8TH INTERNATIONAL MEETING ON PHYTOLITH RESEARCH

ESTES PARK, COLORADO, USA

SEPT. 15–17, 2011

PREFACE

Welcome to the 8th IMPR, held at the Rocky Mountain Park Inn, Estes Park, Colorado, USA!

The Organizing Committee and PaleoResearch Institute are honored to sponsor the International Meeting on Phytolith Research in the United States for the first time. A workshop was held at PaleoResearch Institute in Golden, Colorado, for 2 1/2 days, just prior to the 8th IMPR. This workshop had two components: laboratory methods and microscope, which included nomenclature, taxonomy, and reference. Approximately 20 people registered for this workshop. International participation at the 8th IMPR includes people from 14 countries.

There will be a reception Thursday evening at 6:00 pm. A banquet is scheduled for Saturday at 6:30 pm, and is included in the registration fee for attending the entire conference. All participants who have registered for the entire conference are invited to attend the banquet.

Two notes:

- The dates listed for the conference (Sept. 15–17) include only the days when papers and posters are being presented, not the optional field trip on Sept. 18.
- The abstracts starting on page 8 are in alphabetical order by lead author.

ORGANIZING COMMITTEE

Linda Scott Cummings, PaleoResearch Institute

Chad Yost, PaleoResearch Institute

Mikhail S. Blinnikov, St. Cloud State University

Carlos E. Cordova, Oklahoma State University

ORGANIZING INSTITUTION

PaleoResearch Institute, Golden, Colorado

SCHEDULE

THURSDAY		**LAB METHODS/ METHODS—PAPERS**
Linda Scott Cummings	8:45 am	Welcome
Paul Reyerson	9:00	The use of alkali dissolution and floatation methods in tandem for biogenic silica quantification in loess soils: Case studies from Nebraska, USA
Remi Corbineau	9:30	Towards 14C AMS dating of phytoliths: A new protocol for getting pure samples of phytoliths from harvested plants
		REFERENCE, MORPHOLOGY, TAXOMONY—PAPERS
Yan Wu	10:00	The Effects of the Preservation of Phytolith Morphology during Heating: Implications for Archaeological Interpretation
Welmoed Out	10:30	Identification of non-dietary crop products of Eurasian cereals
Rosa Maria Albert	11:00	The GEPEG Phytolith-Core Reference Collection
	12:00-1:30	**LUNCH**
	1:30-3:00	**METHODS, REFERENCE, MORPHOLOGY, TAXOMONY—POSTERS**
Sheahan Bestel		Phytolith and starch residues from denticulate Peiligang stone sickles in early Neolithic China
Caroline Braune		Opal phytoliths in plants: a new extraction method
Heloisa Coe		Use of a New Phytolith Index for Identifying Changes in Palm Trees Cover Density in the Region of Búzios, Rio de Janeiro, Brazil
AnnaLisa Maddox		A typologic and morphometric analysis of phytoliths produced by the inflorescences of selected species of millet
Margarita Osterrieth		Morphological Differentiation of Globular Phytoliths in Monocotyledons: Its Application to Fossil Phytolith Record of Pedosedimentary Levels Associated to "Escorias y Tierras Cocidas", Chapadmalal Formation, Buenos Aires, Argentina
Margarita Osterrieth		Silicophytoliths and Calcium Oxalate Crystals in Plants and Soils of Brazil Mangrove Environments
Petra Tallberg		Separating diatom and phytolith biogenic Si: A chemical approach
	3:00-3:30	**BREAK**
	3:30	**REFERENCE, MORPHOLOGY, TAXOMONY—PAPERS—CONTINUED**
Jianping Zhang	3:30	Phytolith Analysis for Differentiating between Foxtail Millet (Setaria italica) and Green Foxtail (Setaria viridis)
Yan-Sheng Gu	4:00	Comparative research on the phytolith morphology from the wild and domesticated rice species in Southeast Asia
Alison Weisskopf	4:30	Comparing modern rice cultivation systems and wild rice through soil phytoliths: first results of Early Rice Project analogue studies
Alice Novello	5:00	Phytoliths of sub-Saharan grasses and present-day vegetation
	6:00	**RECEPTION**

FRIDAY		**ENVIRONMENT/PALEOENVIRONMENT/INTEGRATED ANALYSES—PAPERS**
Carlos Cordova	8:30	The Stipa-type short cell: what does it mean taxonomically, climatically and ecologically?
Jenny McCune	9:00	Using phytoliths to reveal the vegetation history of southeastern Vancouver Island at intermediate temporal and spatial scales
Mikhail Blinnikov	9:30	Silica phytoliths as possible proxies of the Pleistocene vegetation of the Arctic: analysis of modern analogs from Alaska.
J. Byron Sudbury	10:00	Quantitative Phytolith Analysis: A Key to Understanding Buried Soils and to Reconstructing Paleoenvironments
Aline Garnier	10:30	Phytoliths for reconstructing palaeoenvironments from fluvial records. Application to the last 6000 years deposits of the Yamé River (Dogon country, Mali)
Ahmed Fahmy	11:00	Taxonomic, environmental and phytogeographical significance of leaf phytoliths in West African grasses
Katharina Neumann	11:30	The Central African rainforest during the Last Glacial Maximum: Phytoliths and sponge spicules from alluvial sediments in southern Cameroon
	12:00-1:30	**LUNCH**
	1:30-3:00	**ENVIRONMENT/PALEOENVIRONMENT/INTEGRATED ANALYSES—POSTERS**
Steven Bozarth		Paleoenvironmental Reconstruction of Late Holocene Alluvium in Travis County, Texas, Based on Biosilicate, Charred Phytolith, and Particulate Charcoal Analysis
Carlos Cordova		Graminoid phytolith indicators of rainfall seasonality in South Africa
María Gabriela Fernández Pepi		Festuca gracillima community: phytolith analysis in their southernmost distribution area, Tierra del Fuego ecotone (Tierra del Fuego, Argentine)
Alexandra Golyeva		Local paleoenvironmental and anthropogenic evolution of Teotihuacan period (central Mexico) based on distribution of phytoliths and other silica microbioparticles.
Maria Lehtimäki		Phytoliths as silicon transport vectors from Finnish catchments areas to the Baltic Sea
Margarita Osterrieth		Silicophytoliths in Sedimentary Sequences in the Laguna Potrok Aike, Santa Cruz, Argentina.
Noelia Patterer		Phytolith analysis in fluvial sediments of El Palmar Formation (Late Pleistocene) in the eastern Argentina.
Noelia Patterer		Plant communities phytolith assemblages relationship with the native flora from El Palmar National Park (Entre Ríos Province, Argentina).
Terri Woodburn		High-resolution biosilicate Analysis of the Pleistocene-Holocene Transition: The Brady Soil, Southwestern Nebraska.

Xinrong Zhang		Phytolith record on paleoclimate changes and its relationship with Ancient rice agriculture of Hemudu area, China
	3:00-3:30	**BREAK**
	3:30	**ENVIRONMENT/PALEOENVIRONMENT/INTEGRATED ANALYSES—PAPERS—CONTINUED**
Linda Cummings	3:30	Integrating Microfossil Data Sets: Completing the Record
Luc Vrydaghs	4:00	Combining the evidence: integrating phytolith studies and micromorphology: the case study of Brussels' Dark Earth
Alexandra Golyeva	4:30	Interrelation between phytolith profile type and land topography
Akos Peto	5:00	Integrating soil chemical, physical and micro-archaeobotanical data and evidence to reconstruct the base burial of an Early Bronze Age (EBA) kurgan. A methodological approach and case study from NE Hungary.
Rand Evett	5:30	The Status of Phytolith Research in California Paleoecology: Opportunities and Obstacles
SATURDAY		**LANDSCAPE/GEOLOGY—PAPERS**
J. Byron Sudbury	8:30	Sponge Spicules-An Underutilized Biogenic Silica Resource in Soil
		PANGEA/GEOLOGICAL ERAS—PAPERS
Renske Kirchholtes	9:00	Redbed phytoliths from Texas: first fossil evidence of vegetation in western equatorial Pangea across the Permo-Triassic boundary
Caroline Stromberg	9:30	The early evolution of grasses: New phytolith evidence from the Late Cretaceous of India
		ETHNO/ARCHAEOLOGY—PAPERS
Barbara Eichhorn	10:00	Seed phytoliths in West African Commelinaceae: classification and significance for palaeoecological and palaeoethnobotanical reconstructions
Chad Yost	10:30	Commelinaceae Seed Phytoliths in North America: Recovery from Archaeological and Paleoecological Contexts, and comparison to modern reference material
Chad Yost	11:00	The Calathea allouia (Marantaceae) and Commeliniaceae Conundrum: The Search for Diagnostic Phytoliths
Luc Vrydaghs	11:30	Prospect into the phytolith analysis of ceramic thin section
	12:00-1:30	**LUNCH**
	1:30-2:30	**GEOLOGY, ARCHAEOLOGY, AND ETHNOLOGY—POSTERS**
Cristina Augustin		Geomorphic Interpretation of Proecesses and Climatic conditions in the Upper Pleostocene in Southeast Brazil: Contribution of Phytoliths
Heloisa Coe		Contributions of Phytolith Studies on the Identification of Soil Genesis and Environmental Changes in the São João River Basin, Rio de Janeiro, Brazil.

Winston (Bud) Hampton		Ethnoarchaeologic Perspectives of Bamboo Tools in the Highlands of the Indonesian Western Half of the Island of New Guinea.
Margarita Osterrieth		Amorphous Silica Biomineralizations in Plants and Soils, and Their Role in the Biogeochemistry of Silicon in the Southeast of the Pampean Plain, Argentina.
Gergo Persaits		Preliminary results of Arpadian age channel system survey based on phytolith analysis
	2:30	**ETHNOLOGY AND ARCHAEOLOGY—PAPERS**
Marta Portillo	2:30	Early Neolithic husbandry practices at Tell Seker al-Aheimar (Upper Khabur, Syria): An ethnoarchaeological study of phytoliths and dung spherulites
Kai Uwe Radomski	3:00	Phytolith sampling of grinding stones from Ungwar Kura, Nigeria
	3:30-4:00	**BREAK**
Monica Tromp	4:00	Population-level Analysis of Dental Calculus Using BSE-SEM-EDS for Diet Reconstruction
Irene Esteban	4:30	The use of plant resources at the MSA sites PP13B and PP5/6 (Mossel Bay, South Africa)
	5:00	Business Meeting—All conference attendees
	6:30	Banquet—Travel by car to Big Horn Mountain Inn for barbeque
SUNDAY		
	8:30 am	Field Trip—Meet in hotel lobby

ABSTRACTS

(ALPHABETICAL, BY LEAD AUTHOR)

THE USE OF PLANT RESOURCES AT THE MSA SITES PP13B AND PP5/6 (MOSSEL BAY, SOUTH AFRICA)

Albert, Rosa Maria,[1] Irene Esteban Alama,[2] and Curtis W. Marean[3]

[1] ICREA/GEPEG. Department of Prehistory, Ancient History and Archaeology, Universitat de Barcelona. rmalbert@ub.edu

[2] GEPEG. Department of Prehistory, Ancient History and Archaeology, Universitat de Barcelona. irene.esteban.alama@gmail.com

[3] Institute of Human Origins, School of Human Evolution and Social Change, PO Box 872402, Arizona State University, Tempe, AZ 85287-2402 USA. curtis.marean@asu.edu

PAPER ABSTRACT

The capacity to detect remnants of fire usage in archaeological sites, along with a better understanding of its use by prehistoric populations, can help us to shed light on advances in pyrotechnology and its consequent impacts on hominin cognition, social organization, and technology. At the same time, little is known of the use of plant resources for other purposes such as diet during Middle Paleolithic and Middle Stone Age periods. Pinnacle Point 13B (PP13B) and 5/6 (PP5/6) are two of several South African Middle Stone Age (MSA) sites that show an abundant presence of visible lenses of burnt material and intact hearths associated with other archaeological remains such as fauna, shells, lithics, etc. Phytolith and mineralogical analyses, through Fourier Infrared Spectrometry (FTIR), at PP13B and PP5/6 have been used to identify the types of plants used as fuel in the hearths as well as other possible plant uses. In PP13B the high alteration noted in general in the phytoliths is used as a marker to signal the areas with higher alkaline conditions related to dripping water and compared to FTIR results which shows the presence of dahalite that may also affect the phytoliths. On the contrary, the excellent preservation of multicellular structures from the epidermal leaves of dicotyledonous plants in some areas suggests that these areas belonged to *in situ* structures with practically no chemical or post-depositional alteration. A most interesting pattern is the abundance of dicotyledonous leaves in some of the samples, namely from the rear of the cave, which might point either to obtaining specific leaf-fuels for the fires, short-term fire activities, or to other activities such as cooking. In PP5/6 phytoliths do not present strong signs of dissolution, and their presence in the uppermost levels has been related to natural input either from aeolian transport or percolation from the upper vegetated levels.

THE GEPEG PHYTOLITH-CORE REFERENCE COLLECTION

Albert, Rosa M.,[1] Xavier Esteve,[2] Marta Portillo,[2] Agata Rodríguez-Cintas,[2] Dan Cabanes,[2] Irene Esteban,[2] and Francisco Hernández[2]

[1] CREA/GEPEG. Dept. of Prehistory, Ancient History and Archaeology, University of Barcelona (Spain). C / Montalegre, 6-8. 08001 Barcelona. rmalbert@ub.edu

[2] GEPEG. Dept. of Prehistory, Ancient History and Archaeology, University of Barcelona (Spain). C / Montalegre, 6-8. 08001 Barcelona

PAPER ABSTRACT

The Research Group for Palaeocological and Geoarchaeological Studies (GEPEG) of the University of Barcelona was created in 2005 with the purpose of conducting phytolith and mineralogical analyses of archaeological sediments to better understand the exploitation of plant resources by past populations, as well as to conduct climatic and vegetation reconstructions, taking into account the different postdepositional processes that can affect these silica microremains.

At present the group participates in different international projects which include Eastern and Southern Africa as well as the Mediterranean region. During these years of research, GEPEG has been collecting images that might serve as a reference catalog to identify the phytoliths from the different areas of study.

We present here the GEPEG Phytolith-Core Reference Collection. This is a new phytolith catalog available at http://gepeg.org/enter_PCORE.html.

The catalog is based on phytolith images collected from three different sources:

- Modern reference plant material from the study areas.
- Modern soils collected from the same areas as modern plants or from areas that were previously described in terms of vegetation. The modern soil catalog aims to better understand dissolution processes of phytoliths, after their deposition in soils, as well as to obtain better phytolith spectra from different vegetation units.
- Archaeological material.

The catalog provides not only microphotographs of phytoliths but also background information such as provenience of the sample, date of collection, in the case of modern soil assemblages, description of the vegetation from where the samples were collected, etc. With this new catalog database, we seek to make available an online database of phytoliths that can be used by researchers, both as an identification tool to recognize phytolith morphotypes from different plants and plant parts as well as to obtain better vegetation interpretations taking into account taphonomy, dissolution of phytoliths, and mineralogy of soils.

GEOMORPHIC INTERPRETATION OF PROCESSES AND CLIMATIC CONDITIONS IN THE UPPER PLEISTOCENE IN SOUTHEAST BRAZIL: CONTRIBUTION OF PHYTOLITHS

Augustin, Cristina,[1] Heloisa H. G. Coe,[2] Karina F. Chueng,[2] and Alessandra M. C. Vasconcelos[1]

[1] Instituto de Geociências, Universidade Federal de Minas Gerais, Av. Antonio Carlos, 6.627, CEP:31270-901 - Belo Horizonte – MG, Brazil. chaugustin@hotmail.com

[2] Universidade do Estado do Rio de Janeiro, Faculdade de Formação de Professores, Departamento de Geografia, Rua Dr. Francisco Portela, 1470 - 24435-005 - São Gonçalo, RJ, Brazil

POSTER ABSTRACT

The occurrence of aluvial-coluvial sequences characterized by a clay-organic layer is very common in the Espinhaço Meridional, a Precambrium orogene localized in the southeast of Minas Gerais, Brazil. The climate is tropical sub-humid with two well defined seasons: a wet and hot summer and a dry and relatively cold winter. The vegetation is a type of savanna, known in Brazil as "cerrado". The area presents evidences of slow fluvial dissecation processes although it has a deep weathered mantle developed over schist and granit-gnaisse rocks. These clay-organic layers are found below soils, and they are ^{14}C dated of the Upper Pleistocene. One of these depositions, at the margins of a small river, presents a ^{14}C dating of 14,305±105 Ka BP, and it is buried by 2.5m of pedogeneized coluvium. The type and degree of organic matter decomposition suggest cooler temperatures than in the present. This can be associated to the topographic situation of the Espinhaço mountain range, where cooler climates during the LGM were inferred by some authors. At the same time the high percentage of organic matter (18-23%), as well as the percentage of clay present in the layers, seem to be associated with a humid environment, but free of turbulent water flow, what is usually expected in rivers with high speed and that are compatible with concentrated rain or torrential rains, typical of semi-arid areas. In addition, the alluvial sequence shows evidences of different environmental conditions than from those of the coluvium deposited on its top. These differences indicate alterations in water availability in the system: constant humidity during the clay-organic sequences deposition and less humid conditions during the coluvium deposition, resulting in the deposition of material with coarser granulometry. It is important to remark that these are only preliminary results and their interpretation is not conclusive. Therefore, other scenarios could have occurred, including a climate without higher amounts of precipitations, but better distributed during the year. The deposition of clay-organic sequences could indicate that this material stayed in a low turbulence environment, the result of fine and well distributed rainfall which did not generate strong concentrated flow that would have allowed the removal of these particles by fluvial erosion and transport. Likewise, a dryer climate does not necessarily mean semi-arid conditions, but the occurrence of two well defined seasons: a dryer and more prolonged one, and a shorter one with concentrated rainfall events, what would be responsible for the reactivation of slope processes and basal erosion by the small rivers. In order to validate one or more of these possible climate and vegetation scenarios and their contribution to the type and intensity of the erosion processes in the last 14,000 years BP, phytolith analysis are being carried out. Seven samples of the sequences from the alluvial-coluvial profile were taken as well as eight samples of the main current vegetation formations (high mountain and rupestrian grasslands; mesophytic forest; mesophytic forest with palm trees; grass, open and forested savanna; riparian forest) which will be used as modern reference assemblages. To infer the climate parameters that can corroborate the higher or better distributed rainfalls hypotheses, some phytolith indexes will be calculated in modern and fossil assemblages: tree cover density (D/P), climatic Index (Ic), aridity index (Iph) and water stress index (Bi%).

PHYTOLITH AND STARCH RESIDUES FROM DENTICULATE PEILIGANG STONE SICKLES IN EARLY NEOLITHIC CHINA

Bestel, Sheahan,[1] Li Liu,[2] Arlene Rosen,[3] and Chen Xingcan[4]

[1] PhD Student, School of Geography and Environmental Science, Monash University, Clayton, Vic, 3800, Australia. Visiting Researcher, East Asian Languages and Cultures, 450 Serra Mall, Bldg 250, Main Quad, Stanford University, Stanford, CA, 94305-2000 USA. sbestel@stanford.edu

[2] Sir Robert Ho-Tung Professor in Chinese Archaeology, East Asian Languages and Cultures, 450 Serra Mall, Bldg 250, Main Quad, Stanford University, Stanford, CA, 94305-2000, USA. liliu@stanford.edu

[3] Professor of Environmental Archaeology, Institute of Archaeology, University College London, 31-34 Gordon Square, London WC1H 0PY, United Kingdom

[4] Institute of Archaeology, Chinese Academy of Social Sciences, 27 Wangfujing Dajie, Beijing, People's Republic of China

POSTER ABSTRACT

Denticulate stone sickles dating to the Peiligang period (c. 9000 – 7000BP) were examined for residues. The knives came from three sites in Henan Province in China, including Egou and Shigu in the north and Jiahu in the south. These knives are typically thought to have been used for harvesting millet cereals (*Setaria italica* ssp. *italica* and *Panicum miliaceum*) which were newly domesticated during this period (Chang, 1986:93). As such, they are used as a proxy for agriculture in Chinese Neolithic archaeology (e.g. Chang, 1986:91) despite a lack of residue or usewear studies. This research presents the first residue study of these artefacts.

During experimental research using replica stone sickles, three hypotheses regarding the use of the ancient stone sickles were tested. Replica sickles were used for half an hour each to harvest *Typha* sp. reeds, Poaceae grasses of various sorts and *Quercus* cf. *robur* acorns from an oak tree. The residues retained on experimental sickles after this research were compared to the residues extracted from ancient Peiligang sickles.

Despite the small numbers of starch and phytolith residues recovered from ancient sickles, it seems that the tools may have been multi-functional. Various phytoliths and starch grains were recovered from the different tools, and each site had a singular assemblage. Although the tools had been in museum storage for decades after excavation, viable and uncontaminated residues were still able to be extracted.

Bilobate phytoliths were recovered from sickles from the Shigu site. The disarticulated bilobes cannot be identified with any certainty but are typical of panicoid grasses including the millet Paniceae tribe. They are unlike the *Setaria italica* ssp. *italica* cross-shaped phytoliths that Lu *et al.* (2009: figure 2) describe as being typical of foxtail millet. However they are similar to the bilobe-shaped *Panicum miliaceum* glume phytoliths from broomcorn millet that the same team describe (Lu et al. 2009: figure 2). More research is needed to identify them with certainty.

