Cadernos do Lepaarq

RECONSTRUCTING PRE-COLOMBIAN AGRICULTURAL PRACTICES IN THE BOLIVIAN SAVANNAH: STRATIGRAPHIC AND PHYTOLITH EVIDENCE FROM RAISED FIELDS AT CAMPO ESPAÑA, WESTERN LLANOS DE MOXOS

RECONSTRUINDO PRÁTICAS AGRÍCOLAS PRÉ-COLOMBIANAS NA SAVANA BOLIVIANA: EVIDÊNCIAS ESTRATIGRÁFICAS E FITOLíTICAS DOS CAMPOS ELEVADOS NO CAMPO ESPAÑA, LLANOS DE MOXOS OCIDENTAL

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Reconstructing pre-Colombian agricultural practices in the Bolivian savannah: stratigraphic and phytolith evidence from raised fields at Campo España, western Llanos de Moxos

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Abstract: Pre-Columbian inhabitants of the western Llanos de Moxos, Bolivia, transformed large expanses of seasonally flooded savannah into a complex agricultural landscape. Extensive raised field systems, along with associated canals and causeways, suggest a sophisticated approach to managing land and water resources for permanent, intensive, agricultural production. However, the detailed construction history, specific crops, and palaeoenvironmental impacts of these fields are poorly known. To investigate these issues, we analyzed stratigraphy and phytoliths from two raised fields (camellones) at the site of Campo España, western Beni, Bolivia. Results indicate that prior to field construction, vegetation was mainly palm savannah. A decline in arboreal phytolith frequencies is associated with human clearing and initial field construction. A peak in burnt grass phytoliths followed by an increase of Asteraceae, suggests a period of regular field maintenance and intensive agricultural use. Maize (*Zea mays*) and possibly manioc (*Manihot esculenta*) were grown. A small increase in arboreal phytoliths suggests some forest recovery after field abandonment. This study demonstrates the utility of phytolith and stratigraphic analyses in reconstructing construction, cultivation, and palaeoenvironmental histories of raised field systems, and assessing their role within the advanced agricultural landscape management practiced by pre-Columbian populations in the Bolivian Amazon.

Keywords: Raised fields, Agriculture, Palaeoenvironment, Phytolith Analysis, Stratigraphy, Amazonia.

Resumo: Os habitantes pré-colombianos de Llanos de Moxos ocidental, Bolívia, transformaram grandes áreas de uma savana sazonalmente inundada em complexas paisagens agrícolas. Extensos campos de plantação, assim como canais e caminhos associados, sugerem uma abordagem sofisticada para o manejo da terra e dos recursos aquáticos para produção agrícola intensiva e permanente. No entanto, detalhes sobre suas histórias construtivas, plantações específicas e os impactos paleoambientais destes campos são pouco conhecidos. Para investigar estas questões, analisamos a estratigrafia e os fitólitos de dois destes campos elevados (*camellones*) do sítio Campo España, oeste de Beni, Bolívia. Os resultados indicam que antes da construção dos campos, a vegetação era majoritariamente uma savana com palmeiras. O declínio na frequência de fitólitos arbóreos é associado com uma limpeza da área pela ação humana e o início das construções dos campos. Um pico nos fitólitos de grama queimada seguido por

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um aumento de *Asteraceae*, sugere um período de manutenção regular dos campos e uso agrícola intensivo. Eram cultivados milho (*Zea mays*) e possivelmente mandioca (*Manihot esculenta*). Um pequeno aumento dos fitólitos arbóreos sugere certo grau de recuperação da floresta após o abandono dos campos. Este estudo demonstra a utilidade de análises de fitólitos e estratigráficas na reconstrução dos processos de construção, cultivo e história paleoambiental dos sistemas de campos elevados e na avaliação de seus papeis dentro do avançado manejo de paisagens agrícolas praticadas por populações pré-colombianas na Amazônia boliviana.

Palavras-chave: Campos elevados, Agricultura, Paleoambiente, Análise de Fitólitos, Estratigrafia, Amazônia.

INTRODUCTION

The Llanos de Moxos of lowland Bolivia are known for their extensive pre-Columbian earthworks, including canals, causeways, large habitation mounds, and raised fields. The scale of these earthworks suggest the area was home to a large, socially-complex population prior to European contact (NORDENSKIÖLD 1913, 1924; DENEVAN 1966; DOUGHERTY and CALANDRA 1984; ERICKSON 2000a, 2000b; DENEVAN 2001; PRÜMERS 2004; WALKER 2004; ERICKSON 2006; ERICKSON and BALÉE 2006; PRÜMERS 2006; ERICKSON 2008; WALKER 2008a, 2000b; PRÜMERS 2009a, 2000b; ERICKSON, 2010; WHITNEY et al. 2013). Of the various types of earthworks documented in the region, raised fields (or camellones) are among the most spatially extensive (PLAFKER 1963; DENEVAN 1970; LEE 1979; ERICKSON 1980, 1995; LEE 1997; WALKER 2000, 2004; ERICKSON 2006; WALKER 2008a; NORDENSKIÖLD and DENEVAN 2009; LOMBARDO 2010; LOMBARDO et al. 2011; RODRIGUES et al. 2014). In the Llanos de Moxos they are found west of the Mamoré River, in the south around the modern towns of San Borja and San Ignacio de Moxos, and north around the modern town of Santa Ana de Yacuma. These raised fields are presumed to have been constructed by pre-Columbian people as a way to improve agricultural productivity by draining areas of the landscape regularly affected by seasonal flooding (LEE 1997; DENEVAN 2001; LOMBARDO et al. 2011), and improving soil fertility and growing conditions (LEE 1997; SAAVEDERO 2006; ERICKSON 2006, 2008; WHITNEY et al. 2014; but see LOMBARDO et al. 2011). Construction of raised fields may have occurred as early as 400 BC, based on dates obtained by Erickson and colleagues (ERICKSON et al. 1991; cited in ERICKSON 1995, 2006) at the site of El Villar along the San Borja-Trinidad highway. The raised fields at nearby Bermeo were in use as early as AD 570 (RODRIGUES et al. 2014). Archaeological sites associated with fields in the Santa Ana de Yacuma area were inhabited by AD 600 (WALKER 2004).

Although most researchers agree that the raised fields were artificial platforms constructed for growing agricultural crops, only recently have archaeobotanical studies been conducted to identify the actual species cultivated on the fields, and the paleoecological consequences of cultivation (ERICKSON 1995; WHITNEY et al. 2014). Denevan (2001) proposed that raised fields would have been most suitable for growing root crops, such as manioc (*Manihot esculenta*), but lacked empirical data to test his hypothesis. Pollen from *Bixa*, *Ilex*, and *Xanthosoma*, along with a wide range of grasses, trees, and aquatic plants, was recovered from fields examined by Erickson (1995) and colleagues at El Villar, which suggest that the fields were used to cultivate both food and industrial crops. Phytolith analysis on raised fields associated with the archaeological site of El Cerro in the Iruyañez-Omi area north of Santa Ana de Yacuma documented evidence for the cultivation of maize (*Zea mays*) (WHITNEY et al. 2014). Palynological analysis of cores from two nearby lakes confirmed the use of maize, and also indicated that sweet potato (*Ipomoea batatas*, which does not produce phytoliths) was cultivated. Assessment of the phytolith and pollen records showed a history of field construction, fire-use, cultivation, landscape management, and later field abandonment before European contact (WHITNEY et al. 2014).

There is a good deal of variability in where raised fields are located on the landscape, their shape and orientation, and soil type. They are found not only on clays of low-lying, inundated or waterlogged savannah, but also on moderately fertile loam or silt soils of river levees and forested areas (LOMBARDO et al., 2011; RODRIGUES et al. 2014). Lombardo et al. (2011) suggest that raised field complexes in different areas were constructed for different purposes, related to local topography, inundation patterns, and cultural needs, but mainly they were built for drainage purposes.

As part of the Leverhulme Trust funded project ‘Pre-Columbian land-use and impact in the Bolivian Amazon’ investigating human-landscape interactions, we examined several raised field systems from different locations in the western Llanos de Moxos in order to compare construction histories, cultivation practices, and palaeoenvironmental impacts. In this article we present results from analysis of raised fields at the Campo España site in the far western part of the Llanos de Moxos, approximately 3 km northeast of the modern town of San Borja (Fig. 1). The site is named after the ranch on which it is located. It was first investigated by Erickson and Faldin in 1978 (ERICKSON 1980), who noted a complex set of earthworks, including canals, causeways, mounds, an artificial walled reservoir, and raised fields (camellones) covering an area of several square kilometers. In 2010, we visited the site and excavated trenches across two of the raised fields and their adjoining channels, to investigate their stratigraphy and construction, and to obtain sediment samples for analysis.

Environmental Setting and Modern Vegetation

Campo España is situated near the western edge of the Llanos de Moxos, a vast (130,000 km^2) seasonally inundated landscape of mixed savannah and forest in the Beni Department of Bolivia, part of the Amazon watershed. Vegetation around the site today is mostly open grassland with dispersed trees and small patches (<20 m to 1 km across) of tropical *cerrado* and secondary evergreen forest. Current land use is predominantly cattle pasture. Livestock grazing, along with periodic burning of the grasslands during the dry season, keeps the vegetation more open than it would be without human intervention. The topography is flat and drained by rivers that originate in the Andean foothills to the west and in the dry-season are meandering and slow-moving. The site is approximately 3 km north of the Río Maniqui, a tributary of the Río Rapulo, which eventually flows into the Río Mamoré. Numerous infilled oxbows and lateral accretion deposits in the area evidence the meandering history of the river.

A botanical survey of the modern vegetation was conducted on the Campo España raised field complex and surrounding area by JDS. Taxa encountered in the survey areas were identified and recorded (Table 1), and voucher specimens placed in the herbarium of the 'Noel Kempff Mercado' Natural History Museum in Santa Cruz, Bolivia. Results of the survey show that modern vegetation on the camellones is dominated by grasses and herbs, such as *Aristida capillacea*, *Panicum discrepans*, *Sauvagesia erecta*, *Hyptis* sp., *Desmodium triflorum*, and *Vernonia patens*. Many of the species found on the platforms are also found in the channels of the camellones, although several grasses tend to be more abundant in the channels. These channels are dry during the dry season (May-October), which is when the botanical survey was conducted. Occasionally, small *cerrado*-type trees or shrubs grow on the camellón platforms. Vegetation in the nearby wetland areas includes aquatic herbs like *Ludwigia sedoides*, *Eichornia* sp., and *Diodia kuntzei*.

Average annual temperature is 25 °C, and annual rainfall is 1500-1750 mm, most of which occurs between November and April. Flooding can occur as the result of localized precipitation in the San Borja region or heavy rainfall in the Andes (LOMBARDO et al. 2011). The landowner reported that during the rainy season at Campo España, the major canals occasionally overflowed into the adjacent channels between the raised fields, but the field platforms themselves remained above the water level.

Table 1: Modern floristic inventory of the Campo España site.

