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Morphological study of modern phytolith assemblages in guinea Sahara region of Nigeria

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Abstract

Morphological study of phytolith was carried out from 11 plant species in 10 different plant families in Nigeria.Fresh plant leaves were randomly collected each from family which consists of leaves from 11 species for phytolith analysis. Schulze's solution was the standard method used to extract phytolith from the sample. The extracted samples were examined with Olympus Bx41 microscope. Phytolith results revealed a wide range of phytolith morphotypes with considerable degree of variability. However, 9 species were reported to have cuneiform bulliform phytolith shape, 1 bilobate phytolith shape and 1 reported globular echinate phytolith shape. Psilate and verrucate surface texture was observed from the study. These results of phytolith analysis could serves as baseline data that represent the modern vegetation assemblage of the study area for future paleoenvironmental study and environmental reconstruction.

Keywords: Analysis; Family; Morphology; Morphotypes; Phytolith

1. Introduction

Phytolith is a Greek words (*phyto*) "plant" and (*lithos*) "stones" [1,7,17]. Phytolith are amorphous silica structures produced and precipitated in and between the cells of plants tissue [3,6,14,17]. Silica uptake in plant is absorbed when plant take water from the soil and the nutrient it requires for growth. Phytolith absorbed were precipitated throughout the plant in different location by polymerization process [7,14,17,18,20]. The absorption of liquid silica by plant root are usually stored in monosilic acid $Si(OH)_4$ [5,17]. The extraction of phytolith can be achieve by chemical or ashing technique [8,14].

Phytolith are very small in sizes ranging between 20-200 µm across [14,17]. When plant decay off, the phytoliths incorporated into soil where they remain for millennia. Phytolith morphology is specific and identifiable even though they are highly amorphous [1,14,17]. Past plant vegetation information of the past can be traced through phytolith analysis [4,15]. Phytolith assemblage from soil and lake sediment were used as climatic and vegetation indicators for environmental reconstruction and paleoenvironmental studies [2,3,4,11]

Phytolith study is still controversial since its interpretation is uncertain hitherto as a result of redundancy and multiplicity of it recovery [4,11]. The scientific community are still debating on why phytolith is not considered as an essential element of plant [10]. However, plant reproduction researches revealed that plants growing in less silica medium lack structural support because phytolith protect the plant from biotic and abiotic stress [1,7,14].

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Phytolith research revealed the presence of grass family in the past 2,500 years according to [9]and [13] revealed that phytolith are produced more in the leaves than in the inflorescence of grass family. Phytolith assemblage recovered from the soil serve as an indicator of grass in many tropical and temperate regions which is due to the fact that phytolith shape in unique and specific within the Poaceae family [4,16].

Reconstruction of past plant vegetation associated with microfossil from the soil can be achieve through phytolith analysis [2,11,21]. Excavated phytolith from an environment can be compared with the modern reference to help in reconstruction of plant related environments transition over time [6,22]. However, this study aimed to catalogue the present plant vegetation for future paleoenvironment and environmental reconstruction.

2. Material and methods

Plant materials were collected from plant leaves and dried at Gasma study area for phytolith analysis (Figure 1), (11) plant species were involved in this study from10 families. Chemical treatment method of phytolith analysis was accord with Schulze's solution [14]. The sample was placed directly into a centrifuge tube and 10 ml of Schulze's was added to it. The sample was stirred for proper immersion with the Schulze's solution [14]. The sample will then be centrifuge and phytolith material will then be extracted and prepared for examination using an Olympus BX41 microscope under 400x [14].

2.1. Study Area

Figure 1 Gasma study area in Yobe state at 12°52'55.00"N 10°58'29.59"E

3. Results

Out of 11 plant leaves collected from 10 plant families for phytolith analysis, 9 species were observed to have cuneiform bulliform phytolith shape, 1 bilobate phytolith shape and 1 globular echinate phytolith shape. Light microscope (LM) was used in the entire examination under 400 x magnifications. Phytolith morphotypes were catalogued according to shapes, sizes and surface texture as shown from Table 1. The study presents the light microscope photomicrograph of phytolith from each species as shown from Figure (23).Various phytolith morphotypes were found in less abundance which includes: cylindrical polylobate, globular, cuneiform, mesophyll long cell, long cell echinate and parallepipedal bulliform phytolith. The surface texture found from this study was verrucate of majority.