A single fan-shaped phytolith dissimilar to those recovered from *Oryza* sp. was recovered from the Jiahu site where rice is known to have been cultivated (Zhang and Wang 1998; Zhao and Zhang 2009). In addition, small clusters of starch grains similar to those recovered from the acorn-harvesting experimental sickle were extracted from several Jiahu sickles. Along with dicotyledonous leaf hair phytoliths from the same sickles, this

suggests a possible nut or dicotyledonous plant processing or harvesting usage for these sickles. More research and greater residue numbers are needed to fully understand the plant processing functions of these artefacts.

Acknowledgements: Henan Provincial Institute of Archaeology for access to materials. Duncan Jones for assistance in sample collection. Participants in Experimental Grinding Workshop held at La Trobe University, Melbourne, March 2009 (Dr. Richard Fullagar, Dr. Wei Ge, Mr. Duncan Jones, Mr. Anthony Wilson, Dr. Shaun Shaodong Zhai). Rudy Frank for assistance in making the replica sickles.

REFERENCES

Chang, K.C. 1986. *The Archaeology of Ancient China* (4th edition ed.). New Haven CT: Yale University Press.

Lu, Houyuan, Jianping Zhang, Naiqin Wu, Kam-biu, Deke Xu, and Quan Li. 2009. Phytolith analysis for the discrimination of foxtail millet (*Setaria italica*) and common millet (*Panicum miliaceum*). *PLoS one, 4*(2), e4448 (+4415).

Zhang, Juzhong, and Xiangkun Wang. 1998. Notes on the recent discovery of ancient cultivated rice at jiahu, henan province: A new theory concerning the origin of *Oryza japonica* in China. *Antiquity, 72*, 897-901.

Zhao, Zhijun, and Zhang Juzhong. 2009. Jiahu yizhi 2001 niandu fuxuan jieguo fenxi baogao. 贾湖遗址2001年度浮选结果分析报告。. Kaogu 考古 8, 84-94.

SILICA PHYTOLITHS AS POSSIBLE PROXIES OF THE PLEISTOCENE VEGETATION OF THE ARCTIC: ANALYSIS OF MODERN ANALOGS FROM ALASKA.

Blinnikov, Mikhail S.

Geography, St. Cloud State University, St. Cloud, MN 56301, USA. +1(320)308-2263. msblinnikov@stcloudstate.edu

PAPER ABSTRACT

Phytolith research of terrestrial paleoenvironments to date has focused primarily on tropical or temperate regions. Assemblages of silica phytoliths from these settings are dominated by morphotypes from Panicoid, Chloridoid, or Bambusoid grasses and tropical trees (e.g., palms). In temperate regions, ratios of C_3/C_4 grass morphotypes have been used to document regional or subcontinental trends in paleovegetation in mid-latitudes, e.g., in North American Great Plains (Fredlund and Tieszen, 1994). The high-latitude/high-altitude contexts received considerably less attention with limited research conducted in Russia and the Alps, where the main phytolith producers are C_3 grasses (Festucoids) and sedges (Cyperaceae) with limited diversity of morphotypes (Blinnikov, 1994). In Eastern Beringia, Bombin (1984) provided a pioneering work analyzing phytoliths from selected grasses and sedges and a few lake sediments.

A limited modern analog collection of samples from grassland sites in Central Alaska is presented and discussed in this study. Communities in central Alaska today tend to be dominated by only a handful of Festucoid C_3 genera, all of which produce primarily rondel and trapezoid/creante forms (Elven, 2007; Watson

and Dallwitz, 2008; Blinnikov et al., 2011). I present some ideas about applicability of phytolith analysis for future studies in the Arctic based on botanical literature (Kassler, 1979; Swanson, 2006) and modern samples.

In the summer of 2009 I obtained samples from 12 modern analog sites in Central Alaska from dry south-facing bluffs along the Tanana and Delta rivers and central portion of the Alaska Range along Denali Highway. Vegetation on some of the sites had been described by Kassler (1979). Most samples come from grasslands dominated by *Calamagrostis purpurascens, Poa glauca, Bromus ciliatus, Carex spp., Artemisia frigid,* and some forbs. We also obtained samples from forb-and sedge-rich tundra and a low elevation black spruce–cottongrass bog. All have been processed for silica phytoliths using standard wet oxidation and flotation technique of Blinnikov (1994). All samples, except the bog, yielded abundant silica phytoliths. As expected, Alaskan modern assemblages are dominated by wavy crenate forms (long and short) with some presence of rondels. However, even limited modern dataset presents opportunities for meaningful interpretation of differences in plant composition on modern plots with obvious implications for the paleoecological analysis (Blinnikov et al., 2011; Wooller et al., 2011).

REFERENCES

Blinnikov, M. S. 1994. Phytolith analysis and Holocene dynamics of alpine vegetation: Veroffentlichungen des Geobotanischen Inst. Stiftung Rübel, Zurich, H. 115, pp. 23-42.

Blinnikov, M.S., Gaglioti, B., Walker, D.A., Wooller, M.J., Zazula, G.D. 2011. Pleistocene graminoid-dominated ecosystems in the Arctic. *Quaternary Science Reviews* (in press).

Bombin, M. 1984. On phytoliths, late Quaternary ecology of Beringia, and information evolutionary theory. PhD diss., Dept. of Anthropology, Univ. of Alberta.

Elven, R. (Ed.) 2007. Checklist of the Panarctic Flora Vascular Plants: http://www.binran.ru/infsys/paflist/index.htm.

Fredlund, G.G., Tieszen, L.T. 1994. Modern phytolith assemblages from the North American Great Plains. *Journal of Biogeography 21, 321-335.*

Kassler, K. C. 1979. Relicts of the late Pleistocene Arctic-steppe: investigations of certain south-facing slopes in interior Alaska. BA Thesis, Middlebury College, VT.

Swanson, D. K. 2006. Biogeographical Evidence for the Grass (Poaceae) Species of Pleistocene Beringian Lowlands. *Arctic* 59, 191-200.

Watson, L., Dallwitz, M. J. 2008. Grass genera of the world: http://delta-intkey.com/grass/.

Wooller, M.J., Zazula, G.D., Blinnikov, M., Gaglioti, B.V., Bigelow, N.H., Sanborn, P., Kuzmina, S., La Farge, C. 2011. The detailed paleoecology of a mid-Wisconsinan interstadial (w31,000 14C years) paleo-turf from interior Alaska. *Journal of Quaternary Science* (in press).

Yurtsev, B.A. 1982. Relics of the xerophyte vegetation of Beringia in Northeastern Asia. In *Paleoecology of Beringia,* Hopkins, D.M., Matthews Jr., J.V., Schweger, C.E., Young, S.B. (eds.). Academic Press, New York, pp. 157–177.

SILICOPHYTOLITHS AND CALCIUM OXALATE CRYSTALS IN PLANTS AND SOILS OF BRAZILIAN MANGROVE ENVIRONMENTS

Borrelli, Natalia,[1,3] Margarita Osterrieth,[1] Heloisa Helena Gomes Coe,[2] Stella Maris Altamirano,1 and Mariana Fernández Honaine[1,3]

[1] Instituto de Geología de Costas y del Cuaternario, FCEyN-UNMdP. CC 722 Correo Central 7600 Mar del Plata.

[2] Universidade do Estado do Rio de Janeiro, Faculdade de Formação de Professores, Departamento de Geografia.

[3] CONICET. mosterri@yahoo.com.ar

POSTER ABSTRACT

In plants, silicophytoliths ($SiO_2.nH_2O$) and calcium oxalate crystals ($CaC_2O_4.nH_2O$, COC) are the most common types of biomineralizations. These biomineralizations become part of the soil once the organic matter has been degraded. The silicophytoliths remain on the soil while calcium oxalate crystals, due to their high susceptibility to weathering, quickly degrade. The study of both types of biomineralizations has relevance for botany, taxonomy, pedological, paleobotany, and biogeochemistry.

Mangrove ecosystems are considered very productive and have great ecological and socioeconomic importance. Nevertheless, almost no information exists concerning the production of biomineralizations and their content in mangrove soils, so the aims of this study are to: 1) describe and quantify the silica and calcium biomineralizations in leaves of vegetal species characteristics of these ecosystems, and 2) describe the phytolith assemblages of mangrove soil developed in the municipality of Casemiro de Abreu, Rio de Janeiro, Brazil.

We worked with *Rhizophora mangle* (Rhizophoraceae), *Avicennia schaueriana* (Avicenniaceae), *Laguncularia racemosa* (Combretaceae), and *Acrostichum aureum* (Pteridaceae). The silicophytoliths were extracted from the leaves by calcination method; calcium oxalate crystals were analyzed by diaphanized and cross sections. In each soil site, samples were taken 5cm below the surface to analyze the proportion of silicophytoliths regarding the total mineralogical components of the soil. For this purpose, iron, organic matter, and clay minerals were removed by routine analysis.

Silicophytoliths were observed in *A. schaueriana*, *A. aureum*, and *L. racemosa*. Predominant morphotypes were tabular polygonal phytoliths and cylindrical sulcate tracheids in *A. schaueriana*; stomatal complexes and jigsaw phytoliths in *A. aureum*, and a few fragments of tissues with cell walls silicified in *L. racemosa*. Druses (COC) were observed in hypodermis and phloem in *R. mangle*; and spongy parenchyma and associated to vascular bundles in *L. racemosa*.

A superficial soil sample was collected under a *R. mangle* and *A. schaueriana* mixed mangrove, with few *L. racemosa*. A lot of sponge spicules and diatoms, characteristic of hydromorphic environments, were observed, but very few phytoliths, all very weathered and broken. Predominant morphotypes were globular echinate, globular granulate, point shape, elongate, and debris of unidentifiable phytoliths. They are all associated with terrestrial vegetation developed around the mangroves. Probably, the silicophytoliths generated from the plant species associated to mangroves are not reflected in the soil due to its low production and/or state of silicification.

Acknowledgements: Financial support for this work has been provided by the: UNMdP EXA 551/11; the ANPCyT, PICT N° 2010-2036 and PICT N° 1871 and CAPES-MINCYT (Código: BR/09/13).

PALEOENVIRONMENTAL RECONSTRUCTION OF LATE HOLOCENE ALLUVIUM IN TRAVIS COUNTY, TEXAS, BASED ON BIOSILICATE, CHARRED PHYTOLITH, AND PARTICULATE CHARCOAL ANALYSIS

Bozarth, Steven R., and Terri L. Woodburn

Department of Geography, 1475 Jayhawk Blvd., 213 Lindley Hall, University of Kansas, Lawrence, KS 66045. sbozarth@ku.edu

POSTER ABSTRACT

Analysis of biosilicate assemblages, charred phytoliths, and particulate charcoal demonstrate a dynamic, late Holocene paleoenvironment at 41TV410 on Onion Creek, Travis County, Texas. Vegetation was dominated by Chloridoids (short grasses adapted to arid environments) throughout the seven-meter section in which ten paleoenvironmental zones were delineated. The most dramatic climate changes occurred in the upper three meters. Analysis of charred phytoliths and particulate charcoal provided abundant evidence of the importance of burning to the local ecology.

OPAL PHYTOLITHS IN PLANTS: A NEW EXTRACTION METHOD

Braune, Caroline

Biocentre Grindel and Zoological Museum, University of Hamburg, D-20146 Hamburg, Germany, caroline.braune@uni-hamburg.de

POSTER ABSTRACT

Next to oxygen (47 %), silicon (Si) is the second most common element in the earth crust with 28 %. Si mainly exists as silicon dioxide and is available to plants as silicon acid. Significant Si accumulations occur in Poaceae and Cyperaceae, which have Si contents of >4 % (Currie, Perry 2007). In the plant tissues, silica acid polymerizes to silica gel and finally deposits as opal phytoliths in intracellular or extracellular spaces (Piperno 2006; Prychid et al. 2004). The amorphous structure of opal phytolith ($Si \bullet nH_2O$) is the result of a yet not fully understood biological and physical process (Runge 2000).

Opal phytoliths and their basic component, silicon acid, are useful for plants to increase abiotic and biotic stress resistance (Ma, Yamaji 2006). Abiotic influences, like a high intensity of light or the existence of toxic metals, have been shown to be regulated by the silicon metabolism and induce a benefit effect to the plants (Epstein 1999; Hodson, Evans 1995; Piperno 1998).

Furthermore, opal phytoliths are considered an effective defense reaction against feeding by herbivores (McNaughton, Tarrants 1983). In that respect, opal phytoliths may fundamentally contribute to understand

the co-evolution of mammals and their food plants, thus helping to understand some of the major turnover events in earth history. The Miocene is the starting point of the mega herbivore effect of landscape transformation.

For understanding mammalian teeth–phytolith interactions, morphologically-intact phytoliths are needed. Moreover, the chemical composition and biomechanical properties of opal phytoliths in unaltered conditions and their interaction with dental surfaces have to be analyzed in detail. Therefore opal phytoliths have to remain in their origin solution or an equivalent to protect their molecular structure. Here we describe a new extracting method without using chemical acids or heating-treatments on high temperatures.

Fresh leaf material of *Arundodonax* L. and *Phragmites australis* (Cav.) Trin. Ex Steud. was heated in distilled water in a microwave oven for 3-4 hours, homogenized, and afterwards decanted through a plankton sieve (50 µm mesh). After purification the plant tissue matrix was successfully degraded and single opal phytoliths and cell debris were isolated.

Two common methods have been developed to extract opal phytoliths: the dry ashing method relies on high temperatures (500-800°C), and the wet oxidation on high concentrated acids. Both methods are widely used for the preparation of reference phytolith collections used for the reconstruction of past environments (in palaeo- and archaeobiology), as well as identification of plant remains in extant soils and their classification.

The importance of phytolith research in plant taxonomy and physiology is increasing. Thus, the traditional extraction methods are compared and discussed (Parr et al. 2001). Our presented method has the potential to support the qualitative analyses of unimpaired properties of single opal phytoliths.

REFERENCES

Currie, H. A., Perry, C. C. 2007. Silica in Plants: Biological, Biochemical and Chemical Studies. *Annals of Botany*, v. 100, p. 1383-1389.

Epstein, E. 1999. Silicon. *Annual Review of Plant Physiology and Plant Molecular Biology*, v. 50, p. 641-664.

Hodson, M. J., Evans, D. E. 1995. Aluminium/silicon interactions in higher plants. *Journal of Experimental Botany*, v. 46, p. 161-171.

Ma, J. F., Yamaji, N. 2006. Silicon uptake and accumulation in higher plants. *Trends in Plant Science*, v. 11, p. 392-397.

McNaughton, M. M., Tarrants, J. L. 1983. Grass leaf silicification: Natural selection for an inducible defense against herbivores. *Proceedings of the National Academy of Sciences of the United States of America*, v. 80, p. 790-791.

Parr, J. F., Lentfer, C. J., Boyd, W. E. 2001. A Comparative Analysis of Wet and Dry Ashing Techniques for the Extraction of Phytoliths from Plant Material. *Journal of Archaeological Science*, v. 28, p. 875-886.

Piperno, D. R. 1998. Paleoethnobotany in the Neotropics from microfossils: New insights into ancient plant use and agricultural origins in the tropical forest. *Journal of World Prehistory*, v. 12, p. 393-449.

Piperno, D. R. 2006. *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*. Lanham, Altamira Press. A Division of Rowman& Littlefield Publishers, Inc.

Prychid, C. J., Rudall, P. J., Gregory, M. 2004. Systematics and Biology of Silica Bodies in Monocotyledons. *Botanical Review*, v. 69, p. 377-440.

Runge, F. 2000. *Opal-Phytolithe in den Tropen Afrikas und ihre Verwendung bei der Rekonstruktion paläoökologischer Umweltverhältnisse*. Paderborn, Books on Demand GmbH.

CONTRIBUTIONS OF PHYTOLITH STUDIES ON THE IDENTIFICATION OF SOIL GENESIS AND ENVIRONMENTAL CHANGES IN THE SÃO JOÃO RIVER BASIN, RIO DE JANEIRO, BRAZIL

Coe, Heloisa Helena Gomez,[1] Margarita L. Osterrieth,[2] Natalia Lorena Borreli,[2] Antonio Soares da Silva,[3] and Jenifer Garcia Gomes[1]

[1] Universidade do Estado do Rio de Janeiro, Faculdade de Formação de Professores, Departamento de Geografia, Rua Dr. Francisco Portela, 1470-São Gonçalo, RJ (24435-005). heloisacoe@yahoo.com; jenifergg16@hotmail.com

[2] Universidad Nacional de Mar del Plata, Centro de Geologia de Costas y del Cuaternario, Calle Funes, 3350-(7600), Mar del Plata, Argentina. mosterri@yahoo.com.ar; nlborrel@mdp.edu.ar

[3] Universidade do Estado do Rio de Janeiro, Departamento de Geografia, R. São Francisco Xavier, 524, Maracanã, Rio de Janeiro, Brazil. antoniossoares@gmail.com

POSTER ABSTRACT

This research is part of a project aiming at identifying environmental changes and understanding the genesis of soils in topo-sequences in the São João River basin, Rio de Janeiro, Brazil. The area has a humid tropical climate and its original vegetation cover was rainforests were replaced by pastures.

Four soil profiles are being analyzed: a gleysol, a fluvisol, an acrisol, and a planosol. Preliminary microscopy observations identified phytoliths assemblages in all horizons of these soils, with variations in phytolith content and types, according to the soil type.

In the **gleysol**, the predominant phytolith types in all horizons were bulliform, bilobate, elongate, globular echinate, point shape, saddle, and remains of large unclassified phytoliths. In layer C1 polylobates, trapeziforms, and crosses were also found. In layer C2 there is more globular granulate types and less bilobates than the rest of the profile.

In the **fluvisol** the predominant phytolith types in all horizons were globular granulate, bilobate, elongate, remains of large unclassified phytoliths, some rondel, cross, polylobate, point shape, bulliform, and globular echinate. In the A horizon, the most frequent type is globular granulate. In layer C4 there are several types, with almost no predominance, besides all types found in the A horizon, there are also saddle, polylobate, rondel, and cone shape (only found in this layer and in C6). In layer C7 there is almost no phytoliths, only some globular granulate, point shape, elongate, saddle, and remains of large unclassified phytoliths.

In the **acrisol** the predominant phytolith types in both surface horizons were mainly globular granulate, bulliform, elongate, bilobate, globular echinate, and remains of large unclassified phytoliths. On the horizon Bt, few phytoliths were observed and almost no short cells neither globular echinate. In the deepest horizon (Bt/BC) only a few small and unclassified phytolith remains were found.

In the **planosol** in both more superficial horizons there is few phytoliths and the predominant types are elongate, bulliform, remains of large and very weathered phytoliths, point shape and bilobate (A horizon), and globular granulate and globular echinate (E horizon). In contrast, the deeper horizons have many phytoliths, mainly Bt, being the predominant large (bulliform, elongate, point shape), and many short cells, with predominance of bilobate, but many saddle in Bt and equal amounts of bilobate and saddle in 2Bt. The largest phytolith stock in the deeper horizons can be explained by soil properties, both superficial horizons loosing material (eluvial horizon) that accumulates in illuvial horizons (Bt and 2Bt).

The material that originated soils seems to be related to variations in phytolith stocks and types with depth. Both profiles developed from sediments (gleysol and fluvisol) have very mixed phytolith types and about the same amounts of phytoliths in all horizons, indicating a sedimentary origin of these soils. In both soils developed from parent rock material there is a predominance of certain types such as bulliform and globular granulate, probably from vegetation (current or former) next to the profile. Concerning phytolith stocks, in the acrisol they follow the standard distribution, decreasing with depth. In the planosol, this pattern is inverted because phytoliths are washed from the upper horizons horizons and accumulated in the textural horizons, emphasizing the importance of translocation in phytolith distribution and accumulation within a soil profile.

The results of this research are still preliminary, but promising for using phytoliths in understanding soil genesis.

USE OF A NEW PHYTOLITH INDEX FOR IDENTIFYING CHANGES IN PALM TREES COVER DENSITY IN THE REGION OF BUZIOS, RIO DE JANEIRO, BRAZIL

Coe, Heloisa Helena Gomes

Universidade do Estado do Rio de Janeiro, Faculdade de Formação de Professores, Departamento de Geografia, Rua Dr. Francisco Portela, 1470 - São Gonçalo, RJ (24435-005). heloisacoe@yahoo.com

POSTER ABSTRACT

This work is part of a study aiming to contribute to the paleoenvironmental reconstruction of Buzios, Rio de Janeiro, Brazil, from soil profiles samples. The region presents climatic and ecological peculiarities, with many endemic species, due to a drier climate than its surrounding areas, caused mainly by a coastal upwelling. The lack of non-oxidizing environments, suitable for the use of most of vegetation proxies, led to the choice of phytoliths.

We present the results obtained with four samples from an acrisol located in "Tucuns" district, common name of the Arecaceae *Astrocarium* sp, indicating that, when this area was named, there should be plenty of these palm trees. However, nowadays palms are rarely observed, only a few ones in the highest parts of the region, suggesting natural or anthropogenic degradation.

