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EDITOR'S NOTE

This Society for Phytolith Research Bulletin volume 2, issue 1, is the penultimate one before a complete editorial, graphic and support change. Its life would have been short!! The SPR editorial board and the the SPR board of directors are discussing changes for the future. A proposal will be presented to the General Assembly in 2011 in Denver.

This issue gathers the summaries of the papers presented at the joint 7th IMPR – 4th SMPR event organized by in Mar del Plata, Argentina, December 9-12 2008 By Margarita L. Osterrieth, Mariana Fernández Honaine, Natalia Borrelli, Maria Fernanda Alvarez, Verónica Bernava Laborde, Virginia Bernasconi, Adriana Lopez De Armentia Georgina Erra, Marco Madella and Débora Zurro.

ARTICLES

Phytolith analysis in limited paleoenvironmental contexts: aaa (arctic, alpine, or aquatic)

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Much of phytolith research of terrestrial paleoenvironments has focused on tropical or subtropical regions, in which C4 grasses and a few tropical families predominate producing diverse phytolith morphotypes. Ratios of C3/C4 morphotypes have been used to document regional or subcontinental trends in vegetation in mid-latitudes, e.g., in China or Great Plains of North America. However, in the high-latitude and high-altitude contexts the main phytolith producers are C3 grasses (primarily Festucoids) and sedges with limited diversity of morphotypes. Likewise, many lacustrine or riparian vegetation types worldwide are dominated by C3 grasses or sedges from a few subfamilies. Limited availability of modern analog collections from Arctic, alpine, or aquatic sites hamper paleoenvironmental reconstructions of the more extreme cooler environments, precisely those that we expect to have been more widespread during the late Pleistocene. I discuss potential for improved reconstructions of the Quaternary paleoenvironments with phytolith morphotypes from sites in Alaska (Arctic), Minnesota (aquatic), and the Caucasus (alpine) based on many years of research. Each of the study regions presents challenges and opportunities for further phytolith studies. Samples from central Alaska, for example, tend to be dominated by representatives of only a few genera of C3 grasses. Samples from aquatic vegetation in Minnesota have about a dozen common genera. The Caucasus alpine sites likewise have only a handful of genera of grasses. Because there are strong correlations between phytolith morphology at the genus level in Festucoid grasses, broad reconstructions of paleovegetation may be accomplished with limited modern collections, at least to the level of genus (botanical match). However, modern analogs from soils should not be regarded as genus-level specific, even if we may associate certain typical morphotypes as regionally diagnostic, because of sufficiently high redundancy. A more fruitful approach may be reconstructions based on sediment assemblages as a whole (modern analog match). In this case, however, we will not be able to get adequate matches for true non-analog communities that were common during the late Pleistocene, so a combination botanical-modern analog matching method may be advised.

Calcium oxalate crystals in *Geohintonia mexicana* (Cactaceae: Cactoideae)

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The Cactaceae family is native to the American continent, and the greatest diversity of species is distributed in arid and semiarid regions. The

Chihuahuan Desert (north-central of Mexico to southwestern of EEUU) is one of the main center of cactus diversity and present high degrees of endemism, particularly in the southeastern region, where the state of Nuevo León is located. Calcium oxalate crystals are considered to be the most commonly biomineralizations in higher plants and the Cactaceae family is one of the major producers. *Geohintonia mexicana* Glass & Fitz Maurice (Cactaceae: Cactoideae: Cacteae) is endemic to a small area of southeastern Nuevo León in NE México. The soils where this species develops are Entisols with silt loam texture, high gypsum contents (59-78%), and consequently, high calcium (108-128 mmol/L) and sulfates (134-145mmol/L) contents in soil solution. The aim of this work is to describe the presence of calcium oxalate crystals and to determine their density in the stem and roots of *G. mexicana*. Stem and roots were washed with distilled water, some of the cross sections were cleared with 50% sodium hypochlorite, mounted on gelatin-glycerine and observed under optical and scanning electron microscope. To determine crystal density, all crystals within the following areas were counted: 0.132cm^2 (stem) and 0.088cm^2 (roots). In the stem a high density (53 crystals/cm^2) of druses were observed. The crystals were distributed in the parenchyma, both in rectangular (palisade parenchyma) and isodiametric cells. Druses had an average size of 75x50µm, being smaller (40x25µm) those located below the epidermis. In the roots, a high density (79 crystals/cm^2) of druses (average size: 37.5x35µm) were observed too, being distributed in the cortical parenchyma and in the radium zones. According with Monje y Baran (2002), these druses could be composed of weddellite ($CaC_2O_4.2H_2O$) based on their external aspect. Because of the basal material of the soils is gypsum, it represents a large calcium source to the soil solution, so the high calcium oxalate crystal production could be related with the regulation of intracellular calcium ions and with a physiological mechanism to preserve water.

Typological and metrical attributes of phytoliths of bamboos and their relevance in archaeology

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Bamboos are generally tall, tufted, grass like woody plants growing in the tropical, subtropical and temperate regions of all continents except Europe and Western Asia, from lowlands up to 4000 m altitude. Most genera of bamboos are still not well understood. Precise information on their origin is still unavailable. The study of phytoliths of different species of *Arundinaria*, *Bambusa* and *Phyllostachys* revealed that there are characteristic differentiations in the morphological and metrical attributes. Besides the microtopographic features, the color of phytoliths also play significant role in distinguishing species. Various shapes of silcified bulliform cells, rod shaped, saddles, trapezoids, micro and macro hairs, epidermal cells, hypodermal cells, fibres and tracheids are very characteristic individually or in group to identify different species of bamboos. One of the factors responsible for its geographical distribution is, indeed, different human activity. It has been extensively utilized for a wide range of purposes. Various features such as strength of the culms, straightness, smoothness, lightness, hardness and greater hollowness of bamboos has been exploited by man from remote past to make them suitable for numerous end products/purposes. It is known to be a natural and excellent raw material for manufacturing strong and sturdy handicrafts, weapons, ornaments, etc. There is hardly any other plant material that can rival the utility of bamboo. Even in the early years, bamboo had been used in many ways, not to mention the traditional use of bamboo in the daily life of the early people especially in Asia. This, obviously emphasizes the study of bamboo phytoliths along with palms in archaeological soil samples to reconstruct worked material on which prehistoric man would have been manufacturing different objects like bow, arrow shaft, basket, pins, spear, etc. and other structural activities.

Phytolith morphology in C3 grass subfamilies and restios of the Cape region and highlands of Southern Africa

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Vegetation assemblages in the Cape Floral Region (Fynbos Biome) include the fynbos and the rhenosterveld. Graminoids in these communities are represented by Restionaceae, Cyperaceae, and C_3 grasses of the Danthoniodeae, Erhartoideae and Pooideae subfamilies, and a small number of C_4 grasses of the Chloridoideae, Panicoideae, and Aristidoideae subfamilies. Because this region receives more than 75% of rain during the winter, C_4 grass families are more restricted. Danthonioideae, Erhartoideae and Pooideae grasses thrive elsewhere in South Africa at high elevations (usually above 1800 m), where they are in relatively low percentage in relation to the Panicoideae and other C_4 grasses. Pollen studies reveal that fynbos

and rhenosterveld vegetation had a wider distribution during the cold stages of the Upper Pleistocene, suggesting that grasslands in the Highveld had stronger presence of Restionaceae and C_3 grasses (Scott 2002). The same development during the Pleistocene has been postulated for the highlands of Namibia (Chase and Meadows 2007), where today the Chloridoideae and Aristidoideae grasses predominate. Unlike the Pooideae grasses and Cyperaceae, phytolith shapes in Danthonioideae, Erhartoideae, and Restionaceae have not been studied. This paper presents a protocol developed to differentiate short cells of Danthonioideae and Ehrartodieae, and their similarities to shapes in other subfamilies. Additionally, this paper includes assemblages obtained from soils in the Fynbos, Rhenosterveld, Fynbos Grassland, and Highveld Grasslands of elevations above 1700m. The Danthoniodeae in the Cape is represented by the genera *Karroochloa*, *Merxmuellera*, *Pentachistis*, *Pentameris*, and *Schismus*, among others. Trapezoid shapes are distinctive, although similar shapes are found in the Arundinoideae and the C_4 *Stipagrostis* (Aristidoideae). The Erhartoideae in this region are represented by the genus *Erharta*, whose species have characteristic shapes with similarities to Bambusoideae and Oryzoideae, which are not found in this region. Danthonioideae and Erhartoideae have shapes that can be called *Stipa*-type. However, minor differences in distal parts and plateau make them differentiate from *Stipa*-type in other subfamilies. Shape similarities between Danthonioideae, Arundinoideae and Aristidoideae might be related to a common origin. Formerly these three subfamilies were grouped as Arundinoideae. Some Danthonioideae share shapes with *Stipagrostis*, a genus of the Aristidoideae with dominance in the Kalahari region. The predominantly C_3 Danthonioideae have only one C_4 genus, *Centropodia*, which is almost exclusively found in the Kalahari. The native Pooideae are relatively rare in the Cape Region, as opposed to other temperate areas of Africa. They are represented by *Koeleria*, *Stipa*, *Helictotrichon*, *Melica*, and *Poa*. The modern landscape includes a number of naturalized alien species of *Bromus*, *Briza*, and *Avena*, among others. Restionaceae phytoliths present high diversity and some similarities with Cypearaceae and Poaceae. However, they can be singled out and used as diagnostic for Restionaceae, which are one of the characteristic elements of the fynbos, including dry fynbos, and some high elevation meadows in South Africa. Despite the minor overlaps, short cells of the C_3 grass subfamilies of the Cape Region of South Africa and phytoliths of Restionaceae can be to a certain degree used for reconstructing paleoecological and paleoclimatic conditions.

Phytolith analysis of Cyperaceae from SE Buenos Aires Province, Argentina

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Cyperaceae is one of the main silica accumulator families within the plant kingdom. Conical phytoliths were described by some authors as the most important morphotype in the family, however little is known about the variability and diversity of them, as well as the other morphotypes that are also produced. Since phytoliths are widely used as microfossils, the study of them is essential for the identification of sedge-dominated communities or specific palaeoenvironmental conditions in the fossil phytolith record. Also, silica bodies could be a valuable tool for taxonomic research within the family. The aim of this study is to describe the phytolith morphotypes of leaves, culms and fruits of some species of Cyperaceae from Pampean region in order to analyse their palaeobotanical and taxonomic relevance. Phytoliths from leaves or culms and fruits of thirteen sedges from Pampean region were extracted by using a calcination technique. Silica content was calculated as dry weight percentage. For each species, at least 200 phytoliths were counted and the relative frequency of each morphotype was calculated. Seven quantitative and three qualitative characteristics were measured on cone shape phytoliths. In order to analyze the taxonomic relevance within the family, cone characters and percentages of phytolith morphotypes were subject to Principal Component Analyses. The values of silica content had a great variability within genera and within species. The results showed that silicification process affected not only epidermal tissue, but also xylem, parenchyma and sclerenchyma. The most abundant morphotype, in almost all the species, is the conical phytolith. Leaf or culm cones have a rounded, rectangular or square base; whereas typical fruit cones have a polygonal base and they are bigger and more robust. The results of the PCA, based on quantitative and qualitative characteristics of cone phytoliths and percentages of phytolith morphotypes, showed some differentiation among genera. The results of this study represent the first values of silica content and the first descriptions of phytoliths from leaves, culms and fruits of the principal sedges of Pampean region.

Phytolith analysis of species of aquatic habitats from SE Buenos Aires province, Argentina.

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The most frequent species associated with aquatic habitats in Argentina belong to Typhaceae, Cyperaceae, Juncaceae, Apiaceae and Polygonaceae families, and certain species of Poaceae, among others. Cyperaceae, along with Poaceae, are the main silica producers in plant kingdom. However, the phytolith production of these characteristic aquatic habitat families is scarcely known. The knowledge of their qualitative and quantitative phytolith production would allow the identification of these plant communities as well as particular palaeoenvironmental characteristics in the fossil phytolith records. In order to describe the phytolith assemblages of some of the main species growing in ponds, lagoons and/or aquatic habitats from SE Buenos Aires province (Argentina) we selected thirteen species. Eight families were represented: Amaranthaceae (1 sp.), Apiaceae (1 sp.), Asteraceae (2 spp.), Juncaceae (4 spp.), Onagraceae (1 sp.), Polygonaceae (2 spp.), Solanaceae (1 sp.) and Typhaceae (1 sp.). Phytoliths from leaves were extracted following a calcination technique and silica content was calculated as dry weight percentage. *Juncus* spp., *Solanum glaucophyllum*, *Bidens laevis* and *Mikania parodii* produced abundant and diverse morphotypes. The rest of the species produced very scarce (such as *Ludwigia peploides*, *Polygonum hydropiperoides, Alternanthera philoxeroides,*) or did not produce identificable phytoliths (such as *Typha latifolia*, *Rumex crispus*, *Hydrocotyle* sp.). Silica content ranged between 0.23 (*Juncus* sp.) to 2.71% (*Mikania parodii*). Articulated and isolated cylindrical sulcate tracheid phytoliths and parallelepipedal psilate phytoliths, probably derived from epidermal tissue, were the only morphotypes observed in the species with scarce production. Phytolith assemblages of the species with abundant production were characterized by cylindrical sulcate tracheids, stomatal complexes, elongate psilate phytoliths (*Juncus* spp.), tabular lobate epidermal cells (*B. laevis*), parallelepipedal psilate epidermal cells (*S. glaucophyllum, M. parodii*), silica skeletons composed by isodiametric cells (*S. glaucophyllum*), silicifications of multicelullar hairs (*M. parodii and B. laevis*) and silica skeletons composed by diverse morphotypes. The results showed that silicification process mainly occurred in epidermal cells, trichomes and xylem. These descriptions of leaf phytolith assemblages represent the first contribution to the phytolith analysis of these taxa. Finally, they were compared with the phytolith studies carried on the same families by other authors.

Elemental composition of phytoliths in modern plants (Ericaceae)

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The present study about the elemental composition of phytoliths in modern plants (*Ericaceae*) intends to test the hypothesis proposed by Montes Botella (2001). This author pointed out the possibility of heavy metals (Mn, Fe, etc.) being inertized with Si in *vacuolas* inside the living cells or in the cell wall of the "mine heather" (*Erica andevalensis*). This mechanism, if exists, would confer some advantage to some species over others more sensible to maintain high levels of heavy metals in living cells. *E. andevalensis* is a plant endemism (SW Iberian Peninsula) capable of living in very harsh conditions (Buján y col., 2007). We collected heath species growing in the Touro Mine spoils (very similar to the habitat of *Erica andevalensis*), as well as other heathland species present in Galicia (NW Spain), growing on different kinds of soils. In this communication we show the results obtained from *Calluna vulgaris* leaves (and apical shoots) growing on acidic mine soils, peaty soils, quarzite (podsolic) and serpentinite soils. We compare silica percentage (phytoliths) and elemental composition (RX Fluoresecence) of Calluna and *Erica andevalensis* phytoliths. The results obtained indicate highest silica content in leaves from mine soils, both *Calluna vulgaris* (2,46% ± 0,43) and *Erica andevalensis* (1,78% ± 0,12); followed by Calluna growing on serpentine soils (1,61% ± 0,48), quartzite soils (0,86% ± 0,08) and peaty soils (0,60% ± 0,19). This sequence is coherent with the availability of heavy metals (Cu, Ni, Cr, Fe, As, Pb, etc.), nutrients (Ca, Mg) and H_4SiO_4 (precursor of silica, SiO_2) in the soils studied. The elemental composition of phytoliths reflects the dominant geochemistry in each soil system, characterized by high levels of Fe, Zn, As and Pb in mine spoils where *Erica andevalensis* is stablished; Cr and Ni in serpentinite soils; Cu and Cr in Touro mine spoils. As expected by the composition of the parent rocks, the lowest levels of metals and nutrients were found in quartzite (90% SiO_2) and peaty soils (90% organic matter).

Presence of phytoliths in the gut content of springtails (Hexapoda: Collembola)

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Collembola (size 0.2 to 200µm) arthropods are numerous in terrestrial ecosystems and play several important roles in decomposition processes (Hopkin, 1997). Most springtails (commonly known as Collembola) are considered unspecialized feeders of fungal hyphae and spores, bacteria, decaying plant debris, pollen and mineral particles (Castaño Meneses *et al.*, 2004). Therefore, many gut content analyses of field collected Collembola proved that most were non-specific feeders (Filser, 2001). Despite their relative low biomass, springtails are extremely important influencing the structure of some types of soil. Most soils contain millions of collembolan faecal pellets /m^2 and these are beneficial in slowly releasing essential nutrients to plant roots, as the pellets are broken down by microbes. Collembola are also responsible for redistributing plant material, viable fungal spores and bacteria when they feed in one litter or soil horizon and defaecate in another (Hopkin, 1997). The amount of mineral particles ingested with the food and higher if the organisms live in the soil. For example, in the gut content of some springtails, Vannier *et al.* (1972) found crystals between fungal spores and mycelia, plant cell walls, parenchyma, pollen grains, trachea, chitin, appendages (setae, escales, exuviae). The literature about gut contents in Collembola, deal with fungal, plants or animal components and the importance of this group in decomposition processes (Castaño Meneses, 2004; Greenslade *et al*., 2001; Rosello *et al*., 1986; Zettel *et al*., 2001). Because they occur in the soil, abiotic and biotic processes are closely interlinked and must be studied as such (Eijsackers, 2001), the aim of this work, some preliminary findings of mineral gut content of Collembola from soil samples of several localities of the Pampean region and to show the role of Collembola in the pedogenesis, which is still underestimated. Our results show that gut content of the specimens have been dissimilar, but all show a high proportion of phytolith/other minerals, which show the ingestion of plant debris, mainly Poaceae. The major morphotypes identified in three species of the mine soils were bilobate and rondel, with an intermediate value of the undefined. In addition, elongate and rondel were the major morphotypes in one species in a cultivated soil of the Undulated Pampa. Even though these results are preliminary, they are the first records about phytolith in springtails gut content and show that Collembola are active agents in the translocation of phytoliths across soil profile, in mature soils as well as incipient soils.

