The 11th International Meeting on Phytolith Research

——Geosciences, archaeology, and human future

FINAL CIRCULAR

http://www.11thimpr.cn/

September 14-16, 2018

Wuhan, China

Meeting Programme

14th to 16th September 2018

11th International Meeting on Phytolith Research			
PROGRAM			
Thursday 13th September			
9:00	-	20:00	All-day registrationat the hall of Yingbinlou Building (reception centre): to register and get badge.
14:00	-	17:00	Visiting to Shaw Museum at CUG.
17:30	-	19:30	Supper at the Zhendanyuan Dinning Hall.
Friday 14th September			
8:30	-	9:00	Opening session: welcomed by IPS and CUG.
9:00		9:15	Take a picture of all participants
Session 1 Phytoliths morphology, identification criteria and taxonomy. Chair: Mikhail Blinnikov			
9:15	-	9:45	What is the future of phytolith research? Thoughts and perspectives on the next generation of phytolith studies. **Marco Madella** (KEYNOTE).
9:45	-	10:15	Phytolith analysis for differentiating between broomcorn millet (*Panicum miliaceum*) and its weed/feral type (*Panicum ruderale*). **Jianping Zhang** (KEYNOTE).
10:15	-	10:45	Coffee break.
10:45	-	11:00	An Introduction to the International Code for Phytolith Nomenclature (ICPN) 2.0. **Terry Ball & Luc Vrydaghs**
11:00	-	11:15	Phytolith in the inflorescence of selected Panicoideae (Poaceae) plants. **Yong Ge**.
11:15	-	11:30	An in situ and Morphometric Study of Maize (*Zea mays*) Cob Rondel Phytoliths. **Terry Ball & McCaela Michas**
11:30	-	11:45	Developing morphometric analysis of archaeological phytoliths in soil and sediment thin sections: some examples from Brussels (Belgium). **Luc Vrydaghs**
11:45	-	12:00	Combining a spatial network of soil phytolith data with species distribution modeling to estimate grass distribution in California in the past and predict future distribution under altered climate scenarios. **Rand Evett**.
12:00	-	14:00	Lunch time at the Zhendanyuan Dinning Hall.
14:00	-	17:00	Visiting to Provincial Museum of Hubei.
17:00	-	20:00	Supper at the Zhendanyuan Dinning Hall.
Saturday 15th September			
Session 2 Phytoliths in the surface soil and environmental significance. Chair: Terry Ball			
8:30	-	9:00	Achievements, challenges and prospects of phytolith analysis in the temperate zone. **Golyeva Alexandra** (KEYNOTE).
9:00	-	9:15	Characteristics of Phytolith Assemblages of Topsoil in Typical Communities of Songnen Grassland. **Dehui Li**.
9:15	-	9:30	Diversity and significance of Polylobate phytoliths in grasses of Sunderbans

			delta, India. **Madhab Naskar & Subir Bera**.
9:30	-	9:45	Assessment and calibration of representational bias in soil phytolith assemblages in Northeast China. **Guizai Gao**.
9:45	-	10:00	Depicting the Fynbos biome through the phytolith record. **Irene Esteban**.
10:00	-	10:15	Phytolith Research on Modern Paddy Soil. **Xiujia Huan**.
10:15	-	10:35	Coffee break.
Session 3 Fossil phytoliths and palaeo-environmental reconstruction. Chair: Golyeva Alexandra			
10:35	-	11:05	Challenges and opportunities in phytolith analysis of palaeoenvironments. **Mikhail Blinnikov** (KEYNOTE).
11:05	-	11:35	Holocene C3/C4 Abundance Dynamics in Songnen Grasslands and Its Link to Monsoon-drived Climate Variations. **Dongmei Jie** (KEYNOTE).
11:35	-	11:50	Vegetation and fire history of northeastern Indian Ocean since 45 ka B.P. : Records from phytoliths and micro-charcoal. **Vidusanka Thilakanayaka**.
12:00	-	14:00	Lunchat the Zhendanyuan Dinning Hall.
Session 3 (continued).Chair: Rand Evett			
14:00	-	14:15	Phytoliths in laterite reveal climate changes in the Pleistocene lower reaches of the Yangtze River. **Weiming Wang**.
14:15	-	14:30	Phytolith records of Early Mid-Holocene vegetational and climatic changes in the Lower Yangtze Valley. **Xinxin Zuo**.
14:30	-	14:45	Comparing phytolith analysis of bulk samples and soil thin sections. Preliminary results of a statistical analysis. **Luc Vrydaghs**.
14:45	-	15:00	Peatland ecological responses to phytolith-inferred postglacial hydrological variability in central China. **Hongye Liu**.
15:00	-	15:15	Spatial vegetation dynamics over the last 35,000 years in West Africa. The contribution of phytoliths in a multi-proxy and multi-sit study (FALÉMÉ VALLEY, SENEGAL; DOGON COUNTRY, MALI). **Aline GARNIER**.
15:15	-	15:30	Climatic controls on peat swamp formation and evolution since 1300 yr BP as recorded by phytoliths in the Xishan Mountains, Jiangxi Province. China.**Xinrong Zhang**.
15:30	-	16:00	Coffee break
Session 4 Application of phytolith and starch in the environmental archaeology. Chair: Zhijun Zhao			
16:00	-	16:30	Timing of Shangshan Culture and the Process of Rice Domestication. **Houyuan Lu** (KEYNOTE).
16:30	-	16:45	Phytoliths in microfossil assemblages once more called to understand unknown functional analysis. The case of the Inka “celdas” at Northwestern Argentina. **Alejandra Korstanje**.
16:45	-	17:00	Middle-Holocene sea-level fluctuations interrupted the developing Hemudu culture in the lower Yangtze River, China. **Keyang He**.
17:00	-	17:15	Reconstruction of vegetation dynamics in the Maya Lowlands: human-environment interactions during the preclassic period in the city of Naachtun (Guatemala). **Marc TESTÉ**.

17:15	-	17:30	From West to East – Comparative Study of Phytoliths from archaeological sites from Tajikistan to Greece. **Birgül Ögüt**.
17:30	-	18:00	Posters session& open discussion.
18:00	-	20:00	Supper at the Zhendanyuan Dinning Hall.
Sunday 16th September			
Session 4 (continued). Chair: Marco Madella			
8:30	-	9:00	Four stages for the origin of rice agriculture in China. **Zhijun Zhao** (KEYNOTE).
9:00	-	9:30	Phytoliths: a powerful tool for exploring the deep-time evolution of herbivores. **Yan Wu** (KEYNOTE).
9:30	-	9:45	Waste Heaps in the EBA Pile Dwelling of Lucone (N-Italy): Towards A Geoarchaeology of Daily Activities. **Marta Dal Corso**.
9:45	-	10:00	Phytoliths and other microfossils in archaeological smoking artifacts from Santiago del Estero's plains (Argentina). Museum collections under the microscope. **Alejandra Korstanje**.
10:00	-	10:15	Comparative phytolith analysis between cultural layers and natural sediments at the Kuahuqiao archaeological site in Xiaoshan, east China. **Junwu Shu**.
10:15	-	10:35	Coffee break.
Session 5 Phytoliths linked to global change. Chair: Dongmei Jie			
10:35	-	11:05	Phytolith biogeochemistry and its control on terrestrial biogeochemical carbon cycle. **Zhaoliang Song** (KEYNOTE).
11:05	-	11:35	Modern bamboo phytolith response to the climate change: an example from *Bambusa emeiensis* in the middle Yangtze River. **Yansheng Gu** (KEYNOTE).
11:35	-	11:50	Monthly coordinated variations between phytolith assemblage and alkane composition in the leaves of the bamboo *Dendrocalamus ronganensis*. **Rencheng Li**.
12:00	-	14:00	Lunchat the Zhendanyuan Dinning Hall.
Session 5 (continued). Chair: Zhaoliang Song			
14:00	-	14:15	The storage of soil phytolith-occluded carbon in China's grasslands. **Xiaodong Zhang**.
14:15	-	14:30	Response of phytoliths to heavy metal stress in crops. **Linan Liu**.
14:30	-	14:45	Production, accumulation of phytoliths and the potential of phytolith sequestration carbon in wetland ecosystems. **Shaopan Xia**.
14:45	-	15:00	Silicon distribution and phytolith-occluded carbon of grassland plants in northern China. **Xiaomin Yang**.
15:00	-	15:10	Summary speech by Prof. **Mikhail Blinnikov** (IPS president).
15:10	-	15:30	Coffee break

11th International Meeting on Phytolith Research	
POSTER SESSION	
Can Wang	The Spatial pattern of farming and its influencing factors during the Peiligang culture period in the middle Yellow River valley, China.
Chunguang Gu	Phytolith evidence for the development of agriculture between early and middle Dawenkou and Longshan cultures at the Gongzhuang site in Linquan County, Anhui Province.
Hanlin Wang	Variation of C4 grasses and Asian monsoon climate over the past ~11.0 Ma revealed by phytolith analysis
Linjing Liu	The Paleoclimate Recorded by Phytolith in Anguli-Nuur Lake since the Mid-Late Holocene.
Marta Dal Corso	A Multiproxy Analysis of Daub at the Chalcolithic Tripolye Mega-site of Maidanetske, Central Ukraine (3900–3650 BCE), for the investigation of plant temper and house burning practices.
Mikhail Blinnikov	Formation of anthropogenic landscapes in the Medlle Volga region in the last two middenia through the use of phytoliths and other proxies in soils.
Nannan Li	Holocene *Artemisia*-Chenopodiaceae-dominated grassland in North China: Real or imaginary?
Naoki Hayashi	The different vegetation transitions during Holocene induced by different fire frequencies in a local area, central Japan, inferred from phytolith and macrocharcoal records in cumulative soils.
Ting Ma	New evidence for Neolithic rice cultivation and Holocene environmental change in the Fuzhou Basin, southeast China.
Vidusanka Thilakanayaka	Vegetation and fire history of northeastern Indian Ocean since 45ka B.P. : Records from phytoliths and micro-charcoal.
Wuhong Luo	Phytoliths reveal the earliest interplay of rice and broomcorn millet between 7.3 ka BP and 6.8 ka BP in the middle Huai River valley, China.
Yansheng Gu	Phytolith records of climate change since the Last Deglaciation in the eastern Jianghan Plain.
Yansheng Gu	Discovery of rice phytoliths in the Holocene Core Jh002 and its implications for the early dispersal of ancient Asian domesticated rice in the Jianghan Plain.

The 11th International Meeting on Phytolith Research

Abstract Volume

September 14-16, 2018 in Wuhan, China

Table of contents

Session 1: Phytoliths morphology, identification criteria and taxonomy

Keynote speech

Phytolith analysis for differentiating between broomcorn millet (*Panicum miliaceum*) and its weed/feral type (*Panicum ruderale*)

Jianping Zhang[1,2*], Houyuan Lu[1,2,3*], Minxuan Liu[4],
Xianmin Diao[4], Konglan Shao[1,3], Naiqin Wu[1]

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

[2]Center for Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, Beijing, 100101, China;

[3] University of Chinese Academy of Sciences, Beijing, China;

[4] Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing 100081, China.

Abstract

Domestication of broomcorn millet is one of the most significant events in prehistoric East Asia, which provided enough food for explosive growth of Neolithic population and the transition into complex socialites. However, to date, the process of broomcorn millet domestication is still unknown, particularly due to the lack of clear diagnostic feature to distinguishing between the millet and its wild related grasses from archaeological residuals. Here we examine the percentage of silicified epidermal long cell undulated patterns in the glume and palea from the inflorescence bracts in 21 modern of broomcorn millet and 12 of its weed/feral type *Panicum ruderale* collected cross north China. Our results show that the percentage of ηIII patterns in the domesticated broomcorn millet (23.0% ± 5.9%) (n=63) is about 10% higher than in *P. ruderale* (10.8% ± 5.8%)(n=36), with the quartiles of 17.2%-28.3% and 5.1%-15.5%, respectively. The increase of ηIII pattern percentage has a significant correlation with the decrease of ratio Length/Width of grains. The results statistically suggest that the direct wild ancestor of *P. miliaceum* could possibly has lower ηIII type in the lemma and palea, providing us a potential method to trace the domestication process of broomcorn millet, and will contributing to the methodology which can be applied to distinguish other cereal crops and wild grasses.

Keywords: phytolith, broomcorn millet, *Panicum miliaceum*, *Panicum ruderale*

Keynote speech

What is the future of phytolith research? Thoughts and perspectives on the next generation of phytolith studies

Marco Madella

ICREA Research Professor in Environmental Archaeology

The stage of maturity reached by phytolith research in the last 15 years is testified by the number of works published in journals covering a variety of disciplinary areas. These works critically reflect on the methodology itself and, at the same time, on the technological advancements and the introduction of more sophisticated analytical tools. All those new developments contributed to a widening in scope for phytolith research, including isotopic and DNA analyses. In this presentation I will try to make a "photographs" of the current phytolith research and discuss new strands that have the potential to change our understanding in topics that comprise prehistoric agricultural techniques, domestication processes for key crops from many areas of the world, land use during the Holocene, and palaeoenvironmental dynamics and pedogenesis.

Short biography

After graduating at the University of Milan (Italy) in Natural Sciences (Botany), I worked as a contract scientist at the Archaeological Museum of Como and left the team in 1993 to start a PhD at the University of Cambridge. After finishing my PhD I took up a position as research fellow at the McDonald Institute for Archaeological Research, also teaching archaeology and human evolution at the Institute for Continuing Education (Madingly Hall) of the University of Cambridge. In 2004 I became affiliated lecturer in the Department of Archaeology and in 2005 director of studies in archaeology and anthropology at St. Edmund's College in the University of Cambridge. Since July 2005 I am ICREA research professor first at the IMF-CSIC and from 2014 at Universitat Pompeu Fabra. I currently coordinate the Complexity and Socio-Ecological Dynamics (CaSEs) research group and I teach in the UPF Master in Global History.

Research interests

My background is in archaeobotany and environmental archaeology, and I investigate the socio-ecological dynamics of past human populations from Mediterranean to tropical environments. My interests span from past vegetation histories, the modelling and simulation of processes in human behavioural change, people-plants co-evolutionary dynamics, long term trajectories of biodiversity and sustainability in prehistoric societies, and the origin and resilience of agriculture. Agriculture had an immense impact on humans and non-humans, and the future of our world is linked to making agriculture sustainable by maintaining biodiversity, revaluating traditional knowledge and mitigating environmental impact. Key areas for my work are South and West Asia, and South America.

Combining a spatial network of soil phytolith data with species distribution modeling to estimate grass distribution in California in the past and predict future distribution under altered climate scenarios

Evett, Rand R.[1], Stephen E. Fick[2]

[1] Department of ESPM, University of California, Berkeley, California, USA revett@sonic.net

[2] Department of Plant Sciences, University of California, Davis, California, USA

Abstract

Species distribution modeling (SDM) has been used successfully worldwide to identify the most important environmental factors affecting the distribution of plant taxa. SDM typically combines point-based species distribution data (often from herbarium specimens) with environmental (often climatic) data at each point to build a model of the environmental niche of a species or other taxon; the model is then tested by using the model to map the current spatial distribution of the species and comparing this with the actual distribution. The validated model can be used to estimate distribution of the species under different climate scenarios that occurred in the past or will occur in the future. While pollen data has often been used successfully to provide point-based past species distribution data, soil phytolith data has never been used as an input for an SDM. We combined phytolith data with a species distribution modeling (SDM) approach to estimate the prehistoric distribution of native grass-dominated grassland in California. The goal of our research was to estimate the spatial extent of grass-dominated grassland (until recently, assumed to mirror the current distribution) prior to 1769. Following the arrival of Spanish explorers in California in 1769, cover of native species was replaced by a suite of invasive species on over 7 million hectares, largely annual grasses of Mediterranean origin; less than 1% of the original grassland is relatively intact. However, because grasses are the main source of phytoliths in most of California and phytoliths are resistant to weathering, sites that were dominated by grasses prior to 1769 retain substantially higher soil phytolith content than sites that had little grass cover. Using soil phytolith content data from a network of 120 sites, we built an SDM and mapped the estimated prehistoric distribution of grass-dominated grassland. The estimated distribution of the prehistoric native perennial grass-dominated grassland is much smaller than the current distribution of the exotic annual-grass dominated grassland; prehistoric grasslands in California were probably dominated by forbs rather than grasses. Current research is focused on using the SDM to estimate changes in grass distribution expected under altered climate scenarios. We believe our approach, using phytolith data to build SDM models, is an important addition to the paleoecological toolkit and can also offer insights into the effects of climate change on plant taxa distribution, opening an exciting new frontier for phytolith research.