Family	Species	Location	Habit
Acanthaceae	*Ruellia bulbifera* Lindau	Camellón	herb
Amaranthaceae	*Gomphrena* sp.	Canal	herb
Anacardiaceae	*Astronium* sp.	Forest island	tree
Annonaceae	*Annona dioica* A. St.-Hil.	Camellón	shrub
Asteraceae	*Elephantopus* sp.	Camellón	herb
Asteraceae	*Pterocaulona lopecuroides* (Lam.) DC.	Camellón	herb
Asteraceae	*Stevia* sp.	Grassland, dispersed	herb
Asteraceae	*Vernonia brasiliensis* (Spreng.) Less.	Camellón	shrub
Asteraceae	*Vernonia patens* Kunth	Camellón	shrub
Combretaceae	*Terminalia argentea* Mart.	Grassland, dispersed	tree
Cyperaceae	*Cyperus* sp.	Camellón	sedge
Fabaceae	*Aeschynomene pratensis* Small	Canal	herb
Fabaceae	*Desmodium* sp.	Grassland, dispersed	herb
Fabaceae	*Desmodium triflorum* (L.) DC.	Camellón	herb
Fabaceae	*Mimosa xanthocentra* Mart.	Grassland, dispersed	herb
Hydroleaceae	*Hydrolea spinosa* L.	Canal	herb
Laminaceae	*Hyptis* sp.	Camellón	shrub
Lythraceae	*Cuphea* sp.	Camellón	herb
Malpighiaceae	*Tetrapterys* sp.	Camellón	vine
Malvaceae	*Lueheapaniculata*Mart.	Camellón	tree
Monimiaceae	*Siparuna* sp.	Grassland, dispersed	shrub
Myristicaceae	*Virolase bifera* Aubl.	Grassland, dispersed	tree
Myrsinaceae	*Myrsine laetevirens* (Mez) Arechav.	Grassland, dispersed	tree
Ochnaceae	*Sauvagesia erecta* L.	Camellón	herb
Onagraceae	*Ludwigia sedoides* (Bonpl.) H. Hara	Wetland	aquatic herb
Poaceae	*Aristida capillacea* Lam.	Camellón	grass
Poaceae	*Cynodon dactylon* (L.) Pers.	Canal and camellón	grass
Poaceae	*Guadua* sp.	Forest island	bamboo
Poaceae	*Panicum* cf. *dichotomiflorum*	Canal and camellón	grass
Poaceae	*Panicum discrepans* Döll	Canal and camellón	grass
Poaceae	*Paspalum* cf. *minus* E. Fourn.	Canal and camellón	grass
Poaceae	*Paspalum* cf. *plicatulum*	Camellón	grass
Polygalaceae	*Polygala molluginifolia* A. St.-Hil. & Moq.	Grassland, dispersed	herb
Pontederiaceae	*Eichornia* sp.	Canal	aquatic herb
Pteridaceae	*Adianthum* sp.	Camellón	fern
Rubiaceae	*Diodia kuntzei* K. Schum.	Wetland	aquatic herb
Sapindaceae	*Cupania cinerea* Poepp.	Grassland, dispersed	tree
Solanaceae	*Solanum* sp.	Forest island	herb

METHODS

Excavation and Sampling

Two elongated platform-type raised fields, hereafter called 'camellones' (following the common name in Spanish), and their adjacent channels were selected for excavation (Fig. 1). We use the word 'channel' to refer the wide ditches between the elongated camellones, and reserve the word 'canal' to refer to the longer, usually larger and deeper, excavated features which dissect the landscape. Both camellones excavated for this study were located in a group of roughly parallel fields oriented 50° west of grid north. This group is divided into north, east, south, and west sections by a causeway running southwest to northeast, and a major canal running northwest to southeast. This major canal ends at a large, shallow, seasonally inundated depression, which forms the northern and eastern boundary of the camellón cluster. At the northwest end of this depression is a small (ca. 2050 m^2), circular permanent pond or reservoir, partly surrounded by a ca. 2 m high artificial embankment. It is similar to circular walled reservoirs documented at the Salvatierra mound site in the southeastern part of the Llanos (LOMBARDO and PRÜMERS 2010). A second major canal curves around the southern part of the camellón cluster, and also empties into the seasonal wetland to the east. The study cluster is situated to the south of a complex of earth mounds, causeways, and canals, which appear to be the central zone of the Campo España site (Fig. 1). Additional clusters of camellones are located to the north, east, and west of this zone.

Camellón 1 (S 14 49'37.9, W 66 43'15.2) is located in the north section of the cluster approximately 50 m from the permanent reservoir, and separated from it by a well-preserved, elevated causeway. It is 68.7 m long and averages ca. 4 m wide. A 7.0 x 0.5 m trench was excavated across the camellón and the adjacent channel to the north, to expose the stratigraphic profile and permit column sampling. The elevations of the camellones in this area are high, with the highest point of the field platform approximately 70 cm above the current ground surface in the channel. Within the exposed profile, two sediment columns were taken, one at the highest point of the field platform (Camellón 1), and one at the lowest point in the channel (Channel 1). Samples were taken every 5 cm to a depth of 135 cm BS (below surface) in the field column, and every 5 cm to a depth of 90 cm BS in the channel.

Camellón 2 (S 14 49'40.1, W 66 43'16.3), measuring 171.6 m long by ca. 3.5 m wide, was located in the west section of the cluster, approximately 72 m southwest of Camellón 1. The height of the camellones here is significantly lower than in the north section: the highest point is approximately 30 cm above the channel surface at their southeast end, and their height gradually diminishes towards the northwest until they are undetectable. An 11.0 x 0.5 m trench was excavated across Camellón 2 and its adjacent channel to the north. At the highest point of the field platform (Camellón 2), samples were taken every 5 cm until 45 cm BS and every 10 cm thereafter to a depth of 95 cm BS. Within the channel (Channel 2), samples were taken every 5 cm to a depth of 45 cm BS, and then every 10 cm to a depth of 65 cm BS. In addition, three sediment scatter samples were taken from subsurface contexts between the middle point of Camellón 2 and its northwest end.

The stratigraphy exposed in the face of each excavated trench was recorded and each stratigraphic unit was described in the field with respect to soil colour, mottling, structure, texture, and the nature of the boundaries with adjacent units. These field descriptions formed the basis of the interpretation of the stratigraphic units prior to phytolith analysis.

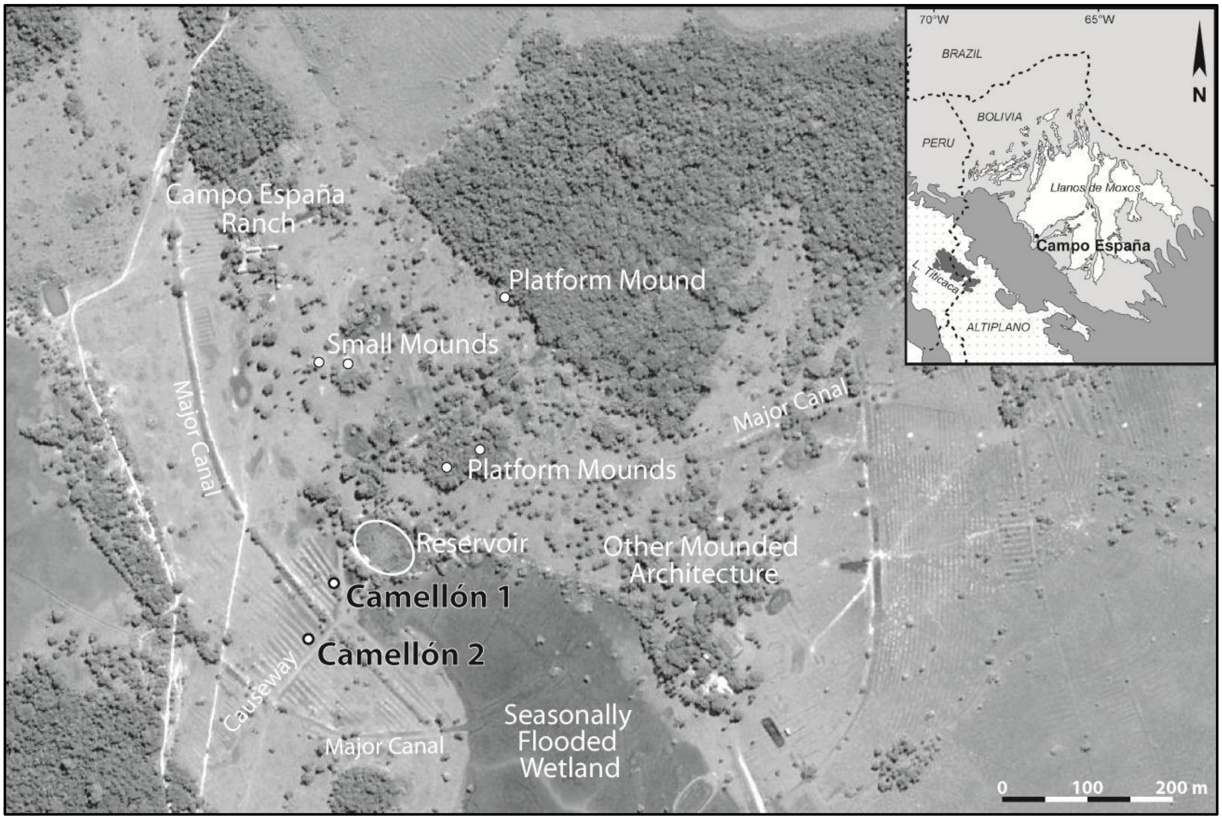

Figure 1: Map of the Campo España ranch showing location of excavated raised fields and surrounding earthworks. Inset map shows the location of Campo España within the Llanos de Moxos (white). Base map from Google Earth 2014.

Phytolith Analysis

The following sediment samples were selected for phytolith analysis: In Camellón 1 and Channel 1, samples from every 5 cm were analyzed from the top 35 cm of the columns, and then every 10 cm from 40 to 80 cm BS. In Camellón 1, two additional samples from deeper levels were analyzed:

one at 105-110 cm BS, and one at the base of the excavation at 130-135 cm BS. In Camellón 2, samples from every 10 cm were analyzed to a depth of 45 cm BS, and then a final sample at 75-85 cm BS near the base of excavations. Within Channel 2, samples from every 5 cm were analyzed to a depth of 25 cm BS, and then every 10 cm to a depth of 45 cm BS.

Phytoliths were extracted from sediments following standard protocols (PIPERNO 2006). One hundred cubic centimeters of sediment per sample were pre-treated to remove clays through deflocculation, agitation, and gravity sedimentation. Samples were divided into silt (A/B-fraction, < 50 µm) and sand (C-fraction, >50 µm) fractions, and the amounts of each fraction recorded, along with the approximate amount of coarse sand/gravel (>250 µm). The sum of these fractions was subtracted from the starting amount of sediment to determine the approximate amount of clay in the sample.

Three ml each of the A/B-fraction and the C-fraction were wet digested with 36% HCl to remove carbonates, and 70% HNO_3 to remove organics. Phytoliths were concentrated by heavy-liquid flotation using $ZnBr_2$ prepared to a density of 2.3 g/cm^3. Approximately 10 mg of extracted phytolith residue from each sample was mounted in Entellan® on a microscope slide. If processed samples yielded less than 10 mg of residue, the entire amount was mounted and scanned. For the A/B-fraction, phytoliths were examined, described, and photographed at 500× magnification. After a minimum of 200 phytoliths were counted, the rest of the microscope slide was scanned to identify any other diagnostic morphotypes and to document Poaceae cross-bodies which were included in discriminant function (DF) analysis to identify the presence of maize (see below). Among grass (Poaceae) phytoliths, only short cells were counted, since long cells, bulliforms, and trichomes are of limited taxonomic value among Neotropical grasses (Piperno, 1988; Piperno and Pearsall, 1998; Piperno, 2006). For the C-fraction, the entire slide was scanned at 200× magnification and all diagnostic phytoliths counted.

With the exception of six samples from Camellón 1 (analyzed prior to the other samples), burnt Panicoideae bilobates were counted in each sample to provide a preliminary perspective on burning on the fields, since particulate charcoal levels have not yet been assessed for the profiles. Burnt phytoliths were identified visually by a darkened colour and reduced transparency and opalescent qualities (PARR 2006). Burnt phytoliths were observed among morphotypes other than Panicoideae, including those associated with herb, sedge, and arboreal taxa; however, these other morphotypes were not present in sufficiently high numbers to permit a statistically robust calculation of burnt phytolith frequency.

Frequencies of morphotypes in the A/B-fraction were calculated as the number of a particular morphotype divided by the total number of phytoliths counted in the sample (i.e. percentage). Burnt Panicoideae bilobate phytoliths were calculated as a percentage of total Panicoideae bilobates. Because

C-fraction samples often yielded fewer phytoliths than the A/B-fraction, and residue amounts were variable, C-fraction frequencies were calculated as an index rather than a percent. This index was calculated as: the number of a particular morphotype divided by the mass (mg) of residue extracted. Data were plotted using the software program C2 (JUGGINS 2003).