Characterization and macropattern of calcium oxalate phytoliths in argentinean endemic species of Chenopodioideae (Amaranthaceae)

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The subfamily Chenopodioideae comprises species with a worldwide distribution, although most of them are confined to xeric or saline areas. Calcium oxalate crystals are abundant in these species in the form of large aggregates as well as crystal sand; frequently both forms coexist within a single leaf. Crystals in the shape of octahedrons or prisms are infrequent. Mature leaves of *Atriplex undulata*, *Nitrophila australis* and *Suaeda divaricata* were collected in Salitral de la Vidriera (Prov. Buenos Aires), killed and fixed in FAA and processed using common techniques for anatomical studies and crystal macropattern identification. Cross sections of leaves of *A. undulata* show that crystals occur subepidermically in the chlorenchymatic tissue, frequently within idioblasts. In *S. divaricata* they occur deeper in the mesophyll. In *N. australis*, crystals are seen within the acquaeous tissue surrounding the vascular bundles. Only *A. undulata* has two types of crystals: druses and prisms. The arrangement of the crystals in the druses may differ: pyramids or inverted pyramids, whereas druses of the other two species are formed by non inverted pyramids. In cleared leaves of *A. undulata* and *N. australis* crystals can be observed in intercoastal areas. In *A. undulata* druses formed by pyramidal crystals are the most abundant, occur at random in the whole lamina, and their size increases both acropetally and centripetally, whereas prisms and druses formed by inverted pyramids are found only towards the margins of the leaf and they do not show any great variation in size. A few small druses (with pyramidal crystals) occur at the base of the lamina but only close to the midrib. Druses in *N. australis* are located from the foliar margins to regions near the midrib; few of them are found in the apical zone. In *S. divaricata* they occur in the median region of the lamina, associated with minor veins. Crystal size varies. Druses: *A. undulata* 17-55 µm, *N. australis* 20-42 µm, *S. divaricata* 9-17 µm. Prisms (occurring only in *A. undulata*): 12-19 x 19-24 µm. The characterization of crystals and their macropatterns are useful for the identification of these species, which implies their taxonomic value.

It is possible, however, that the amount of crystals in the three species might be related to the abundance of certain minerals in the soil or to seasonal variations in the environment, facts that have not been taken into consideration until recently.

Phytolithic associations of the "vegas" vegetation in the Bolsón valley (Catamarca, Argentina)

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In the Bolsón Valley, where we are conducting our research on peasant landscape in archaeology, we can identify three micro-environments corresponding to the phytogeographic formations known as Altoandina, Prepuna y Monte. It is a high altitude valley (2900 – 2500 m. masl. in the bottom of the valley) that has environmental characteristics that shows a transition between the Puna and the rest of the valleys area (Aschero y Korstanje, 1996). We consider that the vegetation reconstruction from prehispanic times, and the paleo-environmental characterization for the Bolsón Valley are important elements when we try to reconstruct the history of ancient populations that inhabited it and the relation that they established with their landscape. The goal of this research is to obtain a characterization of the phytolith associations that are identifiable in the different environments and types of vegetation found in such a place, and that might have had different limits and developments in the past. Towards the transition to the Puna area, at the higher altitudes of the valley, we find the vegetation called "vegas" or "humedales", which are part of the Puna phytogeographical province (Cabrera 1974). In this particular environment we sampled and collected plants with the purpose of recognizing the flora composition, the covertures, and the distribution of the principal floral associations. From the herbarium we obtained the material to process and extract phytoliths through the "dry ashing" technique. Finally we realized a quantitative and qualitative analyses of the different morphotypes. This work will be completed with the characterization of the phytolith associations of the other microenvironments involved in the valley, to get a broader and detailed reference in order to study the paleo-environmental fluctuations and their possible effects over ancient populations.

Regional distribution of globular echinates in North America: a call for collaboration

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Globular echinates have been reported in the Arecaceae (Palmae), Euphorbiaceae, and various other families. These forms are noted in samples from wetlands, grasslands, on terraces, and from drier sediments farther removed from streams and other wetlands, as well as deserts in sediments from temperate areas. Recovery of a large quantity (20%) of these forms from a ceramic sherd suggests cooking a plant growing in temperate latitudes that produces these forms. These globular echinates are morphologically distinct from those produced by palms. The broad distribution of the forms suggests that globular echinates represent multiple genera and possibly multiple families. Recovery of these forms is mapped for North America. Collaboration in mapping the occurrence of globular echinates by phytolith researchers across broad geographic areas, including all of the continents, would facilitate the interpretation of these forms, whether related to environmental interpretations from stratigraphic records or interpretation of plant processing and use of features by people. The frequency of recovery of these forms requires that we spend time identifying plants that produce globular echinates and further, that we are more specific about the morphology of the forms. This paper is both a presentation concerning the recovery of these forms and a plea for world-wide collaboration in plotting evidence for these forms, as well as possibilities for identification.

Differentiating Musaceae phytoliths (diploids, triploids and hybrids) through morphometry.

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Humanity played a dominant role in the diffusion of the edible banana over the tropical world. Only with the help of moving and/or intercommunicating human populations could this vegetatively propagated crop have reached a pantropical distribution starting from its primary diversity centre

in South Asia and Southeast Asia. Thus, traces of edible banana in archaeological context have the potential to document not only cultivation and domestication but also the movement of humans in pre-historical times. Archaeological research by classical means has been almost impossible in the case of the edible banana because the plants contain neither wood, seeds or pollen. Fortunately, it produces phytoliths and starch grains. Recent research suggests that these microfossils have the potential to become an efficient tool for tracking the banana in different archaeological configurations and continents. However, archaeologists may, in many places, recover microfossils from banana plants with quite different historical backgrounds. Hence the need for differentiation. The present contribution explores the contribution of the Musaceae phytolith morphometry to this question. Among the numerous edible AA diploid varieties only a few have become popular particularly in South East Asia. The vast majority remained in New Guinea and the Philippines where they must have derived from the wild *Musa acuminata* subspecies *banksii* and *errans*. The bulk of the popular edible bananas, however, consists of triploids (2n= 3x = 33), with the different genome-configurations AAA, AAB, ABB, "A" denoting the "*acuminata"* genome and "B" the "*balbisiana*" genome. The many cultivars in each group are further classified in subgroups of which the members are presumed somaclonal variants of a basic cultivar in the past. Important subgroups are the starchy African and the Pacific Plantains, both belonging to the AAB group, as well as the AAA East-African Highland starchy/beer bananas. All three subgroups underwent a long period of somaclonal variation right in the regions where they are now common, since most if not all of their cultivars are not found anywhere else. Another particular group of edible bananas is confined to the southern Pacific and New Guinea. They are assumed to be diploid derivatives of *Musa maclayi*, a member of the *Musa* Section 'Australimusa'. Finally, and within the archaeological perspective, phytoliths from the rather ubiquitous Genus *Ensete* can complicate the attempted differentiation in many areas. The present contribution reports on the results of a morphometric study of the Musaceae phytoliths. It intends to determine 1) if the phytoliths of the different wild ancestor species could be differentiated; 2) if the domestication increase the size of the Musaceae phytoliths; 3) if the phytoliths from triploid bananas could be distinguished from those produced by diploids; 4) if phytoliths produced by the triploid bananas could be differentiated according to species and genome groups; 5) the effect of interspecific hybridization on phytolith morphometry. The results suggest that combining morphometric and historical analysis can help investigators make some inferences about the taxa producing banana phytoliths gathered in archaeological contexts.

Inputs and limitations of the phytoliths studies in soils, sediments and paleosols, in the Pampean region

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The geology of the Pampean plain is complex and its study has been approached by different disciplines for many years. The complexity of these studies resides in the geomorphic variability of the Pampean plain, the type of deposits that constitute it and the alternation of pure and reworked loessic sediments, sometimes affected by pedogenesis, among others. Moreover, the scarcity of reliable stratigraphic indicators makes it impossible to estimate large-scale correlations. In particular, the mineralogical studies of the Pampean plain show the predominance of light minerals and, among them, the high percentage of those constituted by amorphous silica of organic (phytoliths) and inorganic origin. The vegetation that predominated in this region during its evolution in the late Cenozoic was of the grass type, which is one of the major producers of silicophytoliths. Their study has contributed significantly to evolutionary and paleoenvironmental interpretations both in general and, specifically, of plains. In this talk, the results of phytolithic studies carried out in the area of the southeast of the Pampean plain will be presented.

Phytoliths - a potential tool to decipher major environmental issues

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Pollution is a direct or indirect change in the component of the biosphere having a harmful effect on the living components. Any substance causing pollution is referred as a 'pollutant'. A pollutant can be any solid, liquid or gaseous substance present in such a concentration, which may be harmful or injurious to the environment. 'Dust' is an example of air pollutant in solid form. Dust particles constitute a variety of micro materials out of which spores, pollens, microbes and phytoliths play an important role in environmental study. In social environment factors the medicinal value of these microfossils can prove to be good medicines in

Dermatology to treat various skin ailments occurring due to pollution or other factors. However pollen, spores and microbes are said to produce allergic responses like asthma, bronchitis etc. Study of phytoliths not only indicates the vegetation of a particular region but also acts as a pollution indicator. Biosphere is an important component of our ecosystem, for maintaining its equilibrium it necessary to understand the surrounding vegetation, fauna, the diet of living organisms etc. Thus an attempt is made here to study the basics of this science and investigate phytoliths with an environmental approach. Phytoliths are the natural mini Carbon sinks existing in the environment. These particles exist everywhere in the environment. They can be related to the pollution control studies because of their contribution in trapping Carbon. It can be used in edaphic studies as they can represent the soil element quality. This also helps in the field of agriculture by determining the soil quality and desirable plant growth as per the content. The role of Phytoliths in the Air and Soil Quality management is crucial. The present study focuses on the study of this science to expose the importance of these minute particles. This research can lead to a keen attitude in the field of research and development and decipher the major environmental issues.

Phytolith profiles in soils: speeds of formation and transformation

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It is necessary to distinguish formation and replacement processes of phytoliths profiles in soils. In the first case it means creation profile on the mineral substratum which has been not mentioned by processes of soil formation, for example, after intensive erosive processes or on large mineral deposits. In the second case it is a question of change of structure already generated in earlier phytolith profiles in connection with the changed conditions of the environment, factors of soil formation of natural or anthropogenic genesis. Research into the law of formation in phytolith profiles in series of young soils (2-20-40 years), generated at the bottom of career in the southern taiga European part of Russia was carried out. It is established that young specific phytolith profiles are fixed already in 2nd year of soil formation. Microbiomorphs (pollen, fungies and phytoliths) are marked at every depth of the generated profile without accumulation and the primary profile is created. The phytolith complex reflects the structure of modern vegetation. There is no accumulation of phytoliths for 40 years; they are equally distributed on all formed profiles. According of development of processes of soil formation, there is an accumulation of microbiomorphs in the top part of the profile and, as a rule, an accumulative type of primary profile is formed. Thus, formation of microbiomorphs profiles in mineral thickness consists of two stages. The first – the first 5-50 years – creation of a primary profile of homogeneous microparticles at aconsiderable depth (to 30cm). The second (40-100 years) – a concentration of particles in the top part of the profile and the creation of a well-expressed profile; as a rule, an accumulative type. For definition, the speed of the transformation process of components in the microbiomorphical profile two soils located in humid taiga zone on loams has been investigated. On the first site, there was a cutting down in the 40-50th years of the 20th century, which has grown deciduous and then coniferous trees. In the second area wood has been cut down 100 years ago and the soil develops since then under a meadow. Thus, there is a possibility to study two objects with a range of 50 to 100 years. For the first 40-50 years, in the top 4cm and for 100 years in the top 8cm of loamy soils there was practically full replacement of the structure phytolith complex. Below (5-7cm in 50 years and 8-17cm in 100 years) phytolith complexed have a mixed structure, further it is again homogeneous. Hence, 40-50 years are enough for a full change in phytolith complex in the top 4cm, and for 100 years thickness will be transformed at 8-10cm. It is possible to consider conditionally, that on loamy soils speed of process of transformation phytolith profile makes 1cm for 8-10 years. On sand the given process goes much faster. With depth speed and intensity of transformation initial phytolith complex decreases, which allows the early phytoliths to remain in bottom part of the phytolith profile. These features of process of transformation allow the reconstruction of the stages of landscape development.

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Mammals and biostratigraphy of the quaternary of the pampean region

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The periodic climatic alternation of glacial and interglacial epochs during the Pleistocene modified the distribution, composition and biomass of mammal communities in South America as in other regions of the world. The Pliocene to Recent continental faunistic sequence of the Pampean area of eastern Argentina gave the basic framework for

the South American chronological scale. Previously, the scale was based on a "Land mammal age" succesion, but recently a biostratigraphic scale was devised for tempting to sustain the time scale more precisely and improve temporal resolution. From the Pleistocene to the Holocene, four biostratigraphic units (biozones) were recognized. The *Mesotherium cristatum* and *Megatherium americanum* biozones provide the basis for the Ensenadan (early to middle Pleistocene) and Bonaerian (middle Pleistocene) Stages. The *Equus (Amerhippus) neogaeus* biozone is the basis of the Lujanian Stage (late Pleistocene to early Holocene), and the *Lagostomus maximus* biozone represent the biostratigraphic basis of the Platan Stage (early to late Holocene). An important faunal turnover is represented by the boundary between the *Mesotherium cristatum* and *Megatherium americanum* biozones. The *Equus (Amerhippus) neogaeus* biozone was defined by a much smaller faunal turnover. The deposition of sediments representing the Platan appear to have occurred after the mammal mass extinction in South America.

Phytoliths, phylogenies, and fossils: inferences in 'deep time' using plant silica

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Phytolith assemblage analysis has a long history of application in archaeobotany and Quaternary paleoecology. In contrast, phytoliths have traditionally been regarded as less informative for deep-time vegetation and climate inference. In recent years, this has started to change with the discovery of well-preserved plant silica assemblages going back at least to the Late Cretaceous in the Americas, Africa, and Eurasia. In particular, phytoliths have emerged as the most important source of direct, paleobotanical evidence for reconstructing the mid-late Cenozoic spread of grass-dominated habitats in areas where other plant fossils are scarce. Phytoliths have three characteristics that make them a unique, and in many cases superior, source of data for Cenozoic paleoecology. First, they remain preserved in well-oxidized sediments in which palynomorphs and macrofossils are rare, but where fossil mammals more commonly occur. As a result, plant silica assemblages help to fill in spatial and temporal gaps in the plant record and provide direct paleoecological links to faunal data. Second, phytolith assemblages often record spatial variation in vegetation structure (trees vs. grasses) more faithfully than, for example, palynolomorphs. Finally, unlike grass pollen, grass short cell phytoliths are highly diagnostic within Poaceae. When mapped onto the Poaceae phylogeny, they provide a sensitive tool for reconstructing grass taxonomic and ecological evolution. The great potential of phytolith analysis notwithstanding, more work is needed to make it part of the average paleobotanist's toolkit. Here, I will review recent advances in the field of deep-time phytolith analysis and identify avenues of future research to bridge the gap to other kinds of paleoecological inference.

Phytoliths in sequences with icnites in coastal BuenosAires, Argentina

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The sedimentary sequences carrying icnites or fósil traces of vertebrates are located on abrasion platforms in the supralitoral area of the beach. They stretch along 5 km parallel to the coastline between the seaside cities of Pehuén-Co and Balneario Monte Hermoso (latitude and longitude). The fossil footprints or icnites are numerous and were left by more than 20 different species of mammals and birds. The age of the site is 12, 000 ± 110 years, which places it within the Upper Pleistocene (Aramayo and Manera de Bianco, 1987,1996). The highest frequency of icnites is found in pelites and diamictites of continental origin. These deposits have been attributed to ephemeral fluvial accumulations by Zavala and Quattrocchio (2001) and described as belonging to a wide variety of facies ranging from cohesive debris –flow, to distal levels consisting of graded tabular beds made up of sand and clay strata. Phytolith content in the sequence with fossil footprints of mammals and birds reaches approximately 30%; if the phytoliths that have not been defined are also included they reach over 40% of the total of mineral components. Diatoms are rare (2%), present only in the bird icnite area. As regards morphotype diversity, a greater variety can be noticed in the sediments with bird fossil footprints, even though they have lower levels, especially of short-cell grass, among which the bilobates, panicoids, trapeziforms and elongate long cells stand out. The sequences with megamammal fossil footprints are rich in big phytoliths, such as elongates, bulliforms and unciforms. The contents, the diversity in the morphologies that were found, and the state of preservation of the phytoliths would signal the presence of moderate grass vegetation covers,

coincident with the moment when the footprints were left during the Upper Pleistocene in this area of the Pampean Plain.

Phytoliths in pedosedimentary sequences of the Late Quaternary, in Rio Tercero, Cordoba, Argentina

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The study area is located at the central part of the province of Córdoba (32º 05' to 31º 45' S; 64º10' to 63º30'W) in the Plains region, inside Tercero Arriba Department. It belongs to the Chacopampean Plain, and more precisely inside the Pampean Plain (Sayago, 1981). It is described as a depressed to undulated plain, involving Quaternary aeolian, fluvial and lacustrine materials. According to the Lands Classification System (Sayago,1982; Sanabria, 2000), Corralito barranco lies within Plataforma Basculada Association (Tilted Platform Association) (Capitanelli, 1979). Regarding climate, it is considered as mesothermal with a warm summer. Two seasonal cycles are clearly distinguishable during the hydrologic year: one for the summer, from October to March, and the other from April to September, corresponding to winter. During the summer cycle, rain average surpasses 82 mm/month, whereas during the autumn-winter one, it stays below 50 mm. The whole area is nowadays almost exclusively used for agriculture. The profile comprises about 115 ka, and because of the presence of both loess and paleosoils, many assumptions, concerning climate and environment may be made. The study of phytoliths has permitted the detection of a sequence of paleoedaphic levels from the mid-upper section of the sequence (1.6 m), which continues to its base (9 m). Some levels show a predominance of short-celled phytoliths—saddle, cross and panicoid bilobates—the majority of which indicate C4 grasses, possible indicators of meadows with a high proportion of graminea subfamilies: Chloridoideae and Panicoideae. Toward the base there are grass phytoliths of the subfamily pooideae, typical C3 grasses, with bilobate, rondel and trapeziform morphotypes. Both situations alternate throughout the length of this Late Quaternary sequence; moreover levels with very low levels of phytoliths are intercalated where pedogenesis was either incipient or inexistent with others affected by fluvial processes and reworkings of sediments, including the phytoliths.

Silica biomineralizations in holocene peatland environments, Tierra del Fuego, Argentina.