An Introduction to the International Code for Phytolith Nomenclature (ICPN) 2.0

International Committee for Phytolith Taxonomy (ICPT): Katharina Neumann[1], Rosa Maria Albert[2,3], Terry Ball[4*], Linda Scott Cummings[5], Caroline Strömberg[6], Luc Vrydaghs[7*]

[1] Goethe University, Institut for Archaeological Sciences, Norbert-Wollheim-Platz 1, 60629 Frankfurt am Main, Germany;

[2] ICREA. Pg. Companys, 23. 08010 Barcelona, Spain;

[3] ERAAUB. Dept. of History and Archaeology, Universitat de Barcelona, Spain;

[4] 210H JSB, Department of Ancient Scripture, Brigham Young University, Provo, UT, 84602, USA;

[5] Paleoresearch Institute, 2675 Youngfield St., Golden, CO, 80401, USA;

[6] Department of Biology and Burke Museum of Natural History and Culture, University of Washington, Seattle 98195, USA;

[7] Centre de Recherches en Archéologie et Patrimoine. Université libre de Bruxelles CP 133/01. Avenue F.D. Roosevelt, 50 . B-1050 Brussels, Belgium.

[*] Authors presenting at 11thIMPR

Abstract

In 2000, the primary governing body for the discipline of phytolith analysis, now the International Phytolith Society (IPS), recognized the need for standardization of nomenclature and terminology in the discipline and subsequently commissioned a committee to draft an International Code for Phytolith Nomenclature. That code, known as ICPN 1.0, was published in the Annals of Botany in 2005 (ICPN Working Group: Madella et al., 2005), and has become a widely cited and utilized standard in phytolith analysis. More than a decade of use of the code has prompted the need to revise, update, expand, and improve it. The International Committee for Phytolith Taxonomy (ICPT) was appointed to make the revisions by IPS in 2014. The ICPT has now drafted ICPN 2.0 which revises some of the principles recommended for naming and describing phytolith morphotypes, presents the revised names, diagnosis, images and drawings of the 18 morphotypes that were included in ICPN 1.0, plus three others, and includes an illustrated glossary of common terms for description. This presentation will introduce and review ICPN 2.0.

Madella, M., Alexandre A., Ball, T. 2005.International Code for Phytolith Nomenclature 1.0. *Annals of Botany* 96(2): 253-260.

An *in situ* and morphometric study of maize (*zea mays*) cob Rondel phytoliths

Terry Ball[1], McCaela Michas[1], Karen R. Adams[2], Chad L. Yost[3], Kathryn Puseman[4]

[1] 210H JSB, Department of Ancient Scripture, Brigham Young University, Provo, UT, 84602, USA;

[2]Archaeobotanical Consultant, 2837 E. Beverly Dr., Tucson, AZ 85716-5716;

[3] Department of Geosciences, University of Arizona, 1040 E 4th Street, Tucson, AZ 85721, USA;

[4]Paleoscapes Archaeobotanical Services Team, 734 Mockingbird Trail, Bailey, CO 80421, USA

Abstract

Considerable research on rondel phytoliths produced in the cobs of maize (*Zea mays* L.) has been conducted, and various topologic paradigms for discriminating between maize races have been developed (e.g. Piperno and Pearsall, 1993; Hart *et al*., 2003; Chavez and Thompson, 2006; Boyd *et al.*, 2008). This paper will present a first study of the *in situ* location of rondel phytoliths in maize cobs, and the preliminary results of a detailed morphometric analysis of rondel phytoliths produced in 27 different southwestern U.S. and northern Mexico indigenous landraces of maize that were all grown in a single controlled environmental setting (Adams et al., 2006). The study is designed to determine if morphometric analysis of maize cob rondel phytoliths can be used to distinguish between the landraces of maize and, if so, to develop morphometric paradigms for identifying the landraces in archaeological contexts.

Adams, Karen R., Cathryn M. Meegan, Scott G. Ortman, R. Emerson Howell, Lindsay C. Werth, Deborah A. Muenchrath, Michael K. O'Neill, and Candice A.C. Gardner. 2006 MAÍS (Maize of American Indigenous Societies) Southwest: Ear Descriptions and Traits that Distinguish 27 Morphologically Distinct Groups of 123 Historic USDA Maize (*Zea mays* L. ssp. *mays*) Accessions and Data Relevant to Archaeological Subsistence Models. Manuscript on file, http://farmingtonsc.nmsu.edu.

Boyd, M., Varney, T., Surette, C., Surette, J., 2008. Reassessing the northern limit of maize consumption in North America: stable isotope, plant microfossil, and trace element content of carbonized food residue. *Journal of Archaeological Science* 35, 2545–2556.

Chavez, S.J., Thompson, R.G., 2006. Early Maize on the Copacabana Peninsula: implications for the archaeology of the Lake Titicaca Basin. In: Staller, J., Tykot, R., Benz, B. (Eds.), *Histories of Maize: Multidisciplinary Approaches to the Prehistory, Linguistics, Biogeography, Domestication, and Evolution of Maize.* Academic Press, Burlington, Massachusetts, pp. 415–428.

Hart, J.P., Thompson, R.G., Brumbach, H.J., 2003. Phytolith evidence for early maize (*Zea mays*) in the Northern Finger region of New York. *American Antiquity* 68, 619–640.

Piperno, D.R., Pearsall, D.M., 1993. Phytoliths in the reproductive structures of maize and teosinte: Implications for the study of maize evolution. *Journal of Archaeological Science* 20, 337–362.

Developing morphometric analysis of archaeological phytoliths in soil and sediment thin sections: some examples from Brussels (Belgium)

Vrydaghs, L. [1], Ball, T.B.[2], Devos, Y. [1, 3]

[1] Centre de Recherches en Archéologie et Patrimoine, Université Libre de Bruxelles ;

[2] Brigham Young University

[3] Vrije Universiteit Brussel

Abstract

Within soil and sediment thin sections, phytoliths are observed along 3 main distribution patterns: isolated, clustered and articulated. Articulated phytoliths are those for which their original distribution within the plant tissues has been preserved. Articulated phytoliths not only share a common botanical origin, they also derive from the same plant part. Consequently, researchers can be confident that when conducting morphometric analysis of articulated phytoliths all the phytoliths in the assemblage come not only from a single taxon, but also from a single part of a single plant.

For several years we have been collecting a reference morphometric data collection of articulated dendritic phytoliths produced by the major cultivated cereals, their wild ancestors, and other taxa that produce similar morphotypes (Ball et al.,2017). This presentation intends to explore how this reference data can be used to make inferences about archaeological material. Two examples will be presented: the first demonstrating its application in identifying plant remains within a horse coprolite; the second demonstrating its application in identifying ancient crops cultivated in medieval Brussels.

Reference:

Ball, TB.,Vrydaghs, L., Mercer, T., PEearce, M., Snyder, S., Listztes-Szabo, Z. and Peto, A., 2017. A morphometric study of variance in articulated dendritic phytolith wave lobes within selected species of Triticeae and Aveneae. Vegetation History and Archaeobotany 26 (1): 85-97.

Phytolith in the inflorescence of selected Panicoideae (Poaceae) plants

Yong Ge[1, 2], Houyuan Lu[3, 4, 5*], Xing Gao[1, 2, 5]

[1] Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, 100044, China

[2] Center for Excellence in Life and Paleoenvironment, Chinese Academy of Sciences, Beijing, 100044, China

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

[4] Center for Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, Beijing, 100101, China

[5] University of Chinese Academy of Sciences, Beijing 100049, China

Abstract

Phytolith is a valuable tool in the classification of Poaceae plants, the reconstruction of paleoenvironment, and the investigation of ancestral plant resource utilization. Phytolith in the inflorescence of Poaceae plants, which can be identified to species level (e.g. *Panicum miliaceum*), has various morphology among different plants. While less attention has been paid to the non-major crop plants, which composite most of the Poaceae, resulted in a lack of reference and the potential of misidentification. Selected common Panicoideae inflorescence samples were ultrasonic cleaned and divided into four parts: involucre, glume, lemma and palea. Results showed that most species produced different types of phytolith in the four parts, it could be summarized that glumes usually produce the same types of phytolith with leaves, while other parts do not. It is also noticeable that the fertile and infertile floret in the same species produced different types of phytoliths in the lemma and palea, the infertile floret produce the same types of phytolith with leaves, while the fertile floret commonly produce dendritic silica layer. The morphology of dendritic silica layer vary between species, mainly in the undulation part, which could be diagnostic in the genus level. Phytoliths with peculiar morphology could be found in the involucre (e.g. *Sorghum bicolor*), with the potential of being diagnostic types. Overall, various phytoliths in the inflorescence of Panicoideae plants could be distinguished from genus level, which could be helpful in the investigation of ancient plant resource, and provide a tool to investigate the plant taxonomy and seed protection strategy.

Keywords: Phytolith, Panicoideae, Poaceae, Taxonomy, Archaeobotany

Session 2: Phytoliths in the surface soil and environmental significance

Keynote speech

Achievements, challenges and prospects of phytolith analysis in the temperate zone

Golyeva Alexandra

Institute of Geography RAS, Moscow, Russia

Abstract

Phytolith analysis is widely applied in paleoenvironmental reconstructions and archaeological studies within the temperate zone, particularly, in Russia. The fact that all cultivated cereal crops are introduced grass species belonging to the C4 photosynthetic pathway group, while all native species belong to the C3 group, provides possibilities for the confident identification of ancient arable soils on the basis of occurrence of characteristic dendritic phytoliths. This also serves as a basis for reconstructions of ancient trade routes, e.g., the presence of rice phytoliths in a cultural layer of an ancient settlement is indicative of its trade with the south-east regions.

Moreover, phytolith analysis allows diagnostics of ancient plant communities in paleoenvironmental reconstructions. The author's system for identification of plant communities based on specific shapes and sizes of most widespread phytoliths of the temperate zone (i.e., trichome and elongate phytoliths) has been widely applied for many years and proved to be reliable.

However, it is very difficult to express the knowledge obtained in terms of generally accepted international classifications, which are designed for southern geographic regions, where most phytoliths are formed within short cells of grasses. The temperate zone is dominated by forest communities with diagnostic assemblages of phytoliths formed within long cells and trichomes.In the international nomenclature all trichomes are found in a single group with a lack of detailed classification and, therefore, it is necessary to provide a complicated and lengthy description for each diagnostic feature of a certain trichome phytolith. A high informative value of phytolith analysis as well as a growing demand for its application within temperate zone creates an imperative need for new amendments.

The forthcoming report by the author will focus on achievements, challenges and prospects of phytolith analysis in the temperate zone with specific examples given and existing terminological problems described.

Characteristics of phytolith assemblages of topsoil in typical communities of songnen grassland

De-Hui Li[1]， Dong-Mei Jie[1], Gui-Zai Gao[1], Nan-NanLi[1], Li-Dan Liu[2], Hong-Yan Liu[3], Cheng-Cheng Leng[1]

[1] School of Geographical Sciences, Northeast Normal University, Changchun 130024, China;

[2] College of Resource and Environment Science, Hunan Normal University, Changsha 410001, China;

[3] School of Resources Environment & Tourism，Anyang Normal University，Anyang 455000, China

Abstract

Phytoliths are significant and potentially effective in grassland paleovegetation reconstruction. This study collected 57 topsoil samples corresponding of 24 typical community types in Songnen Grassland, and investigated phytolith morphotypes and assemblages in them. According to community types, 57 samples were classified into four groups: shrub community, forb community, C3 grass community, and C4 grass community.

A total of 30 phytolith morphotypes were identified and grouped into seven categories according anatomical items: I. *Short cell phytolith*, II. *Long cell phytolith*, III. *Hair cell phytolith*, IV. *Bulliform cell phytolith*, V. *stoma guard cell and subsidiary cell phytolith*, VI. *Epidermal cell phytolith*, VII. *Phytolith that anatomic unknown*. Besides, other Bio-Si like diatoms and sponge spicules, which containing environmental significance were also identified and counted. Diatoms and sponge spicules were excluded when calculating phytolith assemblages, because their origination were different with phytoliths. However, since these Bio-Si also contained environmental significance, we calculated their percentages respectively by regarding the sum of phytoliths counts, diatoms counts, and sponge spicules counts as denominator.

Rondel flat was the dominant type of most topsoil phytolith assemblages, and rondel flat in C4 grass communities were less than C3 grass communities. The dominant phytolith types in forb communities were rarely to be flat rondel.

Detrended Correspondence Analysis (DCA) was applied to find the ecological meaning of each phytolith morphotypes in Songnen Grassland. Discriminant analysis (DA) was employed to find the differences between shrub community, forb community, C3 grass community and C4 grass community, and these community types were discriminated correctly with accuracies at least of 79.2%. The finer discriminant result with a high accuracy probably indicated that DA is applicative in discrimination of community types, and could do some help in future palaeovegetation reconstruction in Songnen Grassland.

Assessment and calibration of representational bias in soil phytolith assemblages in Northeast China

Guizai Gao[1], Dongmei Jie[1 *], Dehui Li[1], Nannan Li[1], Lidan Liu[2], Hongyan Liu[3], Chengcheng Leng[1]

[1]School of Geographical Science, Northeast Normal University, Changchun 130024, China;

[2] College of Resource and Environment Science, Hunan Normal University, Changsha 410001, China;

[3] School of Resources Environment & Tourism, Anyang Normal University, Anyang 455000, China.

Abstract

The assessment and calibration of representational bias in modern soil phytolith assemblages provide the basis for improving interpretation of fossil phytolith assemblages. We studied soil phytolith representation by comparing phytoliths from living plant communities with those from paired surface soils, representing 39 plant communities in Northeast China. Together with the use of representation indices, the 34 and 30 soil morphotypes observed in forest and grassland samples, respectively, were both classified into the following four groups: “Associated types” were similarly represented in soils and in the corresponding species inventory data; “Over-represented types” and “Under-represented types” were respectively over- and under-represented in soils compared to the inventory data; and, in the case of “Special types,” the relationship with the parent plants was unclear. In addition, the diagnostic types exhibited different degrees of representation,while the most common morphotypes were equally represented between grassland samples and forest samples. On this basis, a comparison between the original and corrected soil phytolith indices of the additional 29 soil samples was conducted. The soil phytoliths frequencies corrected by R-values differed between plots with differing plant compositions,and were moderately consistent with actual plant richness in the plot inventory data. We therefore confirmed that R-valuesare a promising means of correcting soil phytoliths for representational bias in temperate regions. The corrected soil phytoliths can be used to reliably reflect vegetation variability. Overall, our study provides an improved understanding of soil phytolith representation and offers a potential method for improving the accuracy of paleovegetation reconstruction.

Keywords: Phytolith, Representation, Calibration, Northeast China

Depicting the Fynbos biome through the phytolith record

Irene Esteban[1,2], Richard Cowling[2], Marion K. Bamford[1,2]

[1] Evolutionary Studies Institute and School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa

[2] African Centre for Coastal Palaeoscience, Nelson Mandela University, Port Elizabeth, South Africa,

Abstract

The south coast of South Africa has been recognized as one of the most important places for its ecological, floristic, climatic, palaeontological and archaeological record. It is also located along the southern coast of the Greater Cape Floristic Region (GCFR), which comprises the world's most diverse extra-tropical flora, both in terms of richness and endemism. We aim at understanding plant foraging strategies in relation to habitat settings and its coupled response to climate changes during the South African Late Pleistocene. To do this, one must use actualistic studies of modern assemblages from extant habitats to develop analogies for the past. The work presented here aims at expanding previous work [1] conducted at the central south coast by studying modern surface soils from fynbos habitats at four different climatic regions, covering the whole southern GCFR from west to east. We sampled a total of 24 sites associated with seven fynbos vegetation types. Phytolith morphotypes were grouped in plant types and plant parts, and grass short cells divided into rondels, oblongs, lobates and saddles. Four phytolith indices (shrubby cover-D/P, fynbos-Fy, aridity-Iph, climatic-Ic) were calculated to further characterize floristic composition. The data were statistically analysed to identify phytolith distribution among regions and vegetation types. Restionaceae phytoliths were identified in high numbers independently of the region and vegetation type, indicating that restios are consistently diagnostic for fynbos. We found a significant relationship between high D/P and Fy values for dune, limestone, sand and mountain fynbos, while low values characterize grassy fynbos. Grass phytoliths dominated grassy fynbos vegetation, while they were scarce in the other types. Among grasses, short cell lobates typify grassy fynbos vegetation. Finally, we did not observe variations in the distribution of grass short cells along a west-east gradient but did along coastal-inland gradient, with a higher presence of rondels in samples from the inland realm. Our results correlate well with our previous research, and further show the potential of phytoliths for identifying fynbos vegetation, contributing to our understanding of past vegetation on the South African fossil record.