Discriminant function (DF) analysis was applied to Poaceae cross-shaped phytoliths from each sample to determine the presence of maize leaves. Cross-shaped phytoliths are produced in the leaves of many grasses, but a discriminant function analysis developed by Pearsall and Piperno (PEARSALL and PIPERNO 1990; PIPERNO 2006; see also IRIARTE 2003) uses size and three-dimensional morphology of cross-shaped variants to statistically identify the presence of maize in soil phytolith assemblages from the Neotropics. Cross-shaped phytoliths were classified to eight morphological variants based on three-dimensional rotation (PIPERNO 2006). The width was measured using digital imaging software and the mean calculated for each Variant. The discriminant function is as follows (PIPERNO 2006:55):

Maize Prediction: -1.96669 + 0.1597589 (mean width for Variant 1) - 0.0126672 (mean width for Variant 5/6) + 820956 $^{-3}$ (% Variant 1)

Wild Prediction: 2.96669 - 0.1597589 (mean with for Variant 1) + 0.0126672 (mean width for Variant 5/6) - 8.20956 $^{-3}$ (% Variant 1)

DF analysis was not applied to assemblages of less than 20 cross-shaped phytoliths.

RESULTS

Stratigraphic Analysis

The stratigraphy of Camellón 1 is complex, the product of construction, maintenance, and erosion and further transformed by pedogenic processes over several centuries before and after field construction (Fig. 2A). The tropical climate of warm temperatures and frequent rainfall provide conditions for intense weathering, while seasonal inundation of the soils causes frequent changes in redox conditions that control iron mobility. Within the field section of the profile, the basal stratigraphic unit (Unit 1) of red blocks within a light brown-red clay loam matrix appears to be undisturbed pre-construction subsoil, with structure and colour variation that reflect natural pedogenic processes dominated by seasonal changes in soil moisture. Within the channel, this stratigraphic unit is not encountered (although it may be present below the maximum depth excavated) and it seems probable that it was dug out during initial construction and piled alongside to create the original field platform.

The stratigraphic units overlying Unit 1 in the field section lack the large-scale structure and colour differentiation seen in Unit 1 interpreted as indicative of undisturbed matrix. Therefore, we suggest that these overlying units have either been re-worked *in situ* or moved to this location during field construction and use. The presence of mottling in Unit 4 is indicative of iron mobility during seasonal waterlogging of the sediments. The morphology and colour of Units 3, 4, and 6 are consistent with mixing and accretion (either gradual or rapid) during the period of field use, followed by pedogenic horizonation since abandonment.

As mentioned, Unit 1, interpreted as undisturbed subsoil, is not observed in the channel. Therefore, the stratigraphic units of the channel are interpreted as accumulated sediments that post-date field and channel construction. There is little strong morphological evidence for their origin, although in Units 7 and 8 there is some tendency towards banding, potentially a product of incremental *in situ* deposition. Given the time available for post-depositional disturbance and the potential for bioturbation, the minimal nature of this evidence and the absence of layering in the surface horizon (Unit 9) are not surprising. The main distinction between the stratigraphic units within the channel is based on colour, and it is likely that this is dominated by pedogenic processes, especially the supply of organic matter and the mobility of iron. There is little variation in texture between the units, all comprised of clay loam. Therefore, while these units are interpreted as the product of gradual sedimentation of the channel (potentially both during and after active field use), there is no strong morphological evidence to assess the rate of deposition or if it varied over time. At the margins of the field platform, there is stronger evidence of soil mobility in the bright wedges of yellowish brown silt interspersed with light brownish grey silt evident in Unit 2.

Camellón 2 is not as high as Camellón 1, and the stratigraphy is less complex (Fig. 2B). It appears that this camellón is either more degraded than Camellón 1 or was originally a lower relief feature. The basal stratigraphic unit (Unit 1), consisting of reddish-brown blocks interspersed with a whitish clay loam matrix, is interpreted as the pre-construction subsoil, like Unit 1 in Camellón 1. The upper boundary of this unit follows the contours of the modern field surface; however, it has limited lateral extent. If Unit 1 was originally more extensive, parts of it have been excavated from the channel. The profile of Unit 1 suggests that the original camellón platform was at least 38 cm above the level of the channel, and likely more. Unit 2 extends from the lateral margins of Unit 1 across the remainder of the raised field and channel. It consists of a white clay loam matrix with orange mottles, indicative of episodic iron mobility. It is interpreted as reworked soil from camellón construction, either *in situ* on the field platform or transported into the channel. The surface unit (Unit 3) overlies both the field and the channel. It is a horizon of grey loam of relatively uniform thickness (ca. 10 cm), interpreted as being of pedogenic origin, the colour reflecting organic matter input from the surface vegetation. The uniform thickness suggests that the pedogenic environment that formed this horizon has operated on the land surface since establishment of the current morphology.

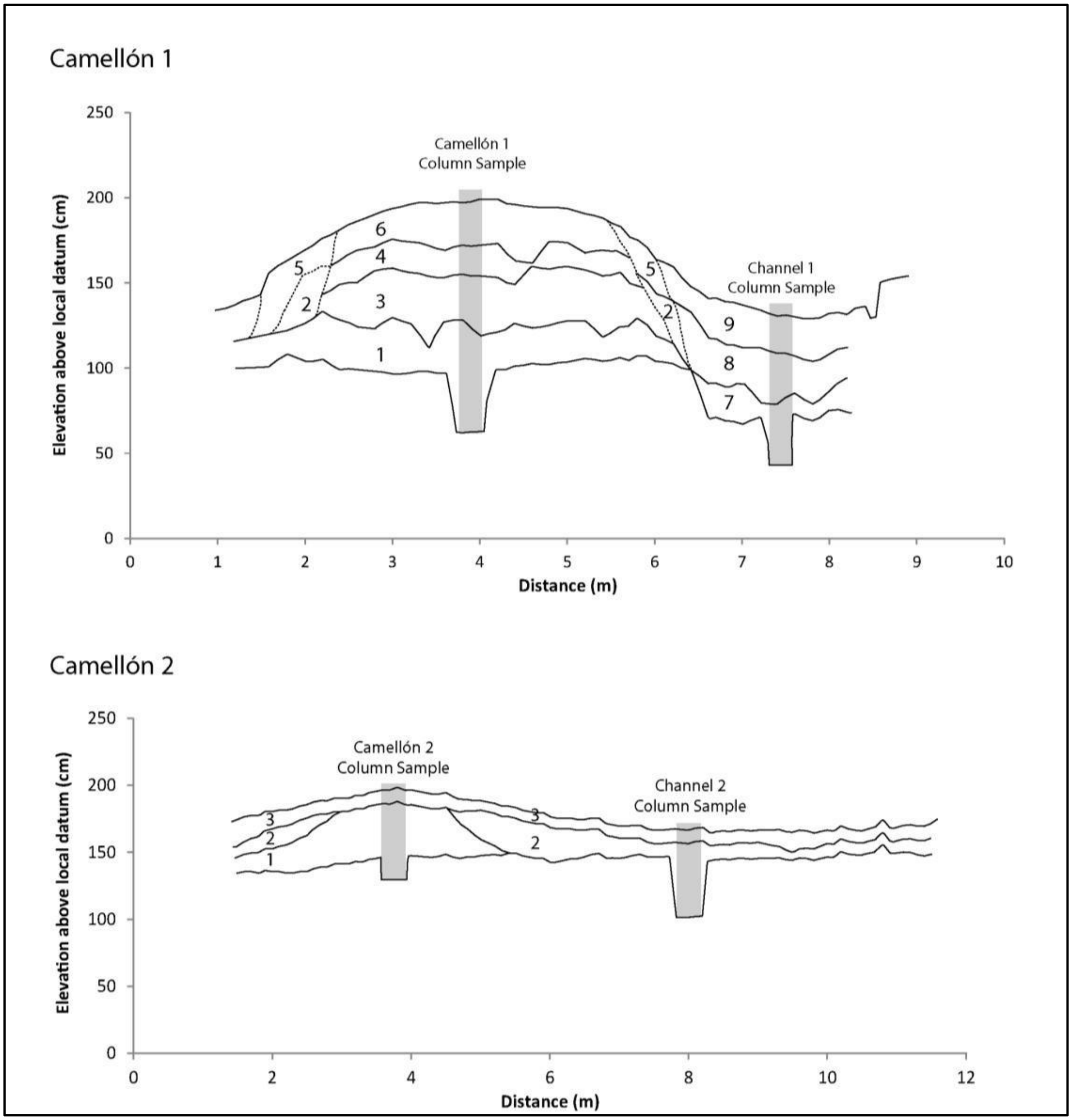

Figure 2: Stratigraphic profiles of excavated raised fields. Vertical exaggeration X 2. See Tables 2 and 3 for descriptions of soil horizons.

Table 2: Camellón 1 stratigraphic units.

Unit	Description	Texture	Colour 1	Interpretation
9	Overlies Unit 8 in channel and extends to surface; diffuses laterally into Unit 5 of field.	Clay loam	Brown (7.5YR 5/3) with pale flecks (1.0x 0.5 cm)	Channel fill
8	Overlies Unit 7 in channel; some light horizontal banding.	Clay loam	Light grey (10YR 7/2) with some orange mottling	Channel fill
7	Basal unit in channel; abuts Unit 1.	Clay loam	Reddish yellow (7.5YR 6/8) with a little light grey streaking	Channel fill
6	Surface horizon over majority of field; very pale brown.	Clay loam	Very pale brown (10YR 3/3)	
5	Surface horizon over margins of field - looks slightly greyer than over main part of field. Lower elevation and possibly higher organic material content; diffuses laterally into Unit 6.		Light reddish brown (2.5Y 6/4)	
4	Overlies Unit 3 over most of the field width and diffuses laterally into Unit 2 at margins; around 4.5/5 m mottling stops and distinction from overlying horizon is problematic.	Loam	Brownish yellow (10YR 6/6) with scarce mottling	Subsurface horizon of field
3	Stratigraphic unit overlying Unit 1 over most of the width of the field; browner than red of Unit 1 below (and yellow/orange of Unit 2).	Loam	Light brownish grey (10YR 6/2) with red patches	
2	Bright wedge that extends from Unit 1 to below surface unit; greatest thickness near channel. Fades into Unit 4 towards centre of field; underlain by Unit 3 at central limit.		Yellowish brown (10YR 5/8) patches interspersed with light brownish grey (10YR 6/2)	
1	Basal unit in field section of excavation profile; unit disappears in channel section - possibly the cut bank of the channel. Red blocks of matrix with light brownish red between.	Clay loam	Red (10R 4/8) with light brownish red (10YR 6/2) between	Naturally occurring subsoil, buried by field material

Table 3: Camellón 2 stratigraphic units.

Unit	Description	Texture	Colour	Interpretation
3	Uniformly thick pedogenic horizon with organic matter.	Loam	Grey	Pedogenic surface horizon
2	Extends from lateral margins of Unit 1 across channel.	Clay loam	White with orange mottles	Reworked sediments of raised field
1	Uneven surface (following shape of camellón).	Clay loam	Red/brown with white matrix between blocks	Naturally occurring subsoil

Phytolith Analysis

Phytolith preservation was very good in the two sampled camellones and their adjacent channels. The diversity of the assemblages is noteworthy, with 61 morphotypes distinguished, although several of these are of unknown taxonomic association (Table 4). A summary of phytolith results is presented in Figure 3, allowing broad comparison between totals of grass (Poaceae), sedge

(Cyperaceae), non-graminoid herb, and tree (arboreal) phytoliths. More detailed diagrams of the phytolith results from each profile, as well as three surface scatter samples from Camellón 2, are presented in Figures 4-8, with results from both the A/B-fraction (black bars) and C-fraction (shaded bars). Raw absolute counts of morphotypes and total phytoliths counted for each sample are presented in Appendix 1 (A/B-fraction, Table A1, and C-fraction, Table A2).