The current cover of the profile is a hypoxerophytic vegetation with predominance of the endemic specie Cactaceae *Pilosocereus ulei* and Anacardiaceae, Apocinaceae, Ericaceae, Bombacaceae. There is almost no Poaceae in the herbaceous stratum, but many Bromeliaceae and also some Araceae and Arecaceae *Allagoptera arenaria.*

The main phytoliths identified were bulliform and globular echinate types. The large amount of globular echinate types, specially in the surface horizons, led us to use a new phytolith index, the Pa/P (palm trees phytoliths/ Poaceae phytoliths) that identified two distinct zones: Zone I, the two deepest horizons (5,800 cal years BP at the base of the profile), with a small phytolith stock, almost only the bulliform type, and the Pa/P index not significant; and Zone II, with the two surface horizons (modern age on top of the profile), with an increase in the phytolith stock, globular echinate type, and Pa/P, indicating a recent significant vegetation change with an increase of palms.

Because phytolith signals in Zone I are weak, phytolith assemblages may record the ancient vegetation over the profile, which should be different from today, but not possible to be defined. However, residual phytoliths in this zone would also be a mixture of the original assemblage, which would have undergone a selective dissolution and/or a preferential translocation of bulliform-type phytoliths, with the input of the translocation of phytoliths from Zone II, which is in agreement with the modern vegetation. In Zone II, phytolith signals indicate the predominance of palm trees, but as this is not currently observed in the area. Therefore, three hypotheses were formulated: (1) the recorded presence of palms would be in a period before the increase of human settlement in the region and indicates relatively recent human disturbances; (2) "*tucum*" palms were concentrated in the highest parts of the slope, and phytolith assemblages are the result of a mixing between the input of the original vegetation, eroded from higher parts, with the more recent one over the profile; and (3) both hypotheses: input of phytoliths from the top of the slope vegetation and recent human disturbances, which would have reduced the presence of palms in the region to more preserved areas, like tops of slopes.

Because phytolith analyses of all soil profiles studied did not indicate major changes in local vegetation cover or climate, the reduction of palms is probably anthropogenic. To go forward testing the formulated hypotheses, and verify the applicability and reliability of Pa/P index, further studies are needed in palm trees covered areas, about Arecaceae *Astrocarium* ecology and the history of this species in the region.

TOWARDS 14C AMS DATING OF PHYTOLITHS: A NEW PROTOCOL FOR GETTING PURE SAMPLES OF PHYTOLITHS FROM HARVESTED PLANTS.

Corbineau, Rémi,[1,2] Anne Alexandre,[1] Guaciara M. Santos,[3] and Paul E. Reyerson[4]

[1] CEREGE, CNRS, UPCAM-III, Europôle méditerranéen de l'Arbois BP 80, 13545, Aix-en-Provence cedex 04, France. corbineau@cerege.fr

[2] LAMM, CNRS, Université d'Aix-Marseille 1, Maison Méditerranéenne des Sciences de l'Homme, 5, rue du château de l'Horloge, BP 647, 13094, Aix-en-Provence, France

[3] Earth System Science, University of California, Irvine, B321 Croul Hall, Irvine CA 92697-3100, USA

[4] Department of Geography, University of Wisconsin-Madison, 550 North Park Street, Madison WI 53706, USA

PAPER ABSTRACT

^{14}C AMS analysis of occluded carbon in phytoliths (amorphous silica particles that form in and between living plant cells and are well preserved in soils and sediments) is a promising dating tool for paleoclimate reconstructions and archaeological studies. In order to assess the accuracy of this method, different tests have been recently carried out on large phytolith-occluded carbon samples extracted from soils and harvested

plants, in association with blank samples of SiO_2 powder to check the absence of carbon contamination during the treatments. Despite this precaution, ^{14}C values from recently harvested plants were inexplicably old (Santos et al. 2010). Nevertheless, we noticed that the chemical extraction protocols that were used did not lead to samples totally free of organic matter. Here we checked the efficiency of different extraction protocols previously presented in the literature. We finally propose a new extraction protocol combining acid digestion and dry ashing to get virtually pure samples of phytoliths from harvested plants. These samples were analyzed by SEM/EDX in order to assess the purity of the siliceous material before AMS analysis. Getting pure samples of modern phytoliths is particularly relevant for further checking the reliability of phytolith ^{14}C AMS dating.

REFERENCES

Santos, G. M., Alexandre A., Coe H.H.G., Reyerson P.E., Southon J.R., De Carvalho C.N. 2010. The Phytolith ^{14}C puzzle : a tale of background determinations and accuracy tests. *Radiocarbon*, vol. 52, n°1, p. 113-128.

THE *STIPA*-TYPE SHORT CELL: WHAT DOES IT MEAN TAXONOMICALLY, CLIMATICALLY AND ECOLOGICALLY?

Cordova, Carlos E.,[1] and Jason P. Joines[2]

[1] Department of Geography, Oklahoma State University, Stillwater, OK 74078, USA. carlos.cordova@okstate.edu

[2] Graduate College, Oklahoma State University, Stillwater, OK 74078, USA

PAPER ABSTRACT

Although found in several grass subfamilies, the *Stipa*-type is the most typical grass short-cell phytolith among species of the Stipeae tribe (Pooideae subfamily), which is often considered a separate subfamily (Watson and Dallwitz, 2010). Besides reaffirming the strong representation in the various species of this tribe, this study explores its geographic distribution in modern samples in the south-central Great Plains of North America and several regions of Eurasia and Africa. Additionally, this study analyzes the occurrence of this type in the Late Quaternary record of the Great Plains of North America.

Although predominantly found in the Stipeae, the *Stipa*-type short cell occurs sporadically in other Pooideae tribes as well in the Danthonioideae subfamily (Cordova and Scott, 2010). One problem that is reflected in reference samples is the plasticity of the "*Stipa*-type" morphotype. If defined as a "trapezoidal bilobate," the *Stipa*-type should include various subtypes: short, elongated, curved, pointy, round, and flat. These variations are found sometimes in different genera, suggesting the possibility of linking morphological variations to lower taxonomic levels.

In the Great Plains of North America, the distribution of Stipa-type grass short cell in soil surface samples closely matches the distribution of the general various species of Stipeae (e.g, *Stipa*, *Hesperostipa*, *Nassella*, *Piptatherum*, and *Oryzopsis*). This presents an opportunity to explore the ecological and climatic variables related to the distribution of this taxonomic group for further use in the interpretation of the Stipa-type short cell in paleo-records.

In late Quaternary sequences in the Great Plains, an increase in *Stipa*-type appears in soils dated to the Younger Dryas (e.g., the Brady Soil and Kanorado Soil). However, this trend is not apparent in the southern

Great Plains (e.g., Texas). In the yet unpublished phytolith records of Hall's Cave in south Texas, the *Stipa* type is one of the most abundant short-cell in the levels dated to the Last Glacial Maximum.

In Ukraine, the genus *Stipa* is common in the steppe, but its abundance increases into areas with lower precipitation in the southeast. In the Crimean Peninsula, this morphotype seems to be related to colder and drier conditions. In Mexico, the *Stipa* genus is widespread in the temperate highlands, but in particular, its presence increases in the high mountains of the central part of the country, where sub-nival conditions are characteristic. In South America's temperate grasslands, the Stipeae are diverse and widespread, becoming very abundant in the Andes and Patagonia. In Southern Africa the Stipaeae are rare and dominated by species introduced from Mexico and South America. Yet, they tend to occur in the winter rainfall area and at high elevations, but no specific environment is evident.

In general, there is a potential in the possible links between the *Stipa*-type and determined climatic conditions, which could add value to phytolith-based paleoclimatic and paleonvironmental reconstructions. The possibility that the *Stipa*-type indicates cold and dry conditions is very high. But this requires more detailed investigation, particularly because its distribution may respond to different variables in other regions of the world.

REFERENCES

Watson, D.J. and Dallwitz, L. 2010. Grass Genera of the World. *Classification*, May 1998. Available at: http://delta-intkey.com/grass/www/index.htm

Cordova, C.E. and Scott, L. 2010. The potential of Poaceae, Cyperaceae, and Restionaceae phytoliths to reflect past environmental conditions in South Africa. *Palaeoecology of Africa* 30, 107-133. Volume edited by Jürgen Runge.

GRAMINOID PHYTOLITH INDICATORS OF RAINFALL SEASONALITY IN SOUTH AFRICA

Cordova, Carlos E.

Department of Geography, Oklahoma State University, Stillwater, OK 74078, United States of America, carlos.cordova@okstate.edu

POSTER ABSTRACT

This study explores the distribution of diagnostic opal phytoliths in grasses (Poaceae), sedges (Cyperaceae), and Cape reeds (Restionaceae) in soil surface samples collected across the winter, all-year, and summer rainfall zones of South Africa. The study aims at finding potential indicators of winter and summer rainfall among graminoid phytoliths. Frequencies of grass short-cell silica (GSSC) morphotypes were plotted against percent and sum winter percent and summer rainfall. The results show that among the best indicators of winter rainfall, the Restionaceae phytoliths rank the highest. The relative abundance of Cyperaceae phytoliths is relatively high in the winter rainfall zone, but they can be substantially abundant in some mesic types of grasslands in the summer rainfall region.

Among the Poaceae, the sum of all C_3 phytoliths presents relatively good correlation with percent and amount of winter rainfall. Their best correlation is with the amount of winter precipitation. The morphotypes

with the best correlation with both percent and amount of winter precipitation belong to the Pooideae and Ehrhartoideae subfamilies.

Although the C_4 grasses dominate in the summer rainfall zone, there is no strong correlation between the sum of all GSSC morphotypes diagnostic of C_4 and the amount of summer rainfall. However, a weak correlation exists with the percent of summer rain. Individual groups of short-cell morphotypes among the C_4 subfamilies show some negative correlation with amount summer rainfall, but this is more related with the adaptation to aridity within the summer rainfall zone.

This study is only part of a testing of phytolith distribution and climatic variables. Although here only rainfall seasonality is tested, the study aims at finding relations between GSSC morphotypes and other climatic variables such as growing-season temperatures, mean annual rainfall, rainfall variability and vegetation type affiliations. The testing of these variables will imply the exploitation of the potential of phytoliths for paleoenvironmental reconstruction in southern Africa.

INTEGRATING MICROFOSSIL DATA SETS: COMPLETING THE RECORD

Cummings, Linda Scott

PaleoResearch Institute, Golden, Colorado, USA. linda@paleoresearch.com

PAPER ABSTRACT

Any microfossil record, whether phytolith, pollen, starch, diatom, or other, will always be incomplete in its representation of the paleoenvironmental or subsistence activities. Integrating microfossil records strengthens the interpretations that are possible. The strength of phytolith analysis includes an ever-growing ability to identify plants at a very specific level. The former presumption that the production of multiple types of phytoliths (multiplicity) within an individual plant was a liability has now been identified as one of the many strengths of phytolith analysis. Preservation continues to be problematic in some settings for either or both pollen and phytoliths; however, it should not be considered a limiting liability. By combining pollen and phytolith records, one may better understand records of the past environment and frequently specific use or processing activities. Examples from archaeological sites illustrate the value of examining multiple data sets to reconstruct past environments and evidence for subsistence or ritual use of plants. For instance, phytoliths, pollen, and starch all contributed to the identification of plant parts burned in a ritual pipe. Pollen often provides evidence of plant communities in general, while phytoliths frequently contribute information concerning plants with specific habitat requirements, particularly Poaceae, that cannot be identified with specificity in the pollen record. As reference and taxonomic work continue to expand our ability to identify phytoliths from individual parts of plants, our ability to interpret the past, whether paleoenvironmental or cultural, expands.

SEED PHYTOLITHS IN WEST AFRICAN COMMELINACEAE: CLASSIFICATION AND SIGNIFICANCE FOR PALAEOECOLOGICAL AND PALAEOETHNOBOTANICAL RECONSTRUCTIONS

Eichhorn, Barbara,[1] Katharina Neumann,[1] and Aline Garnier[2]

[1] Institute of Pre- and Protohistory, Archaeology and Archaeobotany of Africa, Goethe University, Grüneburgplatz 1, D-60323 Frankfurt, Germany

[2] Laboratoire Géophen, Université de Caen Basse Normandie, Esplanade de la Paix, F-14032 Caen Cedex, France

E-mail: b.eichhorn@em.uni-frankfurt.de; k.neumann@em.uni-frankfurt.de; aline.garnier@unicaen.fr

PAPER ABSTRACT

At the site complex of Ounjougou (Dogon Plateau, Mali), seasonal watercourses cut through sediments deposited during the past 100,000 years, revealing an exceptional archaeological and paleo-environmental sequence. With regard to the preservation of plant macro-remains such as wood charcoal in the stratified and well-dated Holocene deposits, Ounjougou is outstanding for West Africa. The macro-remains, however, strongly over-represent the local river vegetation, and pollen preservation is generally poor. Phytolith analysis is thus currently tested and used as an alternative tool for vegetation and climate change reconstruction at Ounjougou.

In the Holocene sediments, we recognized several conspicuous morphotypes which were initially attributed to Marantaceae and Cyperaceae. Peculiarities either of shape, size, or surface vesturing raised doubts concerning this initial attribution. Systematic screening of West African herbarium specimens revealed that the phytoliths in question originate from the seeds of Commelinaceae (spiderworts), a family of mostly tropical and subtropical monocotyledonous herbs. In West Africa, this family is represented by a limited number of taxa, most of them with clear ecological preferences either in anthropogenic (segetal and ruderal) plant communities or wetlands.

Three main morphotype groups with different diagnostic properties could be distinguished: 1. polygonal platelets; 2. flat polygonal prisms with conical top; and 3. subcylindric, distinctly anisopolar, the upper part polygonal prismatic with conical top.

According to either the presence or absence of central protuberances and peculiarities of surface vesturing, several distinct subtypes could be classified. Identification of Commelinaceae seed phytoliths is often possible at low taxonomic levels. Due to the ecological preferences of the different species, the proof of Commelinaceae seed phytoliths is valuable for paleoecological and -economical reconstructions in West Africa and other tropical and subtropical regions of the world. Some members of the spiderwort family are noxious field weeds and their proof by phytolith analysis in paleoecological or archaeological samples may help to reconstruct the presence of agricultural systems, particularly when other archaeobotanical evidence is absent.

THE STATUS OF PHYTOLITH RESEARCH IN CALIFORNIA PALEOECOLOGY: OPPORTUNITIES AND OBSTACLES

Evett, Rand R.
Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720-3114. revett@sonic.net

PAPER ABSTRACT

California's varied geography creates myriad habitats that support >5000 plant species, nearly one-third of the total vascular plants in the USA. Tectonic activity, long-term climatic fluctuations, and the arrival of humans have caused dramatic changes in plant communities over time. The arrival of European settlers in California ~250 years ago initiated a rapid invasion by exotic species that drastically changed and continues to alter many plant communities. The complexity of California's environmental history presents formidable challenges for paleoecologists trying to reconstruct past ecosystems and understand past ecosystem dynamics. Fifty years of paleocological research, principally utilizing pollen analysis, has produced long-term records of vegetation change in regions of California blessed with extensive marine, lacustrine, and/or alluvial sediments, but much of upland California lacks obvious pollen sites.

Given the fact that 10% of California's land area is grassland, one would expect tremendous opportunities to apply phytolith analysis to paleoecological reconstruction. However, there have been only three published phytolith-based studies related to California. Why so few? Drawing on my dozen years of experience as a California phytolith researcher, I will present a short review of California phytolith research to date, highlighting the types of questions that phytolith analysis has successfully answered (absence of extensive understory grass in prehistoric Sierran coniferous forests; extent and nature of pre-European settlement grasslands), followed by an overview of the obstacles currently preventing more widespread application of phytolith analysis (few phytolith-producing species; most grass species produce similar phytolith morphotypes; lack of chronological control in soil phytolith assemblages), and finish with an optimistic description of promising directions for future phytolith research in California (developing a 3-D quantitative morphometric approach to differentiate similar phytolith morphotypes; estimating past fire intensity and frequency through Raman spectroscopy of individual phytoliths; phytolith analysis of radiocarbon-dated paleosols to establish chronological control of vegetation change).

TAXONOMIC, ENVIRONMENTAL, AND PHYTOGEOGRAPHICAL SIGNIFICANCE OF LEAF PHYTOLITHS IN WEST AFRICAN GRASSES

Fahmy, Ahmed G., and Katharina Neumann

PAPER ABSTRACT

This study presents data on leaf phytoliths in West African grasses originating from the Sahelian and Sudanian phytogeographical zones in Burkina Faso, Benin, Nigeria, Niger, and Togo. Phytolith morphotypes are described for 52 common grass species belonging to 31 genera and four subfamilies: Arundinoideae, Bambusoideae, Chloridoideae, and Panicoideae. The study is an addition to our efforts towards a systematic inventory of grass phytoliths in West tropical Africa which is applicable for archaeobotanical and palaeo-

environmental studies in the region. The main concept of the classification is to incorporate a maximum of diagnostic characters such as shape, size, and 3-D subtypes.

69 phytolith morphotypes and 121 subtypes were recognized in the studied material. The total number of phytoliths counted in the Sahelian grasses is 10,635 (short cells: 6839, other types: 3796), and 12,329 (short cells: 7828, other types: 4501) for the Sudanian grasses. Some morphotypes are useful as markers for definite taxonomic categories like subtribes and genera, for example: Bilobates of small length (less than 10 µm) with flattened ends connected to short shanks (less than 4 µm) or with constriction between the lobes were only recognized in species belonging to subtribe Andropogoninae: *Cymbopogon giganteus, C. schoenanthus, Heteropogon melanocarpus, Hyperthelia dissoluta* and *Sorghum aethiopicum.* Also very large length bilobates with flattened ends (> 26 µm) of variant 2 connected to very long shanks (> 7 µm) were recorded in some genera, e.g. *Aristida, Andropogon* and *Digitaria.*

The combination of phytolith characters with distribution data of the studied species suggests that specific morphotypes are phytogeographically significant and can thus be useful for palaeoecological reconstructions.

FESTUCA GRACILLIMA COMMUNITY: PHYTOLITH ANALYSIS IN THEIR SOUTHERNMOST DISTRIBUTION AREA, TIERRA DEL FUEGO ECOTONE (TIERRA DEL FUEGO, ARGENTINA)

Fernández Pepi, María Gabriela,[1] Zucol Alejandro Fabián,[2] and Mirta Olga Arriaga[1]

[1] Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Av. Ángel Gallardo 470, 2° Piso (C1405D-JR), Ciudad Autónoma de Buenos Aires, Argentina. mgfernandezpepi@macn.gov.ar; marriaga@macn.gov.ar

[2] CICYTTP-CONICET, Dr. Matteri y España, s/n, Diamante (E3105BWA), Entre Ríos, Argentina. cidzu-col@infoaire.com.ar

POSTER ABSTRACT

Biodiversity studies in the central fueguian ecotone (S 53° 48′ and W 67° 48′, 10 m.a.s.l.), Rio Fuego region, Tierra del Fuego province (Argentina), allowed understanding of the composition and variations of natural plant communities. With human activity, these communities have been significantly modified, mainly through sheep overgrazing. This contribution is part of the ongoinf analysis to determine the evolutionary vegetation history and changes in the recent past.

Beginning the phytolith study of the natural communities, the *Festuca gracillima* steppe, considered the least affected by grazing, occupies the ecotone fueguino valley bottoms, plateaus and slopes. This community is dominated by *Festuca gracillima* in consocies with *Deschampsia patula, Phleum alpinum, Festuca magellanica, Hordeum pubiflorum, Poa pratensis, Trisetum spicatum*, and other herbs and shrubs such as *Anemone multifida, Gamochaeta nivalis, Berberis empetrifolia,* and *B. microphylla*, and in some areas with chamaephytes cushions of *Empetrum rubrum, Azorella trifurcata, Bolax gummifera*, and *Baccharis magellanica*. Community loss promotes the appearance of adventives such as various species of *Poa*.

Therefore, we first studied the species composition of phytoliths with main emphasis on grasses. Grass-leaf phytoliths assemblages were characterized by the presence of sinuate trapezoid (pooid and festucoid types), truncated cones, crescents, elongate-prismatic elements with ondulate to smooth contour, stomata complex elements and silicified hair and hooks phytoliths.

The dicotyledons were characterized by polyhedral, rectangular phytoliths jointly with irregular ones, silicified hairs, vascular elements phytoliths, and articulated stomata complex.

Soil profiles from different sampling stations were studied. Samples of the first profiles analyzed showed abundant silica microremains, microcharcoal, and partially degraded tissular fragments. Among phytoliths, graminoid elements with elonagted, point-shaped, conical, and sinuate trapezoids types are found in abundance. Despite a marked abundance of grasses in the recent past, non-graminoid phytoliths made it possible to distinguish certain assemblage variants in different zones of the profiles.

This paper presents the preliminary results obtained in the study of changes of the ecotone communities in Tierra del Fuego, which show that phytolith analysis is a valuable tool to be applied in this southern region.