[1]. Esteban I, De Vynck JC, Singels E, Vlok JHJ, Marean CW, Cowling RM, et al. Modern soil phytolith assemblages used as proxies for Paleoscape reconstruction on the south coast of South Africa. Quat Int. 2017;434:160–79.

Diversity and significance of polylobate phytoliths in grasses of Sunderbans delta, India

Madhab Naskar[1,2], and Subir Bera[1*]

[1] Centre of Advanced Study, Palaeobotany-Palynology Laboratory, Department of Botany, University of Calcutta, Kolkata, India

[2] Department of Botany, Sonarpur Mahavidyalaya, Kolkata, India

[*]Corresponding author's e-mail: berasubir@yahoo.co.in

Abstract

Phytolith production patterns were examined in 110 grass species belonging to 45 genera, 21 sub-tribes, 13 tribes and 7 subfamilies (Oryzoideae- 4, Bambusoideae- 8, Pooideae- 1, Aristidoideae- 1, Panicoideae- 66, Arundinoideae- 2 and Chloridoideae- 28) collected from different eco-successional zones of Indian Sunderbans. Among them 57 Panicoid, 1 Oryzoid, and 3 Chloridoid grass species were found to produce polylobate phytoliths. Grasses of the subfamilies Bambusoideae, Pooideae, Aristidoideae and Arundinoideae were entirely devoid of polylobate morphotypes. We have considered number (from trilobate to nonalobate), regularity (regular and irregular) and diameter of the lobes [small (≤5 μm), medium (5–10 μm) and large (≥10 μm)] to classify polylobate phytoliths into 33 sub-morphotypes. The present study dealing with the grasses of Indian Sunderbans delta reveal that along with bilobate and cross, polylobate phytolith can also be another significant morphotype characterizing Panicoideae subfamily. Three Panicoid taxa *Apluda mutica, Oplismenus compositus* and *Themeda arundinacea* emerge as the most prolific polylobate producer from this region. Only these three grass taxa yield nearly half or more than half of their total phytoliths as polylobates. Furthermore, the micromorphometric sub-categorization of polylobate phytolith was found to be extremely useful in discriminating various Panicoid taxa. Though the representation of polylobate phytoliths was low to moderate in the surface sediments, still their assemblages indicate Panicoid-dominated deltaic sub-environments of true mangrove decline zone, and zone of colonization of non-littoral species in the Sunderbans.

Keywords: Polylobate phytoliths, taxonomic significance, deltaic sub-environments, Sunderbans, India

Phytolith research on modern paddy soil

Xiujia Huan[1,2], Houyuan Lu[1,2,3*], Jianping Zhang[1,3], Can Wang[1,4]

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

[2]University of Chinese Academy of Sciences, Beijing, 100049, China

[3]CAS Center for Excellence in Tibetan Plateau Earth Sciences, Beijing, 100101, China

[4]Hebei Normal University, School of history and culture, Shijiazhuang, 050024, China

*E-mail: houyuanlu@mail.iggcas.ac.cn

Abstract

Rice, as staple crop, is crucial to the formation of civilization of China and makes great contribution to the development of worldwide civilization. However, there is still controversy regarding when, where and how the domestication of rice began since current methods cannot effectively identify early rice remains recovered from archaeological sites. In particular, the lack of quantitative indicators differentiating wild rice and domesticated rice makes it difficult to establish early rice domestication process, thereby limiting the study of early rice origin.

Here, based on systematical study on differences in bulliform phytolith fish-scale decoration numbers between domesticated rice paddy soil and wild rice field soil in South China, results showed that, in domesticated rice soil, the proportion of bulliform phytoliths with ≥9 fish-scale decorations was higher than 57.7%±8.7%, whereas the proportion was less than 17.5%±8.3% in wild rice soil. The results therefore indicate that the proportion of bulliform phytoliths with ≥9 fish-scale decorations can be used to discriminate between wild and domesticated rice. This method is potentially significant in the study of domesticated rice origin.

Furthermore, by analyses phytoliths in 168 soil samples from wild and domesticated rice fields and non-rice fields, we established the discriminant functions which can correctly classified 89.3% of the above samples. The results provide us a robust method for identifying rice paddies and distinguishing between wild and domesticated rice fields.

Session 3: Fossil phytoliths and palaeo-environmental reconstruction

Keynote speech

Holocene C3/C4 abundance dynamics in songnen grasslands and its link to monsoon-drived climate variations

Dongmei Jie[1,2,3*], Nannan Li[1], Manman Xie[4], Guizai Gao[1], Lidan Liu[5], Dehui Li[1], Xiuyun Yang[6], Hongyan Liu[7]

[1] School of Geographical Sciences, Northeast Normal University, Changchun 130024, China

[2] Key Laboratory for Wetland Ecology and vegetation Restoration, Ministry of Environmental Protection, Changchun 130024, China

[3] Key Laboratory of Vegetation Ecology, Ministry of Education, Changchun 130024, China

[4] National Research Center of Geoanalysis, Beijing 100037, China

[5] College of Resource and Environment Science, Hunan Normal University, Changsha 410001, China

[6] School of Urban and Environmental Sciences, Peking University, Beijing 100871, China

[7] School of Resources Environment and Tourism, Anyang Normal University, Anyang 455000, China

Abstract

Temperate steppe, which is dominated by *Leymus chinensis* and *Stipa baicalensis*, is widely distributed in North China and constitutes an important component of Eurasian steppe. Covering about 40% of China's land territory, the temperate steppe contributes to global biogeochemical cycling and associated climate effects greatly. Understanding the responses of grasslands natural vegetation to past climate change is a crucial issue for assessing the impacts of future global climate changes on terrestrial ecosystems. However, due to the differences in pollen representation between *Artemisia*, Chenopodiaceae, and Poaceae, and abrasive and aerobic conditions which prevent the preservation of most biological fossil evidence, paleovegetation composition and its dynamics to past climate change is still not fully understood. This further impeded our knowledge about the feedback-regulation mechanism between the "vegetation-climate" systems. In this study, concerning phytoliths' higher identification ability to classify Poaceae at the subfamily level and resistance to oxidizing conditions in sandy lands, phytoliths analysis and stable carbon isotopic signature of bulk organic matters (BOM) preserved in a radiocarbon dated sand-paleosol section in Songnen Grasslands were used to investigate the Holocene vegetation history and its response to past regional climate changes.

Our results showed that abundant phytolith types attributed to different families of grass and occasionally trees were well preserved in the sand-paleosol sequences, indicating the presence of grass in bloom. The stable carbon isotopic composition of BOM ($\delta^{13}C_{org}$) ranged from −24.38‰ to −20.97‰ through the whole section, suggesting the predominance of C3 plants in Songnen Grasslands at least since the mid-Holocene. However, the $\delta^{13}C_{org}$ profile showed a gradually enriched tendency from the down to up section, indicating the relative expansion of C4 plants. As the $\delta^{13}C_{org}$ variation tendency was almost consistent with the phytolith-calculated Ic and Iph indices, we could conclude that both the phytolith and isotopic signatures evidenced the synchronous variation of C3/C4 plants ratio since the mid-Holocene. Compared with stalagmite $\delta^{18}O$ variation profile, which is a reliable monsoonal precipitation proxy, the late-Holocene C4 expansion seems to be a response to the mid- to late Holocene climate transition. Referencing to the $\delta^{13}C_{org}$ signature of modern plants and phytolith assemblages in topsoils, we deduced a relative expansion of C4 plants which have a higher water use efficiency than C3 plants as a response to the drying and cooling climate since the late-Holocene. In other words, it is the climate change, especially the variations in precipitation (or water availability) in sandy lands have driven the vegetation dynamics in grasslands. Based on which, we proposed that, even in the semi-arid and semi-humid area, the intensity of East Asian monsoon still have a profound

impact on (even dominate) the gransslands vegetation composition and its variations.

Keynote speech

Connecting past and present: Challenges and opportunities in phytolith analysis of palaeoenvironments

Mikhail Blinnikov[1,2]

[1]St. Cloud State University

[2]Kazan Federal University

Presenter's e-mail (Mikhail Blinnikov): fitolit@gmail.com

Abstract

Phytolith analysis has become a mature method of palaeoecological investigations since its inception in the mid-19th century. Much progress has been achieved since 2000 C.E. in all major regions of the world. While archaeological research remains the main focus of the phytolith analysis, a lot of recent studies have used phytoliths for palaeoecological reconstructions of past vegetation and climate unrelated to humans. Important achievements have been made, for example, in the study of past distributions of forest and grassland ecotones; alpine and tundra treelines; history of aquatic vegetation; C3/C4 grassland studies; long-term vegetation and climate change spanning the Pleistocene, Pliocene, Miocene and even earlier periods; and in all major natural zones of the world ranging from the sub Arctic to the equatorial.

The challenges remain in: a) better usage of consistent typological and morphometric approaches in morphotype classifications, b) understaing of phytolith taphonomy including depositional biases, post-depositional dissolution, vertical and horizontal translocations; c) variability of morphotypes within single species across long environmental gradients, d) application of phytoliths in conjunction with other established methods, such as spore and pollen analysis and macrofossil analysis. Question of scale, of such importance to geographeres, cannot be neglected by phytolith analysts. Some studies done in very local settings can hardly be replicated across longer gradients, while global synthesis of phytolith data remains elusive gvien the lack of universally accepted publication protocols and few datasets submitted to major international archives of palaeodata. This talk makes a plea to resolve these issues in favor of better global connections of all phytolith researchers, including those done under the auspices of the International Phytolith Society.

Keywords: Databases, phytoliths, palaeoecology, taphonomy

Spatial vegetation dynamics over the last 35,000 years in West Africa.The contribution of phytoliths in a multi-proxy and multi-site study (FALÉMÉ VALLEY, SENEGAL; DOGON COUNTRY, MALI)

Aline Garnier, Laurent Lespez, Sarah Davidoux , Michel Rasse, Brice Lebrun, Chantal Tribolo , Maria Lorenzo Martinez , Benoit Chevrier , Sylvain Soriano , Eric Huysecom

Abstract

In West Africa, palaeoenvironmental data covering the Upper Pleistocene are rare. The lack of reliable and integrated cultural data with well-dated sedimentary records prevents a sufficient spatial reconstruction to understand the climatic, environmental and human settlements dynamics that operated during this period. The recent discovery of particularly well-preserved deposits covering the last 70,000 years in the Falémé Valley (Senegal, Sudanian zone) offers new research perspectives. In particular, the very good preservation of phytoliths in the sedimentary records attributed to stage 2 (MIS 2, 24-12 ka. BP), in part contemporaneous with the last arid period at the end of the Pleistocene (20-12 ka. BP) and the transition to the Holocene, bring new information on palaeoenvironmental conditions during this poorly known period in West Africa. This communication aims at presenting the results for the sedimentary and landscape dynamics of the Falémé from 35 000 to 5000 years BP and to compare these with the new phytolith analyses from Ounjougou's site located more northward in the sahelo-sudanian zone. For both sites, researches combine investigations conducted in the field (geomorphology, chronostratigraphy, archaeology) and in the laboratory with sedimentological, micromorphological and phytolith analysis of the deposits. This multi-proxy approach is particularly usefull to reconstruct the complex taphonomy of the sites. The interpretation of more than 60 samples combined with a robust chronostratigraphical pattern (OSL and ^{14}C dating) and abundant Palaeolithic discoveries provides (1) new and original information on the environmental changes from the Late Pleistocene onwards and (2) the opportunity to analyze the relations between environmental changes and human settlements for the last 35 ka. Moreover, the analyze of new samples from the Ounjougou's deposits for the same period allow to define more precisely the chronology and the spatial distribution on a regional scale of the strong vegetation dynamics occurring during this period in West Africa.

Peatland ecological responses to phytolith-inferred postglacial hydrological variability in central China

Hongye Liu[1], Yansheng Gu[1, 2]*,Zijian Lun [1], Xianyu Huang [1, 2], Yangmin Qin [1, 2]

[1] State Key Laboratory of Biogeology 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

*Corresponding author's email: ysgu@cug.edu.cn

Abstract

The depth to water table (DWT) in peatlands is a key environmental factor affecting their ecological integrity and carbon sequestration function. Increased oxygen availability caused by water table drawdown can directly enhance the decomposition rate of organic matter and induce a significant change in ecological community composition and plant biomass accumulation. Thus, exploring the past and present ecological responses to DWT of peatlands is important for understanding the mechanisms underlying peatland ecological responses to hydroclimatic changes.

We synthesized modern hydroecological survey and past DWT reconstruction to derive impacts of a wide range of hydrological change on peatland ecological succession. A modern ecological investigation and in-situ monitoring from Dajiuhu peatland in central China indicated that peatland biodiversity and carbon dynamics depends strongly on the peatland DWT. The DWT falling to below 20cm would destabilize peatland carbon stocks and induce the peatland droughts, then, the enhancement of biodiversity and carbon losses and peat degradation occurred when the DWT fell to below 30cm.

Phytolith-inferred hydrological reconstructions from a peat core (ZK5) with a depth of 165 cm collected at the center of the Dajiuhu peatland were further assessed by relying upon an extensive multi-proxy comparison with some moisture-related proxy records from central China and demonstrated three relatively high DWT periods occurring at 13000-11500 yr B.P., 9600-6700 yr B.P., 3000 yr B.P.-present and two extended low DWT periods occurring at 11500-9600 yr B.P., 6700-3000 yr B.P. since the past 13000 yr B.P. in study area.

The results show that low (high) DWT affected the peatland ecolosystem (e.g. vegetation, microorganisms, bacteria and carbon dynamics) includingenhanced (weakened) aerobic decomposition, increase (decrease) in xerotolerant species of microorganisms and carbon losses from peat, decrease (increase) of methanogens activity, and even amplified (damped) peat degradation. This study may be significant to predict future peatland ecological evolution trendsunder global warming conditions.

Keywords: Phytoliths, palaeohydrology, quantitative reconstruction, 13000-year, Dajiuhu

Acknowledgement: This work was jointly supported by the National Natural Science Foundation of China (grant number 41572153) and the State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (No. GBL11203).

The Paleoclimate Recorded by Phytolith in Anguli-Nuur Lake since the Mid-Late Holocene

Liu Linjing[1,2], Li Chang'an[3], Jie Dongmei[4], Zhang Ruchun[5]

[1] Institute of Hydrogeology and Environmental Geology, Chinese Academy of Geological Sciences, Shijiazhuang 050061, China

[2] Key Laboratory of Quaternary Chronology and Hydrological Environment Evolution, CAGS , Shijiazhuang 050061, China

[3] Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074, China

[4] School of Geographical Sciences, Northeast Normal University, Changchun 130024, China

[5] Institute of Geographical Sciences, Hebei Academy of Sciences, Shijiazhuang 050011, China

Abstract

Bashang area of Heibei Province is located in the East Asian monsoon-margin region and the ecotone between agriculture and animal husbandry. East Asian monsoon variability significantly affects the development of human civilization within its area of influence. In order to reconstruct the climate changes in Bashang area and understand the interactions between past climate and human civilization, a continuous 120-cm sediment profile was recovered from Anguli-Nuur Lake based on phytolith and pollen analysis. The results showed that, the climate in this region is gradually becoming cold and dry during the last 5000 years, which is related to the weakening of East Asian monsoon produced by gradually of solar radiation. However, the climate is relative wet during the periods of 5030~3074 cal. a BP. On the centennial scale, Anguli-Nuur has experienced seven obvious cold and dry events, which occurred during ~4500 cal. a BP, 4100-3800 cal. a BP, ~3500 cal. a BP, ~3000cal. a BP, ~2100 cal. a BP, -1100 cal. a BP and 795~268 cal. a BP. The cold and dry events are consistent with weakening stage of the East Asian monsoon that is probably affected by high latitude climate and the solar activities. In this region, the development of human civilization is sensitive to climate change. Agriculture civilization is relatively developed during warm and humid stage, and grassland civilization appears during cool and arid stage.

Comparing phytolith analysis of bulk samples and soil thin sections. Preliminary results of a statistical analysis

L. Vrydaghs[1], I. Esteban[2,3], J.-L. Slachmuylder[4], R.M. Albert[3,5,6] and Y. Devos[1, 7]

[1] CReA-patrimoine, Univeristé Libre de Bruxelles, Brussels. Belgium.

[2] Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa.

[3] African Centre for Coastal Palaeoscience, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa

[4] ROOTS asbl, Brussels, Belgium

[5] ERAAUB, Dept. of History and Archaeology. Universitat de Barcelona, Montalegre, 6-8, 08001 Barcelona, Spain

[6] ICREA, Barcelona, Spain

[7] Vrije Univeristeit Brussel, Brussels, Belgium.