Camellón 1

Grass (Poaceae) phytoliths dominate almost the entire sequence from the Camellón 1 profile, reaching their highest frequencies in the upper 10 cm (92% of total counted phytoliths in the A/B-fraction in 0-5 cm BS, and 91% in 5-10 cm BS). Their lowest frequency (39%) occurs at the very base of the excavation (130-135 cm BS), but they increase sharply to 80% at 80-85 cm BS. Thereafter, they remain above 80% frequency for the remainder of the profile, except at 15-30 cm BS where they dip slightly to 77-79% of total counted phytoliths (Fig. 4). Within the grass phytolith assemblage, bilobates from the subfamily Panicoideae (Fig. 9A) are the most frequent, and their profile curve is similar to the overall total Poaceae curve (Fig. 3). Panicoid grasses are typical of warm, humid conditions, such as tropical and subtropical environments. *Aristida*-type bilobates (Fig. 9B) were found in low frequencies (<2%) in the middle levels of the profile, but were not seen in the base or surface levels. On the other hand, scooped bilobates from the subfamily Oryzoideae were found throughout almost the entire profile in low frequencies (<2%). Arundinoideae-type trapezoidal forms (Fig. 9C) were rare, but noted in several of the lower levels, in the upper section of Unit 1 and the base of overlying Unit 3. Saddle form phytoliths from the subfamily Chloridoideae, grasses generally adapted to hot and dry conditions, were also infrequent, but found throughout the profile in low levels (<2%), except for the upper 20 cm where they were not observed. Frequencies of Bambusoideae phytoliths fluctuate throughout the profile, from 15% in both 105-110 and 70-75 cm BS, to completely absent in 20-25 and 30-30 cm BS.

The presence of maize (*Zea mays*) is documented at 70-75 cm BS, on the basis of DF analysis of cross-shaped phytoliths (Fig. 9D) produced in Poaceae leaves (PEARSALL and PIPERNO 1990; PIPERNO 2006; see Table 5). This level corresponds to the base of Unit 3, which appears to represent the lowest level of soil profile disturbance associated with cultivation or field construction.

Overall, frequencies of sedge (Cyperaceae) phytoliths, including *Cyperus/Kyllinga* achene plates and Cyperaceae conical bodies, remain relatively stable at low frequencies throughout the profile, although *Scirpus*-type achene bodies are predominantly observed in the upper stratigraphic unit (Unit 6). Levels of phytoliths from herbaceous taxa other than grasses or sedges (non-graminoids), such as

Asteraceae, *Heliconia*, *Thalia*-type, and other Marantaceae morphotypes, are also relatively stable throughout the profile, except for a slight increase at 20-25 cm BS. This increase is driven mainly by an increase in globular nodulose phytoliths from Marantaceae rhizomes (Fig. 9G). *Thalia*-type achene bodies (Fig. 9F) were seen primarily in the upper 35 cm of the profile, both in the A/B-fraction and the C-fraction. *Thalia* is a common species in the wet areas of the Llanos de Moxos today, occasionally forming large stands on the shores of lakes and wetlands.

In the base level of the excavated profile where grass phytoliths are at their lowest frequency, arboreal phytoliths are at their highest frequency (56%) (Fig.3). The majority of these are from palms (Arecaceae), both globular echinate and conical (or 'hat-shaped') granulate morphotypes (Fig. 9H and 9I). The frequency of total arboreal phytoliths decreases rapidly in the overlying levels. There is a slight increase to 14-16% between 15 and 30 cm BS, again due mainly to levels of palm phytoliths, primarily globular echinate phytoliths. However, above this in the top 15 cm of the profile, frequencies of arboreal phytoliths drop to their lowest levels, only 1-4% of the total counted phytoliths.

Table 4: Phytolith morphotypes counted and their taxonomic associations.

Phytolith Morphotype	**Taxonomic Association**	**References** [a]
Rounded lobe bilobate, polybate	Panicoideae	1-6
Polybate	Panicoideae	1-6
Sloped (trapezoidal) bilobate	cf. Panicoideae	1-6
Thin, long-shanked bilobate	cf. *Aristida*	2, 7, 8
Trapezoidal curved body	cf. Arundinoideae	2
Scooped bilobate	Oryzoideae	6, 9, 10
Saddle	Chloridoideae	2-5, 11
Collapsed saddle	Bambusoideae	2, 5, 12-14
Keeled bilobate	Poaceae	2
Oval/square bilobate	Poaceae	2
Cross-shaped body (Variant 1, Variant 2, Variant 3/8, Variant 5/6, Misc. Variant)	Poaceae	2, 5, 12, 16-20
Spiked cross-shaped body	cf. Poaceae	
Rondel/trapezoid	Poaceae	2-5
Blocky rondel with saddle top	cf. Bambusoideae	2
Fringed rondel	Poaceae	2
Tall rondel	Poaceae	2, 5, 11, 21
Sinuous suborbicular with central protuberance	*Scirpus* seed	22-25
Granulate polygonal platelet with central protuberance	*Cyperus/Kyllinga* seed	22-25
Smooth conical body with satellites	Cyperaceae	11, 23, 25-27
Granulate irregular cone with dendritic projections	cf. Cyperaceae	
Trough body	*Heliconia*	5, 29, 30
Cylindrical with protuberances or decoration and central protuberance	Marantaceae seed	22
Granulate cylindrical with central conical protuberance	cf. *Thalia*	38
Nodulose or crushed decoration globular	Marantaceae rhizome	5, 22

Large nodulose globular	cf. Marantaceae	38
Anisopolar polygonal top, decorated cylindrical bottom	Marantaceae/ Commelinaceae seed	28
Trapezoidal polygonal plate	cf. *Dichorisandra*	
Opaque perforated plates	Asteraceae achene	5, 12, 31
Druse	cf. Zingiberales	15
Secretory cell	*Manihot esculenta*	37
Globular echinate	Arecaceae	5, 11, 30, 33-35
Conical echinate (hat-shaped)	Arecaceae	5, 11, 30, 33-35
Large globular echinate	cf. Arecaceae	38
Globular granulate	Woody eudicot	5, 11, 36
Large globular granulate	cf. woody eudicot	
Irregular faceted	Annonaceae	5
Sclereid	Sclereid	5, 36
Irregular with narrow processes	Unknown	
Mammiform platelet	Unknown	
Irregular partitioned platelet (FG7)	Unknown	
Angularly crenate elongate (FG8)	Unknown	
Hair cell	Unknown	
Hair base	Unknown	
Irregular dendritic	Unknown	
Bispherical body	Unknown	
Blocky laminated	Unknown	
Brown verrucate	Unknown	
Dendritic rectangular body	Unknown	
Orbicular plano-convex verrucate	Unknown	
Epidermal tissue	Unknown	

[a]**References**: **1.** (Fredlund and Tieszen, 1994); **2.** (Piperno and Pearsall, 1998); **3.** (Twiss et al., 1969); **4.** (Brown, 1984); **5.** (Piperno, 2006); **6.** (Metcalfe, 1960); **7.** (Iriarte and Paz, 2009); **8.** (Mulholland, 1989); **9.** (Chaffey, 1983); **10.** (Pearsall et al., 1995); **11.** (Kondo et al., 1994); **12.** (Piperno, 1988); **13.** (Lu et al., 1995); **14.** (Lu et al., 2006); **15.** (Watling and Iriarte, 2012); **16.** (Piperno, 1984); **17.** (Pearsall, 1978); **18.** (Pearsall, 1982); **19.** (Pearsall and Piperno, 1990); **20.** (Iriarte, 2003); **21.** (Zucol, 1999); **22.** (Piperno, 1989); **23.** (Ollendorf, 1992); **24.** (Schuyler, 1971); **25.** (Honaine et al., 2009); **26.** (Metcalfe, 1971); **27.** (Wallis, 2003); **28.** (Eichhorn et al., 2010); **29.** (Tomlinson, 1969); **30.** (Prychid et al., 2003); **31.** (Bozarth, 1992); **32.** (Honaine et al., 2005); **33.** (Runge, 1999); **34.** (Tomlinson, 1961); **35.** (Bozarth et al., 2009); **36.** (Scurfield et al., 1974); **37**. (Chandler-Ezell et al., 2006); **38.** (Dickau et al., 2013).

Evidence of burning, based on the frequencies of burnt Panicoideae bilobates, is low in the base level of the profile (7%), but jumps to 44% by 105-110 cm BS. Burning peaks at 50-55 cm BS (63%), and then declines. Unfortunately, burnt bilobates were not counted in the 0-5, 5-10, 10-15, 20-25, and 30-35 cm BS samples from Camellón 1 (samples marked by an asterisk in Figure 4), as these samples were analyzed before we initiated the procedure of quantifying burnt Panicoideae phytoliths. Therefore patterns of burning during more recent deposition events of Camellón 1 are currently unknown.

Cyperaceae phytoliths occur throughout the channel profile. Unlike in the field, *Scirpus*-type achene phytoliths are found not only in the surface horizon, but continue to the base of the profile. An unidentified phytolith morphotype, a granulated conical body with dendritic projections from the top of the cone (Fig. 9J), is possibly from Cyperaceae, and was only found between 5 and 25 cm BS in Unit 9. *Heliconia*, Asteraceae, and Marantaceae phytoliths occur throughout the profile in the A/B-fraction. However, there is a noticeable peak in Asteraceae at 50-55 cm BS in both the A/B- and C-fractions, which corresponds to the base of Unit 8. Members of the Asteraceae are typically pioneering herbs and indicators of disturbance (PIPERNO and JONES 2003; PIPERNO 2006; but see DICKAU et al. 2013). In the C-fraction, Asteraceae levels remain relatively high throughout Unit 8, gradually declining until they reach the same low frequency at the base of overlying Unit 9 that there were at in Unit 7. *Thalia*-type achene bodies are mainly seen in the upper two stratigraphic units and absent in the lower levels, a similar pattern to that observed in Camellón 1. This suggests either differential preservation in earlier levels, or that *Thalia* was not part of the original vegetation prior to the construction of the raised fields.

Like Camellón 1, arboreal phytoliths are at their highest frequency in the lowest level of Channel 1, and decrease towards the surface (Fig. 3). They reach their lowest frequency of 4% at 20-25 cm BS, and then very slightly increase to 11% at 5-10 cm BS, declining once more in the surface level. In the lower half of the profile, arboreal phytolith types are represented relatively equally by palm phytoliths and globular granulates produced by woody eudicots, but in the upper half of the profile, palm phytoliths (primarily globular echinate types) make up more than half of the arboreal assemblage.

Camellón 2

Many of the same patterns seen in Camellón 1 are observed in Camellón 2. Grass phytoliths are dominant throughout the profile. They occur at their lowest frequency (71%) in the bottom level, and highest frequency (92%) in the surface level. At the base of the profile, arboreal phytoliths, comprised of both palm and woody eudicot morphotypes, are at their highest frequency (26%). Arboreal levels decline rapidly in the upper levels of the profile.

The grass phytoliths chiefly consist of Panicoideae, followed by Bambusoideae, and small contributions of Oryzoideae, Chloridoideae, Arundinoideae, and *Aristida*-type phytoliths (Fig. 6). Oryzoideae and *Aristida*-type are only seen in the top half of the profile above 35 cm BS, but still occur within Unit 1, which appears to be the original field platform. Among the Panicoideae, levels of burnt phytoliths peak at 77% at 40-45 cm BS, and then decrease to 30% in the surface level. Above this peak are two levels (30-35 cm BS and 20-25 cm BS) with evidence of maize.