PHYTOLITHS FOR RECONSTRUCTING PALAEOENVIRONMENTS FROM FLUVIAL RECORDS: APPLICATION TO THE LAST 6000 YEARS DEPOSITS OF THE YAMÉ RIVER (DOGON COUNTRY, MALI)

Garnier, Aline,[1] Katharina Neumann,[2] Laurent Lespez,[1] and Barbara Eichhorn[2]

[1] Geophen, CNRS-UMR LETG 6554 Université de Caen-Basse-Normandie, Esplanade de la Paix, BP 5186, 14032 Caen cedex, France

[2] Goethe University, Institute of Archaeological Sciences, Grueneburgplatz 1, D-60323 Frankfurt am Main, Germany

PAPER ABSTRACT

Phytolith analysis offers an important alternative fossil vegetation record in fluvial environments. First, because of their siliceous structure, phytoliths are well preserved in terrestrial sediments whereas pollen preservation is mainly restricted to anoxic waterlogged deposits. In alluvium profiles, phytoliths can therefore be found in sandy and gravelly as well as in clayey deposits. Second, whereas macroplant fossils provide information mainly about the woody vegetation, the phytolith record allows for differentiating Poaceae subfamilies and for reconstructing the grass layer (Twiss et al., 1969; Fredlund & Tiezsen, 1994). Charred phytoliths supply detailed information about the kind of vegetation that is burned (Parr, 2006; Morris et al., 2009).

This presentation aims to evaluate the potential of phytoliths as bio-proxies in fluvial deposits of the Yamé valley (Mali), covering the last 6,000 years. This study combines phytolith analysis with stratigraphic research and is based on 40 samples from multi-site sequences of alluvial and colluvial sediments along 125 km in the Yamé valley. The investigation of the sedimentary records yields information about the hydrological and depositional context of the phytolith assemblages. Phytolith dispersal is influenced by several factors such as wind and water transport, fire, and grazing by herbivores and depending on the type of site examined (Fredlund and Tiesen., 1994; Pearsall, 2001; Piperno, 2006). Sediment taphonomy is an important issue because it helps to determine the source area of phytoliths and therefore to delimit the spatial scale of vegetation reconstruction.

The results show that the predominant source areas of phytoliths represented in the deposits vary with the fluvial energy of their transport. Channel deposits, carried during periods of strong fluvial activity, contain larger numbers of savanna grass phytoliths than those deposited locally in the floodplain, where woody

dicotyledons morphotypes are better represented. Data from the modern samples indicate that Panicoideae morphotypes are to a large extent produced by pearl millet and can be a good marker for the presence of fields in a Sahelian context. From 4500 years BP onwards, the increase of Panicoideae phytoliths during a more arid period, coupled with high values of burned phytoliths from the gallery forest, attests for human impact on the Dogon Country landscapes.

REFERENCES

Fredlund, G.G., and L. T Tieszen. 1994. Modern phytolith assemblages from the North American great plains. *Journal of Biogeography* 21 (3): 321–335.

Morris, L.R, R.J. Ryel, and N.E. West. 2010. Can soil phytolith analysis and charcoal be used as indicators of historic fire in the pinyon-juniper and sagebrush steppe ecosystem types of the Great Basin Desert, USA? *The Holocene* 20 (1): 105.

Parr, J.F. 2006. Effect of fire on phytolith coloration. *Geoarchaeology* 21 (2): 171–185.

Pearsall, D.M. 2001. *Paleoethnobotany: A Handbook of Procedures.* Emerald Group Pub Ltd.

Piperno, D.R. 2006. *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists.* Oxford, UK: AltaMira Press.

Twiss, P.C., E. Suess, and R.M. Smith. 1969. Morphological classification of grass phytoliths: Soil Science Society of America. Dans *Proceedings*, 33:109–115.

INTERRELATION BETWEEN PHYTOLITH PROFILE TYPE AND LAND TOPOGRAPHY

Golyeva, Alexandra

Institute of Geography RAS, Moscow, Russian Academy of Science, Staromonetnyi per. 29, Moscow, Russia, alexandragolyeva@rambler.ru

POSTER ABSTRACT

Soils within the limits of the "Russian North" National Park (the Vologda Region, Russia) have been studied for the purpose of identifying specific features of microbiomorphic profiles controlled by topographic position of the soil. A series of soil pits with typical podzolic soils (developed on covering loam under a spruce forest) were dug on a morainal ridge slope, the length of the latter being 24.2 m and its gradient 4°41'. The parent rock is defined as glacial till overlain with silty-clayey sand. The pits for the soil profile studies were positioned on the top of the ridge, at the upper third of the slope, at its lower third, and at the base of the slope. Quantitative characteristics of soil were studied in every profile, as well as the composition and depth of occurrence of siliceous bioliths (phytoliths).

The results of the studies revealed some significant differences in the phytolith profile composition depending on its topographic position. The upper horizon of soil profile on the ridge top appears to be depleted of phytoliths, while those positioned lower on the slope are quantitatively enriched with them. It should be emphasized that in spite of difference in phytolith abundance recorded in the studied profiles, their

qualitative characteristics (such as relation between different forms) make possible reconstructions of changes in plant composition as recorded in all the profiles.

COMPARATIVE RESEARCH ON THE PHYTOLITH MORPHOLOGY FROM THE WILD AND DOMESTICATED RICE SPECIES IN SOUTHEAST ASIA

Gu, Yansheng,[1, 2*] Zhijun Zhao,[3] and Deborah M. Pearsall[4]

[1] State Key Laboratory of Geobiology and Environmental Geology, China University of Geosciences, Wuhan 430074, China

[2] Hubei Key Laboratory of Wetland Evolution & Eco-Restoration (WEER), China University of Geosciences, Wuhan 430074, China

[3] Institute of Archaeology, Chinese Academy of Social Sciences, Beijing 100710, China

[4] Department of Anthropology, University of Missouri, Columbia, MO 65211, USA

* Corresponding author: Yansheng_gu@yahoo.com.cn

PAPER ABSTRACT

Systematic descriptions of phytoliths from rice species in Southeast Asia are scarce. There is even less understanding of the relationships among phytolith morphology, taxonomy, and genome. In order to investigate the relationships among phytolith morphology, taxonomy, and genome, comparative research on phytolith morphology of the wild and domesticated rice species was first performed on the basis of statistics and cluster analysis. We have mainly focused on similarity and differentiation of phytolith morphology, especially that of three typical phytoliths (double-peaked glume cells, cuneiform bulliform cells, and bilobates) derived from rice leaves and inflorescences. The leaves and inflorescences of domesticated and wild rice contain a great diversity of phytolith types including long cells, short cells, bulliform cells, hair cells, irregular epidermal cells, and mesophyll and vascular tissues. Comparative research on phytolith morphology demonstrates that most overlap occurs among long cells, short cells, bulliform cells, hair cells, and vascular tissues at the species level. Rondels, crosses, long cells, hair cells, parallepipedal bulliform cells, tracheid and vascular tissue exhibit no taxonomical value. Complex saddles and irregular epidermal phytoliths might be diagnostic to a rice species that had not been described before. Further comparative research on the morphological features of three phytolith types from the wild and domesticated rice species has confirmed that double-peaked glume cell measurements can separate domesticated *Oryza* species from wild ones successfully. Hierachical cluster analysis on all morphological parameters of bilobates, cuneiform bulliform cells, and double-peaked glume cells strongly demonstrates that phytolith assemblage appears to be under genetic control and therefore reflects taxonomical significance. Our results are significant for plant physiology, rice cultivation, and environmental archaeology.

Acknowledgments: This work was jointly supported by the National Natural Science Foundation of China (grant numbers 40872202, 40930210).

ETHNOARCHAEOLOGIC PERSPECTIVES OF BAMBOO TOOLS IN THE HIGHLANDS OF THE INDONESIAN WESTERN HALF OF THE ISLAND OF NEW GUINEA: BAMBOO PHYTOLITHS ARE KEY TO THE SHARPNESS, HARDNESS, AND STRENGTH OF THE TOOLS

Hampton, O. Winston (Bud)

University of Colorado Museum, Boulder, The Exploration Discovery Center, 1575 Devil's Gulch Road, Estes Park, Colorado 80517, USA. hamptonexplorer@aol.com

Poster Abstract

In a creative adaptation during the Stone Age to available raw materials, the Highlanders added bamboo knives for domestic purposes, the disarticulation and butchering of pigs and for two kinds of surgical slicing procedures; *moli* (sharp) *sike* bloodletting instruments; arrow tips for killing birds (including the 200 pound cassuary), quadrupeds, and humans; and bamboo matchboxes for starting the all-important fire. The biogenetically formed silica in the morphology of silicon dioxide phytoliths within the epidermal tissue of the stems of bamboo (sub-family Bambusoidea of the grass family Poaceae) is fundamental to the success of the Highlanders' bamboo tools that were all used from the Stone Age into the present. The photographs on the posters showing the uses of these bamboo tools are provocative.

References

Hampton, O.W. 1987, 1988, 1989, 1992a, b, c, 1993. Anthropological Explorations and Discoveries in the Highlands of Irian Jaya, Indonesia. Unpublished Explorers' Club Flag Reports. New York, Explorers' Club.

Hampton, O.W. 1997. *The Quarrying, Manufacture, Trade and Uses of Profane and Sacred Stone Tools and Symbolic Stones in the Highlands of Irian Jaya, Indonesia.* Vols. 1, 2, and 3. PhD diss. with 887 pages and 435 colored photographs. Texas A&M University, College Station.

Hampton, O.W. 1999. *Culture of Stone: Sacred and Profane Uses of Stone Among the Dani.* Texas A&M University Press, College Station.

REDBED PHYTOLITHS FROM TEXAS: FIRST FOSSIL EVIDENCE OF VEGETATION IN WESTERN EQUATORIAL PANGEA ACROSS THE PERMO-TRIASSIC BOUNDARY

Kirchholtes, Renske,[1] Cindy V. Looy,[1] and Tom van Hoof[2]

[1] Department of Integrative Biology, University of California Berkeley, Berkeley, CA 94720, USA. Renske. Kirchholtes@berkeley.edu

[2] TNO-Geobiology, Princetonlaan 6, 3584 CB, Utrecht, The Netherlands

PAPER ABSTRACT

252 million years ago, the mass extinction event at the end of the Permian period ended almost all life on Earth. In the semi-arid equatorial region of the supercontinent Pangaea, it resulted in the widespread disappearance of conifer forests. Following ecosystem collapse, seedferns and lycopods became the most important players in the Euramerican floral realm, which was located in the eastern part of the tropical Pangea. Much of what we know about what happened during this extinction event is based on studies from marine samples from the Eastern Tethys Ocean, and palynological and paleobotanical samples from terrestrial high latitudes. Little is known about the paleoenvironmental changes at the Permo-Triassic boundary (PTb) along the western part of tropical Pangea, as we lack good macrofloral or microfloral fossil records. However, in order to analyze the causes and effects of this biotic crisis we urgently require information from non-fossiliferous areas to provide a broader, more global perspective.

Sediments deposited at the coastal Panthalassa margin of Pangea crop out in Caprock Canyon State Park in western Texas. At this location, marine and terrestrial influences initially interfinger, and gradually change into terrestrial river deposits. The fluvial sandstones and the overbank mudstones of the Quartermaster formation are known to include the PTb, as determined by U-Pb dating, and minute quantities enclosed organic matter showing biogeochemical changes associated with the end-Permian crisis that you would expect to find close to the boundary. Caprock Canyon's sedimentary rocks, which are typical redbed formations deposited under oxidizing conditions, have unsuccessfully been studied for pollen. However, when the same samples were processed according to standard phytolith extraction techniques, they proved to be productive. Phytolith slides were scanned entirely and named following the International Phytolith Nomenclature.

Preliminary analysis of the samples revealed that almost all samples contain phytoliths. 23 morphotypes were recognized, most notably the (im)prints of circular boarded pits. Circular boarded pits are characteristic features of coniferous wood, pieces of which were also found in the same section, suggest that vegetation rich in conifers was present at the coastal Panthalassa margin of Pangea. These finds, both phytoliths and wood, are the first evidence for plant life in this region. If the Quartermaster Fm. would prove to be stratigraphically conformable, then these results would imply that, contrary to what has generally been suggested, the Panthalassa margin of Pangea was not barren, but covered in woodland throughout the time period crossing the PTb. For our future work we will focus on establishing the botanical affinity of the encountered morphotypes, and increasing our sample set.

PHYTOLITHS AS SILICON TRANSPORT VECTORS FROM FINNISH CATCHMENTS AREAS TO THE BALTIC SEA

Lehtimäki, Maria, and Petra Tallberg

Department of Food and Environmental Sciences, Environmental Soil Science, P.O. Box 27, FIN-00014 Helsinki University, Finland. maria.lehtimaki@helsinki.fi

POSTER ABSTRACT

The transport of potentially bio-available silicon (Si) pools from the drainage area to rivers, lakes, and the sea influences the ecological state of the receiving water body (Humborg et al. 2000; Smayda 1990). The most important forms of potentially bio-available Si are dissolved silica (DSi) and biogenic silica (BSi). The river fluxes of DSi have been studied for a long time but the importance of the particulate silica load has not been recognized until recently. Particulate BSi carried by rivers to lakes and seas is generally assumed to be composed mainly of diatoms. However, studies in tropical and temperate areas have demonstrated that large part of riverine BSi can consist of phytoliths (Cary et al. 2005). Consequently, the role of phytoliths as Si transport vectors from catchment areas to water courses should also be studied in northern environments.

In this study we evaluate the contribution of phytoliths to the suspended Si load of Finnish rivers to the Baltic Sea. Water samples were collected in spring and in autumn from river mouth areas and analyzed for total BSi concentration, the distribution of phytoliths and diatoms and the concentration of DSi. The land use, soil type, geomorphology and latitude of the catchment areas varied substantially. The total BSi concentration in the water was analysed by hot alkaline digestion (Ragueneau et al. 2005). Diatom and other phytoplankton concentrations were enumerated from all water samples using the inverted microscope technique (Utermöhl 1958). The phytolith samples were centrifuged and then dried at +60°C. The phytoliths were extracted by standard methods modified for seston samples and from each slide the number of particles was analyzed by microscope (Piperno 2006). The phytoliths and diatoms were separated either microscopically based on their distinct features or by gravimetric separation based on the slightly different density of diatoms and phytoliths. Different environmental variables (e.g. pH, N and P concentrations, water discharge, total suspended sediment load of the rivers, and dissolved organic carbon) were also analyzed or obtained from the Finnish Environmental Institute and used for the interpretation of our data.

Preliminary results indicate that phytoliths are very abundant in the river seston at least in the autumn. In part of the samples the BSi was nearly entirely composed of phytoliths. Phytoliths were most abundant in rivers with high suspended material concentrations due to the soil erosion in the catchment, mostly in rivers from southern Finland where agricultural lands are more common than in the northern parts of the country. Our preliminary results demonstrate that BSi transported by rivers can consist of phytoliths to a considerable extent in northern environments as well, and that phytoliths may contribute significantly to the amount of potentially bio-available Si in water ecosystems.

REFERENCES

Cary, L., A. Alexandre, J.-D. Meunier, J.-L. Boeglin, and J.-J. Braun. 2005. Contribution of phytoliths to the suspended load of biogenic silica in the Nyong basin rivers (Cameroon), *Biogeochemistry* v. 74, p. 101–114.

Humborg, C., D.J., Conley, L. Rahm, F. Wulff, A. Cociasu, V. Ittekkot. 2000. Silicon retention in river basins: Far-reaching effects on biogeochemistry and aquatic food webs in coastal marine environments. *Ambio* 29:45-50.

Piperno, D.R. 2006. *Phytoliths: A comprehensive guide for archaeologists and paleoecologists,* AltaMira Press, Oxford.

Ragueneau, O., N. Savoye, Y. Del Amo, J. Cotton, B. Tardiveau, and A. Leynaert. 2005. A new method for the measurement of biogenic silica in suspended matter of coastal waters: using Si:Al ratios to correct for the mineral interference, *Continental Shelf Research* 25:697-710.

Smayda, T. 1990. Novel and nuisance phytoplankton blooms in the sea: Evidence for a global epidemic. In *Toxic Marine Phytoplankton,* ed. Graneli, E., Sundstrom, B., Edler, L., Anderson, D.M. Elsevier, New York, pp 29-40.

Utermöhl, H. 1958 Zur Vervollkommung der quantitativen Phytoplankton-Methodik. *Mitteilungen* der *Internationalen Vereinigung* der *Limnologen v.* 9, p. 1-38.

PHYTOLITHS ANALYSIS FOR THE DISCRIMINATION OF FOXTAIL MILLET (*SETARIA ITALICA*) AND COMMON MILLET (*PANICUM MILIACEUM*)

Lu, Houyuan,[1]* Jianping Zhang,[1] Naiqin Wu,[1] Kam-biu Liu,[2] Deke Xu,[1] Quan Li[1]

[1] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China,

[2] Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, Louisiana, United States of America

* Corresponding author: houyuanlu@mail.iggcas.ac.cn

POSTER ABSTRACT

Foxtail millet (*Setaria italica*) and Common millet (*Panicum miliaceum*) are the oldest domesticated dry farming crops in Eurasia. Identifying these two millets in archaeobotanical remains is still problematic, especially because millet grains preserve only when charred. Phytoliths analysis provides a viable method for identifying this important crop. However, to date, the identification of millet phytoliths has been questionable, because very little study has been done on their morphometry and taxonomy. Particularly, no clear diagnostic feature has been used to distinguish between Foxtail millet and Common millet. Here we examined the anatomy and silicon structure patterns in the glumes, lemmas, and paleas from the inflorescence bracts in 27 modern plants of Foxtail millet, Common millet, and closely related grasses, using light microscopy with phase-contrast and microscopic interferometer. Our research shows that five key diagnostic characteristics in phytolith morphology can be used to distinguish Foxtail millet from Common millet based on the presence of crossshaped type, regularly arranged papillae, Ω-undulated type, endings structures of epidermal long cell, and surface ridgy line sculpture in the former species. We have established identification criteria that, when used together, give the only reliable way of distinguishing between Foxtail millet and Common millet species based on their phytoliths characteristics, thus making a methodological contribution to phytolith research. Our findings also have important implications in the fields of plant taxonomy, agricultural archaeology, and the culture history of ancient civilizations.

A TYPOLOGIC AND MORPHOMETRIC ANALYSIS OF PHYTOLITHS PRODUCED BY THE INFLORESCENCES OF SELECTED SPECIES OF MILLET.

Maddox, AnnaLisa,[1] and Terry Ball[2]

[1] Student, Brigham Young University, Provo, UT, 84602. 3smartpeople@gmail.com

[2] Department of Ancient Scripture, Brigham Young University, Provo, UT, 84602. terry_ball@byu.edu

Poster Abstract

Millets are an important small-grain cereal crop. The millets include both panicoid and chloridoidgrasses from several genera, including *Pennisetum, Panicum, Eleusine, Echinochloa, Paspalum, and Urochloa.* This study presents a typological and morphometric analysis of phytoliths produced by the inflorescences of selected species of millet using computer-assisted image and statistical analysis. The study is part of a larger effort to develop taxonomic tools to distinguish among the phytoliths produced by the various taxa of millet.

VEGETATION AND LAND USE IN THE TEOTIHUACAN VALLEY, MEXICO: MIXED SIGNALS FROM DIFFERENT PROXIES

McClung de Tapia, Emily, and Carmen Cristina Adriano-Morán

Laboratorio de Paleoetnobotánica y Paleoambiente, Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México. emily.mcclungtapia@gmail.com

Paper Abstract

For decades archaeologists have speculated about the environmental conditions of the region within which the urban center of Teotihuacan in the northern Basin of Mexico developed between approximately A.D. 1 and A.D. 650. The demise of this important prehispanic city has been variously attributed to resource degradation resulting from deforestation and intensive agriculture, as well as climate change (Sanders 1965, Sanders et al. 1979). However, until relatively recently, archaeologists generally based their estimates of productivity and the population that could be sustained on modern soils and vegetation, including modern albeit rural agricultural productivity (Sanders et al. 1979). Recent paleoenvironmental studies in the Teotihuacan Valley are largely based on analyses of soils and sediments in the region, to reconstruct changes in the landscape through time, from the earliest prehispanic human occupation through the early Colonial period. Plant macro- and microfossils, stable carbon isotopes and radiocarbon dating of organic sediment and charcoal (when available) are undertaken together with the analysis of soils in order to develop a more complete picture of vegetation change and human impact.

In this presentation we emphasize the contribution of a detailed analysis of phytoliths from a much-studied profile slightly NE of the ancient city of Teotihuacan: Río San Pablo (Rivera et al. 2007; Solleiro et al. 2011). Additional radiocarbon dates together with a broader range of stable carbon isotope ratios are now available. A concerted effort to improve recovery of pollen from the sequence provides a more complete picture of vegetation change. Together these data contribute to a better understanding of soil development,

erosion events, and human impact in the form of agricultural practices. The objective of this study is to evaluate vegetation and land use changes in the central Teotihuacan region based on the phytolith evidence from Río San Pablo, and to compare these results with the information from stable carbon isotopes and the pollen record. Whereas $^{13}\delta C$ ratios indicate the predominance of C_4 taxa, phytoliths suggest an abundance of C_3 taxa. Preliminary results from the pollen analysis also indicate considerable diversity of arboreal taxa. We explore the significance of these proxies, for the paleoenvironmental record and as indicators of human agricultural activities and their impact through time.