Abstract

Since 2001, phytolith analysis is part of an integrated research conducted on Dark Earth within the historical center of Brussels under the auspices of the Department of Archaeological Heritage for the Brussels Capital Region. Dark Earth is an expression used in European urban archaeology to designate thick, dark coloured, humic, homogeneous units covering large surfaces that are often rich in anthropogenic remains, regardless of their age or geographical location. Taken into account their complex formation histories, the taphonomical history of the components, including the phytoliths, needs to be considered. Therefore, phytolith studies were conducted on soil and sediment thin sections. It enables not only to observe all of the soil components at a microscopic scale, but also to detail their relation and distribution (see for example Devos *et al.* , 2013; 2017; Vrydaghs et al. , 2016).

Phytolith analysis of soil and sediment thin sections does not involve any concentration. Nevertheless it allows the observation of a sufficient number of phytoliths for statistical confidence. Can such analysis also provide statistically valid data for archaeoenvironmental reconstruction? Present contribution intends to address this issue by comparing the results gained by the analysis of bulk samples to those gained from the study of the corresponding soil and sediment thin sections. On basis of a simple test, the first results indicate levels of similarity of more than 75 % between the reconstructed assemblages.

References:

Devos, Y., Nicosia, C., Vrydaghs, L. , Speleers, L., van der Valk, J., Marinova, E., Claes, B., Albert, R.M., Esteban, I., Ball, T.B., Court-Picon, M. and Degraeve, A., 2017. An integrated study of Dark Earth from the alluvial valley of the Senne river (Brussels, Belgium). Quaternary International 460: 175-197.

Devos, Y., Nicosia, C., Vrydaghs, L. and Modrie, S. 2013. Studying urban stratigraphy: Dark Earth and a microstratified sequence on the site of the Court of Hoogstraeten (Brussels, Belgium). Integrating archaeopedology and phytolith analysis. Quaternary International 315:147-166.

Vrydaghs, L.,Ball, T.B. and Devos, Y. 2016. Beyond redundancy and multiplicity. Integrating phytolith analysis and micromorphology to the study of Brussels Dark Earth. Journal of Archaeological Sciences 68: 79-88.

A multiproxy analysis of daub at the Chalcolithic Tripolye mega-site of Maidanetske, central Ukraine (3900–3650 BCE), for the investigation of plant temper and house burning practice

Marta Dal Corso[1], Pia Bodden[1], Stefan Dreibrodt[2], Sarah Martini[2], Robert Hofmann[1], Mila Shatilo[1], Mihail Videiko[3], Johannes Müller[1], Wiebke Kirleis[1]

[1] Institute of Prehistoric and Protohistoric Archaeology and CRC1266, Kiel University (Germany)

[2] Institute of Ecosystem Research and CRC1266, Kiel University (Germany)

[3] Research Laboratory of Archaeology, Borys Grinchenko Kyiv University (Ukraine)

Abstract

The study of phytoliths is integrated in a multi-disciplinary research project at the archaeological site of Maidanestke (Cherkasy Oblast, Ukraine) belonging to the Chalcolithic culture of Tripolye. This is a so-called "mega-site" of ca. 3000 houses, most of which were burnt, and spread over ca. 200 ha. It was occupied between ca. 3900-3650 BCE (late Tripolye period, Early Chalcolithic). The site is located at the border of the North Pontic forest-steppe region on Loess soils. Because of its enormous size and of the difficult conditions of preservation of plant macro-remains, the study of plant economy and of environmental conditions is very challenging and different approaches are needed. After a study of phytoliths from different on-site archaeological contexts, we focused on a preferred archive, e.g. daub fragments from burnt houses. The interest in daub samples is related to the possibility to reconstruct which plant material was used as temper and to investigate house-burning events. Concerning the first aim, pooid cereal chaff has been detected in the phytolith samples from daub fragments, attesting the relevance of cereal agriculture at the site. Concerning the house-burning process, an experimental approach was established, based on the comparison of archaeological daub from a house with daub reproduced in the laboratory with known components and under controlled burning conditions. Here, phytolith assemblage and preservation (light microscopy) were analyzed, together with colors (spectrometric measurements, surface and powder), magnetic susceptibility measurements (surface and powder), and mineral assemblage (xrd). Statistical analysis of the results allows the reconstruction of the fire process (temperature, duration, oxygen access) within a house. The integration of the results from the new approaches on archaeological daub and the experimental investigations feed into an overall integrative and multiproxy analysis that allows, apart from insights into cereal processing activities and local vegetation, to evaluate the relevance of crops in the subsistence regime of a Tripolje mega-site.

Holocene *Artemisia*-Chenopodiaceae-dominated grassland in North China: Real or imaginary?

Nannan Li[1], Dongmei Jie[1,2,3*], Guizai Gao[1], Lidan Liu[4], Dehui Li[1], Xiuyun Yang[5], Hongyan Liu[6]

[1]School of Geographical Sciences, Northeast Normal University, Changchun 130024, China

[2]Key Laboratory for Wetland Ecology and vegetation Restoration, Ministry of Environmental Protection, Changchun 130024, China

[3]Key Laboratory of Vegetation Ecology, Ministry of Education, Changchun 130024, China

[4]College of Resource and Environment Science, Hunan Normal University, Changsha 410001, China

[5]School of Urban and Environmental Sciences, Peking University, Beijing 100871, China

[6]School of Resources Environment and Tourism, Anyang Normal University, Anyang 455000, China

Temperate steppe, which is dominated by *Leymus chinensis* and *Stipa baicalensis*, is widely distributed in North China and constitutes an important component of Eurasian Steppe. Covering about 40% of China's land territory, the temperate steppe contributes to global biogeochemical cycling and associated climate effects greatly. Understanding the responses of grasslands natural vegetation to past climate change is a crucial issue for assessing the impacts of future global climate changes on terrestrial ecosystems. The Songnen grasslands were traditionally thought to be dominated by *Artemisia* and Chenopodiaceae plants as early as by the late Pleistocene. However, more and more evidences have called that interpretation into question. To shed new light on the paleovegetation evolution of the arid and semi-arid steppe in North China, phytolith assemblages preserved in the region's sand-paleosol sequence (DK section) are used as a proxy for paleovegetation structure. The results show that both the sand and paleosol sediments in the Songnen grasslands contain well-preserved phytoliths attributed to different families of grass. This replenished our knowledge about the vegetation condition during the sandy layer episodes which was unknown for a long time. Moreover, phytolith evidences indicate that plant successions happened within the subfamilies of Poaceae through the time. Referring to phytoliths in modern plants, topsoil and statistical analysis results, we proposed phytolith assemblages in DK section originated from Poaceae dominant communities rather than *Artemisia*-Chenopodiaceae ecosystem. Both the phytoliths, historical and modern vegetation relationship evidences lead to the rejection of the hypothesis of a widespread *Artemisia*-Chenopodiaceae ecosystem in the Songnen grasslands. Instead, using published radiocarbon and thermoluminescence data, it is proposed that the present Poaceae-dominated grasslands developed as early as the early Holocene. This study also highlights the usefulness of phytolith analysis in paleovegetation reconstruction in arid and semi-arid lands.

The different vegetation transitions during Holocene induced by different fire frequencies in a local area, central Japan, inferred from phytolith and macrocharcoal records in cumulative soils

Naoki HAYASHI[1*], Tatsuichiro KAWANO[2], Jun INOUE[1]

[1] Department of geosciences, Osaka City University, 3-3-138 Sugimoto, Sumiyosi-ku, Osaka 558-8585, Japan

[2] West Japan Engineering Consultants, Inc., 1-1-1 Watanabe-dori, Chuo-ku Fukuoka 810-0004, Japan

[*] Email:yusayutyu@gmail.com

Abstract

To evaluate the long-term effects of fire disturbance on vegetation in respective areas adjacent to each other under different human-driven fire regimes in the past,we examined phytoliths and macrocharcoals in cumulative soils and reconstructed vegetation transition and fire history in these areas on the Kannabe region, central Japan. One area (Mt. Kannabe area) is covered by Japanese pampas grass (*Miscanthus sinensis*), which has likely been maintained by annual burning for a long term. Anotherarea(Mt. Nishiki area) that is located at 1.5 km distance from Mt. Kannabe, is now used for tree plantation and has not likely been disturbed by fire in modern ages. Results of our study are as follows. In Mt. Kannabe area, *Sasa* grassland developed prior to 8,000 cal BP and then changed to *Pleioblastus* grassland around 8,000 cal BP underan increase in fire frequency. A *M.sinensis* grassland has developed under a high fire frequency since approximately 2000 cal BP. In Nishiki area, a *Sasa* grassland developed prior to 3,000 cal BP and then changed to a *Pleioblastus* grassland during 3,000-2,000 cal BP under an increase in fire frequency. A *Pleioblastus*-*Sasa* mixed grassland developed after 2,000 cal BP under a low fire frequency. This difference of the vegetational transitions under the different fire regimes during the Holocene implies that the vegetation type in these areas has been predominantly determined by the fire regime for a long time. Results of this study show that human-driven fire may have caused vegetation changes even under humid climate with very few natural fire occurrences such as Japan.

Vegetation and fire history of northeastern Indian Ocean since 45ka B.P. : Records from phytoliths and micro-charcoal

Vidusanka Thilakanayaka, Luo Chuanxiu*, Ariful Islam

Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, 164 West Xingang Road, Guangzhou 510301, China

* Corresponding author: xiu104@scsio.ac.cn

Abstract

Phytoliths are considered to be a reliable proxy to reconstruct the paleo-vegetation types, even when other microfossils are not available. Micro-Charcoal (MC) is a primer to reconstruct the fire history. Phytoliths and MC in the ocean sediment have unique distributing methods, while phytoliths are distributing through riverine and currents derived pathways and MC scatters causing both wind and hydrological pathways.Our Main Objectives are to reconstruct the Paleo-vegetation History, paleo-fire history and to find the correlation between Size distributions of these elements with other paleo-environmental parameters. The current study assesses the phytoliths and MC based on 63 samples, from the sediment core YDY09 (85.960985 N, 9.99351 E, water depth 3520m), extracted from the Deep Indian Ocean. Phytoliths were classified into 27 and MC into 3 well described morphotypes, according to the shape under the light microscope. Each morphotype classes of Phytoliths and MC were grouped into three size classes, respectively. According to the results from MC, regional fires were intense during the glacial period than in interglacial, while contributing large grass charcoal particles into the sediment. According to the phytolith morphotype distribution, grasses such as Pooideae, Arundinoideae, Panicoideae from Poaceae, were prominent during glacial periods than in interglacial.This study serves as the first phytolith and MC based paleo-environmental study in northeastern Indian Ocean.

Keywords: Indian Ocean, Deep ocean sediment, Phytolith, Micro-Charcoal.

Acknowledgments:This work was funded by the National Natural Science Foundation of China (grants NSFC 41376058, 41676047).

Variation of C4 grasses and Asian monsoon climate over the past ~11.0 Ma revealed by phytolith analysis

Hanlin Wang[1], Huayu Lu[1, 2*], Lin Zhao[1], Timothy D. Herbert[2], Hongyan Zhang[1], Fang Lei[1], Yichao Wang[1]

[1] School of Geography and Ocean Science, Nanjing University, Nanjing 210046, China.

[2] Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, Rhode Island 02912, USA.

Abstract

The origin and variation of the Asian monsoon and associated forcing mechanisms during the Cenozoic are still debated. Here, we use the sedimentary record of phytoliths (plant silica) from Weihe Basin, central China, to semi-quantitatively reconstruct the history of C4 grasses and Asian monsoon climate change since the late Miocene. Our results show that C4 grasses were a dominating grassland component since ~11.0 Ma, suggesting an earlier expansion of C4 grasses in East Asia than previously thought. The variation of C4 grasses during 11.0-4.2 Ma was minor, and a subsequent marked decrease in C4 grasses happened at late Pliocene. Our phytoliths based quantitative reconstruction of mean annual temperature and precipitation also marked decreased at late Pliocene from 11-15.3℃ and 800-1673mm to 3.3-11℃ and 443-900mm. Taken together, we suggest the decrease in C4 grasses was forced by decreases in temperature and precipitation which were probably driven by global cooling and the associated weakening of the Asian summer monsoon. Our newly obtained record of the variation of C4 grasses conflicts with previous results from East Asia; nevertheless, it emphasizes the importance of global pCO2 and temperature as determinants of late Neogene vegetation and monsoon variations in East Asia.

Phytoliths in laterite reveal climate changes in the Pleistocene lower reaches of the Yangtze River

Wei-Ming Wang

CAS Key Laboratory of Economic Stratigraphy and Palaeogeography, Nanjing Institute of Geology and Palaeontology; Center for Excellence in Life and Paleoenvironment, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing 210008, China

Abstract

As a product of bioclimatic process, the laterite (red soil) developed extensively in the tropics, subtropics areas, and partly expanded to the temperate areas of the world, combining with loess in the North, constitute two major soil types on the continental surface. In the past decades, great progress has been made in the study of the loess, verifying its geochemical and biota contents to be significant evidence in illustrating past climatic changes on the land, while study on the biota component of laterite was scarcely recorded. Phytolith analysis was proved to be an effective approach in the palaeoclimatic study. Here we report climate variations revealed by phytoliths from a profile of the patterned laterite in the lower reaches of the Yangtze River, dated between ca. 0.817 and 0.126 Ma before present, which are possibly comparable to the past global changes. The profile with a height about 13.5 m is located in the Xuancheng County, Anhui Province (30°54′ N, 118°51′E). It is composed of a basal pebble layer, a yellow sand layer, and 15 purple paleosol and brown-yellow clay interbeds in ascendant order. Significant climate changes including 8 warm-cool cycles are recognized with the warm periods mostly correspond to the paleosols while the cool ones to the clay and sand layers. We could not clearly distinguish the possible relationship between the warm and the aridity. It seems that chance for the occurrence of dry and less dry conditions is nearly same under the warm or cool climate. Changes in aridity are more distinct and frequent at the lower part than at the upper part, and a changing tendency of less dry is recognized at the upper part of the profile. C_4 grasses are dominant in the whole profile, indicating that the laterite areas were generally warm during the deposit period. This study provides a fundamental evidence that phytoliths in laterite can serve as a unique bio-signal to indicate the past climate cycles in the continental.

This study was supported by National Science Foundation of China (Nos. 49971076, 41472010, 41771219)andtheCAS Strategic Priority Research Program of Chinese Academy of Sciences, (Grant No: XDB26030404).

Climatic controls on peat swamp formation and evolution since 1300 yr BP as recorded by phytoliths in the Xishan Mountains, Jiangxi Province, China

Xin-Rong Zhang[1,2*], Yu Du[1,2], Chun-Mei M[1,3], Shuai-Fei Ping[1,2], Feng Chong[4], Cui Anping[3]

[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

[3] School of Geography and Ocean Science, Nanjing University, Nanjing 210023, China

[4] Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China

Abstract

Over the past millennium, climate change has had a profound impact on society. There have been a number of documented precipitation–temperature cycles characterized by instabilities in the eastern monsoon region in China, but the processes, mechanisms, and anthropogenic activities potentially responsible for the cycles remain poorly understood. In this study, we present an analysis of phytoliths from an ombrotrophic peat swamp drilled in Jiangxi Province, China. Our results show that the peat swamp was developed on the poorly drained site of an earlier forest fire, and has recorded five climatic stages in the past 1300 yr. The climate from ca. 800–1270 AD was similar to the Medieval Warm Period (MWP) and the climate from ca. 1370–1900 AD was similar to the Little Ice Age (LIA). The climate entered the Present Warm Period (PWP) after ca. 1900 AD, when the climatic conditions reached their contemporary form. Phytolith assemblages and Iph, Iwx, and D/P values demonstrate that there was a significant cold–wet stage from ca. 1108–1140 AD during the MWP, and three brief increases in humidity at ca. 957, 1050, and 1115 AD. During the LIA, there was a marked wet interval from ca. 1782–1844 AD, and three short warm events at ca. 1353, 1470, and 1773 AD. The phytolith analysis also showed that the transition from the MWP to LIA took ca. 100 yr, and was characterized by a marked humidity increase in a cooler climate early in the transition period and numerous alternations between cold–wet and warm–dry events later in the transition period. Correlations between the phytolith assemblages and historical records are evident at ca. 1250–1340, 1678–1800, and 1827–1920 AD, and these provide important insights into paleoclimate change in the eastern monsoonal region of China.