Table 1 Morphological structure and measurement of phytoliths (μm) of the studied plants

No.	Species name	Common name	Family	LENGTH MEAN±SD	WIDTH MEAN±SD	*MAJOR SHAPE	*MINOR SHAPE
1.	*Abelmoschus esculentus L.*	Okra	Malvaceae	32.4±10.27	21.2±5.15	CBF	PPB
2.	*Acacia nilotica L.*	Gum arabic tree	Fabaceae	27.1±7.77	17.7±4.89	CBF	CFM
3	*Allium cepa L.*	Common onion	Liliaceae	25.0±7.48	19.0±6.23	CBF	GBL, PPB

4	*Anacardium occidentale L.*	Cashew	Anacardiaceae	27.0±7.33	18.7±7.35	CBF	PPB
5	*AzadirachtaindicaL.*	Neem tree	Meliaceae	27.7±6.10	19.2±5.03	CBF	PPB
6	*Balanitesaegyptiaca L.*	Desert date	Zygophyllaceae	38.1±7.57	26.5±8.38	CBF	MLC, PPB
7	*Borassusaethiopium*	Palmyra palm	Arecaceae	21.4±4.29	20.2±3.71	GBE	PPB
8	*Cola acuminata L.*	Cola nut	Malvaceae	28.7±5.10	19.7±6.35	CBF	PPB,GBL
9	*Calotropispocera*	Rubber tree	Apocynaceae	28.9±7.92	21.7±6.84	CBF	PPB
10	*Citrus limon L.*	Lemon	Rutaceae	26.0±8.29	15.5±4.97	CBF	PPB
11	*Pennisetum glaucum*	Millet	Poaceae	20.4±4.25	10.9±1.73	BLT	LCE, CDP

*CBF = Cuneiform bulliform cell, CFM = Cuneiform, BLT = Bilobate short cell, GBL= Globular cell, GBE= Globular echinate, CDP = Cylindrical polylobate, LCE = Long cell echinate, MLC = Mesophyll long cell, PPB = Parallepipedal bulliformphytolith.

Below is LM photomicrograph of phytolith major and minor shapes of plant species investigated as recorded in Table 1?