REFERENCES

Rivera Rivera-Uria, M.Y., S. Sedov, E.Solleiro-Rebolledo, J. Pérez-Pérez, E. McClung, A. González, and J. Gama-Castro. 2007. Degradación ambiental en el Valle de Teotihuacan: evidencias geológicas y paleopedológicas, *Boletín de la Sociedad Geológica Mexicana* 59(2): 203-217.

Sanders, W.T. 1965. *The Cultural Ecology of the Teotihuacan Valley.* Department of Anthropology and Sociology, The Pennsylvania State University, University Park.

Sanders, W.T., J.R. Parsons. and R.S.Santley. 1979. *The Basin of Mexico. Ecological processes in the Evolution of a Civilization*, Academic Press, Orlando.

Solleiro, E., S. Sycheva, S. Sedov, E. McClung, Y. Rivera, C. Salciso, and A. Kuznetsova. 2010. Fluvial processes and paleopedogenesis in the Teotihuacan Valley, Mexico: responses to late Quaternary environment changes. *Quaternary International*, doi:10.1016/j.quaint.2010.08.005.

USING PHYTOLITHS TO REVEAL THE VEGETATION HISTORY OF SOUTHEASTERN VANCOUVER ISLAND AT INTERMEDIATE TEMPORAL AND SPATIAL SCALES

McCune, Jenny L.,[1] Marlow G. Pellatt,[2] and Mark Vellend[3]

[1] Department of Botany and Biodiversity Research Centre, University of British Columbia, Vancouver, BC V6T 1Z4, Canada. jmccune@interchange.ubc.ca

[2] Parks Canada, Western Canada Service Centre, Vancouver, BC V6B 6B4, Canada

[3] Département de Biologie, Université de Sherbrooke, Sherbrooke, QU J1K 2R1, Canada

PAPER ABSTRACT

The vegetation of southeastern Vancouver Island is unique in coastal British Columbia because of a relatively dry climate. Pollen records indicate that open Garry oak (*Quercus garryana*) savannahs have existed here since an even drier period about 8,000 years ago, and were maintained up to the time of the European settlement despite wetter, cooler conditions likely due to deliberate use of fire by the indigenous peoples (Pellatt *et al.* 2001, Brown & Hebda 2002). Following European settlement, most of these savannahs have been lost due to a combination of agriculture and development, as well as encroachment by Douglas fir (*Pseudotsuga menziesii*) forests on many of the remaining savannahs (Lea 2006, Bjorkman & Vellend 2010). The soil phytolith record may provide the finer temporal and spatial resolution required to gain a more local understanding of the extent and variability of oak savannahs prior to European settlement, and whether or not changes

can be more directly linked to known human activity. Preliminary data from two test cores indicate that the distinctive asterosclereid phytoliths originating from Douglas fir needles (Boydon *et al.* 1963, Blinnikov 2002) are significantly more abundant in soil beneath Douglas fir forest than in adjacent oak savannah. We have recently extracted twenty-three soil cores from within the known historical range of oak savannahs on Vancouver Island, representing a variety of current vegetation types from savannah to closed-canopy Douglas fir forest. Three cores were taken in close proximity to an archaeologically well-known prehistoric village and burial site. By correlating surface phytolith assemblages with present vegetation, we hope to use changes in phytolith composition in the soil profile to indicate changes in the vegetation at these local sites in the past. This research will address fundamental questions regarding the relative roles of human and climatic influences on vegetation in the past, and the duration of time lags between changes in human land use and subsequent vegetation change. It also aims to improve our understanding of the historical range of variability of the Garry oak savannah ecosystem in this region.

REFERENCES

Bjorkman, A.D., Vellend, M. 2010. Defining historical baselines for conservation: ecological changes since European settlement on Vancouver Island, Canada. *Conservation Biology* 24:1559-1568.

Blinnikov, M. S. 2005. Phytoliths in plants and soils of the interior Pacific Northwest, USA. *Review of Palaeobotany and Palynology* 135:71-98.

Boydon, J. E., Dore, W. G., and Clark, J. S. 1963. Silicified plant asterosclereids preserved in soil. *Soil Science Society Proceedings* 27:476-477.

Brown, K. J., and Hebda, R. J. 2002. Ancient fires on southern Vancouver Island, British Columbia, Canada: A change in causal mechanisms at about 2,000 ybp. *Environmental Archaeology* 7:1-12.

Lea, T. 2006. Historical Garry oak ecosystems of Vancouver Island, British Columbia, pre-European contact to the present. *Davidsonia*17:34-50.

Pellatt, M. G., Hebda, R. J., and Mathewes, R. W. 2001. High-resolution Holocene vegetation history and climate from Hole 1034B, ODP leg 169S, Saanich Inlet, Canada. *Marine Geology* 174:211-226.

THE CENTRAL AFRICAN RAINFOREST DURING THE LAST GLACIAL MAXIMUM: PHYTOLITHS AND SPONGE SPICULES FROM ALLUVIAL SEDIMENTS IN SOUTHERN CAMEROON

Neumann, Katharina,[1] Mark Sangen,[2] and Joachim Eisenberg[2]

[1] Goethe University, Institute of Archaeological Sciences, 60323 Frankfurt am Main, Germany. k.neumann@em.uni-frankfurt.de

[2] Goethe University, Department of Physical Geography

PAPER ABSTRACT

For the Late Glacial Maximum (LGM, 23-19 ka), proxy data on the vegetation in tropical Africa are sparse due to the rarity of pollen-containing lake and swamp deposits. Phytoliths from alluvial sediments

prove to be a valuable alternative. We present here a study on phytoliths from the alluvia of three rivers in South Cameroon, located in the area of modern tropical rainforest, dated between 22 and 13 ka. The ratios between phytoliths and complete and fragmented sponge spicules serve for an assessment of the autochthonous and allochthonous components in the assemblages and for deciphering fluvial system dynamics. The index D:P is used as indicator for the relative proportion of forest and grassland, burned phytoliths for bush fires and instable landscape conditions, and the globular echinate morphotype for the presence of palms and high groundwater table.

The results indicate a distinct climatic gradient between the sites from N to S. The assemblages from Belabo on the river Sanaga, at the modern rainforest-savanna boundary, have burned phytoliths, large numbers of *Oxytenanthera* saddles, and low D:P values. This points to the presence of grasslands and gallery forests dominated by the fire-resistant bamboo species *Oxytenanthera abyssinica*. Further south, the assemblages from sites along the river Nyong indicate a mosaic of forest and savanna, regularly subject to bush fires. Only at the southernmost site Meyos on the river Ntem, rainforest persisted in a refuge, probably under continuous high rainfall. GSCP are completely absent in the assemblages from this site, and high numbers of the globular echinate morphotype and complete sponge spicules point to a swamp forest with continuous water supply. Most surprising is the similarity between samples from the LGM and those from the period after 17 ka when rainfall distinctly increased. It seems that hydrological conditions remained unstable, thus preventing the establishment of closed forests in Central Africa until the beginning of the Holocene around 11.5 ka.

Several questions remain open and require further research. Highly variable percentages of sclereids in the assemblages might serve as indicators for different types of woody vegetation, but cannot be interpreted so far because of the lack of modern reference material. The same is true for the D:P, showing values between 0,8 and > 100. In some cases, the D:P even could not be calculated due to the absence of GSCP. Such high D:P values have not yet been described for modern assemblages from tropical Africa. Extensive studies on soil surface samples and on modern plants are necessary for a better interpretation of the fossil phytolith assemblages.

PHYTOLITHS OF SUB-SAHARAN GRASSES AND PRESENT-DAY VEGETATION

Novello, Alice,[1,2]* Doris Barboni,[2] Pierre Poilecot,[3] and Patrick Vignaud[1]

[1] IPHEP, Institut International de Paléoprimatologie, Paléontologie Humaine: Evolution et Paléoenvironnements, UMR 6046 CNRS-INEE, Université de Poitiers, UFR-SFA, 40 avenue du Recteur Pineau, 86022 Poitiers cedex, France.

[2] CEREGE, Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement, UMR 6635 CNRS, Université Aix-Marseille, BP80, F-13545 Aix-en-Provence cedex 4, France.

[3] CIRAD, Centre International de Recherche en Agronomie pour le Développement, Campus International de Baillarguet, UR AGIRs, TA C/22 E, 34398 Montpellier cedex 5, France.

* Corresponding author: alice.novello@univ-poitiers.fr or novello@cerege.fr

PAPER ABSTRACT

The taxonomical and environmental resolution of phytoliths has improved since the last decade thanks to extensive work on modern plant material in many regions. Few studies, however, have dealt with African species, despite the fact that phytoliths have been found preserved at many paleontological and archaeological sites in Africa. In fossil-rich paleosols where pollen grains are rarely found preserved, phytoliths may provide the only direct botanical evidence for reconstructing past vegetation. In order to improve the resolution of phytoliths for reconstructing tropical African paleovegetation, we built a phytolith reference collection based on modern tropical African grass taxa. We extracted and analyzed the phytolith content of leaves and inflorescences of 73 different species belonging to 9 different tribes among the Panicoideae, Chloridoideae, Aristidoideae, Ehrhartoideae, and Arundinoideae grass sub-families. We also collected data on the ecological preferences and habitat of the grass species in Africa. Most grass species are largely distributed at low altitude in Chad and throughout tropical sub-Saharan Africa. Microscopic observations of the silica bodies were carried out using three-dimensional shapes in order to take into account the morphological variability among the main categories of grass silica short cells (GSSCs). Among the criteria used to improve the phytolith descriptions further, we considered the shape of base vs. top, appearance of the cross-section, mean size, and shape of lobes when present. In total, we described more than 50 different GSSC types. To appreciate the significance of such morphological discrimination we used multiple correspondence and canonical correspondence analyses in combination to environmental and taxonomical parameters.

Preliminary results show that the size of GSSCs and the nature of the section (tabular or trapeziform) are relevant morphological features improving the taxonomical and environmental resolution. Long bilobates (>20 µm) with long shaft occur preferentially in short grasses of arid savannas or steppes (including species of the Aristideae tribe and the chloridoid genus *Ctenium*). Trapeziform bilobates and crosses are more commonly produced by the Andropogoneae tribe (Panicoideae sub-family) that includes mainly tall grass species several m high of humid savannas. Rondels, however, are found in all grass subfamilies we studied and are thus redundant. This last result is different from the global pattern suggested by Twiss and other researchers. Rondels do not appear as a useful morphotype in the context of sub-Saharan tropical Africa. Moreover, large amounts of rondels in African tropical soils of low altitude cannot be only attributed to the presence of the Chloridoideae sub-family, as was previously described from East Africa.

In conclusion, further analyses using climatic data should allow us to improve the environmental signal of GSSCs and better define the climatic space occupied by grasses of the tropical domain.

SILICOPHYTOLITHS IN SEDIMENTARY SEQUENCES IN THE LAGUNA POTROK AIKE, SANTA CRUZ, ARGENTINA

Osterrieth, M.[1], M.F. Alvarez,[1,2] J. Rojo,[1] M. Fernandez Honaine,[1,2] N. Borrelli,[1,2] L. Benvenuto, N.I. Maidana,[3,2] B. Zolitschka,[4] SALSA, and PASADO Science Teams

[1] Instituto de Geología de Costas y del Cuaternario, FCEyN, UNMdP, Dean Funes 3350, CC 722, Mar del Plata (7600)

[2] Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET)

[3] Departamento de Biodiversidad y Biología Experimental, Universidad de Buenos Aires

[4] Geomorphology and Polar Research (GEOPOLAR), Institute of Geography, University of Bremen, Germany. http//www.icdp-online.org/front_content.php?idcat=1949. mosterri@mdp.edu.ar

POSTER ABSTRACT

The circular maar lake Laguna Potrok Aike (PTA; 51°58′ S,70°23′ W) is a 100 m deep crater lake, with a maximum lake diameter of 3.5 km and a volume of 0.41 km^3, located in southern Santa Cruz, Argentina, in the Patagonian steppe. The climate in the region is very and semi-arid and windy.

The aim of this study was to analyze the silicophytoliths present in actual soils corresponding to the most representative plant communities from W-SW sector of Santa Cruz province and from soils surrounding Laguna Potrok Aike (PTA). Also, phytoliths were described from 46 samples from cores obtained with the framework of SALSA (South Argentinean Lake Sediment Archives and modeling) and ASADO (Analysis of Sediment Distribution in Laguna Potrok Areal Aike) projects; and 40 samples from cores coming from Potrok Aike Sediment Archive Drilling Project (PASADO). Around 2-5 g of soil and sediments samples were taken from each level and analyzed following routine techniques. At this stage, we analyzed the total sample, determining the percentage of phytoliths, diatoms, spicules, and Chrysophyceae cysts and scales, related to the total mineralogical components in each level. The samples were mounted with immersion oil, and 400 mineral grains were counted in each slide under a light microscope for the quali-quantitative analysis. The phytolith morphotypes were described according to ICPN descriptors (Madella et al. 2005).

The results of modern soils in the main plant communities had a predominance of phytoliths with respect to other biomineralizations. They were mostly represented by rondel and elongated morphotypes, and other phytolith morphologies such as unciform and cuneiform.

The results of the 46 samples of the different cores from PTA showed a predominance of diatoms (entire and broken) with respect to other biomineralizations. Phytoliths were observed in low percentages, and were mostly represented by rondel and elongated morphotypes, all corresponding to the Pooideae. A low number of bilobates and weathered phytoliths were also found. Due to the presence of vegetation around the lake, the percentage of phytoliths in samples from shallow areas was higher. In relation with phytolith distribution within the lake, higher values were detected in the northern sector, while the lower ones were in the southern sector. The quantities, morphology and the preservation state of the phytoliths found in these samples involved taphonomic aspects that reflected their transport from the surrounding soils. Also, reworking

occurred through morphodynamic processes of the lake, incoming streams, and waves associated with the predominant and strong westerly winds.

The preliminary exporation of the upper sector of the PASADO composite core showed that almost all the analyzed levels were sterile, with very low content (< 1%) of largely weathered and broken elongates and rondels, and eroded diatoms.

Therefore, these studies made possible to make inferences about taphonomic, environmental, and paleoenvironmental processes in the Potrok Aike maar lake region.

Acknowledgements: To Drs. M. M. Paez and A F. Quintana for providing the studied samples and UNMdP for the financial support (EXA 551/11).

AMORPHOUS SILICA BIOMINERALIZATIONS IN PLANTS AND SOILS AND THEIR ROLE IN THE BIOGEOCHEMISTRY OF SILICON IN THE SOUTHEAST OF THE PAMPEAN PLAIN, ARGENTINA

Osterrieth, Margarita,[1] Natalia Borrelli,[1,2] Fernanda Alvarez,[1,2] Mariana Fernández Honaine,[1,2] Julio Luis del Río,[1,3] Heloisa Helena Gomes Coe,[4] and Marco Madella[5]

[1] Instituto de Geología de Costas y del Cuaternario, Funes 3350 - CC 722 Correo Central (7600) Mar Del Plata

[2] CONICET

[3] Universidad Tecnològica Nacional

[4] Universidade do Estado do Rio de Janeiro, Faculdade de Formação de Professores, Departamento de Geografia

[5] ICREA. Institución Milà y Fontanals, CSIC, Barcelona, Spain

Poster Abstract

Amorphous silica biomineralizations (silicophytoliths) are commonly produced in the plant communities that have dominated the Pampean Plains during the Cenozoic. The transfer of amorphous silica from these biotic systems to soils in these temperate and wet Pampean environments is considered as a condition for silica biogeochemical processes. The biogeochemistry of silicon, the second most abundant element in the world, is poorly known in continental environments and particularly in the Pampean Plain of Argentina.

This study includes Molisols and Fluvisols (and their vegetation) from dry environments, ponds and groundwaters. Soils were analyzed at different scales (mega, meso, micro, and submicroscopic), with special emphasis in mineralochemical determinations. The presence of silicophytoliths and their weathering degree was assessed through routine methods in plants, soils, palaeosoils, and sediments. The concentration of silica was determined in the soil solution, the temporary ponds, the Los Padres wetland and its tributaries (Los Padres stream, inflow stream; and La Tapera stream, outflow stream), and in groundwaters.

The results indicated that the amount of silica content ranged between 2% and 18% (dry weight) in the most common monocotyledons of the region, and between 1% and 4% in most dicotyledons. The content of

silicophytoliths in epipedons of Molisols is high, with values of 59.6 x 10^3–103.5 x 10^3 Kg/ha. The concentration of SiO_2 in soil solution and its distribution along the profile is variable and reflects present and past plant communities, the root development and the nutritional requirements of the species. In plots planted with *Acacia* sp. and *Eucalyptus* sp., the concentration of SiO_2 in the soil solution of the Mollisols decreases with depth (from 1106 to 406 µmol/L), whereas in plots with grass cover silica concentration increases with depth (from 421 to 777 µmol/L). Grasses are silica accumulators that have a shallow root system so the absorption from the soil solution is higher at the surface, and this could explain the lower silica content in epipedons with grass vegetation. The average concentration of silica in surface waters is 60 µmol/L. In Los Padres wetland, the silica content is 19.1 to 917 µmol/L, being higher in autumn and winter and decreasing in spring during the diatom boom. In the inflow stream, values increase (660-917,5 umol/L) in relation to silica concentration in the soil solution and groundwater (where the average value is 840 umol/L).

The contribution of silicophytoliths by grass plant communities has been ongoing during all the Cenozoic and it has increased with agricultural and livestock exploitation during the last 150 years. These balances show that much of the silicon/amorphous silica re-circulates in the unsaturated zone, where it contributes to form an amorphous silica enriched matrix of aggregates, which increases and maintains the structural stability of soils. Part of the silicon/amorphous silica, however, moves to the saturated zone and associated waters.

Acknowledgements: Financial support for this work has been provided by the UNMdP EXA 551/11, the ANPCyT, PICT N° 2010-2036 and PICT N° 1871, and CAPES-MINCYT (Código: BR/09/13).

MORPHOLOGICAL DIFFERENTIATION OF GLOBULAR PHYTOLITHS IN MONOCOTYLEDONS: ITS APPLICATION TO FOSSIL PHYTOLITH RECORD OF PEDOSEDIMENTARY LEVELS ASSOCIATED TO "*ESCORIAS Y TIERRAS COCIDAS*", CHAPADMALAL FORMATION, BUENOS AIRES, ARGENTINA

Osterrieth M.,[1] M. Fernandez Honaine,[1,4] E. Morel,[2,3] M.L. Benvenuto,[1] and G. Erra[2,4]

[1] Instituto de Geología de Costas y del Cuaternario, Facultad de Ciencias Naturales y Exactas–Universidad Nacional de Mar del Plata, Mar del Plata

[2] División Paleobotánica, Facultad de Ciencias Naturales y Museo, La Plata.

[3] CIC. Provincia de Buenos Aires

[4] CONICET. mosterri@yahoo.com.ar

POSTER ABSTRACT

Globular silicophytoliths have been commonly assigned to Arecaceae family. However, diverse authors have identified similar morphologies in other monocotyledon families. Due to the potential that silicophytoliths have as indicators of past plant communities and their associated palaeoenvironments, it is necessary to understand the morphological differences of this characteristic morphology between monocotyledons families in the fossil record.

The objectives of the study were: 1) to analyze the phytolith morphologies of selected species belonging to Arecaceae, Bromeliaceae, Cannaceae, and Strelitziaceae (families that have been described as globular

producers); 2) to identify and describe the morphometric characteristic that differentiate them; 3) to identify and describe the morphometric characteristic of the silicophytolits present in the pedosedimentary sequences; and 4) to analyze if such characteristics can be used to differentiate the families in fossil phytolith record.

Species from the four selected families were collected and the leaves from at least two individuals were processed through the calcination technique. Phytoliths from soils and sediments were obtained after routine techniques. The plant ashes and soils and sediments phytoliths obtained were described and analyzed under optic and electronic microscope. From each plant species a minimum of 300 phytoliths were counted and 30 globular phytoliths were described according the following characteristics: form, outline, diameter, presence of spines, and form of the spines. Soils and sediments silicophytoliths were determined by observation and counting of 500 grains under optical microscope. Multivariate analyses were applied to analyze as much as possible the differences between families. The results were compared with silicophytoliths present in the pedosedimentary sequences.

The pedosedimentary sequences analyzed were associated to enigmatic glassy materials (escorias) and red bricklike materials (tierras cocidas) located in discrete stratigraphic levels (the top of the Chapadmalal Formation). These materials are attributed to a mid-Pliocene impact event with a radiometric and magnetostratigraphic age of 3.3 Ma (*sensu* Schultz *et al.*, 1998), in the Buenos Aires Province, Argentina. The studied paleosols presented a high percentage of globular phytoliths between 9 and 22 μm in diameter. Also, other morphologies such as elongates, rondels, and bilobates were described in these samples. With the purpose to analyze the family producer of the globular phytoliths in these samples, the morphometric characteristics obtained from multivariate analyses were used for the identification. The palaeoflora inferred from phytolith analyses in these Pliocene sequences constitute an important advance toward plant palaeocommunities knowledge of Chapadmalal Formation, where no palaeobotanical evidences have been described until now.