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The peatlands of Isla Grande de Tierra del Fuego (52-55º S), Argentina, have preserved peat sequences and clastic sediments of up to 11 m. They have been investigated for many palynological studies because they keep very important records of paleoenvironmental information since the Late Glacial (15-10 ka A.P.). In this paper, the first results of ongoing research are presented, aiming to evaluate the potential of Fuegian peatlands as reservoirs for silica biomineralization as indicators of paleoenvironmental conditions. Two sedimentary sequences were studied: 1) the Río Turbio minerotrophic mire, developed in a deltaic plain generated in the headlands of Lago Fagnano; and 2) stratified deposits along the fluvial banks of Arroyo Catalanes, north of Lago Fagnano. Firstly, samples were described by binocular magnifier. Due to differences in the materials, two different treatments were used. Phytoliths from Rio Turbio samples were extracted using the Labouriau's (1983) calcination technique and silica content was calculated based upon the differences of weights. Phytoliths from Arroyo Catalanes samples were extracted using Na politungstate (Madella *et al.*,1998). At least 200 phytoliths were counted and the percentage of diatoms, sponge spicules, Crysophyceae stomatocysts and phytoliths were calculated. Phytoliths were classified according to ICPN and phytolith morphotype percentage was calculated. Mesoscopic observation of the Río Turbio samples revelead that over 90% of the material is composed by vegetal remains (leaves, glumes, rootlets and unidentified material). The silica content values vary between 1 and 21%. Phytoliths represent the largest percentage (50-97%) of the biogenic silica fraction, except in two levels. Four levels contained sponge spicules (<2%). Stomatocysts percentages varied from 3.54 and 42.56, whereas diatom values ranged between 0 and 36.62%. Intermediate levels (1-1.3m) would have developed in the largest saturation conditions, probably in temporary ponds and small lakes formed by subsidence processes or changes in stream bed orientation. The dominant morphotypes are elongate phytoliths and grass phytoliths (rondels, bilobates and trapeziform crenate). In level 0.2-0.3m the largest percentage of

articulated phytoliths (7%), the largest percentage of elongate >30µm phytoliths and the absence of degraded elongate, would indicate that this level have evolved under important environmental stability conditions, which would have permitted the preservation of articulated and larger phytoliths. It also could indicate a fast establishment of different plant species. The mesoscopic study of the Arroyo Catalanes samples showed differences with Rio Turbio samples: only the AC4 level showed some plant remains (70%) consisting in leaves, rootlets and material strongly mineralized and/or unidentified. The phytolith content is low, between 4-5%, probably indicating that it was a poorly vegetated alluvial plain. The highest phytolith content (23%, AC4 level) would indicate a thicker plant cover which could be related to a modification in stream pattern. The dominant phytolith morphotypes are elongate <30µm phytoliths. Elongate >30µm phytoliths and prickles abundances increase with depth, meanwhile the unidentified phytoliths and trapeziform crenate decrease. The latter ones are associated to Poaceae, subfamily Pooideae, and are very abundant in the AC2F sample. This would reflect a thicker plant cover, consequence of a modification in stream pattern or disminution of environmental moisture, or stream recession.

Phytolith and pollen analysis of camelids coprolites from CerroCasa de Piedra 7 (ccp7) archaeological site, province of Santa Cruz, Argentina

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Cerro Casa de Piedra is a hill of volcanic origin in the river basin of Río Roble, and Burmeister Lake, 900m above sea level, with a temperate cool and semiarid climate. The site is in an ecotone located between a forest of *Nothofagus* sp. and a shrub steppe (Civalero and Aschero, 2003). It has a stratigraphic sequence that includes 19 levels, with human occupation between *ca*. 9,700 and *ca*. 3,400 yrs. (Civalero and Franco, 2003). The site could have been a gathering point for human microbands in the summer, when camelids availability of the highest fat level are present (Aschero, 1996). Before 9000 yr BP, vegetation at CCP7 could have been dominated by a grass steppe, with humid and cooler conditions than the current ones. After 9000 yr BP, the important grasses diminished; and the increase in *Nothofagus*, shrubs and herbs suggest the forest-steppe ecotone establishment until *ca*. 3500 yr BP (Mancini, 2005). The aim of this work is to present the preliminary results about phytolith and pollen analysis of camelids coprolites from Cerro Casa de Piedra 7 (CCP7) (Parque Nacional Perito Moreno, province of Santa Cruz). We worked with coprolites recovered in four archaeological layers, associated with the following radiocarbon dating (^{14}C): 1) layer 17: 9640±190 yr BP; 2) layer 14: 8460±400 yr BP; 3) layer 11: 7880±150 yr BP; 4) layer 7: 5610±110 yr BP. Of each coprolite, external and internal parts were separated. For the phytolith analysis, both portions were treated with 30% hydrogen peroxide at 70°C in order to oxidize the organic material. Phytoliths and pieces of amorphous silica (<7,5µm) were discriminated, and about 250–300 phytoliths were counted. Pollen analysis was done in coprolites of the 17, 14 and 7 layers. In both portions of each coprolite, pollen was extracted with an acetolithic mixture (9 parts of $(CH_3CO)_2O$ and 1 part of SO_4H_2), and counted under an optical microscope. Pieces of amorphous silica content increase from more modern (15,8%) to ancient (25,1%) coprolites, suggesting the importance of taphonomical processes on phytolith conservation. In general, the predominant isolated phytoliths correspond to Poaceae morphotypes: 1) Rectangle (20-35%), 2) Rondel (16-24%), and 3) Elongate psilate (2-8%). In the more modern coprolites, the predominant articulated phytoliths are composed of epidermal polygonal phytoliths and hair cells that could be attributable to dycotiledons; instead, in the ancient coprolites, the predominant articulated phytoliths are composed of Poaceae elongated cells; according to Mancini (2005) vegetation changes description for the study area. Pollen analysis show more abundance of *Empetrum* taxa (dycotiledon) in the ancient coprolites; while in the more modern coprolites, the representative taxa are Caryophyllaceae, Asteraceae and *Nothofagus* (all dycotiledons) and Poaceae (monocotyldedons). On camelid coprolites of the same excavation, paleoparasitological analysis were carried out (Fugassa, 2006; Taglioretti, 2008; Fugassa et al., 2008); and some studies of vegetal rest recognition are being carried out (Yagueddú y Arriaga, 2008). The interdisciplinary coprolites study, based on different indicators, will allow us to adjust the results and build interpretations of the past environmental conditions in the study area.

Environmental significance of phytoliths and soil organic matter in a hyper-developed umbric epipedon of an oxisol

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The reconstruction of paleoenvironmental conditions which contributed to the definition of pedogenetic processes, organic matter input and stabilization in a very thick (> 1m) umbric epipedon of a Humic Hapludox profile from Minas Gerais State (Brazil), was performed through phytolith assemblage analysis. Many plants deposit part of the soluble silica absorbed from the soil as monosilicic acid (H_4SiO_4) in and between their cells, generating opaline silica ($SiO_2 \cdot nH_20$) bodies called phytoliths. Although phytoliths are susceptible to dissolution under extreme environmental conditions (e.g. very high pH), they tend to remain in the soil for long periods of time under normal conditions, and they can help in the reconstruction of past landscapes and climates. The results based on the phytolith assemblages from the soil were compared to carbon data (C-total, C-organic and $\delta^{13}C$) of the same profile. The principal component analysis and the agglomerative hierarchical algorithm aplied to the phytolith frequencies discriminate three phytolith clusters from bottom to top of umbric epipedon: Zone 3 (110-50 cm, from ca. 4000 to 2000 BP): the assemblage is dominated by Poaceae morphotypes with low frequency of the Dicotyledon globular rugose and palms globular echinate morphotypes. The climatic/vegetation indices show some variability: D/P values range between 0.02 and 0.12 (average of 0.06); Iph between 45.2 % and 92.5%; Ic values between 42.0 and 73.2. Zone 2 (50-10 cm, from ca. 2000 BP to ca. 160 BP): this zone is characterized by an increase in palms and araucaria phytoliths. The values of the indices for this zone are: D/P ratio constantly <1; Iph between 18.8% and 51.3%; Ic between 49.2 and 67.4. Zone 1 (10-0 cm, ca. 160 BP to present): The phytolith assemblage of this zone represents the current vegetation; it has an increase in Panicoideae grasses (C_4) and the presence of Pooid (C_3). This zone has the highest values of globular smooth and rugose morphotypes produced by woody dicotyledons. The D/P ratio is 0.16; the Ic ratio is 60.70; the Iph ratio is 0. The genesis of the organic matter took place predominantly under a forest of C_3 plants during the Late Holocene (ca. 4000 years BP). The phytolith analysis complemented the $\delta^{13}C$ results making apparent some variation in Holocene humidity, supported also by the presence of diatoms and spores of ferns and/or fern trees, and similarly to the results presented by Alexandre et al (1999) in the Salitre region (Brazil). The phytolith analysis indicates some variation in humidity. These humidity oscillations are in synchrony with those identified throughout the Holocene by Vernet et al. (1994), Behling (1995), Pessenda et al. (1996; 1998; 2005) and Scheel-Ybert et al. (2003). It is clear that there is the need to refine the indexes through the study of modern phytolith assemblages from South American tropics to be able to calibrate their values to the local characteristics of topography, temperature and humidity, and their related vegetation structures.

Effects of grazing on temperate grasslands: opal phytoliths evidence and relevance for palaeoclimatic reconstructions

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About 87% of the Uruguayan territory is occupied by natural grasslands, which represent the basis of the national agro-economic development. These grass-dominated ecosystems form – with the Pampas in Argentina and the Campos in southern Brazil – the Rio de la Plata grasslands, one of the largest natural temperate and subhumid grasslands of the world. The present structure and function of these grasslands derive from the interaction between regional climate, soil properties and the disturbance regime (grazing, fire, exotics species invasions), that was drastically altered by European's settlements 500 years ago. Previous work in paired grazed and ungrazed fenced plots (where livestock was excluded for periods of 4 to 30 years), showed that grazing removal induces changes in community structure, ecosystem functioning and productivity of Uruguayan grasslands. Among other effects, grazing promoted increases in plant diversity and the replacement of cool-season tussock grasses by warm-season prostrate grasses. Using a similar approach, we sampled soils up to one meter depth in five pairs of grazed and ungrazed plots in Uruguay and Argentina. At these sites livestock was excluded from the ungrazed plots for the last 10 to 30 years.

Our objectives were: 1) to test the sensibility of phytolith analyses to evaluate changes in plant species composition occurred after grazing removal in decadal timescales, 2) to describe potential changes in plant species assemblages occurred after livestock introduction 5 centuries ago and 3) to obtain a pre-disturbance grassland record that is climatically adjustable. At all sites, C_3 grass phytoliths contents were graeter in the topsoil (first 5 cm) of ungrazed plots compared to the grazed plots, mirroring observed increases in C_3 grasses at ungrazed plots. Below 5 cm depth, phytolith assemblages were similar between each grazed and ungrazed paired plots, thus revealing a homogeneous pre-exclosure species composition. Soil samples from 5 to 30 cm depth revealed that C_3 grasses decreased and C_4 grasses increased during the last period of time (C_3 grass phytoliths increased from 5 to 30 cm depth), while soil samples from 30 to 100 cm depth show a stable species composition across time at each site. A ^{14}C analysis of a soil sample obtain from 30 to 50 cm was dated in ~2500 yr. These results suggest that species composition where relatively constant during soil formation and that livestock introduction 500 years ago could have decreased C_3 grasses (and increased C4 grasses). In agreement, grazing showed the same effect on community composition in short-term periods (5 to 30 years) at grazed – ungrazed plots. Finally, phytolith assemblages from the topsoil profiles (0-5 cm) of ungrazed sites were related with meteorological and geographical variables. A linear correlation between C_3/C_4 phytoliths and temperature was established, and implications for paleoenvironmental reconstruction are discussed.

Phytolithic composition of the Tezanos Pinto Formation (Late Pleistocene loess) at the Southwest of the Entre Ríos province, Argentina

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The Tezanos Pinto Formation (Last Glacial Maximum in age) appears as a continuous mantle in the Southwest of Entre Ríos province (14.000 km²; North Pampa) forming the Crespo Loessic Hills Geomorphological Unit. This unit forms the northeastern border of the Peripherical Loessic Belt of the Pampean Aeolian System, defined by Iriondo and Kröhling in 1996. The Quaternary stratigraphic sequence of the study area comprises two defined cycles of aeolian deposition. The Tezanos Pinto Fm corresponds to the most recent cycle, accumulated during the Oxygen Isotopic Stage 2 (OIS 2), in a range spanning from 36,000 to 8,500 years BP. The aeolian facies of the unit formed by primary loess is dominant in the area, with an areal thickness ranging between 2 - 5 meters. It corresponds to a friable and permeable brown (7.5 YR 5/4) massive deposit, with prevalence of silt (63-4 μm; 60,7-80,3%), with subordinate clay and scarce very fine sand, that forms vertical cliffs. In order to investigate its phytolith composition, representative profiles from the Southwestern Entre Ríos province, were relevated by continuous sampling (equidistant points 10 cm) following a NW-SE transect. Samples were processed according to the methodology of Zucol and Osterrieth (2002). The studied profiles of the Tezanos Pinto Fm showed high abundance of phytolith, with dominance of prismatic, globular and truncated cone morphotypes. The flattened prismatic morphotypes, with side edges smooth (the most frequent type), scalloped, serrated or wavy, mainly with graminoid affinities, were associated with others of probable cyperoid affinities. Other phytoliths with graminoid affinities, such truncated cones, mainly of arundinoid or more rarely pooid type were also present. Less frequent forms included phytoliths originated by prickles or trichomes, symmetrical or asymmetrical fan-shaped, saddle forms of chloridoid affinity, polyhedral and bilobate or dumbbell-shaped with panicoid affinity. The assemblage also includes abundant sponge spicules, primarily smooth macroscleres from freshwater sponges, as well as stomatocysts from Chrysostomataceae, and in lower proportions, different types of diatoms. No compositional changes were observed along the sampled sequence. The paleocommunity would have been formed by gramineans (primarily arundinoid types, arid warm climates, and pooid, and to lesser extent chloridoid and panicoid) with associated palm trees and sedges. The presence of freshwater sponge spicules with scarce degree of alteration, joined with the occurrence of diatoms, indicate the existence of water bodies. The low percentage of cyperacean phytoliths and chrysostomatacean cysts indicates scarcity of lentic water bodies. This scenario agrees with geological interpretations that indicate arid conditions for the first cycle (36–16 ka), and semiarid characteristics for the second cycle (14-8.5 ka) of depositation of this formation in the province of Santa Fe.

Preliminary studies on phytolith content in the Toropí Formation (Upper Pleistocene), Corrientes, Argentina

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The Toropí stream flows into the Paraná River 10km. south of the city of Bella Vista (Dep. Bella Vista), in the province of Corrientes Argentina, 28° 36´ S and 59° 02´ W. In this province, the Upper Pleistocene is represented by two juxtaposed fossiliferous lithostratigraphic units, corresponding to the Toropí and Yupoí formations. Recent OSL datings indicate that both formations belong in the Upper Pleistocene (ca 58 ka and 28 ka BP respectively). Lithologically, the Toropí formation consists of clay sands, sandy lime mud and, in part, sandy clay, whereas the Yupoí formation has a higher content of fine sands and a lower content of clays. From an environmental point of view, these units include floodplain deposits. The evidence suggests that present day Mesopotamia used to have its own paleobiogeographic identity. This situation continued until the Upper Pleistocene since the paleozoological, paleobotanical, palynological and sedimentological evidence indicates that this area had probably developed environmental climatic processes in general more humid and warmer than those estimated for the Pampean region and the central-northern area of Argentina.This is the first approach to the analysis and interpretation of the phytoliths contained in the sediments of these two formations. In the five samples analyzed, the inorganic mineral components always exceed 50%, the highest levels being in N4 (Toropí roof) and N3 (Yupoí base), whereas the highest levels of phytholites (around 20%) appear in N5 and N2 (Toropí base in the profile analyzed and the middle section of Yupoí). These levels are also very similar in texture, with a predominance of fine materials, very fine clays and lime muds, and they show the highest levels of diatoms, especially N5 with 8%. The intermediate levels (N3·, N1 and N4) have thicker textures where the middle and fine sands predominate, but they have lower amounts of phytoliths and diatoms. Based on the general characterization of the different components of each sample analyzed in the sequence, N2 and N5 would correspond to an environment with less energy, where the fine particles, which allow a higher expression of diatom communities and a better development of vegetation cover, are concentrated. These levels would evolve under conditions of less environmental humidity and more evapotranspiration, coinciding with the presence of bilobate and cross type phytoliths (typical C4 grasses) whose evolution requires conditions of higher hydric stress, salinity and insolation. In general, the morphotypes observed in all the levels correspond to bilobate, rondel and flat elongate. In N1, N3·and N4, where the mineralogy is higher granulometrically, big-sized elongates, bulliforms and aciculars, probably due to non-grass vegetation, were also observed.The succession of these environments coincides with previous speculations based on the study of vertebrates which aimed at explaining the presence of different adaptative types in temporal synthesis.

Holocene changes in tree cover density at Cabo Frio (Rio de Janeiro, Brazil) inferred from soil phytolith assemblages.

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The region of Cabo Frio, Rio de Janeiro, Brazil (22°30'–23°00'S; 41°52'– 42°42'W, 0-500m altitude), is considered as a phytogeographical enclave. Its local climate is affected by the presence of a coastal upwelling. The local xeromorphic forests (with "caatinga" physiognomy) are characterized by abundance of Cactaceae, Bromeliaceae and thick-stemmed plants. They are surrounded by regional humid forests. Although sediments from the Cabo Frio coastal lagoons have revealed Quaternary marine transgression/regression phases and changes in the upwelling intensity, the lack of continental sedimentary depositions has precluded vegetation reconstructions. Thus Holocene history of the xeromorphic forests at Cabo Frio is still to be reconstructed. This study aims to identify Holocene vegetation changes at Cabo Frio through the morphological study of phytolith assemblages extracted from four weathering profiles developed at the expense of gneisses. Samples were subject to soil analyses (Embrapa-solos, Rio de Janeiro, Brazil), organic matter $\delta^{13}C$ and $\delta^{15}N$ analyses (Cena, São Paulo, Brazil), and lignin analyses (UFF, Niterói, Brazil). Phytolith abundance and phytolith weathering degree were quantified.

For each assemblage, more than 200 phytoliths with taxonomic significance were counted under microscope (CEREGE, Aix en Provence, France). Phytolith indices such as D/P and Pa/P, respectively indicators of tree cover density and palm cover density were calculated. Fossil phytolith assemblages were interpreted by comparison with modern phytolith assemblages collected from humic horizons developed under different vegetation types encountered in the Cabo Frio area (xeromorphic forest, moist forest, Cactaceae-dominant vegetation and marshy vegetation). A few SOM (soil organic matter) samples were analyzed in ^{14}C by AMS (UCI, Irvine, USA). Assuming that, at the bottom of the soil profiles oldest SOM and oldest phytoliths dominate and have close mean ages, this helps to constrain the chronology of the phytolith records. Field investigation highlighted that the four weathering profiles were subject to an erosion/deposition phase. Thus the soil phytolith assemblages may record autochthonous and allochthonous vegetation, presently similar. BC horizon at the bottom of the oldest weathering profile (P1), presently developed under the xeromorphic forest, gives a mean age of SOM of 13ka BP (cal. ^{14}C age). Higher in the soil profile, a mixed horizon gathering SOM from buried and deposited A horizons as well as SOM from the more recent soil development, gives a mean age of 4.5ka BP (cal. ^{14}C age). Thus the erosion phase occurred between 13ka BP and 4.5ka BP. The current xeromorphic forest and moist forest give D/P values of 0.4-0.5 and 1.9, respectively. D/P values obtained along the oldest soil profile P1 are always lower than 0.7 suggesting that since cal. 13ka local and regional vegetations never reached the moist forest state. In the BC horizon (13ka), D/P value (0.3) is lower than the modern one (0.5). Below and above the mixed horizon D/P values are both higher (0.6) than the modern. D/P values decrease above, towards the modern value. Assuming that, on the studied slope (current elevation of 70m.a.s.l.), vegetation was always similar, the phytolith record evidences that before ca.13ka BP, the vegetation was less woody than today. The tree cover density increased later on and reached a value higher than the modern one, before the erosion phase (<4.5ka). After the erosion phase, phytolith assemblages record a tree cover lower than or close to the modern one. This record will be discussed by comparison with coastal and marine reconstructions of the upwelling intensity. Although this record is limited by its very low time resolution and by the lack of a constrained chronology, inherent to reconstructions from soils, it gives a unique clue on the Holocene history of the xeromorphic forests at Cabo Frio.