Keywords: Phytoliths, Peat swamp, Climate controls, late Holocene, Xishan Mountains, China

Phytolith records of Early Mid-Holocene vegetational and climatic changes in the Lower Yangtze Valley

Xinxin Zuo[1,2*], Houyuan Lu[3,4,5*],Zhen Li[6] and Bing Song[7]

[1] State Key Laboratory for Subtropical Mountain Ecology of the Ministry ofScience and Technology and Fujian Province, Fujian Normal University, Fuzhou, China;

[2] School of Geographical Sciences, Fujian Normal University, Fuzhou, China;

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

[4] Centerfor Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, Beijing, China;

[5] University of Chinese Academy of Sciences, Beijing, China;

[6] School of Earth and Ocean Sciences, University of Victoria, Canada;

[7] Nanjing Institute of Geography & Limnology, Chinese Academy of Sciences, Nanjing, China

[*] Corresponding author: zuoxinxin@fjnu.edu.cn; houyuanlu@mail.iggcas.ac.cn

Abstract

Phytoliths have been analysed in a high-resolution sediment core from the Lower Yangtze Valley, providing a detailed picture of past vegetation and climate for the early to mid-Holocene (~9000-7200 cal yr BP). The good chronological sequence of the presented record is based on 11 radiocarbon dates from terrestrial plant macro-remains or char, which was sufficiently accuracy to enable the detection centennial-scale vegetational and climatic changes in the study area during the early to mid-Holocene. We identified and classified phytoliths into 30 morphotypes from seven taxonomic groups: Panicoideae, Pooideae, Panicoideae, Chloridoideae, Oryzoideae, Arecaceae(palms), and broad-leaved trees. The main phytoliths assemblages show that palms, bamboo forest, and other evergreen broadleaf tree increased significantly after 8200 cal yr BP. Both Panicoideae and Pooideae grasses decreased from 9000 to 7200 cal yr BP, indicating that climate became wetter and warmer during that period. The general climatic amelioration is interrupted by several centennial-scale intervals in composition of bamboo and Pooideae phytolith around 8200, 7700, and 7300 cal yr BP, coinciding with weaker precipitation or lower temperature as suggested by other high-resolution records. After comparing the new phytolith results with previous pollen data from the same core, we find good agreement between these two proxies throughout. This study has not only provided a reliable reconstruction of climatic changes, but also provided a more detailed plant community than generated with pollen-based taxa in the areas where regional vegetation is evergreen and deciduous broad-leaved mixed forest.

Phytolith records of climate change since the Last Deglaciation in the eastern Jianghan Plain

Yansheng Gu[1, 2*], Maria Gabriela Arevalo Serrano[3]

[1] State Key Laboratory of Biogeology 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] School of Environmental Studies, China University of Geosciences, Wuhan 430074, China

[*]Email: ysgu@cug.edu.cn

Abstract

The Jianghan Plain has the one of the largest freshwater lake groups in China geographically located in the hinterland of the Asian monsoon region. Therefore, this area is strongly affected by the change of the monsoon and is the crucial area for the study of climate change and regional sedimentary response. The aim of this study was to employ phytoliths (plant silica bodies) to reconstruct high-resolution of paleovegetation and palaeoclimate changes since the Last Deglaciation and to explore the relationship between climate change and lake deposition in the middle reaches of the Yangtze River.

The Jh001 Core is located in Xiantao (30° 31 '14 "N, 112°41' 37" E), Hubei Province. A total of 216 samples of phytoliths were analyzed in this study. Additionally four dating three AMS14C samples were examined.Tthirty-two phytoliths morphotypes were classified and well-described according the shape, anatomical origin, and ecological significance by ICPN 1.0. protocols. The phytoliths in this Jh001 Core sediments originated from the following groups: Poaceae, fern, gymnosperm, and broad-leaved plants, which were crucial to describe the paleovegetation evolution.

Eight phases of climate changes and vegetation composition since the LDG were divided in this study, marked by alternations of warm-wet to cold-dry conditions with a rising temperature tendency. This research offers a high-resolution study to understand the intrinsic interaction between lake deposition environment and climate change. It additionally provides basic data for handling climate change and regional sustainable development.

Acknowledgements: This work was jointly supported by the National Natural Science Foundation of China (grant number 41572153) and the State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (No. GBL11203). We are indebted to Drs. Liu Hongye, Guan Shuo, and Tian Wen for their help with core sampling in the field.

Discovery of rice phytoliths in the Holocene Core Jh002 and its implications for the early dispersal of ancient Asian domesticated rice in the Jianghan Plain

Yansheng Gu[1, 2*], Zijian Lun[3]

[1] State Key Laboratory of Biogeology 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] School of Environmental Studies, China University of Geosciences, Wuhan 430074, China

[*]Email: ysgu@cug.edu.cn；

Abstract

The mid-lower Yangtze Valley is considered as a potential area of the origin of rice domestication and pottery (Zhao, 1998; Zhao and Piperno, 2000; Zhang, 2002; Wu et al., 2012). Since the early Holocene, the warm climate and the rapid rising of sea level not only resulted in the sedimentary environment transition of the middle Yangtze Valley but also played a major role in the occurrence of wetlands in the middle Yangtze Valley (Gu et al., 2017; Liu et al., 2017). The Holocene Optimum was the prosperous period of Neolithic cultures such as the Chengbeixi Culture (8500-7000 cal a BP), Daxi Culture (7000-5500 cal a BP), Qujialing Culture (5300-4500 cal a BP). A critical question for the study is why there is no rice remains before Holocene Optimum. Up to date, the influences of climate change on the rise and fall of the Neolithic civilization succession and the dispersal of ancient rice remained unknown.

The primary research indicated that the most distributed fossils of rice phytoliths were 14 m with an age of about 11000 cal. a BP. Before the Daxi Culture, the fossil phytoliths were seriously damaged by the later reconstruction, so it is difficult to identify the fish scales and lateral ridge protrusions, but its overall similarity to that of the modern rice phytoliths is up to 40-50%. Since the stage of Daxi culture, due to the shallow burial depth and lightly weathering reconstruction, more rice types of cuneiform bulliform cells were found in the black burnt phytoliths, the rice phytolith characteristics were more obvious, and the similarity with modern rice reached 60-100%, which could be regarded as the ancient cultivated rice phytoltihs. The results showed that climate change and wetland evolution were closely related to the cultivation and propagation of rice in the Holocene in the middle Yangtze River.

Keywords:rice phytolith,core sediments, early Holocene, human activity, middle Yangtze River

Acknowledgements: This work was jointly supported by the National Natural Science Foundation of China (grant number 41572153) and the State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences (No. GBL11203). We are indebted to Drs. Liu Hongye, Guan Shuo, and Tian Wen for their help with core sampling in the field.

Session 4: Application of phytolith and starch in the environmental archaeology

Keynote speech

Timing of Shangshan Culture and the Process of Rice Domestication

Houyuan Lu[1,2,3], Xinxin Zuo[1], Leping Jiang[4], Jianping Zhang[1,2,3], Xiaoyan Yang[5], Xiujia Huan[1,3], Keyang He[1,3], Can Wang[1], and Naiqin Wu[1,3]

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

[2] Center for Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, 100101 Beijing, China;

[3] University of Chinese Academy of Sciences, Beijing 100049, China;

[4] Zhejiang Provincial Institute of Relics and Archaeology, 310014 Hangzhou, China; and

[5] Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

Abstract

Phytolith remains of rice (*Oryza sativa*) recovered from the Shangshan site in the Lower Yangtze of China have previously been recognized as the earliest example of rice cultivation. However, due to the poor preservation of macro-plant fossils, many radiocarbon dates were derived from undifferentiated organic materials in pottery sherds. These materials remain a source of debate because of potential contamination by old carbon. Direct dating of the rice remains might serve to clarify their age. Here, we first validate the reliability of phytolith dating in the study region through a comparison with dates obtained from other material from the same layer or context. Our phytolith data indicate that rice remains retrieved from early stages of the Shangshan and Hehuashan sites have ages of ca. 9400 and ca. 9000 cal yr BP, respectively. The rice bulliform phytoliths indicate they are closer to modern domesticated species, suggesting that rice domestication may have begun at Shangshan nearly10,000 years ago. The evidence also indicates that barnyard grass (*Echinochloa* spp.) was a major subsistence resource, alongside smaller quantities of acorn (*Lithocarpus*/*Quercus sensu lato*) and water chestnuts (*Trapa*). The early managed wetland environments might be initially harvested for multiple grain species including barnyard grasses and rice.

Keywords:rice domestication, radiocarbon dating, Shangshan, chronology, phytolith-occluded carbon

Keynote speech

Phytoliths: a powerful tool for exploring the deep-time evolution of herbivores

Yan Wu[1,2*]

[1] Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, 100044,China

[2] CAS Center for Excellence in Life and Paleoenvironment, Beijing, 100044,China

[*] Correspondence to: Y. Wu,Tel.:+ 86 10 88360162. Email: wuyan@ivpp.ac.cn;

Abstract

In recent years, more and more results based on the phytolith analysis are reported especially in pre-historical agricultural archeology and paleo-environmental archeology. With the progress of phytolith analysis, its unique and un-substitutable advantage has been broadly recognized. As an important behavioral issue, feeding preference of herbivores had become of key research interest, since it concerns the coevolution of herbivores and floral ecosystems. In this study, we first report the discovery of basalmost grasses from the late Early Cretaceous (Albian, 113-101 Ma) of China based on microfossils (silicified epidermal pieces and phytoliths) extracted from a special structure along the dentition of a basal hadrosauroid (duck-billed dinosaur). Thus, this discovery represents the earliest known grass fossils, and is congruent with previous estimations on grass origin and early evolution calibrated by oldest known fossil grasses, highlighting the role of fossils in molecular dating. Besides, we analyze phytoliths in dental calculus of two *Gomphotherium* species from the same strata of the middle Miocene of Asia interior. As far as our knowledge, this is the earliest known grazer in proboscideans. Our result is further confirmed by microwear, isotope and pollen analyses. This result provides an example of behavioral adaptation prior to morphological modification, which may potentially be universal in animal's evolution.

Keynote speech

Four stages for the origin of rice agriculture in China

Zhao Zhijun

Institute of archaeology, Chinese Academy of Social Sciences

Abstract

The new archaeobotanical data from flotation show that the origin of rice agriculture in China can be divided into four stages: The first stage dated to ca.10,000 BP is characterized by the occurrence of rice cultivation, which can been seen as a gestation for rice domestication and rice farming. The second stage dated to ca.8000 BP is the forepart of the transitional period from hunting/gathering to rice farming. It was marked by a mixed subsistence, taking hunting/gathering as the majority and rice farming as the supplement. The Hemudu Culture is an example of the third stage dated to 7000-6000 BP, which was still in the transitional period. Rice farming has become a major part of the subsistence but it still couldn't replace hunting/gathering. The last stage represented by the Liangzhu Culture dated to ca. 5000 BP, is the time of the establishment of rice agriculture, by which rice farming become the dominate part of social economy. Liangzhu Culture was not only the stage of the establishment of rice agriculture, but also a symbol of the beginning of Chinese civilization. The establishment of rice agriculture has laid the foundation for the emergence of ancient civilization, and the formation of ancient civilization has in turn promoted the development of rice agriculture.

From west to east – comparative study of phytoliths from archaeological sites from Greece to Tajikistan

Birgül Ögüt, Arnica Keßeler, Julia Schönicke

Freie Universität Berlin, Germany

Abstract

The increasing demand for phytolith studies in archaeological contexts shows the need and the importance of analytical methods in the field of plant remains. Although in many projects macrobotanical studies are seen as a matter of course, phytolith studies are still a method which has not gained the attention it deserves. Our pilot study conducted at the laboratories of the Freie Universtität Berlin was designed as both: training for examination of different methods and an observation of phytoliths spanning different periods and sites. We could establish a foundation for future work and show the possibilities and the limitations. The geographical and chronological distribution of the analysed samples are the following: a Neolithic site in North-western Greece, two sites from South-eastern Turkey, one Neolithic, one Bronze Age/Iron Age, a Neolithic site from Jordan, a Neolithic/Chalcolithic site from Turkmenistan and finally a Bronze Age/Iron Age site from Tajikistan. Two different extracting methods were applied: the method described in Albert et al. (1999) and the rapid extraction method, following the description of Katz et al. (2010). Three different types of contexts were available for study: sediment from the archaeological site, from ground stone tools and from ceramic vessels. Our aim in this paper is to present the first results as an overview and discuss the future prospects for detailed analyses.

References:

Albert, R. M., Tsatskin, A., Ronen, A., Lavi, O., Estroff, L., Lev-Yadun, S., Weiner, S., Mode of occupation of Tabun Cave, Mt Carmel, Israel during the Period: A study of the sediments and phytoliths. Journal of Archaeological Science 26 (1999), 1249–1260.

Katz, O., Cabanes, D., Weiner, S., Maeir, A. M., Boaretto, E., Shahack-Gross, R., Rapid phytolith extraction for analysis of phytolith concentrations and assemblages during an excavation: an application at Tell es-Safi/Gath, Israel. Journal of Archaeological Science 37 (2010), 1557–1563.

The Spatial pattern of farming and its influencing factors during the Peiligang culture period in the middle Yellow River valley, China

Can Wang [1],Houyuan Lu[2,3,4],Wanfa Gu[5], Naiqin Wu[2,4],Jianping Zhang[2,3], Xinxin Zuo[6],Fengjiang Li[2], Daojing Wang[2], Yajie Dong[2],Songzhi Wang[5],Yanfeng Liu[5], Yingjian Bao[7], Yayi Hu[5]

[1] Department of Archaeology, School of History and Culture, Hebei Normal University, Shijiazhuang 050024, China

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

[3] Center for Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, Beijing 100101, China

[4] University of Chinese Academy of Sciences, Beijing 100049, China

[5] Zhengzhou Municipal Institute of Archaeology, Zhengzhou 450052, China

[6] Department of Geography, College of Geographical Sciences, Fujian Normal University, Fuzhou 350007, China

[7]The School of History and Culture, Henan Normal University, Xinxiang 453007, China

Abstract

The Peiligang Culture is the earliest Neolithic culture in the middle Yellow River valley and represents the emergence of cereal farming in the region. Present records imply the concurrence of millet farming and mixed millet-rice farming in the Peiligang Culture, but their spatial distribution pattern is still unknown, because there is a lack of comparative studies on crop remains from different sites. Here, we present the results of analyses of phytoliths and plant macroremains in archaeological sediments from four Peiligang Culture sites, as well as an integration of crop records from nine other sites. These sites are classified into two types in terms of their geographical locations: those in alluvial plains and those in hilly lands. The results confirm the coexistence of millet and mixed farming in the Peiligang Culture, rather than one or the other. Their spatial pattern involved millet farming in the hilly lands, with mixed farming done in the alluvial plains. Compared to the sites in the hilly lands, the sites in the alluvial plains have enough water sources and vast amounts of flat land, making it possible to cultivate rice and conduct mixed farming. In all Peiligang Culture sites, regardless of any agricultural modes, common millet (*Panicum miliaceum*) was predominant among the crop assemblages. In the same climate background, the agricultural mode selection in different sites was mainly influenced by landform and hydrology. This spatial pattern of farming also reflects human adaptive subsistence practices, which respond to different natural circumstances.

References:

Wang C., Lu H.Y., Gu W.F. et al., 2017. The spatial pattern of farming and factors influencing it during the Peiligang culture period in the middle Yellow River valley, China. Science Bulletin, 62: 1565-1568.

Phytolith evidence for the development of agriculture between early and middle Dawenkou and Longshan cultures at the Gongzhuang site in Linquan County, AnhuiProvince

Chunguang Gu[1], Wuhong Luo[1], Yuzhang Yang[1], Dong Zhang[2],Zhonghe Liang[2], Fang Fang[1], Juzhong Zhang[2]

[1] Department of Scientific History and Archaeometry, University of Science and Technology of China, Hefei 230026.

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

Abstract

Phytolith analysis and AMS^{14}C dating were used to investigate the plant remains at the Gongzhuang site between the early-middle Dawenkou and middle-late Longshan cultures. The results indicate that a certain amount of rice phytoliths were discovered from most samples at the Gongzhuang site during that time, with an increasing trend in their percentage over time, while no evidence for the millets were recovered. This demonstrate that rice farming might be the only agricultural system between the early-middle Dawenkou and middle-late Longshan Cultures, and the utilization of rice showed an increasing trend with time. The statistical results indicated that 60.95% and 70.10% of rice bulliform phytoliths had equal or more than nine shallow fish-scale decorations during the early and middle Dawenkou Culture and middle and late Longshan culture period, respectively, showing that the rate of rice domestication during the early and middle Dawenkou culture at the latest had reached the level of modern cultivated rice. In addition, abundant of phytoliths in Bambusoideae commonly observed at the site, suggesting that these plants were possible widely utilized for the raw materials of instruments, buildings, foods and others. The findings reported in this study can provide significant evidence for studying the utilization of plants, transformation of agricultural system, and the process of rice domestication in the middle Huai River Valley during the Neolithic age.