Acknowledgements: Financial support for this work has been provided by the UNMdP EXA 551/11, the ANPCyT, PICT N° 2010-2036, and PICT N° 1871

REFERENCES

Schultz, P. H, M. Zarate; W. Hames; C. Camilión and J. King., 1998. A 3.3-Ma Impact in Argentina and Possible Consequences. *Science* 11 Vol. 282 no. 5396, pp. 2061-2063.

IDENTIFICATION OF NON-DIETARY CROP PRODUCTS OF EURASIAN CEREALS

Out, Welmoed A., and Marco Madella

Institution Milà and Fontanals, Spanish National Research Council (CSIC), C/Egipcíaques, 15, Barcelona, E-08001, Spain. w.a.out@imf.csic.es; marco.madella@icrea.es; 0034 934423489.

PAPER ABSTRACT

Archaeobotany aims amongst other objectives to understand socio-economic aspects of former societies by studying crop use and cultivation practices. While food production has received much attention, *non-dietary secondary products* (straw, hay, and chaff) are strongly overlooked, despite their economic importance as suppliers of fuel, animal fodder, and components for construction material. The underrepresentation of

such secondary products can be explained by a bias in the current research approach that is primarily based on seeds and fruits, and related issues of deposition, preservation, and taphonomy (Harvey and Fuller 2005). Phytoliths offer a good alternative research method to solve the problems on the preservation of botanical macroremains of secondary crop products.

While identification criteria of phytoliths are increasingly becoming available for Eurasian cereals (e.g. Ball *et al.* 1999; Lu *et al.* 2009, Portillo *et al.* 2006), further development of classification tools remains in need. Moreover, distinction of the various plant parts is essential to recognise the different types of non-dietary products. Therefore, a new study has been set up to develop a new methodological framework based on phytolith analysis for the study of non-dietary products originating from Eurasian cereals.

The first objective is to systematically develop the identification of Eurasian cereal crops and their different anatomical parts by the study of phytoliths from recent plant material. The second objective is to assess the level of confidence with which the developed identification methodology can be applied to archaeological samples from different contexts. It is expected that the results will represent a substantial development in phytolith analyses and will provide a better understanding of European and Asian history and past economy. This paper will further explain the details of the study.

REFERENCES

Ball T.B., Gardner, J.S., and Anderson, N., 1999, Identifying inflorescence phytoliths from selected species of wheat (*Triticum monococcum*, *T. dicoccon*, *T. dicoccoides*, and *T. aestivum*) and barley (*Hordeum vulgare* and *H. spontaneum*) (Gramineae). *American Journal of Botany* 86:1615–1623.

Harvey, E.L., and Fuller, D.Q., 2005, Investigating crop processing using phytoliths analysis: the example of rice and millets. *Journal of Archaeological Science* 32:739–752.

Lu, H., Zhang, J., Wu, N., Liu, K.-B., and Xu, D. 2009. Phytoliths analysis for the discrimination of Foxtail Millet (*Setaria italica*) and Common Millet (*Panicum miliaceum*). *Plos One* 4(2), e4448. doi: 10.1371/journal.pone.0004448.

Portillo M., Ball, T., and Manwaring, J. 2006. Morphometric analysis of inflorescence phytoliths produced by *Avena sativa* L. and *Avena strigosa* Schreb. *Economic Botany* 60(2):121-129.

PHYTOLITH ANALYSIS IN FLUVIAL SEDIMENTS OF EL PALMAR FORMATION (LATE PLEISTOCENE) IN EASTERN ARGENTINA

Patterer, Noelia Isabel,[1] and Mariana Brea[1]

CICYTTP-CONICET, Dr. Matteri y España, s/n, Diamante (E3105BWA), Entre Ríos, Argentina. noepatt1@hotmail.com; cidmbrea@infoaire.com.ar. Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT) PICT 2008 N°0176.

POSTER ABSTRACT

The El Palmar Formation is a Late Pleistocene sedimentary deposit developed during the OIS 5a. This stage is considered to have been the warmest and humid interval of the Late Pleistocene. This formation begins in Pleistocene upper terraces of the Uruguay River and is distributed in a coastal strip at the southern-

most of the Basin in eastern Argentina. In general sense this sedimentological unit is 3 to 12 m thick, lies at the surface, and has not been buried since its deposition; and is mainly composed of medium, reddish, and yellowish ochre sands. Lenses of gravel and pebbles up to 90 m long and up to 2 m thick are interspersed in quartzose sand masses. Sand strata and gravel lenses represent channel facies and fine sediments from facies of inundation. This formation was dated 80,670 ± 13,420 years BP by TL (thermoluminescense dating) at Federación city, and 88,370 ± 35,680 years BP by TL obtained at Salto city (Uruguay), in the upper levels of the sedimentary sequence.

For this study, the silica microremains of different profiles composed by facies characteristics of a high-energy fluvial environment, as well as floodplain environments, were analyzed. Described microremain assemblages are composed by abundant phytoliths (isolated and articulated forms) and whole and fragmented sponges' spicules. The main phytoliths types present in these assemblages are fan-shaped, point-shaped, polyhedrical, and elongated among the largest, whereas among the smaller ones were abundant bilobate, boat-shaped, truncated cone, crescent, square, oblong and crenate and globular spherical and ellipsoidal of spiny surface phytoliths. Phytolith that mostly had graminoid (panicoid, pooid and chloridoid), arecoid affinities and less abundant ciperoid, podostemoid and dicot of affinities. The larger phytoliths showed different degrees of wear, which in many cases cannot be observed clearly contours, while the smallest were unchanged. Comparative analysis of the various studied facies possible to establish differences in their compositions, while on the other hand settled of wears *versus* not wear phytolith abundances were compared in order to establish allochthonous/autochthonous ratios thereof.

PLANT COMMUNITIES PHYTOLITH ASSEMBLAGES RELATIONSHIPS WITH NATIVE FLORA FROM EL PALMAR NATIONAL PARK (ENTRE RIOS PROVINCE, ARGENTINA)

Patterer, Noelia Isabel, and Alejandro Zucol

CICYTTP-CONICET, Dr. Matteri y España, s/n, Diamante (E3105BWA), Entre Ríos, Argentina. noepatt1@hotmail.com; cidzucol@infoaire.com.ar. Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT) PICT 2008 N°0176.

Poster Abstract

Palms are common plant components in the tropical vegetation of America, distributed to warm temperate climate regions. El Palmar National Park is a nature reserve comprising a palm tree savannah and shrubs, and is one of the southernmost distributions of this plant group, in this particular case *Butia yatay.* Located in the east of Entre Ríos province is a relic of 8500 ha, distributed in patches between components of the semiarid forest, gallery forest and pampean grassland (namely mesopotamic prairie). In the present contribution the phytolith analysis of the principal vegetal species of the El Palmar National Park natural communities, selected by their coverage percentage were made. Phytolith extraction was performed by carbonation/calcination technique from leaf samples of selected species. Firstly, the population census carried out showed that grasses (Poaceae) has the highest percentage of coverage in the grassland, with significant values in the forest palm area, being fairly constant in the native forest. Sedges (Cyperaceae) are sparse; there were only low values in the semi-dense forest palm and grassland areas. Shrubs are abundant in the native forest and very scarce in grasslands. While tree species were absent, with the exception of the palms climax community. The principal selected species, in addition to the aforementioned palm (*Butia yatay)* are *Axonopus argentinus,*

A. compressus, Setaria parviflora, Digitaria sacchariflora, Paspalum notatum and *Schizachyrium microstachyum* (panicoid grasses); *Eragrostis lugens* and *Esporolobus indicus* (chloridoid grasses); *Bromus aulecticus* (pooid grasses); *Cyperus reflexus* and *C. aggregates* (Cyperaceae); *Baccharis trimera* (Asteraceae) and other dicotyledons as *Wahlenbergia linarioides* and *Glandularia peruviana*.

In regard to their phytolith assemblages, *Butia yatay* palm was characterized by abundance of the globular echinate type (mostly ranging 5-12 µm in diameter), vascular elements, and small irregular elements. The panicoid grasses were characterized by bilobates with straight lobes, concave and/or convex edges, and crosses; articulated or isolated, associated an elongated elements of sinuous edge very frequent, stomata; polyhedral and vascular elements less frequents. In the chloridoid grasses, the association present, isolated and articulated elements, as bilobates of lobes straight and/or convex, truncated cones, associated with elongated, fan-shaped and polyhedral, with stomata and point shaped, less frequents. For the only species within pooid grasses, the association was characterized by frequent oblong and crenate types, as well as less frequent point-shaped, square, crescent-shaped, and truncated-cone types. Cyperaceae species are characterized by the presence of hat-shaped or conical elements isolated and/or articulated, with rounded or hexagonal bases, associated with phytolith originated in vascular elements.

Asteraceae species show the presence of prismatic rectangular phytoliths jointly with irregular phytoliths, silicified vascular elements, and articulated stomata complex. While the remaining dicots show scarce phytolith material, was presented fundamentally as silicified hairs associated with irregular cells, small elongated and papillated elements.

This is the first contribution to the knowledge of the phytoliths in El Palmar National Park flora. It tested whether the various existing communities can be differentiated through phytolith assemblages. This study represents an initial step for further analysis of soils and sediments to reconstruct the recent evolutionary history of warm temperate savannahs.

PRELIMINARY RESULTS OF ARPADIAN AGE CHANNEL SYSTEM SURVEY BASED ON PHYTOLITH ANALYSIS (TÓKÖZ, NW HUNGARY)

Persaits, Gergő,[1] Dávid Gergely Páll,[1] Pál Sümegi,[1] and Károly Takács[2]

[1] University of Szeged, Faculty of Science and Informatics, Department of Geology and Paleontology, 6722 Szeged, Hungary. www.oslenytan.hu; persaitsg@yahoo.de

[2] Hansag Museum, 9200 Mosonmagyarovar, Hungary. www.hansagi.gymsmuzeum.hu

POSTER ABSTRACT

The studied Arpadian age objects (Takács 2001) are situated on an alluvial plain near Csorna, Tóköz, NW Hungary. A very complex triple channel system is visible in Tóköz that cut across more than one hundred fishponds (f. e.: Lake Fehér, Lake Barbacsi). We dept more geological drillings into the channels and lakes to reconstruct the channel system.

The major aim of our work was to elucidate the environmental background of the Arpadian age triple channel system based on the investigation of phytolith remains retrieved from core samples. Samples were taken at 1 cm intervals vertically from the continuous undisturbed core, and they were analyzed with sedi-

mentological, geochemical, macrobotanical, and palinological methods. The chronological analysis was based on radiocarbon dating.

In our presentation we focus on the phytolith data from which the different cycles of conditioning of the channel systems are visible. We present the traces and cycles of burning and cleaning of the channel bank and the environmental reconstructions of the Arpadian age channel system focusing on the channel operation in Tóköz.

INTEGRATING SOIL CHEMICAL, PHYSICAL AND MICRO-ARCHAEOBOTANICAL DATA TO RECONSTRUCT THE BASE BURIAL OF AN EARLY BRONZE AGE (EBA) KURGAN: A METHODOLOGICAL APPROACH AND CASE STUDY FROM NE HUNGARY.

Pető, Á.,[1] T. Horváth,[2] L. Scott Cummings,[3] M. Logan,[3] and A. Barczi[4]

[1] Hungarian National Museum, National Heritage Protection Centre, Laboratory of Conservation and Applied Research, Daróci út 3., H-1113 Budapest, Hungary. peto.akos@mnm-nok.gov.hu

[2] Hungarian Academy of Sciences, Institute of Archaeology, Úri u. 49., H-1014, Budapest, Hungary. valdemar@archeo.mta.hu

[3] PaleoResearch Institute, 2675 Youngfield Street, Golden, Colorado, 80401, USA. linda@paleoresearch.com; melissa@paleoresearch.com

[4] Szent István University, Institute of Environmental and Landscape Management, Páter Károly u. 1., H-2103, Gödöllő, Hungary. barczi.attila@mkk.szie.hu

Paper Abstract

Burial mounds – also called *kurgans* – are special, human-made formations of the endless steppes of Eurasia. In Hungary, the Great Hungarian Plain is the westernmost territory of the Eurasian steppe belt and home of Late Copper and Early Bronze Age kurgans.

Since kurgans are *ex lege* protected as highly important and vulnerable cultural heritage elements, their excavation – in opposite to the practice of other European countries – is rarely permitted.

Because of recent human damage, in 2009, our research team seized the opportunity to excavate one of the biggest kurgans in the north-eastern part of the Great Hungarian Plain. The burial mound, belonging to the Szabolcs Group was bisected in order to expose the buried soil and the cultural layers. The examination of the buried soil and the cultural layers yielded valuable information on the building phases and the one-time environment of the surrounding territory. As the main archaeological feature of the burial mound, the basal burial, was unearthed. Since basal burials of kurgans are rarely found intact we built a protocol consisting of interdisciplinary proxies, not only to reconstruct the environment, but to try to visualize the circumstances of the burial that took place between 2900 and 2300 cal BC.

Samples were collected beneath the skeleton as well as from the sediments of the grave itself. Soil and sediment samples were analyzed to recover micro-archaeobotanical (phytolith and pollen) evidence, Fourier transform infrared spectroscopy (FTIR) and basic soil physical and chemical properties. In addition to the soil

samples, organic residue from a ceramic sherd found in the burial and a colored mat forming the base of the burial were analyzed.

As a result of the integrated analyses we found that the mat the skeleton was laid on or wrapped in was not prepared of plant material, but was of animal origin, and most probably dyed with a mixture of ocher and mammal blood. On top of the burial a very thin (2-3 mm) white powdery layer was recovered. Results show that the burial was covered first with bark, which was almost totally deteriorated, and a layer of grasses collected from the surroundings. We assume that the powdery white layer, which contained extremely high phytolith concentrations, is the result of conscious human activity. With regard to the construction of the grave, we suppose that the usage of animal and plant resources of the environment might have had a specific ritual role, which was then terminated with the erection of an earthen pyramid or kurgan.

EARLY NEOLITHIC HUSBANDRY PRACTICES AT TELL SEKER AL-AHEIMAR (UPPER KHABUR, SYRIA): AN ETHNOARCHAEOLOGICAL STUDY OF PHYTOLITHS AND DUNG SPHERULITES

Portillo, Marta,[1] Seiji Kadowaki,[2] Yoshihiro Nishiaki,[3] and Rosa M. Albert[4]

[1] Juan de la Cierva, Spanish Ministry of Innovation and Science, MICINN/ GEPEG, Department of Prehistory, Ancient History and Archaeology, University of Barcelona, c/ Montalegre 6-8, 08001 Barcelona, Spain. mportillo@ub.edu

[2] The Nagoya University Museum, Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan. kadowaki@num.nagoya-u.ac.jp

[3] The University Museum, University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan. nishiaki@um.u-tokyo.ac.jp

[4] ICREA Research Professor / GEPEG, Department of Prehistory, Ancient History and Archaeology, University of Barcelona, Spain. rmalbert@ub.edu

PAPER ABSTRACT

Tell Seker al-Aheimar is an archaeological mound situated on the flood plain of the Khabur River in Northeastern Syria. The chronology of the site spans from the Pre-Pottery Neolithic B (PPNB) to the Proto-Hassuna (Pottery Neolithic). The site is one of the largest and best known Neolithic settlements in this poorly investigated region in Upper Mesopotamia.

The occupation sequence contains different well-defined architectural phases. The Late PPNB settlement (late 8th to early 7th millennium cal. BC) is characterized by large multi-roomed rectangular mud-brick buildings (about 9 by 6 m) with gypsum-plastered floors. Also remarkable is the presence of gypsum-lined features such as bins and channels running from indoor floors to an open space defined by a plastered courtyard. Questions that arose from this study centered on the identification of domestic activities and their spatial distributions in the site.

The ethnoarchaeological work included the study of plant and dung remains obtained from modern domestic structures on the top of the *tell* and the modern village of Seker al-Aheimar. The examined activity

areas and materials comprised indoor storage and processing spaces, open areas, fireplaces, building materials, and livestock enclosures.

The distributions of both phytolith and spherulite concentrations obtained in the archaeological assemblages are indicative of activities that took place both within and outside buildings. Cereal concentrations were noted in specific areas of the floors, suggesting that these indoor spaces may have been used for storage, crop-processing, or cooking. The correlation between large amounts of phytoliths and spherulites in some of the examined assemblages indicate that grasses where also deposited in the site as livestock dung or dung-products. Thus, the identification of such dung remains in fireplaces suggests the use of dung as fuel.

PHYTOLITH SAMPLING OF GRINDING STONES FROM UNGWAR KURA, NIGERIA

Radomski, Kai Uwe,[1] and Katharina Neumann

[1] Am Waldweg 3, 35415 Pohlheim, Germany. Kaiur@web.de

PAPER ABSTRACT

Ungwar Kura is an archaeological site of the Nok culture in central Nigeria, dated to the first millennium BC. The Nok culture is characterized by terracotta figurines with a wide distribution area and is associated with the presence of early iron. The economic background of this remarkable culture which was largely unknown until recently, is in the focus of a long-term project at the department of African archaeology at Frankfurt University, investigating the Nok culture.

Plant macro- and microremains are used to study the subsistence of the Nok culture. The investigation of grinding stones for starch and phytoliths could reveal the processed plant material. Processing of cereals, e.g. pearl millet (*Pennisetum*) or fonio (*Digitaria* spp.), which were important food plants, requires removal of the glumes in mortars or on grinding stones. Due to the high silica content of the glumes, these tools are potential carriers of phytoliths.

Prehistoric grinding stones of Ungwar Kura were sampled to verify the presence of phytoliths and eventually identify the plants which had been processed. The results of the preliminary study reveal the necessity of considering methodological aspects for a sound interpretation. Taphonomical factors which could interfere with activity patterns on the grinding stones have to be investigated. Significance of the data has to be statistically verified because the counting procedure could influence the results.

THE USE OF ALKALI DISSOLUTION AND FLOATATION METHODS IN TANDEM FOR BIOGENIC SILICA QUANTIFICATION IN LOESS SOILS: CASE STUDIES FROM NEBRASKA, USA.

Reyerson, Paul E.,[1]* and Joseph A. Mason

[1] University of Wisconsin-Madison, Department of Geography, 160 Science Hall, 550 North Park Street, Madison, WI 53706, USA

* Corresponding author: reyerson@wisc.edu

Paper Abstract

Two popular methods exist to quantify biogenic silica (BSi) in soils. The flotation method relies on differences in soil particle densities to mechanically remove BSi from soil samples, which can underestimate total BSi since clay- and fine silt-sized particulates cannot be thus extracted. Subsequent microscope analysis of the particulate extracts can be used to identify and factor out contamination from amorphous and poorly crystalline nonbiogenic silica (NSi), i.e., volcanic glass, pedogenic silica, and cristobalite. Alkali dissolution is able to measure silica in all particle sizes; however, it cannot distinguish between BSi and NSi due to their similar solubilities. Indeed, overestimation of total BSi can occur in soils with significant amounts of NSi. Hence, each method can potentially mitigate the drawbacks of the other: flotation offers BSi and NSi differentiation but cannot account for all particulate sizes, while alkali dissolution removes all BSi and NSi but cannot discriminate between them. In this study, both methods are applied to volcanic glass- and BSi-rich loess soils from Nebraska, USA, and the results of each method are then discussed. The use of the two methods in tandem revealed patterns not discernible by one method alone.

LOCAL PALEOENVIRONMENTAL AND ANTHROPOGENIC EVOLUTION OF TEOTIHUACAN PERIOD (CENTRAL MEXICO) BASED ON DISTRIBUTION OF PHYTOLITHS AND OTHER SILICA MICROBIOPARTICLES.

Sedov, Sergey,[1] Alexandra Golyeva,[3] Emily McClung de Tapia,[2] Serafín Sánchez,[1] and Elizabeth Solleiro[1]

[1] Institute of Geology, UNAM, Mexico

[2] Institute of Archeology, UNAM, Mexico

[3] Institute of Geography RAS, Moscow, Russia

Poster Abstract

Teotihuacan is the greatest pre-Hispanic urban civilization of Mesoamerica; it flourished in the Central Mexican volcanic highlands between second and seventh centuries A.D. Intensive agriculture was proven to be one of the basic elements of its subsistence; however, particular soil conditions and practices of soil use are still not understood sufficiently. Recently, the soil present at the surface during classic occupation was discovered in the

alluvial deposits of Teotihuacan valley.

To reconstruct with more detail the local paleoenvironmental conditions under which the upper bleached horizon of the paleosol was formed, we performed the detailed analysis of the biogenic opaline silica bodies (phytoliths, diatoms, and sponge spicules) in six samples. All these samples come from the Teotihuacan historical period.

Among biogenic silica bodies, plant phytoliths dominate; however, aquatic microfossils– sponge spicules and diatom shells– are present in all samples as well, although in minor quantities. Spicules are few and show irregular distribution; diatoms are more frequent, demonstrating clear tendency to increase towards the upper part of the AE horizon, reaching maximum in the dark layer on top of this horizon, but decreasing significantly in the overlaying alluvium.