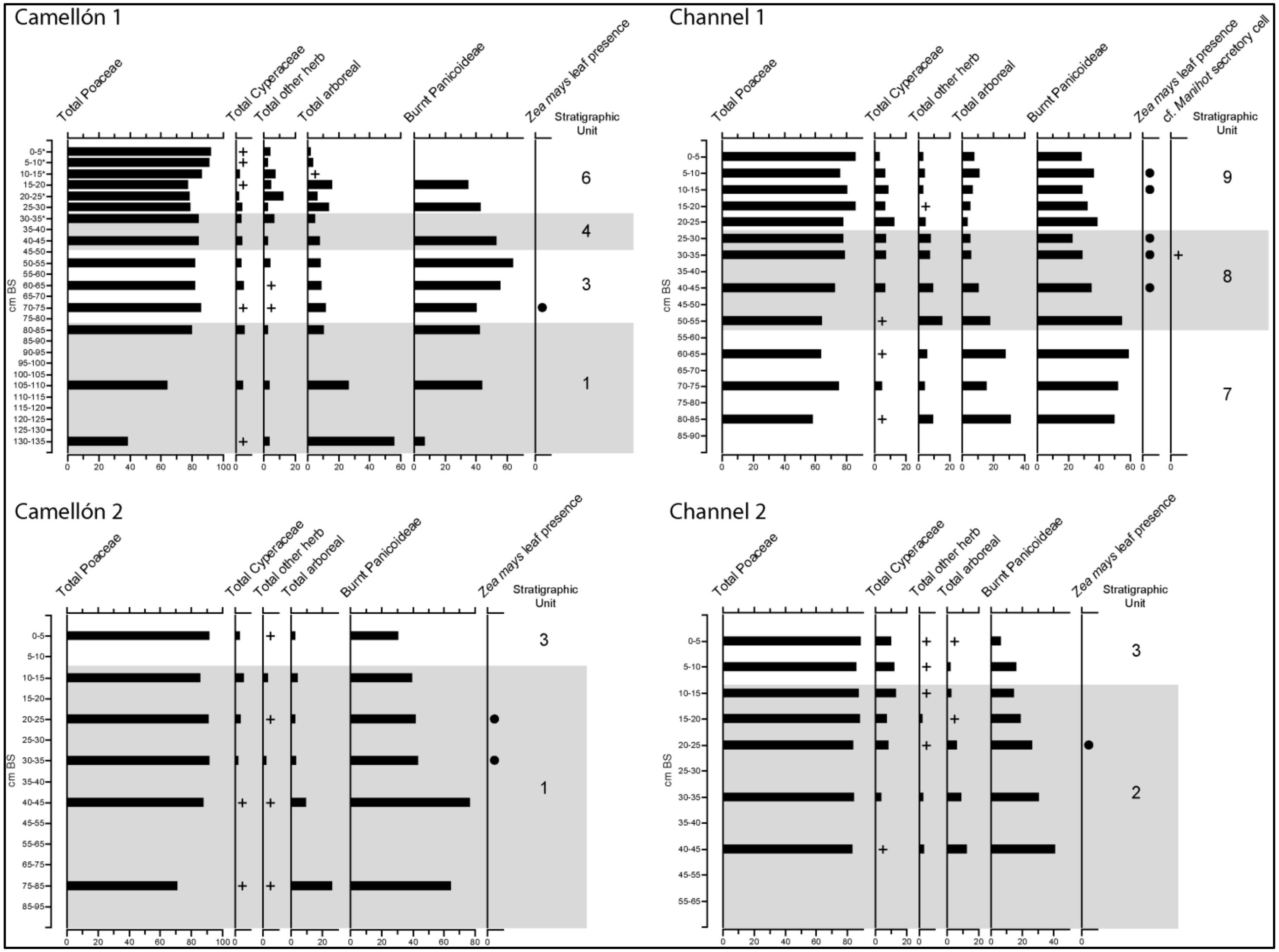

Figure 3: Summary of phytolith data. Burnt Panicoideae calculated as percentage of the total number of Panicoideae bilobates per sample. In Camellón 1, burnt bilobates were not counted in samples marked with an asterisk (*). Taxa with frequencies <2% are marked with (+). The presence of *Zea mays* leaves, calculated by discriminant function (DF) analysis of cross-shaped phytoliths, is marked with a solid black circle (see Table 5).

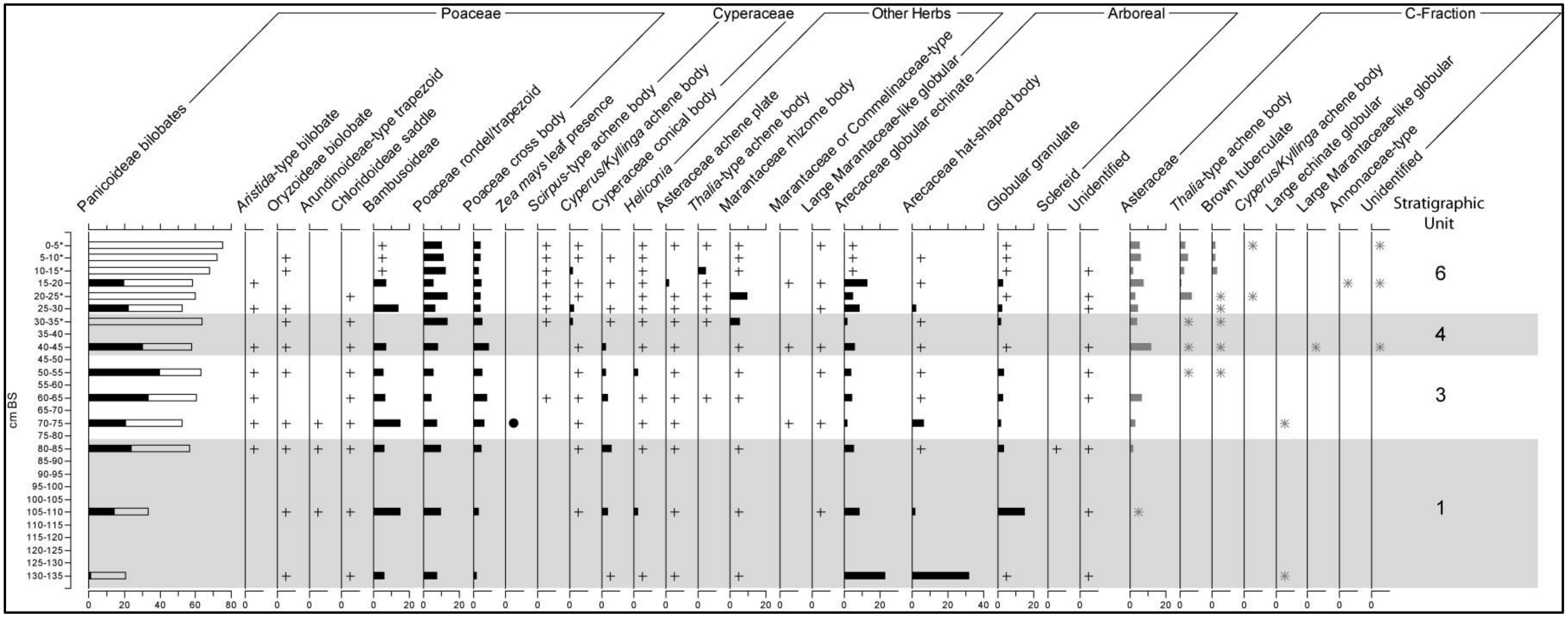

Figure 4: Phytolith results from Camellón 1. For A/B-fraction, relative percent abundance of each taxon is represented by black bars, with the exception of Panicoideae bilobates where total bilobates are represented by an outlined bar and the black section within represents burnt Panicoideae bilobates. Burnt phytoliths were not counted in those levels marked with an asterisk (*). Frequencies <2% are marked by (+). The presence of *Zea mays*, based on DF analysis of a minimum of 20 cross-shaped phytoliths, is marked by a solid black circle (see Table 5). C-fraction results (right side of graph), represented by shaded (grey) bars, are presented as an index, calculated as total number of phytolith type counted per sample/amount (mg) extract. Index values <1 are marked by a star symbol.

Table 5: Discriminant function analysis of cross-shaped phytoliths.

	Sample	**cm BS**	**N (All Variants)**	**X̄ Var 1**	**X̄ Var 5/6**	**% Var 1**	**Maize Prediction**	**Wild Grass Prediction**
Camellón 1	B-10-061	0-5	<20					
	B-10-062	5-10	35	13.8	13.1	25.7	0.28	**0.72**
	B-10-063	10-15	<20					
	B-10-064	15-20	38	13.3	11.7	34.2	0.28	**0.72**
	B-10-065	20-25	<20					
	B-10-066	25-30	50	14.5	14.2	26.0	0.39	**0.61**
	B-10-067	30-35	21	14.7	11.4	28.6	0.48	**0.52**
	B-10-069	40-45	36	14.5	13.9	33.3	0.45	**0.55**
	B-10-071	50-55	36	15.4	13.0	16.7	0.47	**0.53**
	B-10-073	60-65	50	14.5	13.3	24.0	0.38	**0.62**
	B-10-075	70-75	68	15.8	13.1	32.4	**0.65**	0.35
	B-10-077	80-85	34	14.5	14.0	26.5	0.38	**0.62**
	B-10-082	105-110	<20					
	B-10-087	130-135	<20					
Channel 1	B-10-088	0-5	26	14.6	14.9	19.2	0.33	**0.67**
	B-10-089	5-10	47	16.5	15.1	17.0	**0.61**	0.39
	B-10-090	10-15	78	15.5	15.4	24.4	**0.51**	0.49
	B-10-091	15-20	89	13.4	14.9	43.8	0.35	**0.65**
	B-10-092	20-25	130	14.1	12.7	26.2	0.34	**0.66**
	B-10-093	25-30	114	15.4	14.0	24.6	**0.51**	0.49
	B-10-094	30-35	113	15.3	13.7	26.5	**0.53**	0.47
	B-10-096	40-45	64	15.6	14.0	23.4	**0.54**	0.46
	B-10-098	50-55	<20					
	B-10-100	60-65	<20					
	B-10-102	70-75	<20					
	B-10-104	80-85	<20					
Camellón 2	B-10-106	0-5	61	14.4	14.4	16.4	0.29	**0.71**
	B-10-108	10-15	32	15.6	13.5	9.4	0.44	**0.56**
	B-10-110	20-25	30	15.7	14.1	30.0	**0.61**	0.39
	B-10-112	30-35	51	15.3	14.9	31.4	0.54	**0.46**
	B-10-114	40-45	<20					
	B-10-118	75-85	<20					
Channel 2	B-10-120	0-5	63	13.7	13.1	28.6	0.29	**0.71**
	B-10-121	5-10	57	14.6	13.4	33.3	0.47	**0.53**
	B-10-122	10-15	54	14.2	12.5	25.9	0.36	**0.64**
	B-10-123	15-20	62	13.9	12.1	27.4	0.32	**0.68**
	B-10-124	20-25	39	17.2	13.0	17.9	**0.76**	0.24
	B-10-126	30-35	29	14.7	13.6	34.5	**0.50**	0.50

	B-10-128	40-45	<20					
	B-10-132	Surface A	50	15.0	15.7	22.0	0.41	**0.59**
	B-10-133	Surface B	48	14.1	13.6	18.8	0.26	**0.74**
	B-10-134	Surface C	54	14.8	14.5	20.4	0.38	**0.62**

Notes: Maize Prediction = -1.96669 + 0.1597589 (mean width for Variant 1) - 0.0126672 (mean width for Variant 5/6) + 820956 -3 (% Variant 1). Wild Prediction = 2.96669 - 0.1597589 (mean with for Variant 1) + 0.0126672 (mean width for Variant 5/6) - 8.20956 -3 (% Variant 1). The larger score represents the discriminant function prediction between maize and wild grasses and is bolded for each sample. DF analysis was not done on samples with <20 total observed cross-shaped phytoliths.

As with the Camellón 1 field, Cyperaceae phytoliths occur throughout the profile, but in Camellón 2, they are more common in levels above 35 cm. *Scirpus*-type phytoliths are once again absent from the lower levels of the field, although they occur in very low frequencies (<2%). *Cyperus/Kyllinga* phytoliths are also more frequent in the upper levels. Among non-graminoid herbs, *Heliconia* and Asteraceae phytoliths occur in low frequencies throughout the profile. Marantaceae morphotypes and a Zingiberales-type druse (Fig. 9K) are found only in the upper part of Unit 1, but absent from the surface levels (Unit 3). *Thalia*-type achene bodies are very rare here, identified by a single phytolith in 10-15 cm BS level in the A/B-fraction, and completely absent from the C-fraction. C-fraction counts in general were much lower in Camellón 2 than they were in Camellón 1.