Grassland dynamics, sea level change and climatic change in southeast Uruguay: contributions of phytolith analyses in sedimentary cores from coastal lagoons

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The Río de la Plata grasslands are the most extensive biogeographic units of the prairie biome in South America, occupying more than 700,000 km^2 distributed across eastern Argentina, Uruguay and southern Brazil. The ecophysiology and biogeography of grass species are determined largely by their photosynthetic pathway, related to CO_2 conditions and to spatial patterns of temperature and precipitation. As a consequence, the present rapid climatic and atmospheric changes, will most likely affect the structure and functioning of future grasslands. In order to generate an empirical basis for interpreting and modeling the responses of grass-dominated ecosystems to future global changes, fossil records are explored to reconstruct the response of ancient grassland to paleoclimatic changes. In this sense, opal phytolith analyses in sedimentary cores from coastal lagoons of southeast Uruguay have provided the basis to generate a local model of Late Pleistocene and Holocene climatic change. The opal phytolith assemblages recovered from nine cores of six lagoons (Laguna Negra, de Castillos, de Rocha, Blanca, del Diario y del Sauce), suggest the existence of five main climatic events for the last 15.000 years. During Last Pleistocene and Early Holocene (~15.000 to ~8.000 yr B.P) a cool-semiarid climate with prevalence of winter precipitations occurred. *Circa* 7.500 yr B.P, a warmer-wetter climate was established, and persisted until around 5.000 yr BP. Throughout Middle Holocene (5.000 to 3.000 yr BP) grass phytoliths indicate a lower temperature and humidity levels, or at least, precipitations highly centered within winter season. Finally, Late Holocene (2.500 yr BP. to the present) was characterized by the onset of higher humidity and temperature levels. This paleoclimatic record was correlated with local sea level models and evidence of volcanic eruption (i.e tephra deposits), with the aim of generating a more comprehensive model for Holocene paleoenvironmental changes in southern Uruguay. The first (~7000 - ~5000 yr BP) and higher (5 m amsl) Holocene marine transgression took place under warmer and more humid conditions. This period, known as the *Hypsithermal,* was a global event that was characterized by the melting of glaciers. Therefore , an increase in sea level took place. The first Holocene regressive

phase (~4500 - ~ 3000 y.B.P), when sea level was slightly below present level, was accompanied by a climatic deterioration, with alternate periods of glacier re-advancements in the southern Andes. In samples of all cores with a good middle Holocene record, volcanic tephras were registered with chronologies between 4800 – 4000 yr BP. Andean volcanic eruptions could reinforce, on a regional scale, the climatic deterioration caused by glacier re-advancements. The last 2000 yr were characterized by a progressive stabilization of both sea level and climate, until reaching the present conditions.

Phytoliths as environmental indicators: A study case from the great rift valley, ethiopia

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In this paper the results of phytolith analysis on 20 samples of modern soils from different sites from the Great Rift Valley, Ethiopia are presented. The sites are located in the Lakes sub-region in the central uplands of Ethiopia, at an altitude over 1,000 m above sea level. The vegetation surrounding the sites is mainly represented by upland grassland and savanna. The different sites will be compared and assessed in terms of their importance as environmental and paleoenvironmental indicators. Moreover, this research will be put into the broader context of a wider archaeological and palaeoenvironmental study of the area. Results for the Phytolith Index, Tree cover Density Index and Climatic Index values are discussed and the data analyzed statistically. The results are compared with the research of Barboni et al. (1999) carried out in the Middle Awash Valley. In the present research, it emerged that the phytolith assemblages from these sites differ slightly from what was expected by the analysis of modern vegetation. We present a hypothesis for this variation and discuss the potential problems for using modern assemblages as an interpretation tool for archaeological samples.

First survey of airborne phytoliths in Mar del Plata (Argentina)

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A first analysis of airborne phytoliths was carried out in Mar del Plata (38º03'S, 57º33'W), Argentina. The primary aim was to characterize the phytolith morphotypes present in the atmosphere, to quantify their abundance and to detect if exists a seasonal variation exists throughout the year. The final goal was to evaluate the plant-opal transport by current air and so to contribute to interpret the origin of particles deposited into sediments. For the analysis, year 1993 was selected because of its driest characteristics in relation to mean rainfall values from the previous 30-years (difference of 100mm); temperature was also on average 0.6ºC colder than the mean values previously registered. These climatic conditions could favour the presence of these biomineralizations in the air. We have analized the seasonal conditions of climate and the changes in land use as possible factor influencing the type and abundance of airborne phytoliths throughout the year. The standard method for monitoring airborne particulate matter implies the use of Hirst-type suction bioaerosol samplers based on the impact principle. In this work, a Burkard 7-day recording volumetric trap was used. The sampler was placed 15m high on the Universidad Nacional de Mar del Plata building. The trap operates continuously with a flow rate of 10 liters/min, ensuring the provision of both hourly and daily data. Airborne particles were deposited onto Melinex tape coated with an adhesive substance. After exposure, the tape was cut into daily (48 mm) segments. The tape was adhered to a microscope slide with a 10% Gelvatol solution and a few drops of glycerin jelly stained with basic fuchsin. The counting method involved a subsampling unit, consisting of three longitudinal transverse under a magnification of 400x, that upon conversion represents the average concentration of particles during the 24 hour period (p/m^3). Wind speed data were obtained from our local meterological station located next to the sampler, and rainfall data were provided by Meteorological National Service located at the local airport. We selected the windiest days belonging to May and November (high accumulated rainfall values), February and April (low values), and October (intermediate values). Considering eight days of survey, the concentration of phytoliths in the air was of 1543 p/m^3; it was composed by 61% of isolated and 1% of articulated types, the rest were unknown or unidentified phytoliths (38%). This high percentage is in part attributable to the mounting media and to the fact that the material was fixed. Most abundant morphotypes were elongate psilate with 634 p/m^3, followed by rondels with 153 p/m^3. A significative and negative correlation was found between wind speed and phytoliths (Spearman non-parametric coefficient r_s=-0.714; p=0.0465). These preliminary results showed a relation between phytoliths and the agricultural practices of the area. Months with

higher phytolith concentrations coincided with the period where soils are without plant cover due to agricultural management. These practices include burnings of pastures, which occur in the east-northeast area, and blowing of typical crops, common in north and west-southwest area of Mar del Plata.

Phytoliths in a pedosedimentary sequence in a small basin in the subtropical province of Misiones, Argentina

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The Province of Misiones is located in northeastern Argentina. The climate is subtropical humid; the mean annual temperature is around 20°C and the mean annual rainfall around 1850 mm. The ¨preserved central plateau¨ geomorphological unit extends in its central part with an undulated relief developed on faulted basalt rocks. Deep red soils, mainly Ultisols, with a solum thickness about 3 to 7 m above the weathered basalt, cover the unit. The present vegetation is a subtropical forest. In the lower part of the landscape at the foot of the slopes, the soils are quite different. They have sedimentary and hydromorphic features, and from a taxonomic point of view they are classified as Mollisols, Alfisols and Inceptisols. The vegetation in these low lying areas is characterized by grasses. Several recent works on red soils as well as on hydromorphic soils (v.g. Morrás et al., 2008; Morrás and Moretti, 2008; Zech et al., 2008) indicate paleoecological fluctuations in Misiones related to climatic changes during the younger Quaternary. Particularly, multi-proxy studies carried out on a soil-sediment sequence sampled in a weakly flooded small basin located northeast of Oberá city (site D4) indicate several climatic fluctuations from MIS 3 to the Holocene (Zech et al., 2008). In this work phytolithic analyses were carried out on samples from the same D4 soil-sediment sequence, with the aim of providing new data to reconstruct the climate and vegetation history in Misiones. Phytolith content for the whole sample shows contrasting values. In the superior horizons of the present soil there is a high content of phytoliths; more than 90% of the sample consists of silicophytoliths, which would imply the development of histic horizons during most of the Holocene (Stratigraphic unit, SU, A). In the middle section of the Stratigraphic unit, (SU)B, a substantial decrease in the level of phytoliths (12%) in the total mineralogy can be observed. Underlying the middle section and within the same unit, the content of phytoliths doubles (25%); in addition, from here on one can find diatoms which increase until the 2.5m. This increase in the presence of phytoliths and diatoms would allow us to infer the presence of a paleosoil that would have evolved under conditions of saturation and high environmental humidity. In the transition of the SU, B/C and the SUC roof to a depth of 3 m. the content of phytoliths increases again (45%); this would indicate the presence of another paleosoil developed under conditions of less saturation and better pedological conditions; which could sustain a thicker vegetation cover. At the base of the sequence, phytolith content is low. It reaches barely 10% of the total mineralogy.The greatest diversity of morphotypes appears in the present soil, with predominance of bilobate short cells, among which there is a great amount of C4 type bilobate panicoids. Within the same affinity, the saddle and cross type, choridoid morphotypes are abundant, in addition to elongate smooths, bulliform cells, cuneiforms, paralellepipedals, unciforms, hair base and numerous cylindrical sulcated tracheids of different sizes, those of big size being quite common. Several of these forms could be attributed not only to grasses, but also to dicotyledons. Articulated phytoliths are common as indicators of stability. The ratio of altered phytoliths is also high in several horizons, possibly in relation with the alkalis detected in previous studies. There is a close relation between less diversity and less pedogenesis. The presence of carbons and especially of oxidized minerals is noticeable in the SUB as well as abundant carbons in the unit C, which would be possibly related to fires. To sum up, the phytoliths and other silica biomorphs indicate continuous growth of vegetation with the predominance of phytoliths in the inorganic fraction of the first 50 cm. of the profile. Two levels rich in phytoliths follow, which would correspond to paleoedaphic levels developed under different conditions of saturation and environmental humidity from the Late Pleistocene to the transition with the Holocene. This vegetation cover would be represented by varied communities of grasses, panicoids, pooideas and choridoids, as well as dicotyledons.

Phytolith analysis as an approach to understand the genesis of soils in the SW of the province of Entre Ríos (Argentina).

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In the southwest of the province of Entre Ríos (Argentina), most of the well-developed soils are originated from eolian Quaternary deposits, which are known in the region as the Tezanos Pinto Formation. These soils were developed under

herbaceous vegetation and a large part of this area has been replaced by agricultural practices and also by human settlement. Although at present several pedological studies have been carried out on these productive soils, their siliceous microremains are scarcely known, principally in reference to their distribution and origin. In the present contribution, the presence and distribution of siliceous microremains in characteristic soil types of the Diamante Department (La Curtiembre soil-series) are analysed. These soils are aquic Argiudols, characterized by dark brown colours in the superficial horizon, silty clay loam texture, good structure (granular and in block), good provision of organic matter and easiness to work (Plan Mapa de Suelos, INTA, 1991). Two representative profiles were selected from this experience: 2m thick "Cantera Pre-delta" (32° 06´29.4´´S and 60° 37´54.6´´ W), and 1.5m thick "Curva Strobel" (32° 03´32´´S and 60° 36´50.1´´W). Both profiles -with an A horizon (30cm of average thickness), B horizon (40cm of average thickness) and C horizon (105cm of average thickness) - are characterized by silty clay loam or silty loam texture, and granular, in block and mass structures of the dependent type horizon. The phytolith extraction was made following Zucol and Osterrieth's (2002) methodology that comprises the elimination of soluble salts, the remission of carbonates and organic matter and the desegregation with sodium hexametaphosphate (0.1 N). Size separation was made in three fractions: the fine fraction (- 5 μm), the middle fraction (5-250 μm) and the coarse fractions (+ 250 μm). The middle fraction was used for densimetric separation with sodium polytungstate solution (2.3 g/cm^3). The counting was made in a sample of 400 phytoliths per slide and each phytolith was assigned to a particular morphotype based on the classification and descriptors developed by Twiss et al. (1969), Bertoldi de Pomar (1971), Twiss (1992), Zucol (1996) and ICPNWG (2005). The information was analysed by multivariate numerical analysis to describe phytolith assemblage variations across each profile. The results show that the phytolith assemblages are dominated by graminoid phytoliths, associated in less abundance with ciperoid and arecoid ones and scarce stomatocysts, spicules and diatoms. The graminoid types are characterized by the presence of prismatic elongated phytoliths with smooth or undulated contour, fan-shaped and polyhedrical phytoliths, among the biggest components in size. Among the smallest phytoliths in size, bilobate and saddle types are present, especially in the upper and lower samples; although in the middle levels, roundel or truncated cones are more abundant. Echinate globular phytoliths are present with scarce variations across the studied profiles. The quantitative analysis of type abundances allows to interpret the presence of three phytolith sources in soil profiles. The first one is the parental material, the Tezanos Pinto Formation, principally abundant in the lower levels of the profiles. The second one originated in a paleocommunity that was present in early stages of the soils' development, represented in the middle samples of the profiles that clearly show evidence of material mobility along each profile. The third one is the phytolith assemblage of the upper levels, with a composition mainly linked to the current vegetation. These analyses demonstrate that these soils developed in a mixed community in association with the grassland dominated by panicoid and arundinoid affinities, jointly with palms.

Building a soil-phytolith reference base – study of modern soil profiles in different landscape zones of Hungary (methods and first results)

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Complex palaeoecological surveys carried out earlier in Hungary showed that phytolith analysis of buried soil profiles from the Bronze Ages are at least as important and inevitable as other palaeoethnobotanical approaches. In many cases vegetational reconstruction of landscapes evolved under dry environmental conditions were only achievable with the use of anorganic microremains, as organic plant residues were not detectable. Besides realising the importance of phytolith analysis, we recognised the necessity of a reference database in order to compare both findings of these studies. The main idea was to examine quantitative and qualitative phytolith characteristics of recent soils developed in different landscape zones, and to survey soil types under dissimilar land use. In this sense, the main selection criteria was soil type. The study was designed on the basis of the Hungarian soil classification system. Important and abudant soil types were selected. In each case we tried to examine profiles developed under their potential vegetation (e.g. forest vegetation, steppe etc.) and profiles from the same type influenced by human activity (plough-lands, grazing fields etc.)
The aim of this ongoing study is multifarious:

- first, to create the basis for a well-developed future soil-phytolith reference base applied for the Carpathian Basin by identifying quantitative and qualitative properties of phytolith assemblages in various soil types,

- secondly, to interpret human activity in different soil types with the analyses of phytolith distributions, and most importantly
- to create a useful database for comparative archaeological and palaeoecological studies.

So far, 15 profiles have been examined. Profiles include lowland and plain territory soils, water-affected hydromorphic soils, brown forest soils and mountain soils. In all cases basic pedological laboratory analyses were performed including pH (both H_2O and KCl), TOC, humus%, $CaCO_3$%, total salt content, mechanical analysis. Phytolith preparation was accomplished with the common separation method using H_2O_2 digestion, gravity sedimentation and heavy liquid centrifugation. For the identification of plant opal particles ICPN and a classification system developed earlier in Russia was adapted and used. The results consist of a descriptional part. Not only various phytolith morphotypes, but total plant opal content and distribution of the soil profile are demonstrated on graphs. Keysigns of human-induced soil profiles (e.g. effect of ploughing in the mixing of particles along a vertical structure) were identified and grouped by soil type. One of the most interesting results were achieved in a case study of a well-developed Luvisol from the Bakony Mountains. The profile provided good opportunity to understand how complex the *'life of a soil'* may be, and how all important information is archived within one profile in the form of microscopic, silica-built particles.

Comparative phytolith and palaeopedological study of Hungarian burial mounds from the Metal Ages

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Kurgans are special human-made flatland formations of the endless steppes of Eurasia. For centuries, archaeology has been the primary science to examine these objects. Nowadays border~, guard~, living~ (tells) and burial mounds proved to be of great value both for nature and environmental science. Besides the fact that kurgans are bearers of notable botanical, zoological, pedological and geomorphological values, they represent unique aesthetical and culture historical significance of the Great Hungarian Plain landscape. The buried soil profiles under Metal Age burial mounds are the messengers of ancient landscape forming factors and soil generation processes. The aim of the research is to elucidate the construction of mound-bodies, to describe modern soil development, to analyse the buried soil under the formations and to reconstruct the ancient, palaeoenvironment. In this sense we have utilized palaeopedological methods and phytolith analysis as a palaeoethnobotanical approach. Almost a dozen of burial mounds, from several points of the Great Hungarian Plain were involved in the study. Four of them were examined in precise details, either by coring the structure or excavating the burial. Radiocarbon dating of the buried soil profiles and cultural layers were done. In all cases basic pedological laboratory analyses were performed including pH (both H_2O and KCl), TOC, humus%, $CaCO_3$%, total salt content, mechanical analysis. Phytolith preparation was accomplished with the common separation method using H_2O_2 digestion, gravity sedimentation and heavy liquid centrifugation. For the identification of plant opal particles ICPN and a classification system developed earlier in Russia was adapted and used. Data gained from these studies were used to establish a scenario of the Holocene vegetational development of the lowlands of the Carpathian Basin. In this sense we have pointwise data from different Ages and different locations of the basin. Geomorphological and climatical development of basins usually differ from open areas of the same climatic belt. Therefore burial mounds from Russian steppe landscape zones were involved in the study to have control profiles. This comparison allows us to improve our knowledge on the differences in landscape and vegetation evolution in a basin, like the Carpathian.

Coprolite study: food habit, seasonality and reconstruction of palaeoenvironment

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The study of human behavior would be incomplete without the reconstruction of man's environment and the mutual interaction of man and his environment and the tangible record of that interaction. A couple of such tangible records in the form of coprolite have been derived from the habitational area of an early historical site, Kapasi kalan, Koraon sub-division, Allahabad district, India ranging from 200 AD to 400 AD. The study of phytoliths and other plant and animal materials present in the coprolite revealed interesting information regarding food habit of the animal, plausible season and vegetation pattern around the

site. The coprolite contains phytoliths of both wild and cultivated rice, *Dicanthium*, *Cynodon, Pennisetum, Setaria,* bamboos. Besides phytoliths it also consist of druses, hairs, epidermal cells, pollen grains, seed coats, diatoms and *Trichonympha* types of worms and cysts. It seems that the animal population would have been herbivorous and mainly grass eating, most likely *Boselaphus tragocamelus (Nilgai);* the season of the year would have been similar to the present months of June-July in this part of India and grassland ecosystem.