The phytolith assemblage is dominated by silicified grass cells (Poaceae), accompanied by smaller amounts of coniferous tree phytoliths. Among grasses, the presence of hydrophytic elements like Bambusoideae and reed is notable. It is important that phytoliths from domestic corn (*Zea mais*) were encountered (although very few) in all studied samples. The profile distribution of most morphological types is uniform or with minor irregular variations. Again the thin dark layer on top of AE shows a specific pattern: it has minimum of corn phytoliths and maximum of coniferous, festucoid C_3 grasses and forms corresponding to bambucoideae. Some silicified cuticle casts were found in this horizon only. These particles are indicative of soil materials directly exposed at the surface.

THE EARLY EVOLUTION OF GRASSES: NEW PHYTOLITH EVIDENCE FROM THE LATE CRETACEOUS OF INDIA

Strömberg, Caroline A.E.,[1*] Vandana Prasad,[2] AdamD. Leaché,[1] Bandana Samant,[3] Rajiv Patnaik,[4] Liang Tang,[5] Dhananjay M. Mohabey,[6] Song Ge,[5] and Ashok Sahni[7]

[1] Department of Biology, Burke Museum of Natural History and Culture, University of Washington, Seattle, WA 98195, U.S.A.

[2] Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

[3] Postgraduate Department of Geology, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur 440001, India

[4] Centre for Petroleum and Applied Geology, Panjab University, Chandigarh-160014, India

[5] State Key Laboratory of Systematic and Evolutionary Botany,Institute of Botany, Chinese Academy of Sciences, Beijing 100093, P. R. China

[6] Geological Survey of India, Nagpur 440006, India

[7] Centre of Advanced Study in Geology, Lucknow University, Lucknow-226007, India

* Corresponding author: caestrom@uw.edu

PAPER ABSTRACT

Because of the dependence of humans on rice (*Oryza sativa*) as a crop species, this grass and its relatives remain a focal point in agricultural and evolutionary science; however, a paucity of fossils (Strömberg, 2011;

Thomasson, 1987) has obscured their deep-time history. Previously described cuticles with phytoliths from the Late Cretaceous (67-65 Ma) of India indicate that, by the latest Cretaceous, the grass family (Poaceae) consisted of members of the modern subclades PACMAD (Panicoideae-Aristidoideae-Chloridoideae-Micrairoideae-Arundinoideae-Danthonioideae) and BEP (Bambusoideae-Ehrhartoideae-Pooideae), including a taxon with proposed affinities to Ehrhartoideae (Prasad et al., 2005). Here, we report on newly recovered fossil cuticles and associated phytoliths. Using an inferred phylogenetic tree for the Poaceae based on molecular and morphological data, we deduce the placement of the new fossils in the context of 56 extant grass species. Divergence times for Poaceae lineages are estimated using seven previously published fossils and our new fossils, and this framework is employed to investigate the evolutionary history of seven leaf epidermis and phytolith morphology characters. This dataset is supplemented with study of fourteen ehrhartoid taxa. Our analysis reveals that the fossils most likely derive from members of the Oryzeae of grass subfamily Ehrhartoideae and that diversification of the rice tribe began before the end of the Cretaceous. The new date pushes back the time of origin of Poaceae as a whole, necessitating a re-evaluation of current models for grass evolution and palaeobiogeography.

REFERENCES

Prasad, V., Strömberg, C. A. E., Alimohammadian, H., and Sahni, A. 2005. Dinosaur coprolites and the early evolution of grasses and grazers. *Science* 310:1177-1180.

Strömberg, C. A. E. 2011. The origin and spread of grass-dominated habitats. *Annual Review of Earth and Planetary Sciences* 39:517-544.

Thomasson, J. R. 1987. Fossil grasses: 1820-1986 and beyond. In *Grass systematics and evolution,* ed. Soderstrom, T. R., Hilu, K. W., Campbell, C. S., and Barkworth, M. E. Washington, D.C., Smithsonian Institution Press, pp. 159-167.

QUANTITATIVE PHYTOLITH ANALYSIS: A KEY TO UNDERSTANDING BURIED SOILS AND TO RECONSTRUCTING PALEOENVIRONMENTS

Sudbury, J. Byron,[1] and Brian J. Carter[2]

[1] J. S. Enterprises of Ponca City, Inc., P. O. Box 2282, Ponca City, Oklahoma, USA 74602-2282. jschemistry@hotmail.com

[2] Division of Agricultural Sciences and Natural Resources, 160 Agricultural Hall N., Oklahoma State University, Stillwater, Oklahoma 74078-6028, USA. bjc@mail.pss.okstate.edu

PAPER ABSTRACT

Soil phytoliths were quantitatively recovered and analyzed from modern and buried A horizons situated in a current prairie region. The resulting soil phytolith concentration and signature data were used to develop a better understanding of pedogenic processes and to determine past environmental conditions. Enhancements to available published laboratory protocols for quantitative phytolith recovery were developed and implemented.

Soil phytoliths were analyzed from modern shortgrass, mixedgrass, and tallgrass prairies, and from three sites with buried A horizons of known age spanning the Holocene. Phytoliths were quantitatively separated

and recovered from other soil particles based on differences in particle size and density. Using polarized light microscopy, the Poaceae short cell phytolith morphologic type distributions present in the isolated soil sample biogenic silica fractions were ascertained. The resulting soil phytolith concentrations and signatures reflect site conditions at the time of soil formation.

The phytoliths present in buried A horizons reveal information about soil forming processes. The relative phytolith concentration was observed to mirror the soil organic carbon content in well-developed A horizons. In a new soil formed on an alluvial deposit phytoliths are concentrated in the upper portion of the deposit. In a normal melanized A horizon the phytolith concentration decreased exponentially with depth, whereas in a soil undergoing cumulic pedogenesis the soil phytolith concentration is relatively constant down profile. Additionally, the occurrence of soil welding was clearly elucidated in the quantitative phytolith data at one site; in the same buried soil sample sequence, the relative soil diatom concentration was noted to mirror the soil phytolith concentration.

Comparison of the short cell phytolith signature present in buried soils with the phytolith signature observed from modern prairie soils permits determination of the environmental conditions present during past stable landscape intervals. The various short cell phytolith forms evaluated are indicative of C3 vs. C4 grasses thus revealing climatic information. As previously reported by others, a higher C3 phytolith content indicates a cooler moister climate whereas a stronger C4 signature indicates a warmer climate. Overall, broad phytolith seasonality groupings proved to be more reproducible than the individual phytolith short cell morphotypes at a given site. It was also observed that saddle-shaped chloridoid phytoliths in soil samples hold significant potential for detecting vegetation changes in response to environmental change.

SPONGE SPICULES—AN UNDERUTILIZED BIOGENIC SILICA RESOURCE IN SOIL

Sudbury, J. Byron,[1] Peggy Colgate,[2] Mike Taylor,[3] and Don G. Wyckoff[4]

[1] J. S. Enterprises of Ponca City, Inc., P. O. Box 2282, Ponca City, Oklahoma, 74602-2282, USA. jschemistry@hotmail.com

[2] Sam Noble Oklahoma Museum of Natural History, 2401 Chautauqua Ave., Norman, Oklahoma, 73072-7029, USA. peggy.s.colgate-1@ou.edu

[3] Sam Noble Oklahoma Museum of Natural History, 2401 Chautauqua Ave., Norman, Oklahoma, 73072-7029, USA. digtaylor1969@ou.edu

[4] Curator Emeritus, Sam Noble Oklahoma Museum of Natural History, 2401 Chautauqua Ave., Norman, Oklahoma, 73072-7029, USA. xtrambler@ou.edu

PAPER ABSTRACT

Spicules of freshwater sponge species are made of amorphous silica. Spicules can be introduced to the soil via a number of mechanisms including eolian transport, overbank deposition, artificial water transport, and via excreta. When present in soils, spicules are part of the amorphous biogenic silica fraction along with phytoliths, diatoms, and radiolaria. Although a small number of spicules are routinely encountered in many soils, spicules' potential interpretative value is often under-utilized by phytolith researchers. This paper introduces some of the pedogenic and environmental data that may be gleaned from spicules. Potentially

significant pedogenic information was observed in spicules during recent analyses (i.e., end rounding, varying degrees of surface abrasion, pitting, and completeness). Species environmental data is available in the literature.

In order to optimize spicule recovery, the standard laboratory soil sample processing procedure was modified. Rather than sieving the soil to remove the sand fraction and then separating the clay and silt fractions by sedimentation, the sand fraction is first eliminated by sedimentation based on a particle density of 2.65 g/cm3. This modification leaves many of the larger (> 50 micron) less dense biogenic particles suspended in the decanted clay-silt fraction (rather than being retained by the sieve). Next, the clay is decanted from the clay-silt mixture using the calculated settling time for 1.60 g/cm3 particles leaving the biogenic silica particles in the silt fraction. Some larger dense clay particles also remain in the silt fraction, but that clay is readily removed during the subsequent heavy liquid floatation step. This procedure results in an essentially intact biogenic silica fraction (i.e., phytoliths, diatoms, and spicules of all sizes) for subsequent evaluation. The biogenic material is then mounted per the normal method used for scanning slides (Canada balsam was used in this study).

A soil profile along Opossum Creek in northeastern Oklahoma produced numerous spicule sections with varying degrees of surface abrasion, pitting, and end rounding which are tentatively interpreted to indicate that these spicules are re-deposited particles. Examples of spicules with pristine surfaces were also observed in some soil samples; these specimens imply the actual presence of abundant water on, at, or near the site rather than eolian or alluvial re-deposition. Spicules longer than 100 microns were observed. Variations in soil spicule concentration were noted down profile suggesting habitat change over time.

Paleoenvironmental information can also be determined via spicule data. This information is available via a small subset of the spicule data: the so-called "gemmoscleres" which are often identifiable to species. Images of representative gemmoscleres recovered from these soil samples will be shown, and a brief introduction to the interpretative literature provided.

SEPARATING DIATOM AND PHYTOLITH BIOGENIC SI: A CHEMICAL APPROACH

Tallberg, Petra, Maria Lehtimäki, and Virpi Siipola

Department of Food and Environmental Sciences, Environmental Soil Science, P.O. Box 27, FIN-00014 Helsinki University, Finland; petra.tallberg@helsinki.fi

POSTER ABSTRACT

Biogenic silica (BSi) is an amorphous form of silicon dioxide, commonly denoted SiO_2*nH_2O, which is produced by many plant species and by some other organisms (e.g. diatoms, aquatic sponges, testate amoebae, e.g. Nelson et al. 1995). Although the role of Si in nature has several other interesting aspects, BSi is mostly studied for two reasons: either because it is a good paleoproxy, or as part of studies concerning the (global) Si cycle. Most BSi is produced by two groups of organisms: terrestrial plants and aquatic diatoms (Treguer et al. 1995, Conley 2002). Formerly, most research concerned with BSi was either purely paleoontological or paleolimnological: the BSi bodies produced by terrestrial plants (phytoliths) or the BSi remains of diatoms were separated from soil or sediment, microscopically examined, and used to reconstruct past conditions in either aquatic or terrestrial environments (e.g. Koning et al. 2002, Piperno 2006). If both diatoms and phytoliths

were present and the identification of both desired, they were separated either microscopically based on their distinct features or, sometimes, by gravimetric separation, as the density of diatom and phytoliths BSi differ slightly. Both methods are labor-intensive and consequently expensive.

Recently, however, research concerned with the cycling of Si – both on a global scale and with a primarily aquatic interest – has begun to recognize the importance of biological cycling of Si by terrestrial plants and to parse together the research done on aquatic and terrestrial BSi (e.g. Conley 2002, Cornelis 2010). In these studies, it would often be sufficient to know whether BSi found in (e.g.) water bodies is of terrestrial or aquatic origin, but not necessarily which species has produced it. Consequently, there is a need for a more simple and economical method which would separate bulk BSi of terrestrial and aquatic origin. In this study, we attempted to create such a method by assuming that as diatom and phytoliths BSi differ in density and structure, they also differ in solubility to such an extent that it is possible to differentiate between them by a relatively simple chemical extraction. Dried (+60°C) and gently ground laboratory-grown diatoms (Phaeodactylum tricornatum) and plant material with a high phytolith content (reed canary grass, Phalaris arundinacea) were extracted for 3 h with alkaline extractants (Na2CO3, NaOH and KOH) of varying strength (0.1-2M) and at varying temperatures (85 and 100°C) based on the general method for BSi extraction for sediments introduced by DeMaster (1981) and on extractants and strengths generally used (e.g. Conley 1998). Sample aliquots were removed at short intervals (5 -15 min) throughout the extraction and analysed for dissolved Si using standard spectrophotometrical methods (Mullin & Riley 1955). The preliminary results are promising and tentatively indicate that BSi of terrestrial and aquatic origin have different solubility, and may be separated by this relatively simple method. More samples of different diatoms and plants need to be tested, however, before the analysis of natural samples, where minerogenic Si presents an additional challenge, can be attempted.

REFERENCES

Conley, D.J. 1998. An interlaboratory comparison for the measurement of biogenic silica in sediments. *Marine Chemistry* 6:39-48.

Conley, D.J. 2002. Terrestrial ecosystems and the global biogeochemical silica cycle. *Global Biogeochemical Cycles* 16:1121.

Cornelis, J. 2010. *Impact of tree species on silicon cycling in temperate soil-tree systems*, PhD thesis, Universite Catholique de Louvain, Earth and Life Institute, Environmental Sciences, Soil Science.

DeMaster, D.J. 1981. The supply and accumulation of silica in the marine environment. *Geochimica Cosmochimica Acta* 45:1715-1732.

Koning, E., Epping, E., and Van Raaphorst, W. 2002. Determining biogenic silica in marine samples by tracking silicate and aluminium concentrations in alkaline leaching solutions. *Aquatic Geochemistry* 8:37-67.

Mullin, J., and Riley, J. 1955. The colorimetric determination of silicate with special reference to sea and natural waters. *Analytica Chimica Acta* 12:162-176.

Nelson, D., Tréguer, P., Brzezinski, M., Leyneart A., and Quéguiner, B. 1995. Production and dissolution of biogenic silica in the ocean: revised global estimates, comparison with regional data, and relationship to biogenic sedimentation. *Global Biogeochemical Cycles* 9:359-72.

Piperno, D.R. 2006. *Phytoliths: A comprehensive guide for archaeologists and paleoecologists*. AltaMira Press, Oxford.

Tréguer, P., Nelson, D., Van Bennekon, A., DeMaster, D., Leynaert, A., Queguiner, B. 1995. The silica balance in the world ocean: A re-estimate. *Science*, v. 268, p. 375-379.

POPULATION-LEVEL ANALYSIS OF DENTAL CALCULUS USING BSE-SEM-EDS FOR DIET RECONSTRUCTION

Tromp, Monica,[1] and John V. Dudgeon[2]

[1] Department of Anthropology, Idaho State University, 921 S. 8th Avenue, Stop 8005, Pocatello, ID 83201, USA. trommoni@isu.edu

[2] Department of Anthropology, Idaho State University, 921 S. 8th Avenue, Stop 8005, Pocatello, ID 83201, USA. dudgeon@isu.edu

PAPER ABSTRACT

Most microfossil studies in archaeology focus on identification and quantification of phytoliths in sediments. While this is a very useful method for reconstructing ecology and depositional history, it does not provide direct evidence that corresponds with the archaeological event of interest: "What did people put in their mouths?" A more appropriate and direct means of investigating dietary hypotheses is the analysis of phytoliths, starches, and other microfossils extracted from dental calculus. Since the majority of these studies identify small numbers of microfossils in few individuals, issues of analyst time and sample preparation are not paramount. While these studies have been highly successful in answering particularistic questions about past human diet, we argue that population-level microfossil studies, when possible, will produce more informative and statistically-significant reconstructions of dietary preference and availability.

The biggest hurdle to population aggregate studies of microfossils from human dental calculus is the amount of time it takes to count individual microfossils. A previous analysis by the authors of 114 individuals from Rapa Nui (Tromp and Dudgeon, n.d.) took approximately 2,000 hours using a scanning electron microscope coupled with electron dispersive spectroscopy (SEM-EDS). Based on this experience, we developed a method that will significantly reduced analysis time by exploiting high contrast backscattered electron (BSE-SEM) imaging, image processing software, and GIS software. In addition to cutting down analysis time, we argue that this method is a more efficient and repeatable means of analysis than light microscopy, largely due to increased precision of morphological identification and presorting calculus residues on the basis of major chemical class.The comparative speed with which this method can be employed gives an analyst the ability to count more samples in shorter amount of time, enabling population-level studies that might otherwise take several years.

PROSPECT INTO THE PHYTOLITH ANALYSIS OF CERAMIC THIN SECTION.

Vrydaghs, L.,[1,2] and Á. Pető[3]

[1] Research Team in Archaeo- and Palaeo-Environmental Sciences,H. de Brouckère st., 82. B-1160 Brussels, Belgium. luc_vrydaghs@yahoo.co.uk

[2] CreA-Patrimoine, ULB. av. F. D Roosevelt, 50. B - 1050 Brussels, Belgium

[3] Hungarian National Museum, National Heritage Protection Centre, Laboratory of Conservation and Applied Research. Daróci út 3. H-1113 Budapest, Hungary. peto.akos@mnm-nok.gov.hu

PAPER ABSTRACT

Phytoliths have been reported within thin sections of ceramics from Northern France (Douai), Central Europe (Hungary), Central Africa (Rwanda), and the Arabic Gulf (Um al-Quaiwan, U.A.E). To address their significance, the description system is fundamental. The system we developed relies on the scheme we set up for the phytolith analysis of soil thin sections from archaeological deposits (Vrydaghs *et al* 2007). So far four aspects, labelled as indexes, are considered:

- the absence or presence of the phytoliths (or A/P index);
- the morphotype identification (or M index);
- the conservation of the phytoliths (the C index);
- the distribution of the phytoliths within the paste or within the voids (or D index).

Phytoliths enter the ceramic fabric with the plant material used for tempering. Therefore the observed morphotypes represent a conscious human-induced selection, and the liberation of plant opal happens in an unusual way. Since the plant material is used in a fresh or air-dried state, phytoliths only become visible when the ceramic fabric is fired to an oxidized state. Since phytoliths do not liberate from the tissue – as occurs in other micro environments – but the plant tissue is burnt out of the fabric, the visibility of phytolith grains or silica skeletons is highly dependent on the perfection of the firing (oxidizing) process. We consider this as the primary factor of a successful thin section analysis. The outcome of phytolith analysis is expected to be successful in the oxidized zone, however we are usually convinced about the presence of phytoliths – though only hardly and in a partly visible state – in the black-coloured reduction zone of ceramics as well.

The present contribution intends to briefly introduce the potential of the phytolith analysis of the ceramic fabric through referring to two studies.

Relying on the aforementioned indexes, an extensive phytolith study of the collection of thin sections from the ceramic of the site of ed-Dur sheds light on the variations in their presence, distribution, and spectral composition according to the considered wares. These observations contribute not only to the classification of the pottery into local and non-local production and the identification of the plant material used as temper, but also help to refine the identification of the clay sources of the local production (De Paepe et al 2003; Vrydaghs et al in press).

Neolithic ceramic thin sections analysed from five Hungarian archaeological sites are dominated by chaff matetial. Since the observed morphotypes, other than those that are chaff-related, were very scarce in the phytolith record, we suggest that only chaff was used and that none of the by-products produced earlier in the cleaning process (straw and leaf phytoliths, weed indicators) were utilised as vegetal temper. If Neolithic communities harvested the spike to avoid weed contamination, then the straw was left on the field and probably not collected for further utilisation in the pottery production process.

REFERENCES

De Paepe, P., Rutten, K., Vrydaghs, L. and Haerinck, E. 2003. Petrographic, chemical and phytolith analysis of late pre-islamic ceramic from ed-Dur, Um el-Kawein (U.A.E.). In Potts, D. Hasan Al Naboodah, H. and Hellyer, P. (eds.): *Archaeology of the United Arab Emirates. Proceedings of the First International Conference on the Archaeology of the United Arab Emirates*, pp. 207-229.

Haerinck, E., Vrydaghs, L., and Doutrelepont, H. 1998. Des feux sacrificiels pour la divinité solaire à ed-Dur. *Arabian Archaeology and Epigraphy* 9:125-130

Vrydaghs, L., Devos, Y., Fechner, K., and A. Degraeve. 2007. Phytolith analysis of ploughed land thin sections. Contribution to the early medieval town development of Brussels (Treurenberg site, Belgium). Proceedings of the *4th International Meeting on Phytolith Research: New perspectives in Phytolith research: climate, environment and archaeology.* Cambridge (UK). 28th-31st August 2002. Mc Donald Institute for Archaeological Research. University of Cambridge.

Vrydaghs, L., De Paepe, P., Rutten, K. and Haerinck, E. In press. A space of exchanges: Phytolith analysis of ceramic thin sections from ed-Dur (Umm al-Qaiwain, U.A.E.). In Madella, M., and Savard, M. (eds.), *Ancient plants and People: Contemporary trends in archaeobotany.* Arizona University Press.

