review). Their capability to characterize grasslands is due to the fact that phytoliths are particularly distinctive within the Poaceae sub-families (grasses), whereas pollen is not. However, one phytolith type cannot relate to any specific plant taxon, because many basic phytolith types are produced by many different taxa (redundancy) and because one plant taxon may produce many different phytolith types (multiplicity) (e.g. Mulholland, 1989; Fredlund and Tieszen, 1994).

The capability of phytolith assemblages to characterize forests and to detect changes in the tree cover density has been investigated at the local scale, and

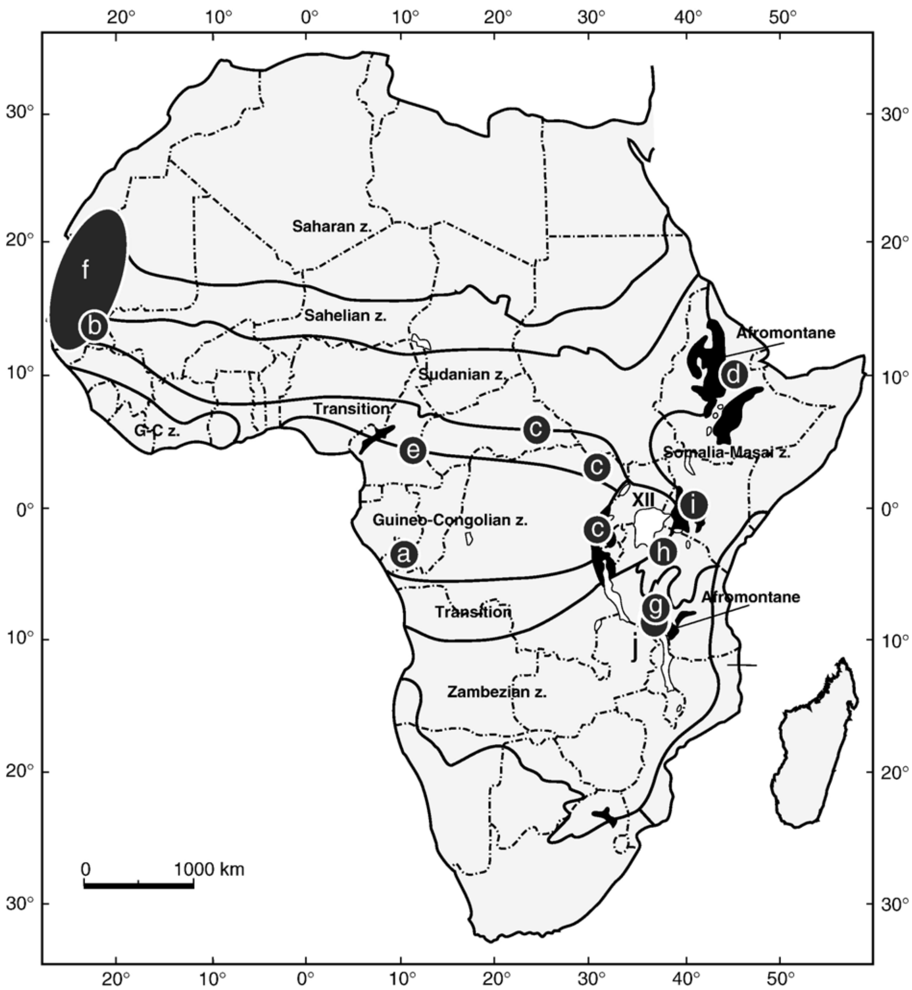

Fig. 1. Phytogeographical zones from White (1983) and modern phytolith studies in Africa. a: Congo — 2 samples, b: Senegal — 4 samples (Alexandre et al., 1997b), c: Central Africa — 17 samples (Runge, 1999), d: Ethiopia — 4 samples (Barboni et al., 1999, and *one unpublished*), e: Cameroon — 26 samples (Bremond et al., 2005a), f: Senegal and Mauritania — 61 samples (Bremond et al., 2005b), g: Tanzania, Mt Rungwe — 10 samples, and h: Mt Kenya — 13 samples (Bremond, 2003; Bremond et al., submitted for publication), i: Tanzania Serengeti Plains — 6 samples (Bremond, *unpublished*), and j: Massoko Lake — 6 samples (Bremond, 2003; Bremond et al., submitted for publication).