Diagnostic phytolith evidence for the presence and abundance of wild rice (*Zizania* spp.) from modern and paleo lake sediments of Central North America

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This paper presents phytolith analysis as a tool to better understand the presence, abundance and paleodistribution of wild rice (*Zizania* spp. L.) from paleo lake sediment cores. *Zizania* is an important food resource for many Native peoples of North America. *Zizania* is a member of a very special group of plants with disjunct distributions between eastern Asia and eastern North America. The timing of *Zizania*'s entry from Asia to North America is unknown. The antiquity of its use by humans is also unknown. This paper presents for the first time an entire phytolith assemblage for *Zizania palustris*. Thirty-seven dominant study area plant species, divided into 180 plant-parts, were investigated for phytolith production, with extra emphasis on co-tribe Oryzeae members *Zizania* and *Leersia*. *Zizania palustris* was found to produce 23 locally diagnostic phytolith morphotypes that were used to calculate concentration and influx of wild rice phytoliths in modern and paleo lake sediments. Methodologies optimized for the extraction, concentration and quantification of the phytolith fraction from highly organic lake sediments were developed, utilizing novel and established limnological techniques new to phytolith analysis, such as the use of an extinct diatom as a marker to determine phytolith concentration. Analysis of 21 modern sediment samples collected along transects across three different wild rice lakes indicate that *Zizania* phytolith deposition is spatially correlated with stand location and density of wild rice. *Zizania* phytoliths were successfully extracted from paleo lake sediments, making paleoenvironmental reconstructions for this important North American grain possible. This research was completed during graduate studies at Saint Cloud State University, Minnesota, USA.

Application of the Lu and Liu (2003) bilobate classification scheme to bilobate dominated phytolith assemblages

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This paper illustrates how the use of a relatively simple lobate phytolith classification scheme developed by Lu and Liu (2003), when applied to contexts dominated by bilobates, can reveal subtle changes in moisture and habitat information, especially when festucoid and chloridoid phytolith abundance is lacking or unchanged in a stratigraphic record. This lobate classification is based on 1) the length of the lobate shank, and 2) the shape of the outer margin of the two lobes. Panicoid grasses exhibiting prolific bilobate production dominate the humid tallgrass prairie region of central North America. Two stratigraphic sediment cores from within this region were analyzed using the Lu and Liu bilobate classification scheme and compared to the pollen record, revealing a correspondence between bilobate derived moisture and habitat change and that derived from the pollen record.

Phytoliths from plants and soils of tundra zone, Kolyma lowland, Northeast Siberia

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Phytolith production and its preservation within soil profiles are not adequately explored. The goal of our work was to study recent phytolith assemblages of tundra plant communities and soil profiles from northeast Siberia, Kolyma Lowland (lower Kolyma River region). The accumulation, diversity and distribution of phytoliths were investigated to improve our understanding of soil-forming factors and processes influencing on forming of phytolith spectra in profiles of permafrost-affected soils. Plant species were gathered from the two vegetation communities: 1) larch association with dwarf shrubs, grass and moss, 2) forbs steppe communities with *Festuca lenensis-Poa botryoides* dominated. The experimental plot was 3 m^2. Plants were collected at the end of their annual growing cycle, to better represent phytolith composition at the moment of their incorporation into soil. Plant material (n=3 specimens) from each of the examined species was dried and charred at 300-400ºC during various days. Permafrost soils in the tundra zone of Kolyma Lowland are presented by Cryozems. Soil samples for phytolith analysis were collected from 2 soil profiles (12 samples) in immediate proximity to plant plot. The phytoliths

were extracted from the soil samples by centrifugation with cadmium iodide and potassium iodide. Thereafter the phytoliths from plants and soils were examined on temporary slides in glycerine under optical microscope Carl Zeiss HBO 50 (AC) at magnification from 200x – 400x. The phytoliths in permafrost-affected soil are well preserved. All 12 soil samples contained abundance and diversity of phytoliths. Some phytoliths in soils are pitted and corroded that apparently dependent on their age and on soil conditions. Quantity of phytoliths in profiles decreased with depth. Accumulation of phytoliths in permafrost base layer was determined. Changes in proportion of morphotypes and in distribution of phytoliths in profiles were interpreted as dynamics of vegetation and climate during Late Pleistocene-Holocene time. The quantitative and qualitative composition of phytoliths was different in modern upper horizons of these two soils, which can be caused by plant cover difference. A comparison of phytolith morphotypes extracted from the plants and soil profiles indicated there are phytoliths typical in both (elliptical, globular, bilobate, polylobate, elongate and hair cell) and others that typical only for plants or soils. Supplementary morphotypes specific for soil samples were not observed in the plants e.g. trihomes, hair cells and plates. Thus phytolith analisys showed that phytolith spectra modern permafrost-affected soils reflects surface cover features and natural condition changes. Investigations of phytolith assemblages in tundra zone can be used for climatic and vegetation reconstruction in this region.

Construction and application of phylolith-climate transfer function in the peat surface deposits of Northeast China

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NE China is a typical continental monsoon climate zone with cold-temperate, temperate humid – sub humid characteristics. It lies to the south of Eastern Siberia, to the west of Sikhote-Alin Mountain, Japanese islands and Korea byland, its south is Bohai Sea, and its west is an ecological fragile zone of the east of Inner Mongolia grasslands. The mean annual temperature in NE China is 5-10ºC, and mean annual precipitation is 400-1000mm, decreasing from the west to the east. According to the climatic data from 1971 to 2002 provided by China Meteorological Administration, 41 peat deposit sites of NE China were selected and sampled for phytolith analysis. The results show that the main phytolith types are bilobate short cells, cuneiform bulliform cells, cubic short cells, tabular cells, trapeziform short cells, saddle, cylindrical polylobate, rondel, hair cells, oblong, and some other types like granulate, or lanceolate, etc. with small contents. The phytolith distribution was controlled obviously by the latitude, the hypsography, and the temperature and heat conditions. R-factor analysis was carried out on the data of phytolith assemblages in peat deposits of the studied area. Seven main factors F1, F2, F3, F4, F5, F6 and F7 were extracted with a total contribution rate of 0.9320. Defined these 7 factors as variable X1, X2, X3, X4, X5, X6 and X7 respectively, and the annual temperature, annual precipitation, and annual relative humidity as dependent variable Y1, Y2 and Y3, the phytolith – climate transfer model was calculated as follows: the annual temperature Y1= 22.741+8.254X1+8.647X2+9.507X6, with an error of 10.37%; the annual precipitation Y2=5252.048+635.991X1-326.642X6, with an error of 7.72%; the annual relative humidity Y3=65.694-2.336 X6, with an error of 7.99%. Using the function, paleo-climate parameters of Yunshu peat profile were calculated and the paleo-climate evolution was then divided into 7 stages: warm-cold-warm-cold-warm-cold-warm. The reconstructed curves also show that the changes of paleo-annual wind speed might indicate the following changes of paleo-temperature and paleo-precipitation, and the warm and wet climate always corresponds with a stable climate system.

The taphonomy of the study of phytolith taphonomy: a brief historical perspective

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Taphonomic factors and processes of phytoliths have profoundly influenced the development and application of phytolith studies in the sciences since the early 19th century, soon after phytoliths in plants were discovered. These affect virtually all areas of phytolith analysis in Archaeology and Geology. Widely varied, sometimes unique and often complex conditions of deposition, preservation, transportation, translocation, etc., frequently provide critical evidence in many areas of phytolith analysis. An early, if not earliest, consideration of phytolith taphonomy was a study generated by Charles Darwin. During an early phase of the Voyage of the Beagle (ca. 1931), Darwin, noting a dust cloud well out at sea collected samples from the ship's sails. Eventually, these were sent to the German microbiologist, C.G.

Ehrenberg, who observed, catalogued and illustrate an impressive variety of Phytolitharia which had been transported a considerable distance. Such studies continue to this day and are often conducted on sediments recovered from oceanographic investigations, and deep sea drilling projects, sometimes as part of commercial oil explorations. Page Twiss, in the 1960's, is best known for publication of the 'tribal" typology of grass short cells (Twiss, Suess and Smith, 1969), which resulted from his earlier studies of wind blown loess deposits in the eastern USA. He was attempting to use phytoliths to determine the donor regions from the vast Great Plains of the central USA. This problem is likewise seen in current studies of phytolith transportation from donor to recipient regions by Glen Fredlund and others. Context-specific deposition is one of the strongest and most valuable sources of taphonomic-based evidence in phytolith analysis. The presence of well-preserved, "dietary" phytoliths in animal feces was demonstrated by a creative method of plant digestion to create reference phytolith assemblages by Baker, Jones and Wardrop (1961). Reference grasses were fed to sheep, using the living digestion system to release phytoliths from the plant matrix which were recovered from feces. Such phytolith assemblages have been studied in both animal and human contexts. Likewise, Armitage (1971) found well preserved "dietary" phytoliths captured in the dental tartar of animals (ungulates). This has been employed in many archaeological studies, such as, Middleton and Rovner (1994). "Dietary" phytoliths captured in carbonized food residues on pottery were first reported in 1929 by Edman, G. and E. Söderberg, a notably early archaeological application of phytoliths. Several of my own studies of phytoliths from archaeological sediments in the eastern USA over the last three decades have demonstrated that considerations of taphonomy, i.e. deposition and transportation, are critical to accurate interpretation of these assemblages. There is a profound difference between decay-in-place residues and those affected by transportation and/or translocation. Moreover, phytolith assemblages in any given archaeological context (and geological ones as well) may be the result of a number of distinct and independent taphonomic sources and processes resulting in a complex and potentially confusing mix of factors. Failure to identify these has already resulted in serious misinterpretation of phytolith evidence leading to false and misleading conclusion in critical area of archaeological history.

Late Quaternary interdisciplinary studies in Brazil and the use of phytoliths from soil organic matter

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Paleoenvironmental reconstructions in the tropics are carried out through interdisciplinary approach and yield to regional paleoclimatic settings. They proved to be powerful in several environments as forest, savanna, peatland, mangroves, etc., in the Amazon region and at Atlantic Rainforest of coastal Brazil. Analytical tools as C and N isotopes, biological (pollen, diatoms, sponge spicules) and geochemical (clay minerals, elemental C and N, etc.) indicators are employed. However, results issued from pollen lake/peat sediments and carbon isotopes from soil organic matter (SOM) records, were rarely compared in a same area during the same time interval. In this case, the use of phytoliths of SOM would be also very important for the environmental reconstruction, improving the vegetation information of the study site. During the determination of C_3 and C_4 plants by stable carbon isotopes of SOM, the phytoliths are the only possible indicators to characterize the plant species presents. The comparison and association of both data will permit the complement of the ecological information about the vegetation dynamics. The stable carbon isotope composition ($\delta^{13}C$) of SOM contains information regarding the presence/absence of C_3 and C_4 plants species in past plant communities, and their relative contribution to community net primary production. The $\delta^{13}C$ values of C_3 plant species (trees) range from approximately -32‰ to-20‰ PDB, with a mean of -27‰, while, in contrast, the $\delta^{13}C$ values of C_4 species (grasses) range from -17‰ to-9‰, with a mean of -13‰. Thus, C_3 and C_4 plant species have distinct $\delta^{13}C$ values and differ from each other by approximately 14‰. The lack of paleoecological records from the montane Atlantic Rainforest of coastal Brazil, considered a hotspot of biological diversity, has until recently been a major obstacle to our understanding of the vegetational changes that have occurred since the last glacial cycle. We present pollen and carbon isotope records in order to access the impact of global environment change, associated with the last glaciation in the Northern Hemisphere, on this area of the Brazilian Atlantic Rainforest region. The study site is a peatbog located in the Curucutu Atlantic Rainforest State Park, in the State of São Paulo, Brazil. The data suggest the presence of a cool and humid Forest from ca. 28,000 to ~22,000 yr B.P. This is in agreement with the ^{13}C and ^{14}C data from SOM, which suggest the presence

of C_3 plants and perhaps C_4 plants ($\partial^{13}C$ of ~-23‰) around the wetland from ~28,000 to ~19,000 yr B.P. The significant increase in the sedimentation rate and algal spores from ~19,450 yr B.P. to ~ 19,000 yr B.P. indicates increasing humidity and probably the presence of a small lake in the study site. The lack of peat sedimentation during the Last Glacial Maximum, between the ages of 19,000 yr B.P. and 13,750 yr B.P. suggest an erosive process caused by high precipitation. The maintenance of tropical forest/savanna mosaic at Curucutu is explained by the overall sufficient moisture in coastal southern and southeastern Brazil. From ca. 10000 yr B.P. to ~1000 yr B.P. a higher frequency of arboreal elements and pteridophytes and lower contribution of terrestrial herbs and algae and the absence of aquatic plants suggest warmer climatic conditions than the previous climatic period. From ~19,000 to ~1000 yr B.P. more depleted $\partial^{13}C$ values (up to -27‰) indicated the predominance of C_3 plants. From ~1000 yr B.P. until the present the anthropogenic effect on arboreal vegetation cannot be discarded. These results are in strong agreement with recent developments in oxygen isotopic studies in speleothems of caves of southern and southeastern Brazil, which suggest humid conditions during the Last Glacial Maximum.

Interpreting content, context and manufacture from use-residues in ceramic vessels from Southern Argentinean puna

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Use-residue analysis from archaeological ceramic vessels is frequently directed to identify contents and to discuss functionality. Recently, Zucol, Brea and Mazzanti (2005) paid attention to different contamination sources for "use-residues", including ceramic and sedimentary matrix, and they proposed control sampling procedures. We agree with them and also, propose that residue analysis allows us to obtain specific information related to use, manufacture and context for archaeological artefacts. From an ample taphonomic point of view, this information can be understood not only in "contamination" terms, but also as genuine data regarding natural and cultural processes of formation and transformation of archaeological record. In this paper, we analyze use-residues from six containers recovered as complete or *in situ* broken vessels, in four partially contemporary archaeological contexts within Punta de la Peña 9 site, at Antofagasta de la Sierra, Catamarca (Southern Argentinean Puna). The vessels belong to the second part of the first millennium AD and comes from two burials -Structure 2, PP9.II (López Campeny 2001) and Structure 1, PP9.I (González Baroni *et al.* 2007)-, a multiple activity place -Structure 3, PP9.I (Babot *et al.* 2006)- and a ritual deposit -PP9.I (Babot *et al.* 2007). Our research design starts with a review of archaeological assemblages that are spatially related to vessels (plant macro-remains, hearts, etc.) and of integrity and dynamic of their contexts of provenience. On this base, we propose hypothesis about the presence of microfossils in use-residue samples, belonging to ceramic and sedimentary matrix as well as cultural and natural processes, both contemporaneous and postdepositational to the discard of vessels. Moreover, we follow Babot (2003, 2007) to establish cultural practices of plant processing -as an additional taphonomic factor- by analyzing starch grain damage and the whole microfossil assemblage. Finally, we carry out a dry and stratified sampling procedure for vessels (Babot 2004) to preserve provenance data for residues (base, body, neck, fresh fracture, macroscopic use residues, stains of probable postepositational origin, etc.). Results obtained allow us to identify aspects of use, manufacture and context for ceramic vessels from use-residue samples, on depending on their integrity and postdepositational history. Additionally, indicators of several cultural practices are recovered, that are directly or indirectly related to the use of vessels, such as processing procedures, burning of roofs and ritual disturb of deposits. As a corollary, we estate that it is possible to consider macrofossils labelled as "contamination", in a positive way, as information that goes far from the use of artefacts, to allow us to understand and cross-check cultural and natural processes of formation and transformation of archaeological record.

Phytolith assemblages and opal concentrations from modern soils differentiate temperate grassland vegetation of different types in an experimental study at Cedar Creek, Minnesota

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Many phytolith researchers assume that the phytoliths in modern soils reflect vegetation at the surface. We test this assumption and determine whether ecotonal boundaries in temperate grasslands can be delineated based on the silica record in the soil. We assess difference in phytolith concentration (percentage of dry soil weight) and diversity of morphotypes under controlled conditions of the Biodiversity II experiment (E120) at Cedar Creek Historical Natural Area, where

mixtures of C3 grasses, C4 grasses, legumes, non-legume forbs and woody plants (*Quercus*) were grown for a period of eight years. The plots have been manually maintained to contain primarily the selected species, and thus provide a unique opportunity to test numerous hypotheses regarding phytolith production patterns under different functional groups of plants. We took soil samples from sixty plots. The 9x9 meter plots in a former brome field were prepared with herbicide and fire, then the top 6-8 cm of soil were removed and uniform sandy soil was brought in. Next the plots were seeded to have 1, 2, 4, 8, or 16 species of plants in different functional group mixtures. Pinch soil samples of 20 g from 10 random locations inside each plot were obtained. We extracted the opal from each sample by chemically removing the organics and carbonates and using heavy liquid flotation. We also used an alternative method of chemical dissolution of opal on selected samples to test the accuracy of the first method. After obtaining opal concentrations, we used digital and optical microscopy to count the phytolith forms found on each plot. Once all of the counts were obtained it was possible to analyze the phytolith forms on the plots against each other and against the phytolith forms found in the plants that grow on each plot. Our statistical analysis includes multiple regression, PCA and cluster analysis. This analysis shows that the extent of ecotonal boundaries and species' composition that is reflected in phytolith assemblages was most successful with the grass-dominated plots: it was very accurate at determining if and where grasses were present and at distinguishing between C3 and C4 grasses. Although the majority of phytoliths were from grass, some were from forbs and woody plants. However, the biomass and percent cover were not reflected as strongly as the species' composition in the modern soil phytolith assemblages.