Channel 2

Like the other profiles, grass phytoliths dominate the assemblage of Channel 2 (Fig. 3). They increase slightly in frequency from the base of the deposits to the surface, but this increase is much less pronounced than the other profiles. Panicoideae bilobates actually show a decrease in frequency from lowest level to surface, a trend not observed elsewhere (Fig. 7). Burnt Panicoideae bilobate frequencies follow this same trend: the highest frequency of burnt phytoliths occurs in the lowest level analyzed, at 40-45 cm BS. *Aristida*-type, Arundinoideae, Oryzoideae, and Chloridoideae are all restricted to the upper 25 cm of the profile, but still within both identified stratigraphic units (Units 2 and 3). Bambusoideae phytoliths are found throughout the profile.

In terms of cultivars, maize is documented in only one level at 20-25 cm BS, within Unit 2, rather than multiple levels as in Channel 1.

Cyperaceae phytoliths occur throughout the profile, but obtain their highest frequencies in the upper levels, similar to the Channel 1. Once again, *Scirpus*-type phytoliths only occur in the upper 35 cm of the profile (Fig. 7), but few levels from lower part of the profile have been analyzed. *Heliconia* and Asteraceae phytoliths occur in low frequencies throughout the entire profile. *Thalia* is represented by a single achene phytolith 5-10 cm BS, echoing the low frequency seen in the adjacent field profile. Marantaceae rhizome phytoliths are observed only in the lower stratigraphic unit, although large verrucate globular phytoliths that may be from Marantaceae were identified in the upper levels.

Like the other profiles, arboreal phytoliths show the inverse trend of grass phytoliths, decreasing in frequency from the base of the profile to the surface. They consist of both palm morphotypes and globular granulates from woody eudicots. Within the C-fraction, most of the larger phytoliths are found in the upper 25 cm, in very low frequencies.

Camellón 2 Surface Samples

Three surface scatter samples were taken at various points along the length of Camellón 2 to test for spatial differences in cropping and camellón use (Fig. 8). No phytolith evidence of any cultivars was observed in the samples; however, given the depth at which maize and manioc were found in the excavated profiles, it is possible that the samples were not deep enough to recover evidence of crops. The phytolith assemblage of these three samples shows that the vegetation across the camellón did not vary a great deal. Poaceae, Cyperaceae, and arboreal phytolith levels are nearly the same for all three samples. There are slight differences of several minor taxa, all present in low frequencies (often <2%). For example, *Dichorisandra*-type polygonal plates (Fig. 9L) are only observed in sample B-10-132, whereas Arundinoideae-type trapezoids and Chloridoideae saddles are only observed in B-10-134. These small differences probably represent micro-local variations in vegetation, such as the presence of one or two individuals of a particular species. In general, the phytolith assemblages are similar to those seen in the surface levels of the excavated profiles, comprised of the same morphotypes.

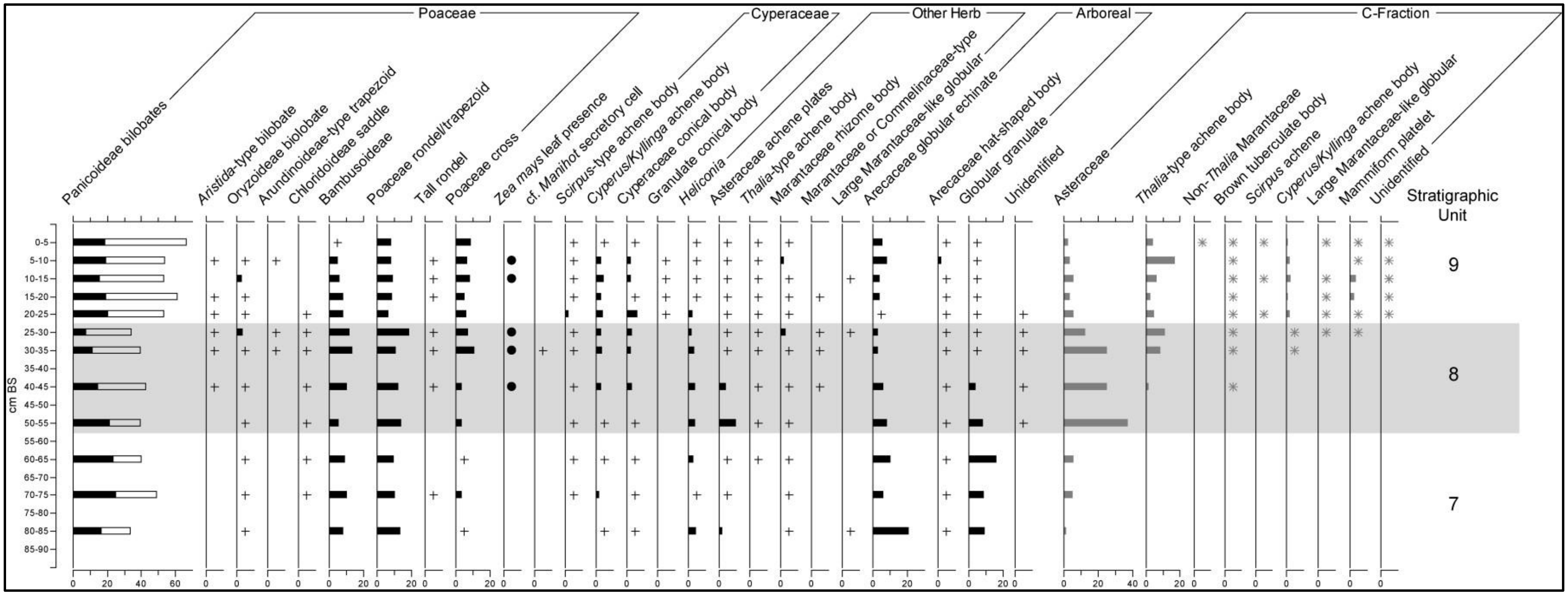

Figure 5: Phytolith results from Channel 1. See Figure 4 for diagram notes.

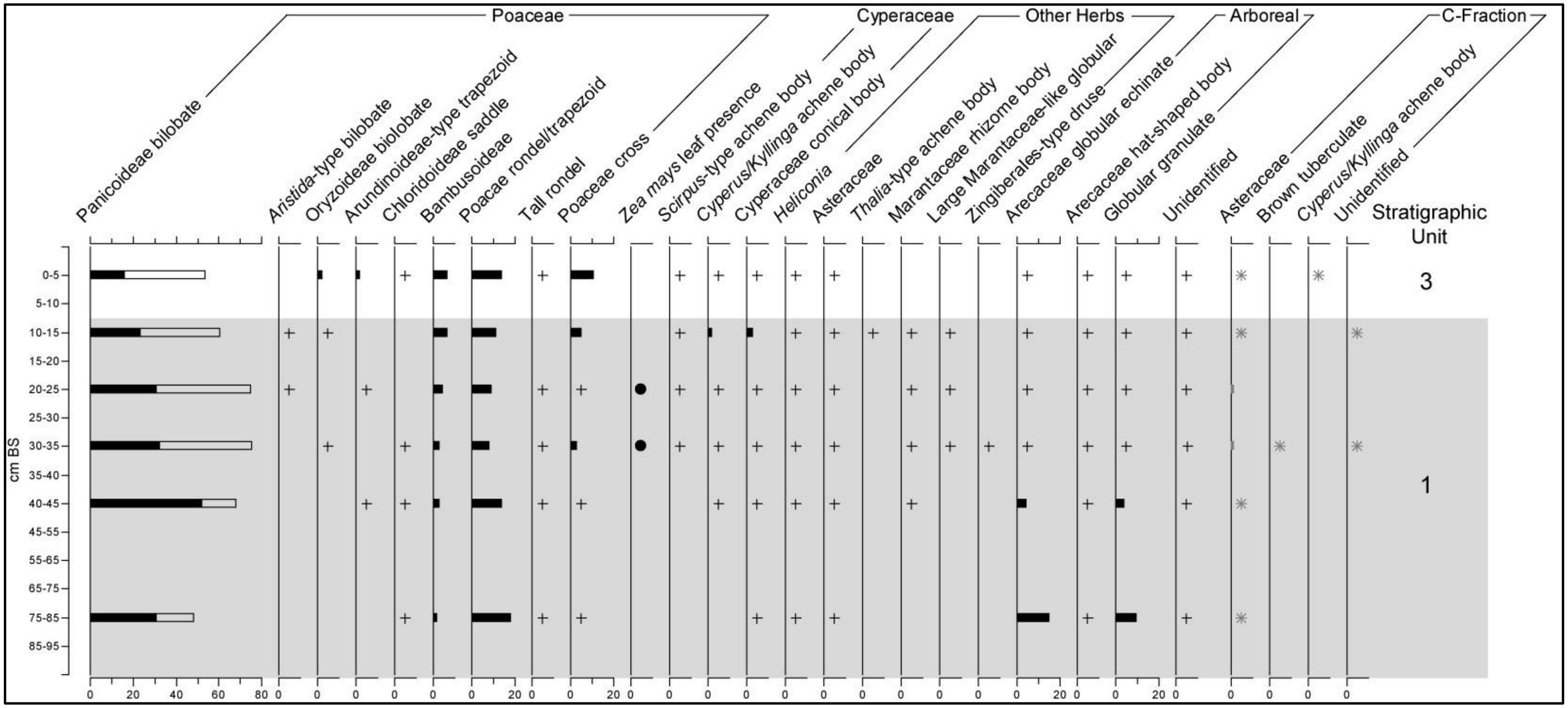

Figure 6: Phytolith results from Camellón 2. See Figure 4 for diagram notes.

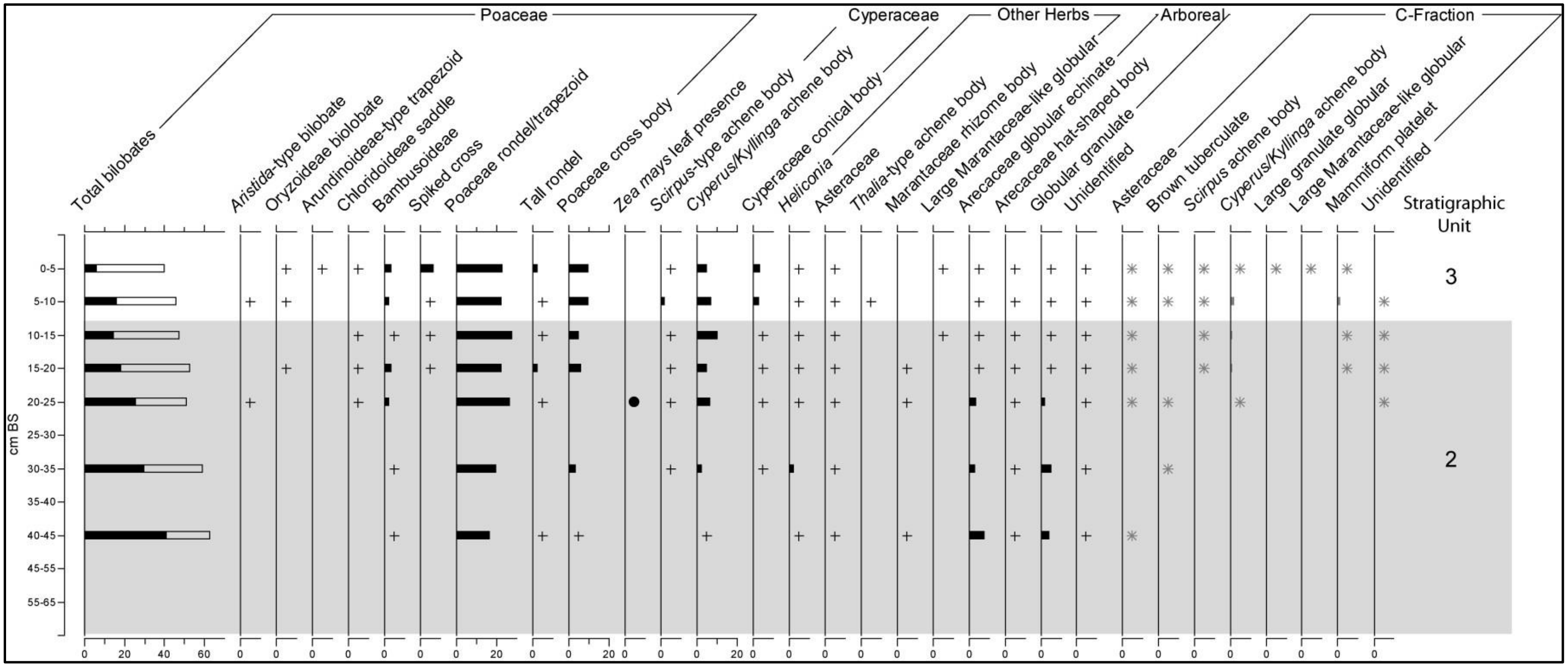

Figure 7: Phytolith results from Channel 2. See Figure 4 for diagram notes.