Keywords:Gongzhuang site, phytolith, rice domestication, rice farming, Bambusoideae

Comparative phytolith analysis between cultural layers and natural sediments at the Kuahuqiao archaeological site in Xiaoshan, east China

Junwu Shu[1], Leping Jiang[2]

[1]Key Laboratory of Economic Stratigraphic and Palaeogeography, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, 210008, China

[2]Zhejiang Provincial Institute of Archaeology and Cultural Relics, Hangzhou, 310014, China

Abstract

How to distinguish between human-induced signals and natural environment information remains challenging in the Holocene archive. Here we attempt to choose archaeological cultural layers and co-eval natural sediment at the same site to make comparative phytolith analysis in order to reveal similarity and difference between them.

The Kuahuqiao site is situated in Hangzhou, north of Zhejiang Province. It is located at the mouth of the Qiantang River draining northeastward into Hangzhou Bay. Kuahuaqiao, dated to 8000–7000 cal.aBP, is located in a small low-lying basin occluded by two parallel lines of low hills Excavation of Kuahuqiao has yielded rich archaeological artifacts and abundant biological remains, among which is the dugout pine canoe dated to around 8000 cal. BP with paddles, the earliest one so far found in China. Early rice cultivation has been unearthed with more than recovered 1000 rice grains.

Our results show that:

1) From the point view of phytolith assemblage, phytolith flora from cultural sediment is dominated by long saddle, long elongate, and short elongate types. Others are scarce such as long saddle, bilobate, and square types. In contrast, long elongate and fan-shape phytolith characterize natural records with percentage amount more than 50%. Others are common such as short saddle and bilobate. *Phragmite* phytoliths peak in the lower part of natural sequence.

2) In terms of crop phytoliths, rice phytoliths such as fan-shape and double-peak types occurred frequently in cultural layers with low percentage less than 10%, whereas they are sporadic in natural sediments with incontinuous presence.

3) Unusual presence of dentritic elongate phytolith in archaeological sequence in consistent occurrence of fan-shape rice phytolith suggests that they are likely produced from rice inflorescences. However, this type is not found in the natural sediments.

Acknowledgement：this study is supported by grants from National Science Foundation（No. 41371207）and the Chinese Academy of Sciences (XDPB05).

Middle-Holocene sea-level fluctuations interrupted the developing Hemudu Culture in the Lower Yangtze River, China

Keyang He[1,2]*，Houyuan Lu[1,2,3]*, Yunfei Zheng[4], Jianping Zhang[1,2], Deke Xu[1,2], Xiujia Huan[1,3], Jiehua Wang[5], Shao Lei[5]

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

[2] Centre for Excellence in Tibetan Plateau Earth Science, Chinese Academy of Sciences, Beijing 100101, China

[3] University of Chinese Academy of Sciences, Beijing 100049, China

[4] Zhejiang Provincial Institute of Cultural Relics and Archaeology, 310014, Hangzhou, China

[5] Ningbo Municipal Institute of Cultural Relics and Archaeology, 315012, Ningbo, China

Abstract

The eastern coastal zone of China is densely populated and widely recognized as a center of rice domestication, which has undergone dramatic sea-level fluctuation during the Holocene epoch. Hemudu Culture is distributed mainly in the eastern coastal area and was once presumed as a mature agricultural economy based on rice, making it an ideal case for examining the remarkable human-environment interaction in the Lower Yangtze River. Though numerous studies have been conducted on the cultural evolution, ecological environment, and rice domestication of Hemudu Culture, the impact of sea-level fluctuation on human settlement and food production remains controversial. In this study, we report high-resolution pollen, phytolith, and diatom records, and accurately measured elevation from the Yushan site, which is the closest site of Hemudu Culture to the modern coastline. Based on the data gathered, we suggest that the Hemudu Culture and subsequent Liangzhu Culture developed in the context of regression and were interrupted by two transgressions that occurred during 6300-5600 BP and 5000-4500 BP. The regional ecological environment of the Yushan site alternated between intertidal mudflat and freshwater wetlands induced by sea-level fluctuations in the mid-late Holocene. Though rice was cultivated in the wetland as early as 6700 BP, this cultivation was subsequently discontinued due to the transgression; thus, full domestication of rice did not occur until 5600 BP in this region. Comprehensive analysis of multiple proxies in this study promote the understanding of the relationship between environmental evolution, cultural interruption, and rice domestication.

Keywords: cultural interruptions,sea-Level fluctuations,rice domestication, middle-Holocene, Hemudu Culture, Lower Yangtze River

Phytoliths and other microfossils in archaeological smoking artifacts from Santiago del Estero's plains (Argentina). Museum collections under the microscope.

Korstanje,M. Alejandra, Mónica G. Burgos y Constanza Taboada
Instituto de Arqueología y Museo (Universidad Nacional de Tucumán).
Instituto Superior de Estudios Sociales (CONICET/UNT).
Tucumán, Argentina

Abstract

Multiple microfossil analysis (Coil *et al*.,2003) has generated important results in the study of archaeological soils and sediments, especially to study agricultural and livestock contexts. Successively, the use of this method to study domestic context and artifacts has also proved its effectiveness (Korstanje 2014). In recent years, smoking artifacts also showed positive results, although given the small amount of sediment obtainable it was a challenge one but not the only route taken by experts (Belmar *et al*. 2016, Martin Silva *et al.*,2016). However, all former positive cases came directly from archaeological contexts (excavation).

In this occasion we present the first results of the recovery and determination of phytoliths and other microfossils from archaeological pipes exhibited as a collection from *Sequia Vieja* site, at the Museum of Anthropological and Natural Sciences "Emilio and Duncan Wagner" (Santiago del Estero, Argentina). They were recovered in nonsystematic excavations carried out in the 1940s, and deposited in glass cases in recent years. Although the recovery and conservation situations were not the desired, it was quite important to understand their use as possible smoking pipes since the site is being revisited at present for their importance in exchange and smoking routes (Taboada 2014), and for moment none was recovered in recent excavations.

Based on this problem, multiple microfossil analysis was carried out in the pipes to determine

a) the substances smoked;

b) the potential diversity represented in the consumption, and

c) the definition of whether they are local species or not.

Comparisons were made with modern collection of plants considered to be part of the known regional prehispanic and current rural smoking complex.

The results show that the methodology of multiple microfossil analysis can also be used safely within a collection context, since it allows to distinguish families of plants from the general smoking complex through contextual analysis. Despite this, it does not offer security for the identification of new local species, which require more controlled identifications, as they are still complete unknown.

References:

Belmar, C., Albornoz, X., Alfaro, S., Meneses, F., Carrasco, C., Quiroz, L., Babot, M. P., & Planella, M. T. 2016. Reconstruyendo las prácticas fumatorias del sitio La Granja (130 a 1000 d.C., valle del río Cachapoal, VI región, Chile central) a partir de los microfósiles. Chungara Revista de Antropología Chilena, 48(1), 53-72.

Coil, J., M. A. Korstanje, S. Archer y C. Hastorf. 2003. Laboratory goals and considerations for multiple microfossil extraction in archaeology. *Journal of Archaeological Science* 30. Págs: 991-1008. Academic Press. ISSN: 0305-4403.

Korstanje, M.A. 2014. Multiple Microfossil Extraction in Environmental Archaeology. En: Encyclopedia of Global Archaeology, pp 5082-5090. Editor-in-chief: Smith, Claire. Springer. ISBN 978-1-4419-0426-3.

Martin Silva, V., G. Miguez y M. A. Korstanje. 2016. Análisis de Microvestigios en Pipas Procedentes en Ocupaciones Prehispánicas ee las Selvas Meridionales del Noroeste Argentino. El Caso de Yánimas 1. Estudios Atacameños. n.53, pp.33-52. Chile. ISBN: 0718-1043.

Taboada, C. 2014.Sequía Vieja y los Bañados de Añatuya en Santiago del Estero. Nodo de desarrollo local e interacción macrorregional". *Comechingonia*, 18, pp. 93-116. Argentina. ISSN: 0326-7911

Phytoliths in microfossil assemblages once more called to understand unknown functional analysis. The case of the Inka "celdas" at Northwestern Argentina.

Korstanje, M. Alejandra, Laura Taddei Salinas, Julieta Zapatie, y Verónica Williams

Instituto de Arqueología y Museo (Universidad Nacional de Tucumán). Instituto Superior de Estudios Sociales (CONICET/UNT). Tucumán, Argentina

Instituto de las Culturas (CONICET/UBA). Buenos Aires, Argentina.

Abstract

When we started developing the method of multiple microfossil analysis (Coil *et al*, 2003) we had a difficult functional quiz to resolve: the circular and semicircular stone enclosures of local prehistory could have different uses along the time and when no artifacts were in surface nor in excavation we were uncertain about their purpose (Korstanje *et al.* 2014).

In this opportunity, we take a similar challenge. We seek for the role of Inca architectural structures that are registered in distinct Northwest Argentina and *circum* Andean areas, informally called "celdas" (prison cells). They are quite different of *kancha* concept as a checkerboard regularized enclosure. They may be located to the side of Inca roads, associated with sites with different functionality as *tampus*, administrative sites or agricultural areas. The bibliography research indicates that similar small structures were built in other places of the *Tawantinsuyu* (De Hoyos and Williams 2016). This architectural pattern should have some role or specific purpose for the Inca State that remained unknown from the formal archaeological methods.

Therefore, based on this problem, we sampled two different sites with "celdas" in Northwestern Argentina to analyze them under multiple microfossil methodology, with the aim of understand if there is a regular pattern of use and functionality or they may be also used for different purposes according to their geographical and political location in the imperial landscape. First results will be shown in this opportunity, understanding phytoliths and other microfossils in and from their archaeological and soil contexts.

References:

Coil, J., M. A. Korstanje, S. Archer y C. Hastorf. 2003. Laboratory goals and considerations for multiple microfossil extraction in archaeology. *Journal of Archaeological Science* 30. Págs: 991-1008. Academic Press. ISSN: 0305-4403.

De Hoyos, M & V. Williams.2016.Abran kancha… Una variante de recinto perimetral compuesto en el noroeste argentino.Estudios Atacameños Arqueología y Antropología Surandinas. No. 55 (2017), pp. 109-134. Chile.

Korstanje, M.A.; Cuenya, P. y M. Maloberti 2014. El análisis múltiple de microfósiles como herramienta para estudiar paisajes agrícolas y prácticas campesinas: una síntesis metodológica. En: *Avances y desafíos metodológicos en Arqueobotánica: miradas consensuadas y diálogos compartidos desde Sudamérica.* Editado por C. Belmar y V. Lema. Pp.252-275 Monografías arqueológicas. Facultad de Estudios de Patrimonio Cultural. Universidad SEK, Chile. ISBN 978-956-7137-82-4

Waste heaps in the EBA pile dwelling of Lucone (N-Italy): Towards ageoarchaeology of daily activities

Marta Dal Corso[1], Cristiano Nicosia[2], Marco Baioni[3], Claudia Mangani[4]

[1] Inst. of Prehistoric and Protohistoric Archaeology and CRC1266 Scales of Transformation, Kiel University, Germany

[2] Dipartimento dei Beni Culturali, Università di Padova, Italy

[3] Museo Archeologico della Valle Sabbia – Fondazione "Piero Simoni", Gavardo, Italy

[4] Museo Civico Archeologico "G. Rambotti", Desenzano del Garda, Italy

Abstract

The study of phytoliths is here applied for the detection of plant use and of the remains of cereal processing in a Bronze Age archaeological site in Northern Italy. The Lucone settlement (Brescia) is one of the pile dwellings belonging to the UNESCO "Prehistoric Pile Dwellings around the Alps" serial transnational site. Its chronology is well established thanks to dendrochronology on the numerous vertical and horizontal wood elements recovered. The earliest fellings date to the year 2034 BCE and the latest to the year 1967 BCE, placing the inhabitation of the site in the Early Bronze Age, and more precisely in the "Polada Culture". Yearly excavation campaigns begun in 2007 and highlighted the presence of several finely stratified or laminated "heaps", containing large quantities of archaeological materials. The heaps are convex-shaped or sometimes more laterally spread out, resulting in a lenticular morphology. They are attested in both the phases of occupation identified at the site (separated by an episode of destruction by fire) and are often superimposed to each other. These heaps are important witnesses of the activities taking place on the platforms, which are never preserved in most pile dwellings. They have been made object of a combined study employing soil micromorphology and phytolith analysis, integrating the evidence from excavation. The results are evaluated in terms of daily activities, choice of combustibles, use of earth-based construction materials, waste management, and environment of deposition.

Formation of anthropogenic landscapes in the middleVolga region in the last two millennium through the use of phytoliths and other proxies in soils

Mikhail Blinnikov[1,3], Ekaterina Ershova[2,3], Elena Ponomarenko[3,4], Ayrat Sitdikov[3] , Leonid Vyazov[3]

[1] St. Cloud State University

[2] Moscow State University

[3] Kazan Federal University

[4] Ottawa University

Presenter's e-mail (Mikhail Blinnikov): fitolit@gmail.com

Abstract

The Bolgar area of Tatarstan (a UNESCO World Heritage Site https://whc.unesco.org/en/list/981) in Russia has been occupied by various archaeological cultures from the Paleolithic time onwards and has seen continuous archaeological excavations during the last hundred years. The combination of pedoanthracological, pollen, and phytolith analyses of over 80 soil samples (with over 20 calibrated radiocarbon dates) at multiple sites of various ages and cultural affiliations was applied to reveal the dynamics of the plant coverage and land use in the last 2000 years. Major depopulation of the area between 2300 and 1700 years ago was followed by its re-colonization in the 3rd to 5th centuries AD during the time of so-called Great Migrations. At that time, the area was forested, with East European lime tree (*Tilia cordata*) being the dominant species based on pollen record. Slopes adjacent to the sites were burned for swidden agriculture, as indicated by soil charcoal of specific size and concentration and presence of heavily burned phytoliths. The combination of *Tilia, Betula*, Onagraceae, and *Cerealia* pollen was interpreted as a signature of Swidden cultivation in the pollen spectra. Phytolith analyses allowed to detect some shifts in both wild and domestic cereals, including a change from early proso millet cultivation indicated by distinct Panicoid suite (5th-7th century AD) to a mixed grain (wheat, barley, oats and millet) cultivation indicated by heavy presence of large dendritic forms since the Bolgar period by the 10th century AD. Charcoal studies from soils suggest that vast plowlands were later interspersed with grazing grounds, the recurrent burning of forest ceased, and the forest was used as a source of firewood, with a preference for deciduous tree taxa, probably during the time of the Russian settlement since the 15th century. The phytolith signature of the new anthropogenic landscape included a large proportion of *Pinus*, Poaceae, Asteraceae, *Cannabis*, and limited presence of upland sedges, which is also confirmed by pollen studies. Detection of limited amount of spruce during this period makes for an interesting case of the impact of the Little Ice Age on the southern taiga distribution across the region between 12th and 18th centuries.

Keywords: Phytoliths, pollen, charcoal, soils, landuse, Middle Volga

Reconstruction of vegetation dynamics in the Maya Lowlands: human-environment interactions during the preclassic period in the city of Naachtun (Guatemala)

TESTÉ Marc [1,2,@], Garnier Aline[1,3], Castanet Cyril[1,4], Purdue Louise[5], Lemonnier Eva[6,7], Dussol Lydie[6,7], Nondedeo Philippe[7], Limondin-Lozouet Nicole[1], Oxlaj Enecon[8]

[1]Laboratoire de Géographie Physique : Environnements Quaternaires et Actuels (LGP) UMR.8591 – CNRS, Université Paris I - Panthéon-Sorbonne, Université Paris-Est Créteil Val-de-Marne (UPEC) - *1 Place Aristide Briand 92195 MEUDON CEDEX – France*

[2]Université Paris I Panthéon Sorbonne - *Institut de Géographie UFR08 191, rue Saint-Jacques 75231 Paris cedex 05 - France*

[3]Université Paris Est Créteil Val de Marne - *Département de Géographie 61, avenue du Général de Gaulle Bat i 94010 Créteil cedex - France*

[4]Université Paris 8 Vincennes Saint Denis - *Département de Géographie 2 rue de la Liberté Bat D 93256 Saint Denis Cedex - France*

[5]Culture et Environnements, Préhistoire, Antiquité, Moyen-Age (CEPAM) UMR.7264 – CNRS, Université Nice Sophia Antipolis *– 24 avenue des Diables Bleus 06357 Nice Cedex 4 – France.*

[6]Université Paris I Panthéon Sorbonne – *Institut d'Art et d'Archéologie UFR03 3 rue Michelet 75006 Paris – France.*

[7]Archéologie des Amériques (ArchAm) UMR.8096 – *CNRS, Paris I Panthéon Sorbonne 21 Allée de l'Université 92023 Nanterre Cedex – France.*

[8]Organizacion de Manejo y Conservacion (OMYC) – *Calle principal, plaza central Uaxactun - Guatemala*

[@]marc.teste@lgp.cnrs.fr

Abstract

The rainforest of Petén, in the northern part of Guatemala, is home to many of the most emblematic archaeological sites of the Maya lowlands civilization. In contrast to the theories of the limits of human societies growth in tropical forest environment (Meggers, 1954), recent estimates suggest an upward reevaluation of demography and density in the Petén region (Clynes, 2018). A higher density of Mayan populations in these fragile forest ecosystems raises questions about the management of plant resources but also about the impact of human activities (agriculture practices, city planning,…) on the vegetation cover. Naachtun, a major Maya regional Center mainly dated from the Classic period (AD 150 – 950) is currently under investigations by both archaeologists and palaeoenvironmentalists as part of an interdisciplinary program of the MEAE (Naachtun archaeological Project), led by Philippe Nondédéo. The first concrete archaeological traces of occupation date back to the 5th century BCE, but the really start of the city growth is dated from the 1st century CE, i.e. to the time of the Maya collapse of the Preclassic period. Using an innovative approach, the aim of this presentation is to enhance the contribution of phytoliths in the reconstruction of vegetation dynamics during this critical period of ecological and cultural changings. Samples from this Preclassic period were recorded by alluvial and colluvial sediments deposited in the karstic polje, named northern *bajo*, located only a few hundred meters north of the site, where the preservation of phytoliths in deposits was quite good.