Biomineralizations: an important source of elements to the soil solution

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Soil minerals are the main sources of elements in the geological time scale, however biomineralizations are important sources of elements to the soil solution in the ecological time scale. Phytoliths ($SiO_2.nH_2O$,hydrated amorphous silica) and calcium oxalate crystals (C_2O_4Ca, COC) are the most common biomineralizations in higher plants. Studying the weathering processes of these biomineralizations is important because silica and calcium are key elements in the formation of organo-mineral complexes necessary for the soil matrix conformation. The aim of this work is to determine the contribution of silica (SiO_2) and calcium (Ca^{2+}) to the solution, from plant biomineralizations and soil samples from Typic Argiudolls with different vegetation cover, through in vitro experimentation. We worked with samples of: 1) vegetation: pieces of leaves cleared with sodium hypochlorite (50%) of: a) *Dactylis glomerata* (Poaceae), phytolith producer; b) *Acacia melanoxylon* (Fabaceae: Mimosoidea) and *Eucalyptus globulus* (Myrtaceae), COC producers; c) *Celtis tala* (Rosaceae), phytolith and COC producer; 2) soil samples (Hz. A, Hz. B, Hz. C) of Typic Argiudolls with different vegetal cover: a) grasses (P1), b) acacia and tala (P2), c) eucalyptus and tala (P3); and 3) volcanic ash (20000 ± 7000 years BP). On the soil samples, heavy liquid separation was realized with sodium polytungstate (δ=2.3 g/cm^3) to separate the amorphous silica fraction (phytoliths + volcanic ash) from the heavy fraction of the soil. Three subsamples were exposed to different treatments for 6 months: 1) control (distilled water), 2) acid solution (pH2, glycine buffer), 3) solution similar to the natural soil conditions (pH6, phosphate buffer), 4) basic solution (pH12, phosphate buffer). The biomineralizations' weathering state was analyzed with an optical microscope and a scanning electron microscope, and the SiO_2 and Ca^{2+} solution content was determinated by UV-VIS spectrophotometry. Regarding the phytoliths, the basic treatment produced the weathering of *D. glomerata* biomineralizations. However, this was not reflected in the solution, since this treatment showed the lowest silica content, which could be attributed to methodological errors. In general, amorphous silica fraction produced higher silica contents (14.05-2558.38µmol/L) than the rest of the soil minerals (11.06-1176.65µmol/L) and, within the amorphous silica fraction, phytoliths contribution was higher than the volcanic ash contribution (16.59-313.36µmol/L). Regarding the COC, acid treatment produced the dissolution of the biomineralizations and the largest calcium release into the solution (18.73mg/L). *Celtis tala* (12.38-65.86mg/L) and *Eucalyptus globulus* (14.65-53.98mg/L) leaves were the ones that made the greatest calcium contribution, with values significantly higher than the soil minerals (0.29-20.72mg/L). The results show that phytoliths and COC produce larger contributions of silica and calcium to the soil solution than do the soil minerals; therefore, they represent important

sources of these elements and have an important role in the soil biogeochemistry.

Opal phytolith extraction procedures in tropical soils

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Phytolith assemblage analysis is an important method for the reconstruction of paleoclimatic conditions. Although this method has been underutilized in soil science, it supplements the analysis of pollen and other microfossils (Blinikov, 2005). Currently, there are a large number of methods for the extraction of phytoliths from sediments, soils and paleosoils, mostly developed and applied in soils, paleosoils and/or sediments from temperate regions or hydromorphic environments (Twiss et al., 1969; Rovner, 1971; Parr, et al., 2001; Osterrieth et al., 2007). Very few studies were conducted in tropical soils with significant Fe and Al oxide and organic matter coatings in the soil matrix (Alexandre, et al. 1997[a], b; Barboni et al., 1999). In the soil, these coatings protect phytoliths from taphonomic process attacks, but hinder morphologic analysis and could compromise phytolith assemblage extraction, analysis and interpretation. In this work, we compared three pretreatment methods for removal of grain coatings of a Latosol with a humic A horizon sampled in Machado (Minas Gerais State, Brazil). *Method 1* consists of the removal of carbonates and iron and/or aluminum oxide coatings by acid hydrolysis (HCl, 7%) followed by an oxidation attack with hydrogen peroxide (H_2O_2, 30%) for organic matter removal, according to the procedures described by Madella et al (1998). This method was the most aggressive to phytoliths, was proven to be the least efficient in phytolith extraction and was the most selective, considering that only the larger diameter/size phytoliths, such as the *Bulliforms* and *Elongates*, were preserved. In *Method 2,* proposed by Mehra & Jackson (1960), the samples were submitted to organic matter destruction with hydrogen peroxide (with and without heating) and iron oxide removal with sodium dithionite-citrate-bicarbonate (DCB). *Method 3* proposes an adaptation of the procedures described by Mehra & Jackson (1960) and Deb (1950) for organic matter oxidation with hydrogen peroxide (with and without heating), iron oxide removal with sodium acetate buffer at pH 5, and uses sodium dithionite in water for iron reduction. Those methods presented very similar results. Method 2 extracted a larger variety and quantity of phytoliths, and a smaller amount of non-phytolith particles, allowing a better characterization and interpretation of the vegetation. Method 3 seems to be as efficient as method 2 in the removal of coatings, and the process is relatively cheaper, since less chemical products are used.

Sorting of silicophytoliths by wind erosion in two soils of a semiarid environment in Argentina

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Wind erosion is an important degradation process of soils of arid and semiarid environments. Little is known about the effect of this process on the mineralogical composition of the soils. Wind and water transport produce a sorting of minerals according to their weight and/or size. As silicophytoliths are common biomorphous of silica of loess soils of Argentina and they have a very low density (by 2 g/cm^3), we supposed that sorting produced by wind should reduce their contents in eroded soils. Therefore, phytolith amounts can be potential indexes of the severity of wind erosion. In order to demonstrate this hypothesis we analyzed the mineralogical composition of an Entic Haplustoll and a Typic Ustipsamment, on samples of the top-soil (2 mm) taken before and after a wind erosion event simulated with a portable wind tunnel. The entire sample was used, pretreated with the routine technique and centrifuged to eliminate clay. Four hundred grains per slide were counted, separating phytoliths, diatoms, carbons and the rest of the components present. The phytoliths were identified following the nomenclature defined in the ICPN (2005) and the classifications developed by Bertoldi de Pomar (1971) and Twiss (1992). Results showed that initial phytolite contents were similar in both soils (by 50%), and that after the wind erosion simulation they decreased to a 20% in the Udipsamment and 15% in the Haplustoll of the total mineral contents. This reduction was attributed to the selective transport of phytoliths by wind and a residual accumulation of heavier minerals. The

phytolith assemblages are dominated by graminoid phytoliths in: 1) Udipsaments the morphotypes are characterized by phytoliths of a lesser size, bilobate, specially bilobate of panicoids, rondels, saddles, crosses and indefinite phytoliths. After conducting experiments with these soils, the bilobates diminished, in particular the panicoid bilobates; elongate with smooth or echinate contour, and those undefined. The cross phytoliths disappeared. After the experiment, rondels increased by 50%; they have a fairly robust and persistent shapes even in the loessic parental materials attributed to pooids, panicoids and chloridoids. Saddles, typical of C4 grasses also increased. There was little variation in the unciform hair cells, acicular hair cells and hair bases. 2) In the Haplustolls, with morphotypes similar to those found in the out soil, after the treatment, the bilobates and the rondels diminish or are lost; while the elongate cells increase and these latter two morphotypes have a behavior contrary to the two soils studied. The saddle (C4) maintain similar states before and after the experiment. The diatoms are scarse, buth their behavior is the opposite in both soils ater the experiment: in the Udipsamment they decrease and in the Haplustrol, they increase. The carbon, with a lesser amount, are only observed in the Udipsamment. We concluded that wind erosion decreased the amount of less dense phytoliths at similar rates in both studied soils, their relative abundance being a potential index for wind erosion severity of the soils. There are similar morphotypes with opposite behavior and others that do not vary: these morphodynamic aspects must receive more detailed studies. Further studies should include the determination of more dense minerals like magnetite or goethite, in order to use their amounts as reference for future calculations.

Phytholiths in pellets and coprolites, posterior redistribución in associated soils and taphonomic implications

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The first results of silicophytholiths in goat pellets in saline soils in Llancanelo, Mendoza and crab pellets in sodic-saline soils in Mar Chiquita, Buenos Aires will be presented. There are no precise definitions of the nomination coprolites and pellets in relation to the different fields that approach them; sometimes they are differentiated according to size, others according to their origin in vertebrates or invertebrates, independently from their size. In the goat coprolites that were analyzed, 2 predominant shapes were observed: the elliptical ones, of a size of 0.6 x 1mm and an average weight of 0.6 g. and the spheric ones of an average weight of 0.9g. Most coprolites have a rough surface and, under a binocular magnifying glass, remains of plants (stems, seeds, etc.) may be observed. Some have very smooth surfaces due to the great concentration of salts from the environment. They were quantified per surface unit in order to establish the relation between area occupied by the coprolites/ average weight / weight of phytoliths per coprolite. The crab pellets analyzed belong to *Neohelice granulata*; it is a crab that lives in the south-western Atlantic, the northern distribution limit of the species is Río de Janeiro (22º 57' S - 42º 49' W) and the southern distribution limit is the Riacho San José (42º 24' S - 64º 36' W). Its distribution is discontinuous because its population is found in lagoons, estuaries and bays with marshes, with different proportions of non-vegetated tide plains and marshes. The conditions of salinity, soil composition and flora may vary both latitudinally and locally. It is a intertidal digger crab, that builds semipermanent caves and feeds on detritus deposits and *Spartina* spp.; the characteristics of the caves and the type of food depends on the area in which the crab lives. It is a key element in these environments; it is considered an ecosystemic engineer due to its ability to modify the environment; it can turn over between 2.5 kg and 6 kg of sediments/day*$m^{2.}$ In addition, they are considered one of the main producers of detritus deposits in these environments. To obtain the feces, male crabs from the tide plains and marshes of the Lagoon of Mar Chiquita were collected (37º 32' S - 57º 19' W). They were taken to the laboratory immediately and they were placed in individual receptacles. During 8 hours and at intervals of 1 hour, all the feces produced by each crab were collected with a pipette; they were placed in Eppendorf tubes and preserved in alcohol. In the goat coprolites, bilobates predominate, especially *Stipa* type ones, followed by panicoids. Rondels are abundant and elongates are very abundant, especially with smooth surface. There is a considerable amount of indefinite ones. Their state of preservation is generally good. The content estimated enables the estimation of the contribution of phytoliths by goat coprolites which will be incorporated to the soil dominated by salicorns and

other halophytes which are not generally carriers of phytoliths. The crab pellets generally have more than 60% of phytoliths, 8% of diatoms, scarce poripherans and carbons and 20% of minerals. Bilobates and rondels are the dominant morphotyes, as well as tabulars, papilates and abundant indefinites. Considering their production, the high population density and the high production of phytoliths, these pellets are also contributors of more phytoliths apart from the ones originated by the degradation of these soils' vegetation. To sum up, crab pellets and goat coprolites in saline and sodic soils contribute further amounts of phytoliths to the system. This taxonimical aspect must be taken into account in the environmental and paleoenvironmental evaluations and associated vegetation in the aforementioned environments and the past.

Finally facing taxonomic reality: Why phytolith typology is fundamentally flawed

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Typological classification is the dominant method in phytolith systematics and the primary basis for taxonomic identification. In spite of considerable efforts, no substantial or valid progress has been made to overcome the problems of multiplicity of types within taxa and the redundancy of types across taxa. Add to this the problem of wide ranging morphological variation within type categories so that more variation occurs within a type than between types. It is long past time to recognize that failure to achieve a successful taxonomy in phytolith analysis lies in the inherent weakness of typology itself. Creation of a type attempts to substitute a single morphological construct for the range of variation of an assemblage. This is antithetical and incompatible with the fundamental reality of Darwinian variation at all levels in the biological world. By seeking to reduce or eliminate variation typology is always arbitrary and artificial, based on observer perception (i.e. subjective opinion), rather than based on objective, verifiable reality. Typology is not real and never can be. Unfortunately, the recently development of a formal descriptive nomenclature exacerbated the typological problem by implying that descriptive consistency provides taxonomic identification. Description does not validate subjective types. Nomenclature does not solve the problems of redundancy and multiplicity and thus, by itself, does not create accurate taxonomy. Moreover, a formal nomenclature reinforces the false nature of morphological types by promoting disregard of inherent variation within phytolith populations. Reduction, often to the point of elimination, of morphological variation in descriptive morphological typology is consistent with equally false assumptions of the nature of quantitative descriptions of biological populations. For example, extensive analysis of morphological variation in seeds has demonstrated that "Nature is not normal." That is, plots of the distribution of morphological variation reveals overwhelmingly that natural populations of seeds are not Gaussian, i.e. "normal" or bell-shaped. Rather, distributions are usually multimodal and unpredictable; that is, there is no consistency in the number or locations of the modes in replicate populations of seed populations of the same taxon. Moreover, unlike bell curves, there is no consistent correlation between mean values and the presence of a mode at the mean value. Thus, reliance on comparisons of mean values and presumptions of normal distributions in selection statistical tests are invalid and prone to systematic error. A review of claims for successful identification of plant taxa relying on the use of mean value and parametric statistics of phytolith populations, e.g. identification of *Zea mays*, is fundamentally flawed and largely false. So long as ineffective typology dominates phytolith analysis to the exclusion of alternate methods, the credibility of phytolith analysis as a whole is in jeopardy.

Geochemistry of silicophytoliths extracted from poaceae, rhizospheric soils and holocene paleosoils- San Luis, Argentina.

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In the present work, the natural bioconcentration of some major, minor and trace elements in inter and intracellular segregations of opal organogen (silicophytoliths) in *Nasella tenuissima* (Trin.) Barkworth are studied. Samples were collected in the piedmont and high pampas of the San Luis Ranges. The relationships of these elements in the mineral rhizospheric and parent material of paleopedological levels and the corresponding silicophytolith contents were established. Analytical determinations were performed using three instrumental techniques, which were compared and tested according to their sensitivity to each element in their concentration order. The techniques used

were: X-ray fluorescence wavelength dispersive spectrometry (XRF-WDS), inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS). The elemental ratios of ashes of *Nasella tenuissima* / Rhizospheric soil resulted higher for SiO_2; CaO; K_2O; P_2O_5; Ni; Cu; Zn and Pb. Similarly, these ash relationships were higher (for the mentioned elements, except for SiO_2) in the root parts than in the aerial ones. By coincidence, Ni, Cu, Zn, and Pb were concentrated in paleoedaphic horizons. The oligoelement contents in the silicophytoliths (aerial part) were similar for both geographical sites. Regarding the rare earth elements (REE), the normalized results to chondrites (Wakita et al.,1971) are presented. The total contents obtained by summing up the light and heavy REE reached the order of 5 ppm for the silicophytoliths extracted from *Nasella tenuíssima*. In the four paleoedaphic levels of the studied sites, the density mineral fraction lower than 2.3 $g \cdot cm^{-3}$ exhibited REE concentration values ranging between 46 and 69 ppm. The coincidence in the relative distribution of the normalized REE values for all the studied samples is worth mentioning. Besides, in the paleosoils of superior levels, a higher concentration of light REE was observed.

Phytolith and geochemical studies in the Río Quinto formation (Neógene) – San Luis, Argentina.

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The faunistic composition of the Río Quinto Formation studied in the Cantera Diaz Nogarol determined that the paleontological deposit belonged to the Chapadmalalence Mammal Age, and representatives of five families of Xenarthra, Notoungulata and rodents were identified in the site. The presence of Euphractini indicated the existence of grass lands and shrubby-arboreal formations whereas the presence of Eutatini, with its cold-tolerant piliferous system, suggested cold semiarid paleoenvironmental conditions. The purpose of this work was to complement and contrast, using geochemical and phytolithical studies, paleoecological aspects related to the vegetation, soil and climate during the formation development. The percentage values of the chemical index of alteration (CIA) showed a direct relation with the intensity of the meteorization and pedogenetic processes. Comparisons were carried out using the index determination in the paleoedaphic parent material of the Quinto Río Formation (Pliocene) and of the San Luis Formation (Pleistocene-Holocene). In the Quinto Río Formation, from the erosive discordance at the top to about 10 m deep, the CIA varied from 61% to 71% with an average of 67% (5 samples). In the San Luis Formation, the CIA varied between 60% and 66% with an average of 64% (20 samples). The CIA values obtained in both formations were similar, indicating a middle alteration process and an Ustic moisture regime. According to the *Soil Survey Staff (1975),* under the Ustic regime the soil presents a moderate non-frozen water reserve in the season with favourable conditions for plant growth, and it remains dry for 90 days or more. This regime is associated with semiarid subtypes of alternating dry and tropical climates (dry-humid). When phytolithical studies were carried out, a correspondence between the percentages (p/p) of the fine limo fraction (20μm to 4μm) and of the organogenic silica concentration ($\delta < 2.3 g \cdot cm^{-3}$) was observed in each formation. The results indicated that there was greater content of fine silt and a higher concentration of organogenic silica in the Río Quinto Formation as opposed to the San Luis Formation in which the percentages were lower. Although the alteration levels of the silicobiolites material are not simple to analyze, the CIA is an appropriate tool to infer the intensity and characteristics of the pedogenetic processes. The phytolith content is quite scarce in the upper levels, represented only by the elongated smooth and some rondel forms, and they present a high level of alteration. At the intermediate level of the sequence (2 m deep), there is a noteworthy increase in phytoliths, with varying bilobate morphotypes, short cells, trapeziform short cells, smooth elongated cells and echinated long cells, cuneiform and parallellepipedal bulliform cells, acicular hair, and unciform cells; some bilobates fractured at the neck, and some of the morphotypes of greater size are fond to be altered and corroded. The conspicuousness in quantity and variety of phytoliths found produced a definition at this level as a paleosoil. At the inner adjacent level, the phytolith content decreased considerably, and even more so at the base of the sequence where, apart from being scarce, the phytoliths appeared to be rounded off and altered. The sediment associated with the Euphractini fossil presents an appreciable content of silicophytoliths with abundant morphotypes assigned to short cell phytoliths: saddle (graminea C4, indicators of dry and dominant conditions associated with the extinct fauna there found.

Phytolithic and geochemical study of the Chapadmalal profile, Mar del plata, Argentina

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The study area is a basin between Punta Lobería and Punta Vorohué (Hotel 4) which is characterized by bioturbated sandy and clay limos, with a grey-yellowish to grey-reddish color, with intercalations of diamictite deposits and fluvial facies, exhibiting pedological features in all the succession. Furthermore, it presents calcareous horizons and tephra levels (Zárate and Fasano, 1989). The succession has been assigned to the Pliocene and Pleistocene because of absolute datation, vertebrates fossil remains and magnetoestratigraphic evidence. The deposition environment is dominated by fluvial deposits and flows of variable characteristics such as laminar and turbulent flows, from no channelled to detritic, with intercalations of some lake deposits (Zárate, 1989). The chemical analyses of 20 elements (majority, minority and traces) from the representative samples of paleosoils and calcrete soils were carried out using X-ray fluorescence wavelength dispersive spectrometry (XRF-WDS), and the obtained data were used to carry out the CPIW norm and the chemical index of alteration (CIA), which allow us to infer the paleoedaphiclimatic conditions and the associated vegetation using the analysis of the phytolithic record. The CIA for the very fine sand (53 to 62 microns) varied between 66% and 71%. In the mineral fraction lower than 44 microns, the index ranged between 62% and 72%. The maximal values corresponded to the paleosoils located at the level (-170cm to -300cm). When comparing the CIA values of the present soils and the paleosoils, it is possible to infer an Ustic moisture regime for the latter (*Soil Survey Staff, 1975),* which is corroborated by the phytolithic record. This phytolith register demonstrates an enrichment of these biomorphous silica in the detected levels in the paleosoils, but this was not the case in the levels with abundant calcium carbonates, that, apart from their scarce content, the phytoliths present high levels of corrosion. The morphotypes found are those corresponding to long, elongated, blulliform and uncifom cells. Phytoliths of shorts cells such as bilobates and rondels are observed in the paleosoil (-2.45 m). The content of total CaO (present in aluminosilicates, carbonates, phosphates and sulphates) in the four non-calcrete paleosoils varied from 2.4% to 3.25% whereas in the calcrete soils, the variation was from 32% to 50%. The distribution of total SiO_2 and total Fe_2O_3 presents an opposite behaviour. Abrupt distribution variations were observed in the profile of the three mentioned elements.