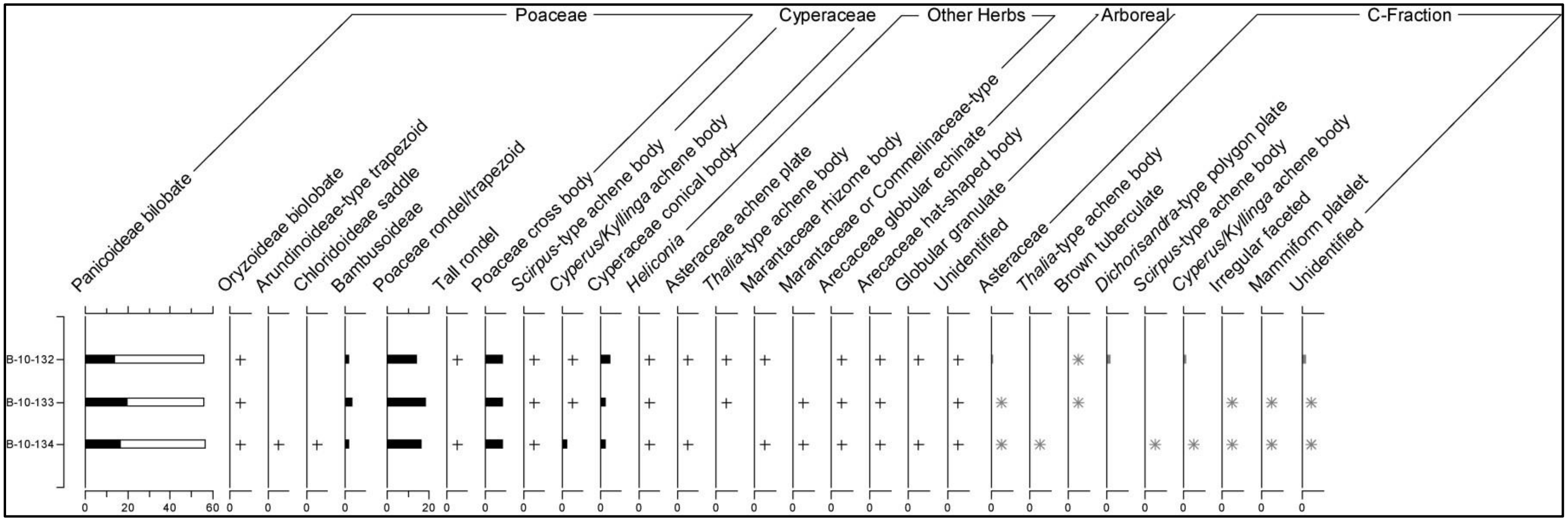

Figure 8: Phytolith results from Camellón 2 surface scatter samples. Samples (Y-axis) represent spatially distinct samples, not stratigraphic sequence as with other phytolith diagrams. See Figure 4 for other diagram notes.

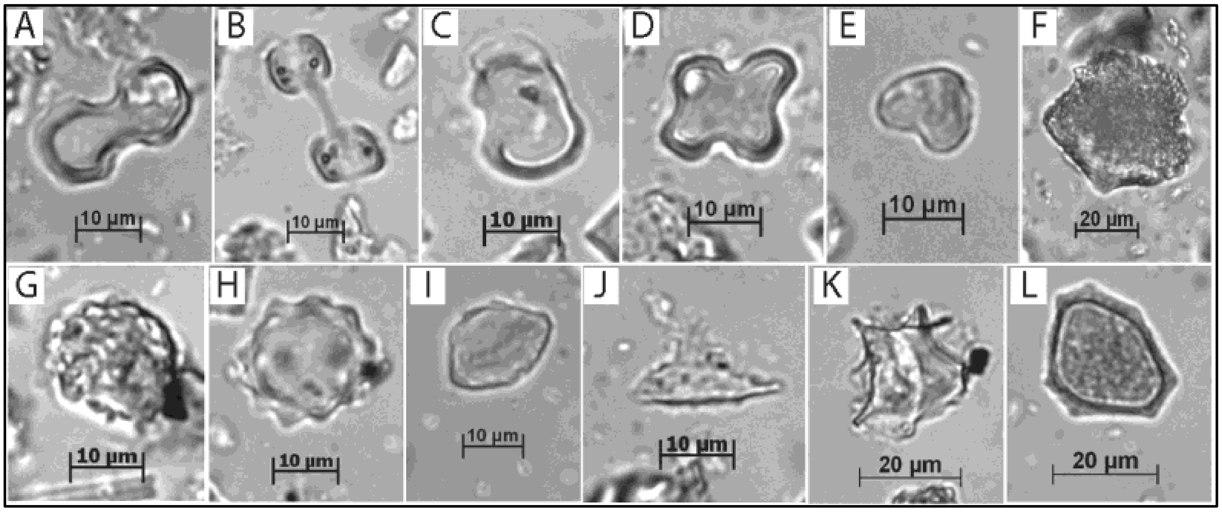

Figure 9: Selected phytoliths. A) Panicoideae bilobate, B) *Aristida*-type bilobate, C) Arundinoideae-type bilobate, D) Variant 1 Poaceae cross-shaped phytolith, E) *Manihot esculenta* secretory cell, F) *Thalia*-type achene body, G) Marantaceae rhizome body, H) Arecaceae globular echinate, I) Arecaceae conical granulate ('hat-shaped' body), J) Unidentified conical granulate with dendritic projections, K) Zingiberales-type druse, L) *Dichorisandra*-type polygonal plate.

DISCUSSION

History of Field Construction and Use

Analysis of the stratigraphy and phytolith record of the two sampled camellones and channels provides insights into the history of their construction, use, and possibly their later abandonment. In the absence of radiocarbon dates with which to anchor this history, interpretations are based on the stratigraphically-derived relative chronology.

The base stratigraphic units in both camellones exhibit blocky structure and are interpreted as the original subsurface on which the fields were constructed. Overlying stratigraphic units lack this structure, instead consisting of mixed clay loam sediments indicative of field construction and periodic reworking. Initial construction of the fields occurred by the builders excavating linear channels and depositing the soil alongside to form the camellón platforms. The truncation of the subsurface unit in Channel 1 reflects this initial excavation of the channel, and is similar to the cut palaeosol (bAh) observed in the stratigraphic profile of a camellón at Bermeo (RODRIGUES et al. 2014). After initial field construction, cultivation practices likely reworked the camellón soils *in situ*. It is also possible that subsequent building events, or periodic field maintenance or renewal via the addition of accumulated silts from the channels (what LOMBARDO et al. 2011 and RODRIGUES et al. 2014 refer to as the

Chinampas model), may have occurred, but in the context of continued cultivation this would not be expected to leave physical stratigraphic evidence. High resolution dating, however, may reveal such patterns. Faint horizontal banding in the lower stratigraphic units of Channel 1 suggests incremental deposition (infilling) of sediments over time without significant disturbance or re-excavation. Regardless, in either scenario, this mixing of sediments within the fields would have been relatively localized. With cultivation, mixing was *in situ*. With field renewal, the sediments being added to the field were more than likely the same sediments that had eroded from the field surface and slope into the nearby channel. There is no evidence to suggest foreign material was brought in and deposited on the fields, either during initial or later construction events. In addition, depending on the frequency of maintenance activities, these mixed sediments would be restricted to a single stratigraphic unit associated with field use, and therefore still generally within stratigraphic sequence.

In all four profiles, arboreal phytoliths are at their highest frequency in the base of the profile. Although grass phytoliths are still dominant in these levels, grass short-cell phytoliths can sometimes be over-represented in paleoecological samples due to their abundant production in glumes, stems, and leaves, and generally robust preservation (NOVELLO et al. 2012; HODSON et al. 2005). However, studies of phytolith assemblages under modern vegetation analogues elsewhere in lowland Bolivia show that phytolith assemblages with high frequencies of Poaceae and small to moderate frequencies of arboreal morphotypes represent open-canopy vegetation such as terra-firme wooded savannah or *cerrado* (DICKAU et al. 2013).

After occurring in their higher frequency in the base levels at Campo España, arboreal phytolith frequencies rapidly decrease, suggesting that prior to the construction of the camellones, there were more trees on the landscape, and that many of these trees were cleared to make way for field construction. This is similar to patterns observed at El Cerro, where phytolith records indicate the removal of savanna trees prior to camellón construction (WHITNEY et al. 2014). The frequencies of grasses, herbs, and palm phytoliths in the base levels at Campo España indicate that the original landscape was likely a palm savannah that included some *cerrado*-type trees, based on phytolith assemblages observed under modern vegetation analogues (DICKAU et al*.* 2013). This is particularly visible in Unit 1 of Camellón 1, which is interpreted to represent the original subsurface on which the field was constructed. The very low frequency of wetland markers like Oryzoideae, Cyperaceae, and *Thalia* in this base unit suggest that during the formation of this subsoil, prior to the construction of the fields, local conditions were drier than today. Rodrigues et al., (2014) suggest that a climatic shift related to increased ENSO activity 1000-2000 years ago, resulting in changing precipitation patterns and more frequent flooding events in southwestern Amazon, may have been the catalyst for the construction of raised fields.

At Campo España, the initial clearing of vegetation prior to field construction may have involved fire. However, the presence of burnt grass phytoliths throughout the entire profiles suggests that fire was an ongoing occurrence, and that the most intensive burning did not occur prior to field construction, but after it, during cultivation. It is likely that this burning was anthropogenic in nature based on its frequency. In the Camellón 1 field profile, evidence of burning peaks at near the top of Unit 3, the first field platform created during initial construction. In the channel, the highest frequency of burnt phytoliths is at the top of the first fill unit (Unit 7). While it is possible this reflects erosion of burnt grass phytoliths into the channel from the nearby field surface, there is no evidence that the channels remained permanently wet year-round, and therefore would have also been affected by fires during the dry season. Similarly, in Camellón 2, the peak in burnt phytoliths occurs midway in the first stratigraphic unit, interpreted to be within the original field platform, rather than at the base of the unit beneath the constructed platform where it would be expected if burning occurred before field construction. The only profile where there is a noticeable decrease in burnt phytoliths is Channel 1. After a peak at the base of Unit 8, the frequencies of burnt phytoliths drop off quickly, despite evidence for cultivation of maize. Like other areas in the Llanos de Moxos (WHITNEY et al. 2013; WHITNEY et al. 2014), levels of burning at Campo España were higher in the past than they are today, but fluctuated over time. Future collection of data on particulate charcoal and regional palaeovegetation patterns may show if this represents possible fire suppression on the camellones, like that documented by Iriarte et al. (2012) in French Guiana, or if fires were more common or even prescribed in the past during peak use of the fields, as speculated by Erickson and Balée (2006). During cultivation periods, fire may have been used to burn off old crop waste and control weeds, pests, and pathogens (STAB and ARCE 2000). However, fire was not mandatory for camellón cultivation, based on the results from El Cerro, where two different periods of landscape maintenance were defined based on different fire use strategies (WHITNEY et al. 2014).