This study focuses on the study of 60 modern samples and 80 fossils samples. To build a modern reference collection of phytoliths assemblages, it was necessary to analyze both forest and cultivated

environments. To do so, we selected 40 samples representing the six plant ecosystems of Naachtun and 20 samples from current cultivated soils sampled in the modern agroforestery community of Uaxactun, 45 km south of Naachtun. Based on a Component Analysis statistical approach this work highlights the possibility of differentiating plant environments on the basis of modern phytoliths assemblages. This study was complemented with the study of 80 paleoenvironmental samples, 60 of them were obtained from 1 borehole and 2 outcrops in the northern *bajo,* and 20 samples from a dozen geoarchaeological outcrops in the archaeological area.

The results of the modern approach highlight a strong phytoliths signature according to the different vegetation types. Closed vegetation such as forests is very well differentiated from open vegetation such as wetlands or grassy undergrowth areas. The study of the assemblages of phytoliths also makes it possible to distinguish the high forests of the archaeological site from the palm forests and low forests which grow in the *bajo*. This ecological characterization of phytolith assemblages allowed us to identify and interpret past changes in the vegetation at Naachtun during the Preclassic period. The sedimentary records of the *bajo*, located in 3 different sectors and dated between 400 BCE and 0 CE (Late Preclassic) reveal assemblages rich in Grass Short Cell Phytolith (GSCP) and Papillae forms. Comparable assemblages are found for the same period in geoarchaeological records within the site itself. These types of phytolith assemblages are characteristic of open vegetation landscapes and are similar to those found in modern anthropized and agricultural areas. These results show a generalized opening of the landscape at Naachtun in the bajo and the hills, prior to the growth of the city of Naachtun.

The *bajo* sedimentary records dated around 1600 BCE (Early Preclassic) show assemblages rich in Papillae forms (Cyperaceae) and Rondel morphotypes, but also in diatoms and sponge spicules. This assembly is typical of the current aquatic environments of the *bajo* wetlands. The geographical dispersion of these assemblages inside the *bajo* area shows that the expanse of water bodies of the Northern *bajo* of Naachtunwas larger than today. These observations are supplemented by the calcareous sedimentology and mollusc richness of these sedimentary units. These results help us reinforce the hypothesis of the early settlement of Maya populations in Naachtun favoured by water availability.

New evidence for Neolithic rice cultivation and Holocene environmental change in the Fuzhou Basin, southeast China

Ting Ma[1], Zhuo Zheng[2], Barry V. Rolett[3]

[1] School of Geography and Planning, Sun Yat-Sen University, Guangzhou 510275, China

[2] School of Earth Science and Geological Engineering, Sun Yat-Sen University, Guangzhou 510275, China

[3] Department of Anthropology, University of Hawaii, Manoa, Honolulu, HI, USA

Abstract

A stratified profile of the Zhuangbianshan (ZBS) archaeological site (Fuzhou Basin, Fujian) was studied to investigate Neolithic era anthropogenic influence and associated environmental changes. Analysis of the archaeological sediments focused on phytoliths, palynomorphs and microcharcoal. A lack of direct evidence for agriculture has made it difficult to know if Neolithic cultures of this area relied on the exploitation of wild plants such as nuts and sago palm, or a combination of farming and foraging. Three types of rice phytoliths were found in ZBS archaeological deposits, providing robust evidence for rice farming as part of a broad-spectrum Neolithic subsistence economy centered on fishing and hunting. Chronologies based on AMS ^{14}C dates and artifact typology place the earliest rice during the Tanshishan (TSS) Period (5,000–4,300 cal BP) followed by a shift to economic dependency on rice in the Huangguashan (HGS) Period (4,300–3,500 cal BP). The ZBS phytolith assemblage contains high frequencies of rice husk (peaked-shape glume cells) phytoliths, with far fewer leaf and stem types. This indicates late stage processing activities such as dehusking, implying a focus on consumption rather than rice production. High concentrations of charcoal in the Neolithic ZBS deposits indicate local human settlement and peaks in fire use. The ZBS pollen record also reflects human settlement and peaks in local forest clearance during the Neolithic. Forest cover was renewed when the site was temporarily abandoned following the Neolithic. Rapid formation of the Min River floodplain began ~2,000 cal BP in association with retreating sea level and intensifying anthropogenic influence. Prior to that, rice farming in the Fuzhou Basin was limited by the scarcity of wetlands suitable for agriculture.

Phytoliths reveal the earliest interplay of rice and broomcorn millet between 7.3 ka BP and 6.8 ka BP in the middle Huai River valley, China

Wuhong Luo[1], Chunguang Gu [1], Yuzhang Yang[1*], Dong Zhang[2], Zhonghe Liang[2], Jia Li [1], Chengqing Huang[1], Juzhong Zhang[1]

[1] Department for the History of Science and Scientific Archaeology, University of Science and Technology of China, Hefei 230026, China

[2] Institute of Archeology, Chinese Academy of Social Sciences, Beijing 100710, China

Abstract

The middle Huai River valley, located in the climatic, cultural and agricultural transitional zone in the central-eastern China during the Neolithic, occupies an important position in the study of the origins, development and spread of rice and millet farming in China. Previous studies indicated thatsome preliminary findings about the emergence and development of mixed farming of rice and millets, and the early rice domestication rate in the valley during the Neolithic have been reported. However, it is still unknown when foxtail millet and broomcorn millet first extended respectively into the valley and connected with rice, and the process of rice domestication during the Neolithic. In this study, phytolith analysis of soil samples from the Shuangdun site during the archaeological excavation, which is a representative site of Shuangdun Culture in the middle Huai River valley dating back to 7.3 ka BP–6.8 ka BP, reveals crop information in the middle Huai River valley, China.Our results show that rice with *japonica* characteristics was the dominant crop at the Shuangdun site, which had a higher domestication rate than that at Shunshanji between 8.5 ka BP and 7.5 ka BP, while broomcorn millet only occupied a small proportion of the total based on analysis of the quantity and ubiquity of phytoliths. Our data extend the record of broomcorn millet use in the middle Huai River valley by nearly 2,000 years. The analysis in this paper provides significant evidence for illustrating the transformation of crop structure and the domestication process of rice in the middle Huai River valley, and also provides some clues for mapping the spatiotemporal route for the spread of rice and millet in central-eastern China during the Neolithic.

Keywords: Phytolith, Broomcorn millet, Rice, Domestication process, Middle Huai River valley, Shuangdun site

Session 5: Phytoliths linked to global change

Keynote speech

Modern bamboo phytolith response to the climate change: an example from *Bambusa emeiensis* in the middle Yangtze River

Yansheng Gu[1*], Yabin Ji[1], Qianqian Tang[1], Hongye Liu[1], Hanlin Wang[2], Rencheng Li[3]

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

[2]School of Geography and Ocean Science, Nanjing University, Nanjing 210046, China

[3] College of Earth Science, Guilin University of Technology, Guilin 541004, China

[*]email:ysgu@cug.edu.cn

Abstract

The morphological size of the phytolith is controlled by the morphological size of the plant cells and the intercellular space, which are affected by the external environmental factors of the living plant (Wang and Lu, 1993). It is of great significance to study the relationship between modern phytolith morphometrics and climate environment. The Bambusoideae is one of the ideal materials to study the ecological response of plants to global change. However, the response sensitivity of the bamboo phytoliths remained unknown. After 7 years of continuous sampling, the morphometric of phytoliths in bamboo (*Bambusa emeiensis*) growing on the campus of China University of Geosciences (Wuhan) in the middle Yangtze River was employed to research the relation among the phytolith assemblages, protion of bulliformcells, sizes oflong cells and short cells and climate and environmental factors such as atmospheric temperature, relative humidity, precipitation and so on. Meanwhile, the carbon isotopes and lipids of bamboo leaves and phytoliths were analyzed. Our results demonstrate that the warmth index (Iw) proposed by Wang et al. (2003) is sensitive to the monthly mean temperature change and water stress index (Fs) proposed by Bremond et al. (2005) is actually sensitive to the monthly average precipitation and relative humidity change, which revealed that bulliform cells in bamboo leaves are related to the mechanism of transpiration and drought stress. In addition, content of long cells depends on the temperature, and is related to the mechanism of plant protection from coldness. The changes of morphological parameters of short cells (bilobates, long saddles) were consistent with the temperature changing process, showing that temperature is crucial to the formation of short cells. This research first revealed that the morphometrics of bamboo phytoliths have a certain significance of plant ecology, which reflects the relationship between phytolith formation and climate environment during the growth process. Our findings not only deepens the understanding of the mechanism of plant response to modern global change, but also provides an important reference for the reconstruction of paleoenvironmental change.

Keywords:*Bambusa emeiensis*, phytoliths, ecological response, climate change, middle Yangtze River

References:

Bremond L, Alexandre A, Peryron O et al. (2005) Grass water stress estimated from phytoliths in West Africa. Journal of Biogeography 32: 311-327.

Wang WM, Liu J and Zhou X (2003) Climate indexes of phytoliths from *Homo erectus*' cave deposit cave deposits in Nanjing. Chinese Science Bulletin 48(18): 2005-2009.

Wang YJ and Lu HY (1993) The Study of Phytolith and Its Application. Beijing: China Ocean Press (in Chinese).

Keynote speech

Phytolith biogeochemistry and its controlon terrestrial biogeochemical carbon cycle

Zhaoliang Song[1]*, Zichuan Li[1], Xiaodong Zhang[1], Xiaomin Yang[1]

[1]Institute of the Surface-Earth System Science, Tianjin University, Tianjin 300072, China

* Correspondence address: Institute of the Surface-Earth System Science, Tianjin University, No.92 Weijin Road Nankai District, Tianjin 300072, China

E-mail: songzhaoliang78@163.com

Abstract

Phytoliths, microscopic silica bodiesformed inside plant tissues, may occlude 0.1–6% of organic carbon (C) for most terrestrial plants. Most of the organic C occluded in phytoliths comes from photosynthesis. Phytoliths may be stable in soil and sediment environments at a centennial to millennial scale depending mainly on the environmental conditions, and chemical composition and morphology of phytoliths. Phytoliths may influence terrestrial biogeochemical carbon (C) sequestration either directly through phytlith C sequestration or indirectly through regulating plant biomass C accumulation under abiotic and biotic stresses.

Phytolith C sequestration is an important biogeochemical C sequestration mechanism. Our study on phytolith carbon sequestration in terrestrial ecosystems of China indicates that phytolith C sequestration rates in terrestrial ecosystems increase in the following order: grasslands < forests < croplands. Furthermore, active management practices, such as organic mulching, amendment of Si-rich materials and cultivation of Si-accumulating plants to increase silicon supply and aboveground net primary productivity (ANPP) have significant potential to enhance the phytolith C sequestration.

The occurrence and turnover of s can mitigate plant abiotic and biotic stresses through multiple mechanisms and enhance the accumulation of plant biomass C. The recovery of plant biomass C in response to silicon accumulation usually exhibits a bell-shaped curve under abiotic stresses and an S-shaped curve under biotic stress. Generally, phytoliths can help to recover approximately 35% of plant biomass C under abiotic and biotic stresses.

Keywords: China, phytolith, carbon sequestration, silicon cycle, stresses, terrestrial ecosystems

Response of phytoliths to heavy metal stress in crops

Linan Liu[1], Zhaoliang Song[1*], Xiaodong Zhang[1], Weihua Yang[1]

[1]Institute of the Surface-Earth System Science, Tianjin University, Tianjin 300072, China

[*] Correspondence address: Institute of the Surface-Earth System Science, Tianjin University, No.92 Weijin Road Nankai District, Tianjin 300072, China

E-mail: songzhaoliang78@163.com

Abstract

Heavy metal polluted-soil will alleviate plant quality and threaten the health of animals and human beings. Silicon (Si) has been well evidenced to be a beneficial element for enhancing plant tolerance to abiotic stresses. Si depositing in plant bodies will form phytoliths which can encapsulate some organic carbon and trace elements. However, the effect and mechanisms by which it works are still scanty. Three main economic crops (i.e., wheat, maize and rice) are assessed to determine the elemental composition and morphological variation of phytoliths in crops under heavy metal stress. The crops originate from heavy metal polluted soil around industrial areas were compared with those from unpolluted areas. The abundance and elemental composition of phytoliths in plant tissues (i.e., leaf, stem, grain) were analyzed. Elemental quantification in plant bodies and phytoliths by means of inductively coupled plasma mass spectrometry (ICP-MS) and inductively coupled plasma-optical emission spectrometry (ICP-OES) was to determine the capacity of phytoliths for containing metal elements; a qualitative research for the microstructures of phytoliths by means of scanning electron microscope (SEM) and X-ray energy dispersive analysis (EDS) was to characterize phytoliths response to heavy metal stressed conditions. The abundance of phytoliths in crops primarily agreed with the availability of Si in soil and its elemental composition might reflect the geochemical conditions. The results would suggest that phytoliths act as defenders of metal stress in Gramineae crops.

Monthly coordinated variations between phytolith assemblage and alkane composition in the leaves of the bamboo *Dendrocalamus ronganensis*

Rencheng Li[1*], Jun Fan[1], Meyers Philip[2], John Carter[3], Yansheng Gu[4]

[1]Guangxi Key Laboratory of Hidden Metallic Ore Deposits Exploration, Guilin University of Technology, Guilin, 541004, China

[2]Department of Earth and Environmental Sciences, The University of Michigan, Ann Arbor, MI 48109-1005, USA

[3] School of Geography, Environment and Earth Sciences, Victoria University of Wellington, PO Box 600 Wellington, New Zealand

[4] State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan 430074, China

Abstract

Leaf phytolith and wax n-alkane are important members in plant leaf epidermaltissues that have similar physiological functions. They all have value as paleoenvironmental proxies in geological archives. Some researches focused on the relationship between the monthly /seasonal variation of them in plant leaves and plant physiology and growing environment. However, little was known of the relationship between the variations of phytolith and *n*-alkane in leaves of plant during the growing season. The phytolith assemblages and molecular composition and isotopic compositionof the dominant n-alkanes in fresh leaves of thebamboo *Dendrocalamus ronganensis* sampled every month over the growing seasons were investigated and compared against leaf age and climate conditions.The results show that the composition and isotopic compositionof the dominant n-alkanes and phytolith assemblages vary throughout the growing season, that the variations are related to the age and/or maturity of plant leaves, and that leaf n-alkane distributions and compositions and phytolith assemblages are influenced by physiology of cells and/or seasonal climatic changes. Phytolith and n-alkane formation ismainly controlled by the physiology of the cell types during leaf opening and developing, influenced by hightranspiration and temperature during the middle stage of growing seasons and by the senescence of plant leaves in the late stage of the growing season,suggesting they vary synergisticallyduring the plant growing season. Thiswork is helpfulto understand the ecological and physiological significance, and mechanismsof phytolith and n-alkane formation in leaves of plant.