12, 000 years of native history in the pampean region: an approach from archaeology

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There is strong evidence that human beings began to settle in the Pampean region approximately 12,000 ^{14}C years ago. Evidence of these early settlements are found in the area between the sierra mountains and the Tandilia sierra mountain range. From that time through the 15th century, the indigenous peoples from the Pampas followed different historical paths within the Holocene and they adapted to the different areas in the region. This variability in adaptation and the main models of the region's population dynamics will be discussed and summarized in this lecture. Information about the most significant sites and the way they contributed to building the present archaeological scene will also be provided.

Global policies, periphery and phytoliths studies: archaeology of the discipline from a Southern perspective

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Science, as any other activity that involves a huge number of people, knowledge, and resources, is cross-cut by current global processes. This 20th – 21st century's global process –called "globalization"- has the characteristic that pushes for certain uniformity all over the world. This mechanism differs little in this sense from those of the 15th to 19th globalizations processes called "colonialism". The most salient and distinctive aspect is that now the standardization-process is not been driven by the leading nations but by invisible groups with common interests -sometimes visible only in multinational corporation's practices. In other organizations -and scientific disciplines-, the problems that global standardization offers regarding unique thought are actively debated in forums, meetings and special conferences. These meetings have the objective not only to understand and profit from the benefits of globalization, but to be prepared to avoid the collateral or direct damages. In Science, instead, this is object of research in the social sciences, while biological and physical sciences tend to continue behind this

scenery, attached to their "insighter" and "objective" way of doing things. If we look around we can easily realize that most of our research colleagues oriented to natural sciences are staying two steps behind of what is called "politics", and even consider it as an incorrect matter to get involved in. While archaeologists tend to move in an interdisciplinary stage between "hard" sciences, social sciences –and many times, even arts-, we resist day after day the global science policies, and we are prepared not only to notice or identify them, but to discuss and analyze their effects. In fact, if I rise or mention this subject in my conference is because I have already "swallowed the bitter pill" of the global policies and feel we have to get informed and be aware of them. From another viewpoint, is not a surprise that we take this subject not only from a social discipline, but also from the peripheries of the "core" of this "global world". The question is why should we discuss globalization within our discipline? To fight against the mainstream?, To take better advantage of it?, To join it? To propose other possibilities, more related to cooperative practices than to hyper competitive ones?. In order to discuss not only my own point of view but also other views of these questions and problems, I made a survey among colleagues of different disciplines, ages and gender, but all of them at the top stages of their careers. All of them develop their research activities in marginalized institutions of a marginalized and underdeveloped country, as it is an inner province (Tucumán) of a southern country as Argentina. A province that, however, has a century-old tradition of science and research. Finally, I will go deeper on what is the most powerful tool to avoid a non desired manipulation in any kind of globalization: History and Identity, in this case, of the phytoliths studies in South America.

Phytoliths as indicators of paleoenvironment and human impact: evidence from superimposed structures inside the Moon Pyramid, Teotihuacan, Mexico

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A preliminary sequence of vegetation change (ca. 5000 BP – present) based on relative proportions of phytolith types identified from dated stratigraphic profiles has been proposed for the Teotihuacan Valley in central Mexico, site of the earliest prehispanic city in Mesoamerica. However, although this sequence provides a general idea of changes in the spatial distribution of vegetation types through time, presumably the result of human impact to a large degree, the resolution is too broad to permit an evaluation of the diverse ways in which specific human populations modified the landscape. Recent archaeological excavations in the interior of the Moon Pyramid, one of several landmarks of the Classic period urban center (ca. AD 100-600) revealed the remains of six superimposed buildings underlying the presently visible monument. Sediments from the fills of the buildings were sampled for macrobotanical remains, pollen and phytoliths, all of which have contributed to an improved understanding of the prehispanic landscape and associated agricultural activities. Although it is generally assumed that construction fill was obtained from nearby fields, our research has demonstrated that, in fact, this is the case and, more important, that these sediments preserve plant remains that contribute significantly to our understanding of local flora and vegetation change during the period of Teotihuacan occupation. In particular, phytoliths recovered from the fill of Buildings 1 (ca. AD 100), 3-4 (ca. AD 200), 5 (ca. AD 300) and 6 (ca. AD 350) indicate variability in the predominance of C4 plants, offering a finer temporal resolution together with direct association between microbotanical remains and human activities, prior to the use of the sediments as construction fill. In addition, changes in phytolith types through time permit the development of hypotheses concerning land use and vegetation change relevant to prehispanic landscape modification. In this study we present the results of the quantitative analysis of phytolith types recovered from these buildings and other structural fills from the Moon Pyramid.

An interdisciplinary approach for Coctaca: stimulating results for the comprehension of an ancient agricultural complex.

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In north-western Argentina (Jujuy province), Coctaca and Rodero sites are known for the ample ancient fields with structures specially prepared for agriculture, which significantly diverge from similar settlements throughout the Andes. The site extends for about 4000 ha., occupied by stone structures. The archaeological landscape is formed by longitudinal irregular lines of field clearing heaps and, between these lines, narrow stone-walled

agricultural enclosures made of simple, double, or double filled stone high walls (that may surpass 2 meters). These structures are surrounded by irrigation canals. Although the beginning of the occupation has not been established yet, Albeck (1995) proposed two moments concerning the construction of the agricultural enclosures. While the last moment completely coincides with the Inka occupation, the oldest segment - sampled for this occasion- could have preceded the last stage of construction by several centuries. The functionality of these enclosures has been object of a long debate. Albeck (1986, 1995, and 1998) and Albeck and Scattolin (1991) suggest that they had been used for agriculture, producing a moderating effect in the local microclimate. The high walls reduced the drying effects of the wind, and by increasing the temperature they facilitated the growth of vegetation inside the enclosures. Following these ideas, we started a microfossil research to understand the functionality of the structures (Maloberti et al 2005). The objective of this investigation was principally the identification of phytoliths corresponding to domesticated vegetal species, making special emphasis in *Zea mays* sp. (Maloberti et al 2007). The extraction of phytoliths and other microfossils followed the methodology for multiple microfossil extraction (Coil *et al* 2003), but since mays phytoliths were not found, some samples were sent to Unicep's Uruguayan laboratory as blind test inter-laboratory control, and therefore another protocol was used for phytoliths separation and identification. At present we are following a new fieldwork and laboratory methodology for this study area and this problem, which attempts an interdisciplinary integration of data (archaeology, phytoliths, diatoms, pollen and soils). In this sense, first pollen data show different preservation - while the sediments with basic pH are the best for pollen conservation- enhancing the presence of the natural vegetation that is dispersed on a regional scale (bushy steppe- Prepuna).

Microfossils for assessing the use as projectile points or knives of archaeological artefacts from Quebrada Seca 3 site,SouthernArgentinean puna (*ca.* 5000-4500 years BP)

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Several lithic artefacts from hunter-gatherer occupations of Quebrada Seca 3 site (Antofagasta de la Sierra, Southern Argentinean Puna, between *ca.* 5000-4700 years BP), are analyzed. These stone tools have recently been defined as stemmed projectile points where the limbs were intensively maintained resulting in asymmetric shapes (Hocsman 2006). Previously, it was proposed the use of these artefacts as knives because of their morphology when the artefacts where discarded (Aschero 1988, Aschero *et al.* 1991). Trying to establish a more complete version of the life history of these artefacts, from projectile points to knives, as it was suggested by techno-typological analysis, we are developing a research design that includes several analytical microscopic techniques to identify the preserved uses. Preliminary information obtained though use-wear analysis and compositional study of macroscopic residues in limbs and stem, indicates the processing of plant material and the use of plant adhesives for hafting. In this paper, we present the results obtained from the microfossil record sampled from active edges and stems to complement and cross-checki previous data.

Phytolith evidence for agricultural production and site formation at kadebakele -- an Iron Age settlement in Eastern Karnataka, South India

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Despite a long history of research, the agricultural practices and modes of subsistence of Iron Age inhabitants in south India is still poorly understood. In this paper we provide preliminary results of phytolith analyses from a well-stratified archaeological midden at the site of Kadebakele to inform research on Iron Age agriculture and site formation processes. Calibrated radiocarbon assessments from the site indicate that the upper areas of an inselberg hill at Kadebakele were densely occupied from ca.1000 BCE to 500 BCE, confidently in the date range (1000 – 300 BCE) commonly used for the Iron Age. The qualitative and quantitative analysis of a stratified phytolith assemblage from a refuse midden dated to this occupational period shows evidence for both changes and continuities in the vegetation of the site and the cultigens being produced and consumed by inhabitants. For example, both fan shaped Oryzoid spp. bulliform phytoliths and blunt pointed trichome varieties of Triticum spp. are present in low concentrations throughout much of the sequence.

However, Oryzoid types show a marked increase toward the latter part of occupation, suggesting an intensification of rice production toward the end of the period. Silicified woody elements in all parts of the profile indicate the presence of woody shrubs and trees throughout the period of occupation. In several levels, highly carbonized phytoliths were identified, indicating high temperature deformation.

Phytoliths and paleoenvironment from the archaeological locality Tapera Moreira La Pampa province, Argentina)

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In this paper we present preliminary results of paleoethnobotany studies performed in the Archaeological Locality Tapera Moreira. This Locality is located at 38° 33′ LS and 65° 33′ LW, on the Curacó River Basin, Lihue Calel District, La Pampa Province, Argentina. The excavations carried out in the Locality allowed us to establish a chronological-cultural sequence that begins 4600 years BP and spreads up to pre-Hispanic moments. Five archaeological sites were identified there (Sites 1 to 5), on the basis of the topographic differences of their emplacement and the characteristics of the archaeological materials present in each of them. The material consists of 17 total mineralogical fraction samples, corresponding to the sedimentary column of the north profile of the Site 1. The sediment of the sequence is typically frank-sandy to sandy-frank, with typical mineralogy of re-worked loess by fluvioaeolic action. The presence of phytoliths is considerable with varied morphologies in all the sedimentary levels. Among the macrophytoliths there were, elongates, bulliform, hair base and unciform hair cells. The short grass cells phytoliths appear in minor proportion, among them, rondels, conical, trapeziform and bilobates -panicoid, simple and *Stipa type*-. It is remarkable the presence of saddle, typical Chloridoid phytolith, of metabolic route of 4 carbons (C_4), especially in the mid and low levels. A notable change in the mineralogical variability respect of the superjacent levels is observed in the samples F17 and F18 corresponding to the levels XXXI and XXXII of the cultural and sedimentary sequence. They are enriched in volcanic ashes of all the sizes (from thick sand to fine lime). Simultaneously, a remarkable lack of cultural evidence characterized the sedimentary levels corresponding to these samples. The presence of a great quantity of articulated phytoliths in big fragments (> to 100 μm) it is extremely interesting in the sample F18 (corresponding to 3,85 m). In addition, the articulated phytoliths still have organic not carbonized remains. This information is relevant in relation to the macroregional level where a wide archaeological hiatus has been dated in the Middle Holocene. This hiatus appears almost simultaneously in the south of Mendoza (7500-4000 years BP), center of La Pampa (6500-5000 years BP) and south of Buenos Aires (5960-5060 years BP) provinces, but in different ranges. Several authors have attributed this hiatus to the effects of volcanism. The hiatus raised for La Pampa represents the previous moment in which the locus of the Tapera Moreira began to be in constant use. Though these results are preliminary, they offer paleoenvironmental information on the region in study, thus providing useful tools to do inferences in man-environment relationship.

Firsts results of the phytholith composition studies of the sedimentary sequence of Alfar archaeological site Eastern pampas,Argentina)

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The firsts results of the phytolith research carried out for the sedimentary sequence of Alfar archaeological site are presented. The aims of this study were to identify the vegetetation associations and to contribute to the reconstruction of past environments during the hunter-gatherers occupation of the site in mid-Holocene. This siliceous microfossil data is also complemented with other proxy evidence derived from the zooarchaeological study of the bone remains recovered from the site. Alfar site (38° 5' 48.9"S, 57° 33' 20.7"W) is located in the city of Mar del Plata City, General Pueyrredón County, Buenos Aires. Is situated in the Pampean plains, on the right margin of Corrientes stream and at 0.65 km north-west from modern littoral (Argentine Sea, Southwestern Atlantic Ocean). In 2006 a total surface of 17 m^2 were excavated, where more than 2,139 lithic artifacts and 8,945 faunal remains were recovered. The archaeological remains were deposited on the edge of a lagoon located in the

dune line. A radiocarbon age of 5,700 years BP places the human occupation within the range of the Hypsithermal (= Climatic Optimum) warm event. Faunal species associated with warm arid (*e.g. Tolypeutes matacus*) as much as with warm humid settings (*e.g. Holochilus brasiliensis*) were recorded in Alfar, forming a non-analogous assemblage. In addition, greater proportions of root etching on bone specimens surfaces were recorded in the sequence's base (19% versus 7.24% on the top), indicating certain landscape stability. It is important to underline the low collagen content of the bones, due to a strong bacterial activity in an aerobic and rich organic matter environment and to temporary water presence in the levels that contains the archaeological remains. The results of the siliceous microremains analysis in four samples (M1, M2, M3 and M4) of Alfar West profile indicate similar phytolith proportions throughout the sedimentary sequence. The dominant morphotypes are: elongated with smooth or echinate, unciform hair cells, acicular hair cells and air bases (especially in M2), short cells -in particular bilobates in M1-, rondel, trapeziform short cells and trapeziform sinuate and cylindrical polilobated (in M2), etc. All of these morphotypes correspond to the gramineous family, typical of the Pampean grasslands. Saddle phytoliths are recorded in the entire stratigraphic column, increasing their frequency towards the top (M3). These cells are characteristic of C4 gramineous plants that grow in environments with elevated temperatures, hydric stress and/or presence of salts. In sum, the results of the palaeobotanical analyses, complemented with the archaeofaunal studies, show the existence of a permanent cover of gramineous communities on a lagoon margin, a considerable pedogenetic activity and a progressive tendency of drying towards the top of the profile. The data obtained indicates that the human populations occupied Alfar site under conditions of dryness, but with warm climate at mid-Holocene Hypsithermal.

Phytolith perspectives in Amazonian archaeology

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The present work will present an overview of phytolith research done in the Brazilian Amazon and to raise future possibilities for this kind of analysis in archaeological sites of the area. In the last decades microvestige studies have resulted in great contributions towards the understanding of life styles of past populations around the world. Due to the variety of archaeological materials where phytoliths are present and their great taxonomical value, a wide range of information can be acquired trough phytoliths such as paleoenvironmental reconstructions, intra-site interpretations of areas regarding activity, and information on diets of past groups. Phytolith research is under progress in Central Amazonian. The result of a partnership between the Central Amazonian Project (PAC) and the Laboratory of Vegetation Paleoecology (LAPAV) of the National Museum (MN/UFRJ) is a phytolith reference collection focused on amazonian species, which is under construction. Phytolith researches are already on the way and will allow reconstructions on the use of plant resources by human groups throughout the area occupation history, permit the evaluation of the use of traditional ethnographic analogies to infer various cultigens uses, and provide data on the origins and trajectories of their dispersions.

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Altitude cultivation: phytolith analysis in archaeological farming structures of "Quebrada del Rio de LosCorrales" site (El Infiernillo, Tucuman, Argentina)

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In recent years, agricultural studies in archaeology has been focus on develop new ways of acquiring evidence about farming process characteristics and the cultivated species involved. Following these lines of investigation, the main objective of this work is to make a microfossil characterization (phytoliths and ostracodes) of samples recovered in archaeological farming structures of "Quebrada del Río de Los Corrales" site (El Infiernillo, Dpto. Tafí del Valle. Tucumán). The site is located more than 3200 meters above sea level and shows a wide cultivation platform system *("andenes"*) on slopes as well as sectors with dwellings and corrals; a cave and other structures of not yet known functionality. Radiocarbon dates made on archaeological materials from excavation contexts provenience, settlement pattern characteristics and ceramic stiles found, allowed us to estimate an occupational lapse for the site from ca. 2300 up to 600 years BP. The absence of unequivocal irrigation structures and the particular environmental characteristics derived of it topographic location (with an important low frequence of daytime cloudiness), make us suppose a rainfed sowing agriculture practice *("Secano"*

agriculture). Because of this, it is of great interest to establish which cultigenous would have been cultivated in this structures and the way farming activities took place in past. The excavation of a cave in the site (CC1) near platforms of cultivation location (500 m) shows the presence of maize (*Zea mays*) grains and bodies. This evidence was founded in stratigraphy and also inside (like stuffing) of rock excavated mortars. Likewise, Quinoa granules (*Chenopodium quinoa*), microthermical tubercles and maize vestiges were recovered from mobile milling artifacts. Results of microfossils analysis in platforms will allow us to interpret this evidence in an integrated and precise frame for the site. Five stratigraphic soundings were made for sample collection; four inside the agricultural structures of the subsector II B of the site (cultivation platforms N° 4, 8, 14 and 17) and the other outside the cultivation platforms area to get a comparative soil profile. Standard phytoliths sample collection techniques were used. Processing, analysis and identification of microfossils were done in the "Microfossils Laboratory"- Archaeology and Museum Institute (IAM), Tucumán State University (UNT). Microfossil data will contribute to infer local palaeoenvironmental conditions, cultivation platform hydrological operating, and cultivated species, revealing this way, economic, technological and social aspects of people's lives during the early Formative Period in Northwest Argentina.

Phytolith analysis of microliths from the ceramic level at the prehistoric site of Bagor, Rajasthan, India

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Preliminary studies of microlithic tools from the prehistoric site of Bagor, Rajasthan, India has given an interesting evidence of the tool use and plant exploitation at the site. The site of Bagor is located in the Mewar district of Rajasthan, India. Recent excavations (2000-2001) at the site have yielded evidence of the evidence of transition from hunting gathering (Aceramic phase dated to 5,700 B.C.) to food production (Ceramic phase 4,500 B.C.) A total of 8 microlithic tools and the associated residue were analyzed from the Ceramic phase at the site to get a preliminary idea of the kinds of plants being exploited by the prehistoric people at the site during period. A considerable large number of phytoliths were extracted from the tools and the residue. Trichomes were recovered in large numbers followed by Festucoid and Elongate types. Panicoids dumbbells of short shaft were also noted. Few short fan shaped bulliforms were also recovered. The residue surrounding the tools showed similar assemblage of a wide variety of phytoliths but fewer phytolith subtypes were found in large numbers. The analysis of residue also shows more bulliforms subtypes such as square, rectangular, stony bulliform and various fan shapes. The preliminary analysis of the tools and the residue suggests that the tools were probably used on plants mostly of hairy nature such as *Cucurbitaceae, Leguminosae* and/ or *Oryza* types. The study on phytoliths from such microlithic tools is conducted for the first time in the Indian archaeological context.