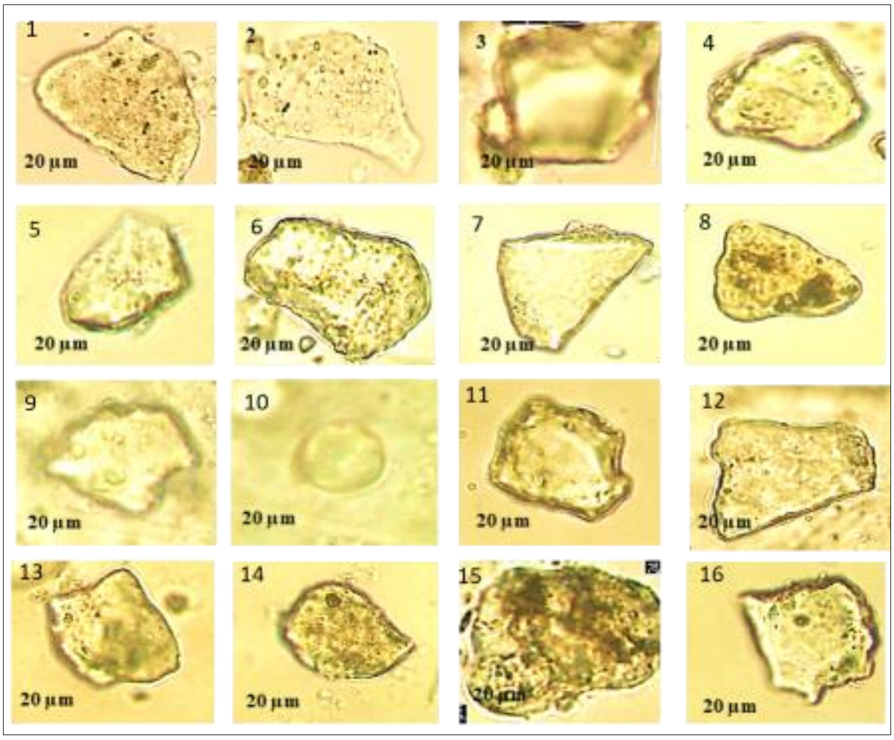

Figure 2 LM photomicrograph of *Abelmoschus esculentusL.* phytolith shape (12) cuneiform bulliform phytolith in major shape and (3) parallepipedal bulliform phytolith in minor shape. *Acacia nilotica L.* phytolith shape (4, 56) cuneiform bulliform phytolith in major shape and (7) cuneiform phytolith in minor shape. *Allium cepaL.* phytolith shape (8) cuneiform bulliform phytolith in major shape, (9) parallepipedal bulliform phytolith and (10) globular phytolith in minor shape. *Anacardium occidentale L.* phytolith shape (11,12) cuneiform bulliform phytolith in major shape and (13) parallepipedal bulliform phytolith in minor shape. *Azadirachta indica L.* phytolith shape (14,15) cuneiform bulliform phytolith in major shape and (16) parallepipedal bulliform phytolith in minor shape