COMBINING THE EVIDENCE: INTEGRATING PHYTOLITH STUDIES AND MICROMORPHOLOGY: THE CASE STUDY OF BRUSSELS' DARK EARTH

Vrydaghs, L.,[1,2] Y. Devos,[2] H. Doutrelepont,[1] and Á. Pető[3]

[1] Research Team in Archaeo- and Palaeosciences, Avenue H. de Brouckère, 82, B-1160 Brussels, Belgium, luc_vrydaghs@yahoo.co.uk

[2] Centre de Recherches en Archéologie et Patrimoine, Université Libre de Bruxelles, Avenue F.D. Roosevelt, 50, CP 175, B-1050 Brussels, Belgium. yadevos@ulb.ac.be

[3] Hungarian National Museum, National Heritage Protection Centre. Laboratory of Conservation and Applied Research. Daróci út 3. H-1113 Budapest, Hungary. peto.akos@mnm-nok.gov.hu

PAPER ABSTRACT

Phytoliths are frequently reported within thin sections of archaeological deposits (Macphail 1981; Stoops and Nijs 1986; Madella and Milek 2000; Sordoillet *et al.* 2007). Last years several studies associating phytolith analysis and micromorphology were conducted (Albert et *al.* 2008; Barczi *et al.* 2006, 2009; Devos and Vrydaghs 2006; Devos *et al.* 2007 and 2009; Osterreith *et al.* 2009; Vrydaghs *et al.* 2007; Shahack-Gross *et al.* 2005; Villagran *et al.* 2010). Most of these contributions can be ranged under two broad categories:

- documenting the presence of phytoliths within (archaeological) units;
- documenting the phytolith distribution within (archaeological) units.

For a long time, Dark Earths have been considered to be a poorly stratified enigmatic phenomenon of rather ephemeral interest. During the last decades, however, interdisciplinary studies have demonstrated their huge archaeological potential (Macphail, 1994; Cammas, 2000; David et al., 2000; Cammas; 2004; Macphail & Linderholm, 2004). The integration of phytolith studies and micromorphology has proven to be of particular interest to investigate these archaeological units, especially in contexts where other botanical remains are poorly preserved (Devos et al., 2009). These analyses take into consideration the composition of the phytolith spectra, as well as the phytolith distribution patterns and phytolith preservation within the archaeological units (Devos and Vrydaghs 2006; Devos et al. 2007 and 2009).

The early development of Brussels is heavily debated. Historians and archaeologists face great difficulties to obtain firm data that can support one of the many hypotheses on its origins, situated somewhere between the 10th and the 13th centuries AD (Degraeve et al., 2010). The discovery of 'Dark Earth' units in the historic centre of the city opens new perspectives. To study their complex origins, formation, and archaeological significance, a specific interdisciplinary research protocol has been developed. The phytolith analysis of thin sections of Dark Earth units is part of this protocol. These analyses contribute significantly to reconstruct a rather open pre-urban landscape. Through the example of the Brussels' Dark Earth, the present contribution intends to demonstrate the potential of integrating phytolith studies and micromorphology.

REFERENCES

Albert, R.M., Shahack-Gross, R., Cabanes, D., Gilboa, A., Lev-Yadun, S., Portillo, M., Sharon, I., Boaretto, E. and Weiner, St. 2008. Phytolith-rich layers from the Late Bronze and Iron ages at Tel Dor (Israel): mode of formation and archaeological significance. *Journal of Archaeological Science* 35:57-75.

Cammas C., 2000. Apports et perspectives de l'analyse micromorphologique des "terres noires". In: *Terres Noires – 1.* Maison des sciences de la ville, de l'urbanisme et des paysages, Tours, pp. 45-60. *Documents Sciences de la Ville* 6.

Cammas C., 2004. Les "terres noires" urbaines du Nord de la France: première typologie pédosédimentaire. In: Verslype, L., Brulet, R. (eds.), *Terres Noires – Dark Earth. Actes de la table ronde internationale tenue à Louvain-la-Neuve, les 09 et 10 novembre 2001.* Université Catholique de Louvain, Louvain-la-Neuve, pp. 43-55. Collection d'archéologie Joseph Mertens, XIV.

David C., Cammas C., Durey-Blary V., Féchant C., Jesset S., Josset D., Naizet F., 2000. Problématique archéologique. Méthodes et techniques appliquées à l'étude des terres noires : état de la recherche. In: *Terres Noires – 1. Maison des sciences de la ville, de l'urbanisme et des paysages*, Tours, pp. 15-38. Documents Sciences de la Ville, 6, 2000).

Devos Y., Vrydaghs L., Degraeve A. & Fechner K., 2009: An archaeopedological and phytolitarian study of the "Dark Earth" on the site of Rue de Dinant (Brussels, Belgium). *Catena* 78: 270-284.

Macphail R.I., 1981. Soil and botanical studies of the "Dark Earth". In: Jones M. & Dimbleby G.W. (eds.): *The Environment of Man: the Iron Age to the Anglo-Saxon Period.* BAR Ltd., Oxford, pp. 309-331. British Archaeological Reports, British Series 87.

Macphail R.I., 1994. The reworking of urban stratigraphy by human and natural processes. In: Hall, A.R., Kenward, H.K. (eds.), *Urban-rural connexions: perspectives from environmental archaeology. Symposia of the As-*

sociation for Environmental Archaeology No. 12. Oxbow, Oxford, pp. 13-43. Oxbow Monograph, 47.

Macphail R.I. & Linderholm J., 2004. "Dark Earth": recent studies of "Dark Earth" and "Dark-Earth-like" microstratigraphy in England, UK. In: Verslype, L., Brulet, R. (eds.), Terres Noires – Dark Earth. Actes de la table ronde internationale tenue à Louvain-la-Neuve, les 09 et 10 novembre 2001. Université Catholique de Louvain, Louvain-la-Neuve, pp. 35-42. Collection d'archéologie Joseph Mertens, XIV.

Madella M. & Milek K., 2000. Sediment micromorphology and phytolith analysis: an integrated approach to the interpretation of a Norse farmstead in Iceland. In: Vrydaghs, L. & Degraeve, A. (eds*): Man and the (Palaeo)Environment: the phytolith evidence.* Abstracts of the 3rd IMPR, 14.

Osterrieth, M., Madella, M., Zurro, D., and Fernanda Alvarez, M. 2009. Taphonomival aspects of silica phytoliths in the loess sediments of the Argentinean Pampas. *Quaternary International* 193:70-79.

Shahack-Gross, R., Albert, R.M., Gilboa A., Nagar-Himan, O., Sharon, I., and Weiner, St. 2005. Geoarchaeology in an urban context: the uses of space in a Phoenician monumental building at Tel Dor (Israel). *Journal of Archaeological Science* 32:1417-1431.

Sordoillet D., Chiquet P., Piguet-Wernli M., Treffort J.-M., Voruz J.-L. 2007. Anthropic sediments from Neolithic to Iron Age settlements: interpretation according to micromorphological, archaeozoological and archaeological data. *Atti della Società toscana di Scienze naturali, Memorie, Serie A*, 112:165-171.

Stoops G., and Nijs R. 1986. Micromorphological characteristics of some tell materials from Mesopotamia. *Pedologi*, 3: 329-336.

Villagran, X.S., Balbl, A.L., Madella, M., Vila, A., and Estevez, J. 2010. Experimental micromorphology in Tierra del Fuego (Argentina): building a reference collection for the study of shells middens in cold climates. *Journal of Archaeological Sciences* 1-17.

Vrydaghs L., Devos Y., Fechner K., and Degraeve A. 2007. Phytolith analysis of ploughed land thin sections. Contribution to the early medieval town development of Brussels (Treurenberg site, Belgium). In: Madella, M. & Zucol, D. (eds): *Plants, people and places. Recent studies in phytolith analysis.* Oxbow Books, pp. 13-27.

COMPARING MODERN RICE CULTIVATION SYSTEMS AND WILD RICE THROUGH SOIL PHYTOLITHS: FIRST RESULTS OF EARLY RICE PROJECT ANALOGUE STUDIES

Weisskopf, Alison,[1] and Dorian Fuller[2]

[1] Institute of Archaeology University College London, 31-34 Gordon Square, London WC1H 0PY, UK. a.weisskopf@ucl.ac.uk

[2] Institute of Archaeology University College London, 31-34 Gordon Square, London WC1H 0PY, UK

Paper Abstract

Our current research programme aims to refine methods for identifying the signature of different rice cultivation regimes through weed seed, phytolith, and diatom assemblages, in order to reconstruct early rice cultivation systems, and to better establish how ancient arable rice systems can be seen using archaeobotanical data. One method is by building modern analogues using associated weed flora, and the phytolith morphotypes from these found within each type of cultivation regime. Rice can be cultivated in a range of crop systems, including upland rain fed, lowland irrigated, and deep water. A variety of arable systems in India, China, Thailand, and Laos have been surveyed, and rice weeds and sediment samples recorded and collected. The seeds have been added to a reference collection, husks, leaves, and culms from the plants processed for phytolith references, and the sediment samples processed for phytoliths in order to establish patterns identifiable to specific systems.

Using correspondence analysis to compare phytolith samples according to the correlation of their constituents, preliminary results from survey and sediment collection from a variety of Indian rice fields, including wild rice stands, suggest there are visible differences in the proportions of phytolith morphotypes that make up the different modern field samples.

A case study of phytoliths extracted from archaeological samples from Neolithic China and India demonstrates how this method can be applied to ancient material to interpret distinctions between arable systems.

HIGH-RESOLUTION BIOSILICATE ANALYSIS OF THE PLEISTOCENE-HOLOCENE TRANSITION: THE BRADY SOIL, SOUTHWESTERN NEBRASKA

Woodburn, T.L.,[1] W.C. Johnson, and S.R. Bozarth

[1] Department of Geography, 1475 Jayhawk Blvd., 213 Lindley Hall, University of Kansas, Lawrence, KS 66045. terriw@ku.edu

Poster Abstract

The Pleistocene-Holocene transition is distinguished on the central Great Plains by development of the Brady Soil between ~14-10 ka in upland loess deposits. Stratigraphy at the Old Wauneta Roadcut site in southwest Nebraska exhibits thick, organic-rich Ab and ABb horizons bioturbated by prairie dog (*Cynomys*

sp.) or a similar burrowing rodent. The lighter colored, carbonate-rich Bkb horizon is extensively mixed by small (~2 cm wide) cicada (Cicadidae) nymph burrows identified by distinctive backfill menisci.

New proxy data from biosilicates and particulate charcoal show detailed characteristics of the environmental changes taking place at the end of the Last Glacial Maximum. High-resolution phytolith analysis reveals quantitative plant taxa shifts from Pooideae (C_3) dominant grasses with relatively large numbers of arboreal dicot spheres and a few Cyperaceae (sedge) present in the Bølling-Allerød climatic period (~14.6 ka to 12.9 ka) to Chloridoideae (C_4) dominant grasses in the early Holocene. *Stipa*-type Pooideae, a cool-season grass preferring dryer soil conditions, marks the onset of this climate shift in the Younger Dryas (~12.9 ka to 11.7 ka). Charred phytolith counts and preliminary particulate charcoal analysis indicate an increase in localized fire occurrence during the early Holocene.

PHYTOLITH EVIDENCE OF MILLET AGRICULTURE DURING ABOUT 6000-2100 CAL. BP. IN THE GUANZHONG BASIN, CHINA

Wu, Naiqin,[1*] Houyuan Lu,[1] Jianping Zhang,[1] Fengjiang Li,[1] Xiaoyan Yang,[2] Weilin Wang,[3] Mingzhi Ma,[3] and Xiaohu Zhang[4]

[1] Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

[2] Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

[3] Shaanxi Provincial Institute of Archaeology, Xi'an 710001, China

[4] College of Urban and Environmental Sciences, Peking University, Beijing 100871, China

* Corresponding author: nqwu@mail.iggcas.ac.cn

PAPER ABSTRACT

Foxtail millet (*Setaria italica*) and common millet (*Panicum miliaceum*) are vitally important food crops for people living in East Asia and even in the entire Eurasian continent prior to the popularity of rice and wheat. However, due to constrained methodology in millet identification and limited archaeological samples, the history of millet cultivation in the Guanzhong Basin, North China is still problematic.

In this paper, we firstly analyzed the phytoliths from modern millets and rice husks (4 species respectively) to clarify the implications of crop phytolith quantity in archaeological samples by using nitric acid oxidative method (nitric acid to oxidize organic materials completely) and high temperature oxidative method (high temperature baking to oxidize organic materials completely). Then we identified millet and rice husk phytoliths from 47 archaeological samples in the Guanzhong Basin, including 18 samples from the Quanhu profile, 19 samples from the Yangguanzhai profile, and 10 pit samples from Quanhu, Yangguanzhai, Huxizhuang, Anban, Wangjiazui, and Shuigou sites, based on a newly method of distinguishing common millet and foxtail millet which was developed recently by Lu et al. (2009).

The analysis of modern crop husk phytoliths reveals that the same weight of common millet and foxtail millet yield almost the same amount of phytoliths. The quantity of these husk phytoliths reflects the relative production of the two millets, rather than the quantity of individual grains collected by the flotation method.

We consider that the quantity of foxtail millet grains concentrated by the flotation should be divided by 3 or more which can substantially reflect the relatively real production of the two millets in the archaeological samples. Moreover, the percentage of double peaked phytolith of rice husk may underestimate the actual quantity of rice. All 47 archaeological samples with 17 ^{14}C age data from Quanhu, Yangguanzhai, Huxizhuang, Anban, Wangjiazui, and Shuigou sites indicate that the percentage of common millet is always much higher (3.4~34.5%) than that of foxtail millet (0~6.2%) from ca. 6000~2100 cal. BP. Even in the relative warm-wet phase, the output of common millets is still higher than that of foxtail millet. Rice may be locally cultivated in Quanhu, Yangguanzhai, Huxizhuang, and Anban sites. These results provide pieces of new evidence to evaluate the relationship in different agricultural patterns, socio-economic mode, and climate changes in the Guanzhong Basin during the Neolithic epoch.

THE *CALATHEA ALLOUIA* (MARANTACEAE) AND COMMELINIACEAE CONUNDRUM: THE SEARCH FOR DIAGNOSTIC PHYTOLITHS

Yost, Chad

PaleoResearch Institute, 2675 Youngfield Street, Golden, Colorado, 80401, USA. chadyost@hotmail.com

PAPER ABSTRACT

In an effort to identify a distinctive phytolith morphotype recovered from archaeological sites in North America that resembled that described by Chandler-Ezell et al. (2006) as being diagnostic for *Calathea allouia* (Marantaceae), an extensive modern reference study of the genus *Thalia* (Marantaceae) was conducted. When *Thalia*, the only member of the Marantaceae native to North America north of Mexico, failed to produce a match for these unknown phytoliths, other members of New World Marantaceae with economic significance were studied, namely species of *Maranta* and *Calathea*. It was during this part of the study that I was unable to replicate the findings of Chandler-Ezell et al. (2006) that *Calathea allouia* tubers/rhizomes produced a diagnostic flat domed rhizome cylinder (26IAb). Recent modern reference work by Eichhorn (2010) and myself have revealed *Commelina* (Commelinaceae) seed phytoliths with a striking similarity to type 26IAb. Based on experimental data that illustrates the fact that both cleaned (sonicated) and uncleaned (non-sonicated) *Calathea allouia* tubers can harbor phytoliths derived from the surrounding soil matrix, it seems likely that phytolith type 26IAb recovered from *Calathea allouia* reference material in Chandler-Ezell et al. (2006) represents contamination from the soil.

REFERENCES

Chandler-Ezell, Karol, Deborah M. Pearsall, and James A. Zeidler. 2006. Root and Tuber Phytoliths and Starch Grains Document Manioc (*Manihot Exculenta*), Arrowroot (*Maranta arundinacea*), and Llerén (*Calathea sp.*) at the Real Alto Site, Ecuador. *Economic Botany* 60(2):103-120.

Eichhorn, B., K. Neumann, and A. Garnier. 2010. Seed phytoliths in West African Commelinaceae and their potential for palaeoecological studies. *Palaeogeography, Palaeoclimatology, Palaeoecology* 298:300-310.

COMMELINACEAE SEED PHYTOLITHS IN NORTH AMERICA: RECOVERY FROM ARCHAEOLOGICAL CONTEXTS AND COMPARISON TO MODERN REFERENCE MATERIAL

Yost, Chad

PaleoResearch Institute, 2675 Youngfield Street, Golden, Colorado, 80401, USA. chadyost@hotmail.com

PAPER ABSTRACT

The recent work of Eichhorn et al. (2010) has illustrated the widespread production and high degree of taxonomic resolution possible for seed phytoliths produced by members of the Commelinaceae. Since 2008, I have been documenting the presence of these (at the time unidentified) phytoliths from historic, prehistoric, and paleoecological contexts in North, Central, and South America. I have recently completed a modern seed phytolith reference study for all of the Commelinaceae genera native to North America, as well as for several introduced (non-native) taxa. Both morphometric and three-dimensional analysis indicate that North American Commelinaceae can be distinguished at least to the genus level, and in many cases, to the species level (e.g., *Commelina*). To date, I have documented the presence of *Commelina* phytoliths at 25 archaeological sites. They have been recovered from a wide variety of contexts that include ground stone tools, ceramic residue, feature fill (middens, pits, hearths), and agricultural fields. Although the low level of *Commelina* seed phytolith recovery at these sites suggests that the presence of this plant may simply be the result of anthropogenic disturbance, some findings suggest intentional exploitation of the seeds.

REFERENCES

Eichhorn, B., Neumann, K., Garnier, A. 2010. Seed phytoliths in West African Commelinaceae and their potential for palaeoecological studies. *Palaeogeography, Palaeoclimatology, Palaeoecology* 298:300-310.

PHYTOLITH ANALYSIS FOR DIFFERENTIATING BETWEEN FOXTAIL MILLET (*SETARIA ITALICA*) AND GREEN FOXTAIL (*SETARIA VIRIDIS*)

Zhang, Jianping,[1]* Houyuan Lu,[1] Naiqin Wu,[1] Xiaoyan Yang,[2] and Xianmin Diao[3]

[1] Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

[2] Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China

[3] The National Key Facility for Crop Gene Resources and Genetic Improvement, Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing, China

* Corresponding author: jpzhang@mail.iggcas.ac.cn

PAPER ABSTRACT

Foxtail millet (*Setaria italica*) is one of the oldest domesticated cereal crops in Eurasia, but identifying foxtail millet, especially in charred grains, and differentiating it from its wild ancestor, green foxtail (*Setaria viridis*), in the archaeobotanical remains, is still problematic. Phytolithic analysis provides a meaningful method for identifying this important crop. In this paper, the silicon structure patterns in the glumes, lemmas, and paleas from inflorescence bracts in 16 modern plants of foxtail millet and green foxtail from China and Europe are examined using light microscopy with phase-contrast and a microscopic interferometer. Our research shows that the silicon structure of ΩIII from upper lemmas and paleas in foxtail millet and green foxtail can be correspondingly divided into two groups. The size of ΩIII type phytolith of foxtail millet is bigger than that of green foxtail. Discriminant function analysis reveals that 78.4% of data on foxtail millet and 76.9% of data on green foxtail are correctly classified. This means certain morphotypes of phytoliths are relatively reliable tools for distinguishing foxtail millet from green foxtail. Our results also revealed that the husk phytolith morphologies of foxtail millets from China and Eastern Europe are markedly different from those from Western Europe. Our research gives a meaningful method of separating foxtail millet and green foxtail. The implications of these findings for understanding the history of foxtail millet domestication and cultivation in ancient civilizations are significant.

PHYTOLITH RECORD ON PALEOCLIMATE CHANGES AND ITS RELATIONSHIP WITH ANCIENT RICE AGRICULTURE OF HEMUDU AREA, CHINA

Zhang, Xinrong,[1,2]* Zheng Hongbo,[3] and Qin Jungan[4]

[1] College of Earth Sciences, Jilin University, Changchun 130061, China

[2] Key-Lab for Evolution of Past Life and Environment in Northeast Asia, Ministry of Education, China, Jilin University, Changchun 130061, China

[3] School of Earth Sciences and Engineering, Nanjing University, Nanjing 210093, China

[4] Institute of Karst Geology, Chinese Academy of Geological Sciences, Guilin 541004, China

* Corresponding author: zhangxr@jlu.edu.cn

POSTER ABSTRACT

Phytolith analysis of a sediment core near Hemudu site shows that there was a fluctuating paleoclimate process since about 30,000 years ago in Hemudu area, which follow as: cold & dry-cooler & drier-warm & wet-warmer & wet-cool & dry-comparatively cold & dry-cold & wet-cold & dry. Rice (*Oryza* sp.) phytolith appeared at about 8,150 YBP and about 7,620 YBP on the studied profile. These perhaps provided useful information for ancient people of Hemudu area on early germination of rice cultivation. During the corresponding third and second culture periods on the sediment profile, the rice phytolith contents are low, which are in line with those on the site. Maybe this is induced by paleocliamte changes. However, the paleoclimate indications of phytolith and algae of the first hard clay in this profile are very different, the reason is being studied.

LIST OF ABSTRACTS BY AUTHOR

$SiO_2 \cdot nH_2O$

Phytolith Fitolito Fitolitok

فيتوليث Phytolithe

Phytolitharia Фитолит

Fitoliti Fytolieten Fitòlit

Fytolit 植硅体 Fitólito

Kieselkörper Fytoliitti