Phytoliths as indicators of burial ritual of the sarmatian culture

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The study of paleosols buried under kurgans (burial earth mounds) in the Early Iron Age within the Orenburg region (south of Russia) has been carried out. The paleosols were buried at the Savromatian Time (5th century BC), the Early Sarmatian Time (4th-2nd centuries BC) and the Late Sarmatian Time (2nd-3rd centuries AD). Based on phytoliths analysis the vegetation cover on the buried paleosols surface was usual for the region studied, the steppe grasses predominated indicating that the precipitation of the Savromatian Time (5th century BC) was as much as it is nowadays. It is likely to suppose that at the Early Sarmatian Time the climatic conditions become more humid and remained without change until the end of the 3rd century AD. Then, at the border between 3rd and 2nd centuries BC or at the latest IIIth century BC, the climatic conditions changed abruptly toward more aridity, when the precipitation reduced considerably – 50-75 mm lower than nowadays. At the beginning of the Late Sarmatian Time the arid climatic episode ended, and increases in precipitation and some fall of temperature are noted. The microbiomorphic analysis of the buried paleosols showed that before the burial mound construction the plant cover on the paleosols surface was burnt in all the cases. In addition, charred phytoliths of big water plants have been observed in almost all the samples. Just those plants are often used for covering and matting of tombs. We supposed that plants (or already spliced mats) used for burial ritual were burnt. One part of the phytoliths observed were not charred. It is possible that the surface of the paleosols were exposed for at least a season after fire and some meadow and steppe grasses had enough time to re-grow. It is not also inconceivable that uncharred

phytoliths were derived from the peripheral parts of burial site, which were not subjected by the strong fire impact. Kurgans were built on the burnt site with the full-grown grasses. The study of the uppermost layers of buried paleosols shows the similarity of the composition for microbiomorphic fractions having the artificial genesis. It lets us conclude the similar character of the burial ritual in all the cases studied.

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Ten years after, how far have we come in our knowledge of ancient agricultural systems and domestic activities through microfossil and soils studies?

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Various years ago we developed a methodology to study ancient agriculture in the southern Andes from the productive open air sites themselves. After some successful results we extended this methodology to domestic activities in sites with poor organic conservation. Ten years later, we offer this synthesis of the archived goals, we explain the new trends we are following, and we share the aspects we could not resolve yet. We started to realize we would find the following problems and situations:

- Most of these studies on agriculture have been about architectural facilities and localization or macro botanical remains, taking into account environmental and ethnographic sources.
- There are not many staples or economic taxa that produce non-redundant phytoliths and are possible to grow in the arid Andes environment (Puna and Sierra).
- Food production in the Andes involves mixed farming and herding systems and a strong reliance on the gathering of wild resources.
- Microfossil assemblages and soil studies should be studied together for ancient agriculture, and combined with other traditional data set as morphology, localization, architectural facilities and other surface features.
- Taphonomic and pedogenetic processes equally affect all particles contained in the silt fraction; therefore microfossils can be displaced both vertically and horizontally.

We present here a discussion around all the case studies we have done these last years in Argentina, most from the Valley of El Bolsón (Catamarca province, but also from Calchaquí Valley (Salta), and Quebrada de Humahuaca, (Jujuy).

Phytoliths in quinoa production fields: ethnobotanical and archaeobotanical approaches

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In this presentation both ethnobotanical and archaeobotanical approaches were used to evaluate if it is possible to identify ancient quinoa production by means of phytoliths analysis of cultivation fields. The archaeological site Bella Vista Loma is located in the town of Villa Candelaria, Colcha K area (Potosi, Bolivia), a place where quinoa cultivation is a common tradition. It was occupied between 1200 and 1450 AD. It has agricultural structures which are supposed to have been associated to a "pukara" at a distance of 3km from this site. For the present work one of the archaeological agricultural structures was excavated following artificial levels from 0 to 40 cm depth. One sediment sample of each level was recovered and processed in order to isolate phytoliths following basic protocols without using heavy liquids. The four levels reflected the presence of different morphotypes which were grouped in: Festucoid 33.45%, Panicoid 27.25%, Chloroid 1.93% and other grass types 7.49%, with no morphotypes of quinoa. In order to interpret these results, ethnobotanical approach was used to: a) analyse modern quinoa production in the Villa Candelaria, b) establish cultivation and post-harvest traditional practices and their spatial management, and c) evaluate possible points of release of phytoliths to the sediment. Ethnobotanical studies were carried out using standard techniques. Results show that during the growing period of the plants in the cultivation fields people used to collect their leaves for fresh consumption. Once the grains are ripe enough people collect panicles and leaves while roots and stems remain in situ. The harvested panicles are placed all together in one place for drying. Threshing ("desgranado") is done inside or outside the field by rubbing the panicles against each other to release the grains. In the same place of threshing the resulting assemblage is winnowed ("venteado"), and grains are prepared for storage. In addition, a characterization of phytoliths assemblages from modern quinoa cultivation fields was done. Two sediment samples were obtained from soil located under specific quinoa plants. Results showed the presence of different morphotypes which were grouped in: Festucoid 35.57%, Panicoid 13.67%, Chloroid 2.03% and Other grass types 12.63%, with the absence of quinoa morphotypes. As a conclusion it can be stated that the absence of phytoliths in archaeological structures not necessarily imply the absence of quinoa cultivation. It is possible now to

generate some hypothesis related to the absence of quinoa morphotypes in archaeological agricultural structures. Bearing in mind that phytoliths of quinoa plants come from leaves, it has been considered three prospective hypothesis: 1) the number of phytoliths released under in situ cultivated plants may be highly reduced by consumption of fresh quinoa leaves, and 2) differential concentration phytoliths areas may be generated after winnowing, which produces a secondary deposition of fragments of the few leaves that accompany the panicle, the localization and extent of these areas may vary depending on the place selected for winnowing and the wind intensity; 3) micro-silicon remains of quinoa can be fragile and, therefore,do not survive in their full morphology in the sediment to be identified as such. These hypotheses will be tested in future work.

First contributions of phytolithic studies to the paleoenvironmental reconstruction of the Maripe Cave site, SantaCruz

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The Maripe Cave is located in the archeological site called “La Primavera” in the Deseado Mass located in the province of Santa Cruz, Argentina, at S 47º51´05´´ and W 68º56´03´´. It is a cave of large dimensions whose stone casing is ignimbrite corresponding to the Chön Aike formation, divided into two chambers (North and South) by a rocky partition that comes down from the ceiling. The objective of this study is to perform the first approach to a paleoclimatic and paleoenvironmental reconstruction of this area. Previous studies indicate differing environmental and depositation conditions in each chamber, which permits us to interpret them as microenvironments. The radiocarbon dating obtained show occupations extending from the Early Holocene up to historical times. The sedimentary sampling was performed during field work in 2007, and the following profiles were taken: N and W profile from square C5 in the north chamber and W profile from squares A12 and B12 in the south chamber. Analyses were done on material from six fires, six associated sedimentary levels in both chambers, and a level of charred compact manure from sheep and/or guanacos that, in their burning, sealed and protected the sequence. The samples were treated according to standard techniques and the phytoliths were described following the nomenclatures defined by ICPN (2005) and Twiss (1992). Four hundred individual portions were counted and a statistical estimate was made according to cluster analysis. In relation to the all the components analyzed, the results obtained from the phytolithic studies show a clear differentiation between the level of pellets, the fires and the sediment in the different layers of the sequence. The phytolith content, as was expected, was at its maximum (75%) at the level of coprolites or pellets, though having a lesser diversity of morphotypes as regards the totality of the components. The fires were where there was the greatest amount of phytoliths, between 50 and 60%, and a greater variety of morphotypes, which differentiates the various sedimentary layers. However, these too have abundant and varied phytolithic morphotypes, which proves the dispersion and manipulation generated by the human activity. The fires (1 and 5) that have less phytolith content (near 40%) are the ones that have a greater content of charred plant remains (carbon 10-15%), with regards to the total components. Two of the fires (3 and 6) have few carbon remains and the sedimentary layers and the level of pellets present scarce or no charred plant remains. Fire number 5 is one of the context markers of one of the most extended occupations of the cave and corresponds to a dates of 8,762 ±50 BP. Its phytolithic content surpasses 40% and the charred remains, 15%. Articulated phytoliths of the remains of epidermis and some subepidermic tissues of grasses of a considerable size were found in the middle of the fires and at every sedimentary level studied. Generally most of the morphologies found in all our samples studied correspond to grass vegetation. Scarce amounts of diatoms were found in the upper level, possibly associated with temporary pooling and crusting of the second layer. These studies together with others (pollen and other pant remains) will provide knowledge about the predominant vegetation existing during different moments of occupation in the cave and its surrounding, climate conditions and how these have changed with the passing of time, and even to construct present environmental conditions, as they would serve as indicators of climatic and evolutionary changes that contribute to achieving better and more precise interpretation of the uses human beings might have make of their environment and of their interaction with available plant recourses.

The early holocene palaeoenvironment of the Dogon-plateau (Mali): phytoliths in a multiproxy context

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The site Ravin de la Mouche on the Dogon Plateau is of special archaeological significance because in its Early Holocene deposits (11.350-10.350 calBP), pottery sherds have been found which are among the oldest in Africa so far. For a better understanding of the environmental conditions which might have contributed to the innovation of pottery making, we applied a multi-proxy approach, including phytoliths, micromorphology, pollen, charcoal and palynofacies. Phytoliths were extracted from the Pleistocene base and the early Holocene layers HA1, HA2 and HA3. The multi-proxy approach also allows reconstruction of the complex taphonomy of the site. In our phytolith study, we used a combination of the general and the specific approaches. We recorded a maximum of morphotypes, and used the summarized data for a calculation of the indices D:P, Ic, and Iph, in comparison with modern surface samples and data from other African phytolith studies. With the general approach, a number of morphotypes could be detected which are useful in describing the Late Pleistocene and the Early Holocene vegetation. The Pleistocene sediment samples, with an age of ca. 30-40 ka BP, have no grass short cell phytoliths (GSCP) und seem to represent a woody-herbal vegetation with no modern analogue. HA1 is a coarse fluvial deposit with mainly redeposited phytoliths of Pleistocene origin. The palaeosoil in HA2 contains phytolith assemblages developed in situ from a terrestrial plant cover. The vegetation was an open tropical grassland and a gallery forest with palms and Marantaceae. The grassland was dominated by annuals from the grass subfamilies Chloridoideae and Panicoideae, with a low biomass production. This might explain the insignificant role of fire, as indicated by the very low number of micro-charcoals. HA3 results from a rhythmic deposition of alluvial sediments, pointing to pronounced seasonality of rainfall and discharge. It contains pollen, charcoal, and phytolith assemblages with a similar composition as in HA2. The abundant micro-charcoal in HA3 mainly originated from woody plants in the gallery forest and gives further evidence for low fire activity in the grassland. The Early Holocene annual grassland on the Dogon Plateau probably harboured a high number of species with edible grains from the grass subfamily Panicoideae. We suggest that the massive expansion of useful Panicoid grasses during the Early Holocene triggered the innovation of pottery production. Cooking wild cereal grains in a ceramic container enabled an effective exploitation of the vast Sahelian grasslands which remained to be successful until modern times.

Preliminary results on the phytoliths of the dutch neolithic site swifterbant as seen from samples retrieved from soils, pig droppings and molars

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The major aim of our work was to elucidate the environmental background of the Dutch Neolithic site Swifterbant based on the investigation of phytolith remains retrieved from soil samples. Another interesting question was to clarify the nature of various pocket structures observable in the layers- whether they were formed as a result of human productive activities (plowing) or simply attributable to natural post-sedimentary processes. Samples were taken at 1 cm intervals vertically from the soil section plus additional samples were taken from each of these pocket structures and the adjacent horizons above and below. Pig coprolites yielded an astonishing phytolith assemblage which was compared to that of the soil samples. A pig tooth also yielded evaluable material via detailed investigation using SEM. The evaluation of phytolith assemblages retrieved from the soil horizons plus those ending up in the droppings of pigs feasting in the area permitted a sketch of a relatively reliable environmental picture of the area. All these refer to the presence of a Neolithic horticulture (cereal cultivation) under balanced micro-climatic conditions as a result of the vicinity of the nearby floodplain.

Phytolith and spherulite evidence for numidian economic diversity at Althiburos (El M'deina, Dahmani, Kef governorate, Northern Tunisia)

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The research carried out at Althiburos (El M'Deina, Dahmani, Kef Governorate, northern Tunisia) has demonstrated the existence of pre-Roman levels in the central area of the site. Questions that arose from their study related to the identification of settlement patterns at this time. The results obtained from the combined study of phytoliths and spherulites

identified in specific archeological contexts at the site are presented and discussed here. Samples were selected from different excavation areas located on the southern edge of the *Capitolium*. The results of this study provide more information about the use of space at the site, and more specifically the manner in which vegetal resources and dung were exploited by the ancient inhabitants of the site. These analyses were only the beginning of systematic studies of phytolith and spherulite evidence for economic diversity at the site.

Inflorescence phytoliths of Sahelian cereals

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The African Sahel has numerous resources of crop plants for alimentation. The archaeological record of wild cereal utilization goes back 11,000 years, domesticated cereals appear around 2000 BC (*Pennisetum glaucum*). The majority of cultivated and gathered cereals of the region belongs to the Panicoideae, a subfamily of the Poaceae (grass family). During the processing of the cereal grains, stone tools were used for pounding, milling and removal of the chaff. As the glumes have a high silica content, these tools are potential carriers of phytoliths. Identification of the processed species by their phytoliths is of high value for archaeobotanical research. A reference collection of inflorescence phytoliths from wild and domesticated Sahelian grasses was performed. Phytolith types were classified based on their two and three dimensional structure with the objective to identify species specific phytolith morphotypes or assemblages. The developed classification will be tested with stone tools from archaeological contexts. Furthermore, we will check if wild and domesticated plants might be differentiated.

Show me the evidence: resolving blake' s early maize-late maize dilemma and the development of agriculture in formative cultures in the new world.

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The ubiquitous presence of maize throughout most of North and South America at the time of European contact supported the perception that maize (*Zea mays* L.) was the foundation of agriculture in the New World. Similarly, it was easy to assume that maize was the economic, social and historical equivalent of Old World Neolithic cereal grains, such as, wheat, barley, rice, etc., in the development of American Formative cultures. As a major silica accumulator, maize had been a prime candidate for phytolith analysis in New World archaeological investigations beginning some 30 years ago, especially in early cultural horizons where preservation of organic remains was problematic. Indeed, initial reports claiming the presence of diagnostic maize phytoliths in early contexts dating to the beginnings of Formative cultures in Central and South America were readily accepted and widely acclaimed. However, as new, independent lines of analysis were developed, e.g., stable isotope analysis, direct AMS carbon dating, DNA-genetics, etc.; consistent and compelling evidence was compiled to indicate a very different history of the importance of maize in the early agricultural systems. A comprehensive review volume (Histories of Maize, Academic Press, 2006). presents a case for the universal absence of maize in early Formative contexts Maize, surprisingly, appears relatively late virtually everywhere, including in Central Mexico, the region of genetic origin of domestic maize. The assumption that maize agriculture is strictly analogous to the Old World Neolithic model is severely questioned, suggesting that native peoples of the New World followed their own uniquely creative and successful industrial and economic progression through history rather than any single, deterministic model of cultural evolution. In Histories of Maize, Michael Blake summarizes and compares many independent lines of evidence for maize origins and development. With one exception, there is a consilience of evidence supporting the late maize model. Only phytolith evidence supports the early maize model. Blake notes the discrepancy but is unable to suggest any reconciliation. It is evident that this requires a thorough review of the phytolith evidence to confirm its validity. Critical scrutiny of published data used to develop maize phytolith identification protocols exposes a distressing combination of misuse and misinterpretation of reference data as well as pervasive systematic errors in typology and measurement. This reported method of identification is false and unreliable. Review of published archaeological data demonstrates that reports of maize phytoliths are far more likely derived from a local grass widely used as roof thatch. The result is a totally inaccurate history of maize which merits summary disqualification. The reported method of maize phytolith identification is so demonstrably flawed and inaccurate that the phytolith community must scrutinize itself to determine why these results were so widely accepted by so many for so long. It demonstrates a disturbing preference for preconceived assumptions and subjective perceptions over clear and objective

evidence, especially by those who continue to support and promote it in the face of such compelling evidence to the contrary.

Phytolith pathways onto a Near Estern Neolithic tell site: some initial perspectives from Çatalhöyük

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Çatalhöyük (East Mound) is an important early agricultural Neolithic tell site situated in Central Anatolia. The site is notable for both its size and long duration of occupation, providing an opportunity to study variability in phytolith assemblages from different types of contexts. This paper will overview some of the approaches used to investigate phytolith pathways onto Çatalhöyük and the relevance this has to the interpretation of phytolith assemblages from Neolithic tell sites. Numerous examples of visible phytolith remains present specific information about plant use in construction and craft activities. The impact of dung fuel use and the utilization of crop-processing by-products on the interpretation of phytolith assemblages from key archaeological contexts are also considered.

Phytoliths as indicators of temporal shifting of craft activity areas at archaeological site

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An attempt is being made to blend archaeological and botanical evidence and techniques in resolving archaeological issues. Archaeobotanical studies done so far in India mainly focused on the analysis of seeds, woods, and grains and in developing pollen profiles of the regions. The application of phytolith study in India to recover information regarding floral remains from archaeological sites is a new area of research. The study of archaeological soil samples recovered from the excavations at Dhanuhi Rock-shelter in the Rewa District, M.P. India a late Upper Palaeolithic site has thrown interesting light on the potential and significance of phytolith study in reconstructing material used in different craft activities carried out by inhabitants at the site. Archaeological evidence retrieved from the spit-wise excavation of the site and its correlation with layers, recording of spatial distribution of lithic artifacts in the excavated grids and variation in the frequency of raw material plausibly suggest that the site had been used for a considerable time but not on regular basis and inhabitants were performing different craft activities in different areas under their occupation. It has been observed that the activity areas were changing with time and space. Botanical evidence, phytoliths retrieved from soil samples of different depth and space highly corroborate with the archaeological evidence. The spatial and temporal distribution pattern of phytoliths of different plants, their quantification and seasonality of plants clearly suggest that the inhabitants after the break who reoccupied the site hardly carried out other craft activities at the earlier spot.

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