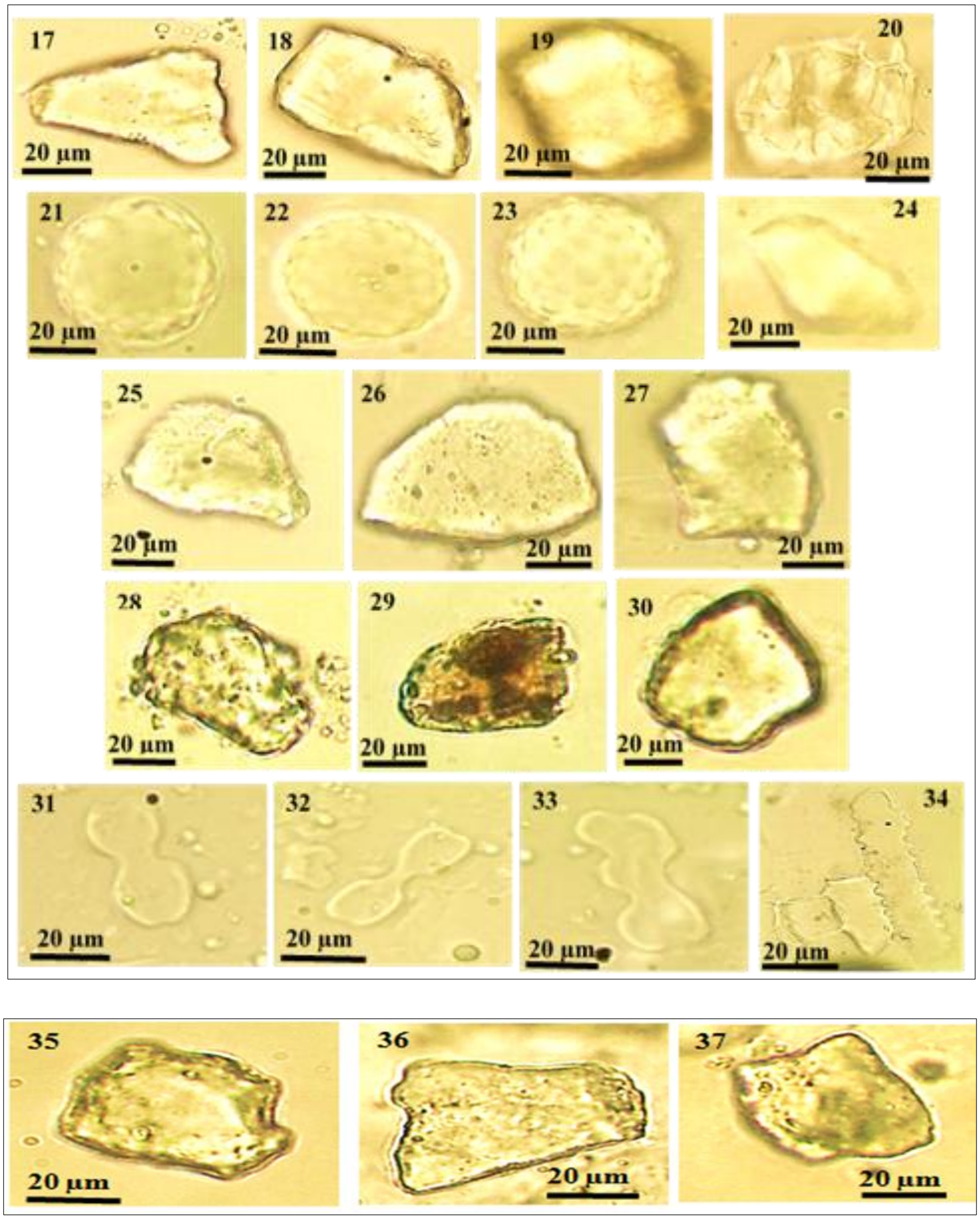

Figure 3 *Balanites aegyptiaca L.* phytolith shape (1718) cuneiform bulliform phytolith in major shape, (19) parallepipedal bulliform phytolith and (20) mesophyll long cell phytolith in minor shape. *Borassus egyptica*phytolith shape (21, 2223) globular echinate in major shape and (24) parallepipedal bulliform phytolith in minor shape. *Calotropis procera* phytolith shape (2526) cuneiform bulliform phytolith in major shape and (27) parallepipedal bulliform phytolith in minor shape. *Citrus limon L.* phytolith shape (28,29) cuneiform bulliform phytolith in major shape and (30) parallepipedal bulliform phytolith in minor shape. *Pennisetum glaucum* phytolith shape (31,32) bilobate phytolith in major shape, (33) cylindrical polylobate phytolith and (34) long cell echinate phytolith in minor shape. *Cola acuminata L.* phytolith shapes (35,36) cuneiform bulliform (37) parallepipedal bulliform in minor shape.

4. Discussion

Plant from wet habitat produce large phytolith due to the availability of water content that influence phytolith size [5,17]. Phytolith studies is associated with redundancy and multiplicity [4]. Previous studies further affirmed that some plant produce large phytolith while others very few [20,22]. Phytolith identification was accorded with international code for phytolith identification system [12].

Phytolith researches revealed a wide range of variability and concluded that phytolith shapes cannot serve as a distinguishing factor to plant families. Since there is no taxonomic shape given to a specific plant except the Poaceae family known to have bilobate phytolith shape [4,14,17]. Plant research showed that phytolith abundance in fruit and seed is higher than in plant leaves (ShakoorBhat, 2014). Phytolith study revealed that variation in phytolith shape may be cause as a result of multiplicity of plant samples taking for phytolith analysis [4,17].

[16], [17] and [19] revealed that bilobate phytolith shape are the distinguishing characteristics of Poaceae family, rondel, polylobate and long cell echinate shape. Another study however, affirmed the fact that bilobate shape phytolith is one of the distinguishing characteristics of Poaceae family which is adapted to the warm humid temperature [3]. Globular phytolith, globular granulate, and globular echinate phytolith were characterized by palms trees from Arecaceae family and gives best account of the satellite tree cover [4]. [1] revealed the presence of cuneiform bulliform phytolith shape in broad leaf plant. Other phytolith shapes may also be available and werereported as minority shapes [1]. Cuneiform bulliform phytolith are the representatives of both monocotyledon and dicotyledon plant [8,17]. Cuneiform bulliform cell and parallepipedal bulliform cell phytoliths are produced in Panicoideae and Oryzoideae found in the warm humid climate of China [3,11]. Some plants produced huge amount of phytoliths, resulting in over-representation of the vegetation [3].

5. Conclusion

Phytolith shapes were catalogued according to shapes, sizes and texture ornamentation.This study affirmed that phytolith shape will not serve as distinguishing characteristics of plant species as such there is no shape given to particular species except the grass family known for bilobate phytolith shape.Eight (9) species were reported to have cuneiform bulliform phytolith shape and 1 bilobate phytolith shape and 1 globular echinate phytolith shape. The minor phytolith shapes observed were found in less quantity reported as minority. The study is compiled with multiplicity and redundancy making the interpretation of phytolith data very difficult as a result.

Compliance with ethical standards

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Disclosure of conflict of interest

There's no conflict of interest in this publication.

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