Keywords:phytolith, n-alkane, carbon isotopic composition, bamboo, plant growing season

Production, accumulation of phytoliths and the potential of phytolith sequestration carbon in wetland ecosystems

Shaopan Xia[1], Zhaoliang Song[1*]

[1] Institute of Surface-Earth System Science, Tianjin University, Tianjin 300072, China

[*] Correspondence address: Institute of the Surface-Earth System Science, Tianjin University, No.92 Weijin Road Nankai District, Tianjin 300072, China

E-mail: songzhaoliang78@163.com

Abstract

Wetlands exert an important role in the global carbon cycle with high net primary productivity (NPP) and low organic carbon decomposition rate representing a significant stock of soil carbon. Phytolith, is present in most plants, some organic carbon is occluded during phytolith formation, and PhytOC (phytolith-occluded-carbon) can remain in some soil layers or sediments for a long time when plants die and undergo decomposition. Carbon sequestration within the phytoliths of plants and soils, a significant mechanism of long-term biogeochemical carbon sequestration, may play a vital role in the global carbon cycle and climate change.

In our research group, we firstly investigated 18 plants in Xixi wetland, and found *Phragmites australis* is the most dominant Gramineae with higher phytolith content and biomass. We analysed phytolith and PhytOC content in different organs of *Phragmites australis* and surface soil (0-15 cm) in Baiyangdian wetland, and estimated about 3.08×10^7 t CO_2 every year would be sequestrated by global wetland ecosystem. Phytolith and PhytOC content were measured in different organs of five rice cultivars and surface soil (0-10 cm) in a paddy with 50 years of cultivation, and about 2.37×10^8 t of CO_2 equivalents might have been sequestrated within the rice phytoliths in China. Assuming a maximum phytoliths carbon bio-sequestration flux of 13.0 g CO_2 m^{-2} a^{-1}, the global annual potential rate of CO_2 sequestrated in rice phytoliths would approximately be 1.94×10^7 t. Furthermore, addition of silicate fertilizer such as slag could improve phytolith C sequestration by increasing PhytOC contents in rice straw and the plants growth. Therefore, the appropriate management to maximize NPP and phytolith content or high-efficiency of phytolith occlusion of carbon, such as the selectivity of plant species and external silicon fertilizer, has the potential to contribute to considerable production and accumulation quantities of PhytOC, which is of vital importance to increase the amount of sequestrated CO_2 and regulate local or global climate change.

References:

Song Z. L., McGrouther K., Wang H. L. 2016. Occurrence, turnover and carbon sequestration potential of phytoliths in terrestrial ecosystems. Earth-Science Reviews, 158: 19-30.

Li Z. M., Song Z. L., Li B. L., et al. 2013. Phytolith production in wetland plants of the Hangzhou Xixi Wetlands ecosystem. Journal of Zhejiang A & F University, 30: 470-476.

Li Z. M., Song Z. L., Li B. L. 2013. The production and accumulation of phytolith-occluded carbon in Baiyangdian reed wetland of China. Applied Geochemistry, 37: 117-124.

Li Z. M., Song Z. L., Parr J. F., et al. 2013. Occluded C in rice phytoliths: implications to biogeochemical carbon sequestration. Plant and Soil, 370: 615-623.

Song A. L., Ning D. F., Fan F. L., et al. 2015. The potential for carbon bio-sequestration in China's paddy rice (*Oryza sativa* L.) as impacted by slag-based silicate fertilizer. Scientific Reports, 5: 17354.

Silicon distribution and phytolith-occluded carbon of grassland plants in northern China

Xiaomin Yang [1], Zhaoliang Song [1*], Linan Liu [1]

[1] Institute of the Surface-Earth System Science, Tianjin University, Tianjin 300072, China

[*] Correspondence address: Institute of the Surface-Earth System Science, Tianjin University, No.92 Weijin Road Nankai District, Tianjin 300072, China

E-mail: songzhaoliang78@163.com

Abstract

Grasslands play a crucial role in the coupled biogeochemical cycles of carbon (C) and silicon (Si) due to their large biogenic Si (BSi) pools. As the most important BSi pools in grasslands, phytoliths contribute partly to the long-term terrestrial carbon sink through phytolith-occludedcarbon(PhytOC). However, grassland desertification has occurred extensively in recent decades.To determinethe impact factors of BSi distribution and evaluate the potential of phytolith carbon sequestration in the grasslands of northern China, we investigated Si content of 184 plant species(above-ground parts) and determined the phytolith and PhytOC contents of the dominant plants (above-ground parts) fromeastern Inner Mongolian steppe. Results showed that most of Si accumulators were commelinid monocots, while many eudicots also accumulated abundant Si. Linear regression suggested that Si content of measured grassland plants was negatively correlated withmean annual precipitation (R^2 = 0.0401, P< 0.01, n = 184), but positively correlatedwith mean annual temperature (R^2 = 0.0347, P< 0.05, n = 184). Si content for 80% of plants in meadow steppe wasbelow 5.00 g/kg (dry weight) and that for 60% of plants in typical steppe was over 5.00 g/kg, resulting in community-weighted average Si content ofplantsin typical steppe (6.53 ±2.88 g/kg) was significantly higher than that in meadow steppe (2.15 ± 0.92 g kg^{-1}). According to the established functional relation between phytoliths and silica and the determined average carbon content of phytoliths, we preliminarily estimated that the PhytOC production flux in meadow steppe and typical steppe was 0.54 ± 0.23 and 0.81 ± 0.36 kg CO_2 ha^{-1} $year^{-1}$, respectively. As desertification progressing, the total contents of phytoliths and PhytOC in aboveground vegetation did not change significantly, whereas the production fluxes of phytoliths and PhytOC were markedly reduced. Our studies demonstrate that plant phylogeny influencesSi content of individual species, whereas grassland type with different mean annual precipitation and mean annual temperature may significantly affect the abundanceof high Si species.Furthermore, grassland restoration (e.g. appropriate grazing) will increase the production fluxes of phytoliths and PhytOC in degraded grassland.

References:

Blecker S. W., McCulley R. L., Chadwick O. A., Kelly E. F., 2006. Biologic cycling of silicaacross a grassland bioclimosequence. Global Biogeochemical Cycles, 20:GB3023.

Jiang G. M., Han X. G., Wu J. G., 2006. Restoration and management of the Inner Mongolia grassland require a sustainable strategy. Ambio, 35: 269-270.

Ji Z., Yang X. M., Song Z. L., Liu H. Y., Liu X., Qiu S., Li J. W., Guo F. S., Zhang X. D., 2018. Silicon distribution in meadow steppe and typical steppe of northern China and its implications for phytolith carbon sequestration. Grass and Forage Science, 73: 482-492.

Ru N., Yang X. M., Song Z. L., Liu H. Y., Hao Q., Liu X., Wu X. C., 2018. Phytoliths and phytolith carbon occlusion in aboveground vegetation of sandy grasslands in eastern Inner Mongolia, China. Science of The Total Environment, 625: 1283-1289.

Song Z. L., Liu H. Y., Si Y., Yin Y., 2012. The production of phytoliths in China's grasslands: implications to the biogeochemical sequestration of atmospheric CO_2. Global Change Biology, 18: 3647-3653.

The storage of soil phytolith-occluded carbon in China's grasslands

Xiaodong Zhang[1], Qian Hao[1], Zhaoliang Song[1]*

[1] Institute of the Surface-Earth System Science, Tianjin University, Tianjin 300072, China

*Correspondence address: Institute of the Surface-Earth System Science, Tianjin University, No.92 Weijin Road Nankai District, Tianjin 300072, China

E-mail: songzhaoliang78@163.com

Abstract

The concentration of carbon dioxide (CO_2) in the atmosphere has a significant increasing trend since the beginning of Industrial Era, which results in the rising temperatures of Earth's surface. Therefore, how to effectively reduce atmospheric CO_2 concentration plays an important role for mitigating global climate warming. Phytolith-occluded carbon (PhytOC), as one of long-term stable biogeochemical carbon sequestration mechanisms, could be preserved in soils or sediments for thousands of years, which has a distinct impact on global carbon cycle. China's grassland, occupying about 41.7% of the country's total land area(about 400 million hectares) and mainly distributing in Inner Mongolia plateau and Qinghai-Tibet plateau. Accurate assessment of PhytOC storages in grasslands and their redistribution among the various grassland ecosystems is of great significance to reveal the potential role of grasslands in the long-term stable carbon sequestration of China's terrestrial ecosystems. Previous studies estimated the production fluxes and rates of phytolith and PhytOC in different grassland ecosystems of China based on phytolith contents and aboveground net primary productivity of China's grasslands. However, the storages of soil phytolith and PhytOC in China's grasslands still remain unclear. In this study, we estimate the storages of soil phytoliths and PhytOC in different China's grasslands on the basis of the concentrations of soil phytolith/PhytOC and bulk density The results show that the storages of soil phytoliths and PhytOC in different grasslands have significant difference, which are mainly controlled by above-ground primary production and climate conditions, which lead to various soil physicochemical properties. Further management measures of grasslands (e.g. high-quality artificial grasslands development and fertilizer application) to maximize above-ground net primary production and litter return flux may be promising ways for significantly increasing the quantity of soil bio-sequestration carbon.

Keywords: China, Grasslands, Soil phytolith, Phytolith-occluded carbon, Carbon sink

SPONSORS AND ORGANIZERS

Sponsors

School of Environmental Studies, China University of Geosciences (CUG)-Wuhan;

Office of Science and Technology Development, CUG-Wuhan;

Office of International Exchange Affair, CUG-Wuhan:

Beta Analytic Testing Laboratory, Xiamen,China.

Organizer

School of Environmental Studies, CUG-Wuhan.

Co-organizers

The International Phytolith Society;

Branch of Phytolith, Palynological Society of China;

Branch of Paleoethnobotany, Archaeology Society of China;

Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China;

Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences, Nanjing, China;

Institute of Archaeology, Chinese Academy of Social Sciences, Beijing, China;

Tianjin University, Tianjin, China;

Shandong University, Jinan, China;

Northeast Normal University, Changchun, China;

State Key Laboratory of Biogeology and Environmental Geology, CUG-Wuhan.

ACADEMIC AND ORGANIZING COMMITTEE

Academic Committee (in alphabetical order)

Chairman: Hongfu YIN, China University of Geosciences, Wuhan, China

Members:

Alexandra Golyeva, Institute of Geography, Russian Academy of Sciences, Moscow, Russia;

Doris Barboni, CEREGE, CNRS, Aix-Marseille University, Aix en Provence, France;

Guiyun JIN, Shandong University, Jinan, China;

Houyuan LU, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China;

Marco MADELLA, Department of Humanities, Universitat Pompeu Fabra, Barcelona, Spain;

Mikhail Blinnikov, Cloud State University, St. Cloud, MN 56301, US;

Shenghong HU, China University of Geosciences, Wuhan, China;

Teng MA, China University of Geosciences, Wuhan, China;

Weiming Wang, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China;

Zhijun Zhao, Institute of Archaeology, Chinese Academy of Social Sciences, Beijing, China.

Organizing Committee

Chairman: Yansheng GU

Members: Maizhi ZUO, Jun HU, Qi LI.

Secretary: Hongye LIU, Yuchuan MI.

WEBSITES AND CONTACT

Website

http://www.11thimpr.cn/

Contact

Hongye LIU, Tel: 86-13071239377; Email: impr_11th@163.com;

Yuchuan Mi, Tel: 86-13307165723; Email: 649450713@qq.com

Yansheng GU, Tel: 86-13986038370; Fax: 86-27-87436235; Email: ysgu@cug.edu.cn.

Postal Address

No. 388 Lumo Road, School of Environmental Studies, China University of Geosciences, Wuhan, Hubei Province, China, Postcode 430074.

Wuhan Tianhe International Airport

Route 1 (total cost: 9 CNY): Walk 479 meters to the subway station "Tianhe Airport" (about 7 minutes), take Metro Line 2 to the subway station "Optical Valley Square", exit from F (cost: 7 CNY); take bus 59 (401 or 709) to the China University of Geosciences (cost: 2 CNY)

Full length: 49.7 km, Duration: 1 hour 49 minutes

Or you can choose to take the taxi (about 51 minutes), full length: 44.8 km, cost: 117 CNY (The nearest route)

Wuhan Railway Station

Route 1 (total cost: 7 CNY): Walk 80 meters to the subway station "Wuhan Railway Station" (about 1 minutes), take Metro line 4 to the subway station "Zhong Nan Road", transfer Metro Line 2 to the subway station "Optical Valley Square", exit from F (cost: 5 CNY), take bus 59 (401 or 709) to the China University of Geosciences (cost: 2 CNY)

Full length: 24.1 km, Duration: 1 hour 11 minutes

Or you can choose to take the taxi (about 29 minutes), full length: 16.2 km, cost: 29 CNY (The nearest route)

Hankou Railway Station

Route 1 (total cost: 7 CNY): Walk 230 meters to the subway station "Hankou Railway Station" (about 5 minutes), take Metro line 2 to the subway station "Optical Valley Square", exit from F (cost: 5 CNY), take bus 59 (401 or 709) to the China University of Geosciences

Full length: 25.7 km, Duration: 1 hour 12 minutes

Route 2 (total cost: 4 CNY): Walk 110 meters to the bus station "Hankou Railway Station" (about 2 minutes), take 10 bus to the bus station "Yangtze River Bridge Hanyang Bridge", transfer bus 401 to the China University of Geosciences (cost: 2 CNY)

Full length: 25.2 km, Duration: 1 hour 49 minutes

Or you can choose to take the taxi (about 40 minutes), full length: 25.8 km, cost: 67 CNY (The nearest route)

Wuchang Railway Station

Route 1 (total cost: 2 CNY): Walk 650 meters to the bus station "Wuchang Railway Station" (about 10 minutes), take bus 59 to the China University of Geosciences

Full length: 12.8 km, Duration: 1 hour 15 minutes

Route 2 (total cost: 5 CNY): Walk 210 meters to the subway station "Wuchang Railway Station" (about 5 minutes), take Metro line 4 to the subway station "Zhong Nan Road", transfer Metro line 2 to the subway station "Optical Valley Square", exit from F (cost: 3 CNY), take bus 59 (401 or 709) to the China University of Geosciences (cost: 2 CNY)

Full length: 12.9 km, Duration: 51 minutes

Or you can choose to take the taxi (about 28 minutes), full length: 11.5 km, cost: 28 CNY (The nearest route)

Basic information for 11th IMPR

1. CUG address

No. 388 Lumo Road,China University of Geosciences, Wuhan, Hubei Province, China.
If you wanna take a taxi to the CUG, please show the following to the driver.

我要去中国地质大学(武汉)东区迎宾楼

地址：武汉市洪山区鲁磨路 388 号

2. Meeting sites

The Reception Centre: Registration, accommodation.

Octagonal Display Hall:Opening/Closing Ceremony, Plenary Talks, Sessions, Oral Presentations, All Posters, Sponsors Desk.

Zhendanyuan DinningHall: Dinner (Sept. 13), Lunch and Dinner (Sept. 14-15), Lunch (Sept. 16)

3. Notes for Presentations

The official language of this meeting is English. The keynote speakers will have 30 minutes (a 20-minute talk + 10 minutes for Q & A) for their presentations, while common speakers will have 15 minutes (a 10-minute talk and 5 minutes for Q & A). A 3-minute remaining sign will be shown to the speakers toward the end of their presentations.

The sizes of the poster are 120 cm (length) and 90 cm (width) (self-provided, within 2 editions per person)


Wuhan Tianhe International Airport
武汉天河国际机场
武汉天河国际机场
三里镇
滠口站
武湖街道
天兴乡
堤角公园
青山区
青山公园
武汉轻工大学
Hankou Railway Station
汉口火车站
汉口站
Yangtze River
长江
Wuhan Railway Station
武汉火车站
武汉站
武汉理工大学
网风飞椅
武昌东站
江汉区
武汉市
Wuhan City
硚口区
郭家湾
东湖落雁景区
汉阳区
龟山
武昌区
Donghu Lake
东湖
武汉植物园
武汉动物园
武汉大学
China University of Geosciences (CUG)
中国地质大学
武昌站
Wuchang Railway Station
武昌火车站
华中师范大学
华中科技大学
洪山区
武昌工学院
华中农业大学


Huaxia Bank ATM
华夏银行ATM
Bank Kalianwang
General Motors ATM
银行卡联网通用ATM
Dida Tunnel
Nanwang Hill
Lumo Rd
Yujia Hill
E 3rd Rd
Ziwei Rd
Taoli Rd
China University of Geosciences
(Wuhan)
Youxian Rd
Honglyi Rd
Huicui Rd
Caochang N Rd
W 3rd Rd
Jewelry Building
珠宝大楼
Lumo Rd
Boxue Rd
Yiran Rd
Caochang E Rd
Shilin W Rd
Swimming Pool
游泳馆
Fossil Wood
化石林
Qiaodong
Dining Hall
餐厅
Library
图书馆
W 1st Rd
Shilin S Rd
Shilin E Rd
Conference Room
会议室
Shaw Museum
逸夫博物馆
Lumo Rd
Reception Centre
接待中心