In most of the profiles analyzed at Campo España, the frequency of Asteraceae is highest in the levels just above peak burning. This is especially apparent in Camellón 1 and Channel 1. Many Asteraceae species are pioneering herbs, adapted to colonizing disturbed areas, and for this reason Asteraceae is a good indicator of human clearing and cultivation activities. Its presence indicates that the camellones were being repeatedly cleared during the deposition of Unit 4 on Camellón 1 platform and Unit 8 of Channel 1, and the upper part of Unit 1 of Camellón 2. *Heliconia* is another disturbance indicator, although some species, such as *H. marginata* are more indicative of wetland conditions. *Heliconia* is present throughout the entire sequence of most of the profiles, and shows less evidence of increasing frequencies during cultivation than Asteraceae. However, in Channel 1, *Heliconia* phytoliths occur at higher frequencies throughout Unit 8, reflecting the pattern seen in Asteraceae.

This association of higher frequencies of Asteraceae with cultivation activities is confirmed by the presence of maize in many of the same levels. Evidence of maize cultivation occurs after peak burning in all profiles except Camellón 1. Here, the presence of maize is documented at the interface of the original subsurface and the first layer of field building. This may represent the cultivation of maize on the original land surface, prior to the construction of the raised fields. Maize is not detected in later stratigraphic levels corresponding to the built field platform in this particular camellón, but it is seen in multiple levels of the channel fill beside the platform, possibly the result of cultivation of the channels during the dry season, or erosion of material from the slopes of the field. At El Cerro, maize was also more frequently identified in the channels than in the camellón platforms (WHITNEY et al*.* 2014).

Cultivation of the fields continues in the upper levels of the profiles, where grasses remain the dominant vegetation cover. Phytoliths from taxa adapted to wetland conditions, such as sedges (including *Scirpus*) and *Thalia*, become more common in the upper levels, reflecting regular seasonal inundation of the channels after construction and use of the fields. Not surprisingly, these wetland indicators are most frequent in the channels, but they also occur on the fields, possibly the result of field renewal with excavated sediments from the channels. *Thalia*-type phytoliths are frequent in the later levels of Camellón 1 and Channel 1, but they are almost completely absent from Camellón 2 and Channel 2. One explanation is that Camellón 1 is closer to the small pond or wetland to the northeast of the field cluster. Moreover, Chloridoideae, which prefers hot and dry conditions, occurs in the upper levels of Camellón 2, whereas it is absent from the upper levels of Camellón 1. It appears that Camellón 2 was drier in later periods than Camellón 1, which may also explain why it was not built as high. It may have been less prone to inundation. Although the frequencies of these dry and wet indicator morphotypes are very low, these differences between the two camellones, only 72 m away from each other, show that terrestrial phytolith records are quite localized, and sensitive to small variability in hydrology, micro-topography, and vegetation in the immediate vicinity.

There are some indications that the camellones were abandoned before the deposition of the final surface level. Maize was not identified in the upper levels of any of the profiles, except Channel 1 where the highest it occurs is 5-10 cm BS. In the other profiles, it is restricted to 20-75 cm BS. Nor was it seen in any of the surface scatter samples. This suggests that maize was no longer being cultivated on the fields when the most recent deposition event(s) occurred. Moreover, in all of the profiles, both channel and field, there is a small, but visible increase in arboreal phytoliths around 5-20 cm BS, before frequencies return to very low amounts in the surface level. This suggests a minor recovery of some trees and shrubs on the raised fields, probably due to a cessation of field clearing and maintenance activities, before the land was re-cleared for modern cattle ranching. Because we have no radiocarbon dates to anchor the stratigraphy, we cannot say when precisely this forest recovery took place. However, it likely reflects the abandonment of fields by pre-Colombian populations around the time of European contact, or even possibly before contact, as appears to be the case at the site of El Cerro to the north (WHITNEY et al. 2014). It is noteworthy that at El Cerro, the recovery of gallery forest (and inferred abandonment of the fields) was observed in the pollen records from the nearby lakes associated with the fields, but there was no evidence of this in the terrestrial phytolith records directly from the fields themselves (WHITNEY et al. 2014). This suggests that at Campo España, even though the increase in arboreal phytoliths near the top of the profile is slight, it potentially represents a significant recovery of woody taxa in the area.

Agricultural Crops and Economic Plants

Maize was identified in all four profiles, on the basis of DF analysis of cross-shaped phytoliths produced in Poaceae leaves (PIPERNO 2006). Although the presence of maize leaves was documented, no diagnostic wavy-top or ruffle-top rondels from maize cobs were observed in any of the samples. This may be in part due to their low production, but it may also reflect a situation where cobs were harvested and removed from the fields, and the rest of the plant was left behind and reintegrated into the fields as mulch, depositing cross-shaped phytoliths.

In addition to maize, manioc may have been cultivated on the fields or waste plant material used for mulch, based on the identification of a secretory cell phytolith (CHANDLER-EZELL et al. 2006). Unfortunately, only a single phytolith of this type was identified, therefore our interpretation of potential manioc cultivation remains tentative. Manioc and other root crops have been proposed as the major staples grown on the raised fields (DENEVAN 2001), and their cultivation was observed by the Jesuits (MÉTRAUX 1948), but empirical archaeobotanical evidence of their cultivation is rare. This is more likely the result of low production and preservation of diagnostic microfossils than an accurate reflection of the contribution these crops to the agricultural economy. Starch analysis from the large habitation mounds in the southeast part of the Llanos de Moxos (not associated with raised fields) documented the use of manioc, along with maize, squash (*Cucurbita* sp.), and several other crops

(DICKAU et al. 2012). Nonetheless, the archaeobotanical evidence as it stands suggests that while manioc may have been present on the raised fields at Campo España, maize was the most abundant crop. In other archaeobotanical studies of raised field systems in the Llanos de Moxos, and elsewhere in lowland South America, maize consistently appears to have been among the most frequently grown crops (IRIARTE and DICKAU 2012). Phytolith evidence of other domesticates was not recovered from the sediments at Campo España, but absence of evidence does not mean other crops were not grown. Some cultivars do not produce diagnostic phytoliths. Additional archaeobotanical methods, such as pollen analysis of sediment cores or starch analysis of domestic artifacts from the nearby mounds, would likely provide a much more comprehensive picture of the agricultural economy at the site.

The depth of the maize in the profiles is noteworthy. Our previous analysis of the phytolith assemblage from the fields at El Cerro to the north showed that maize was present in the top 20 cm of profile of one of the channel profiles, and two shovel test pits (WHITNEY et al. 2014). At Campo España, it found between 5 and 45 cm BS in the channels, and between 20 and 75 cm BS in the camellones. The greater depth of the maize microfossils could reflect slower erosion rates at Campo España, or possibly great deposition rates that buried the cultivation surfaces. Many fields in this area were significantly higher than at El Cerro. In Camellón 1, the depth of the maize phytoliths and their stratigraphic position at the base of Unit 3, identified as the first field platform, suggests that the land was being farmed even before the construction of the raised fields. We note, however, that sediments comprising Unit 3 might have been mixed during construction or cultivation of the fields, and therefore phytoliths may have been moved within the stratigraphy. However, the local loam soils, primarily alluvial deposits of sediment transported down from the Andes by the Maniqui River, were sufficiently fertile to support agriculture without the raised fields. Rather than improving fertility, it appears that the primary purpose of the fields was drainage during wet season flooding events, based on the depth of the channels and the morphology of the fields, in an effort to extend the growing season and increase agricultural output (Lombardo et al., 2011). It is also possible that as the dry season advanced and flood waters receded, farmers took advantage of the residual moisture in the channel soils and began planting crops there. This contrasts with El Cerro, where the poor, clayey soils are not as fertile, and one of the probable benefits of the raised fields, in addition to flood mitigation, was improving soil quality and allowing the cultivation of maize (WHITNEY et al. 2014).

In addition to the cultivars documented, it is possible that some of the other phytoliths recovered may have come from economic taxa that were actively encouraged or managed on the camellones. In particular, palm phytoliths were found throughout the profiles. Although genus and species-specific determinations are not usually possible within the palm family, particular palm genera are marked by the presence of either granulate hat-shaped morphotypes (produced in *Bactris*, *Acrocomia*, *Astrocaryum*, and others) or echinate globular (produced in *Attalea*, *Euterpe*, *Oenocarpus*, and others) (TOMLINSON 1961; PIPERNO 2006; BOZARTH et al*.* 2009). *Socratea* and *Lantania* are the only two genera known to produce both morphotypes (PIPERNO 2006). Many palm species are major economic plants in the Neotropics, used for food, fuel, medicine, craft, and construction material, and one, *Bactris gasipaes*, was domesticated and cultivated in Amazonia (BALICK 1984, 1988; CLEMENT 1988; KAHN 1993; CLEMENT 1999; MACÍA 2004). While we cannot determine if the palm phytoliths recovered from the Campo España camellones represent naturally occurring vegetation or cultivated individuals (or both), it is possible that some palm trees were maintained on or near the fields by the pre-Columbian farmers to provide specific economic resources. Similarly, Marantaceae is a family with numerous economic species. Although none of the phytoliths recovered were consistent with those of domesticated species such as llerén (*Calathea allouia*) or arrowroot (*Maranta arundinacea*), it is possible that other non-domesticated Marantaceae species were encouraged or cultivated on the fields.

CONCLUSIONS

Our analysis of stratigraphy and phytolith records from camellones at Campo España provides insights into the construction and cultivation history of these fields. Prior to field construction, the landscape was dominated by palm savannah. The alluvial loam soils potentially allowed seasonal maize cultivation, but a need to increase agricultural production and/or cope with more frequent flood events prompted people to construct camellones as growing platforms. Woody vegetation was cleared and probably burned, and the fields created by excavating parallel channels and piling the soil alongside in platforms 3-5 m wide. Elevation varied, depending on localized topography, flood height, and drainage patterns. Over the history of field use, the cultivation surfaces may have been occasionally renewed or built up with sediment from the channels, but based on the horizontal deposition visible in the channel profiles, this does not appear to have been a regular practice. The primary function of the fields was drainage, with little evidence of fertilization with silt from the channels (LOMBARDO et al*.* 2011). The camellones were used to grow maize and possibly manioc, and appear to have been regularly burned, perhaps as a method of weed and pest control. Cropping was practiced on the field platforms, but also potentially within the channels during the dry season, since evidence of domesticates was found there as well. An increase in arboreal phytoliths near the top of the stratigraphic profile of the fields is interpreted as recovery of woody taxa due to abandonment by pre-Columbian farmers. Although we currently lack absolute dates for the profiles, it is likely this abandonment of the fields occurred sometime between 1200 and 1550 based on dates from other field systems in the Llanos de Moxos (ERICKSON 1995; RODRIGUES et al. 2014; WHITNEY et al. 2014).

The complexity of other earthwork s at Campo España, including canals, causeways, a reservoir, and several mounds, indicate a structured and sizable settlement of people associated with the raised fields. The site holds significant potential for research into the economic production and organization of the fields, and the socio-political structure that managed the fields and was in turn supported by them. The pre-Colombian societies of the Llanos de Moxos created a vast agricultural landscape through the sophisticated management of water and land resources. In depth, field-based analyses such as this are essential to reconstructing the details of construction, the crops cultivated, and the palaeoenvironmental context. In turn, this data can inform broader questions of human-landscape interactions and the strategies people use to cope with a challenging and changing environment.

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APPENDIX: RAW PHYTOLITH COUNTS

Table 1: A/B-Fraction raw phytolith counts and totals.

	Cat #	cm BS	Poaceae Cross Variant 1	Poaceae Cross Variant 2	Poaceae Cross Variant 3/8	Poaceae Cross Variant 5/6	Poaceae Other Cross – shaped Body	Poacaeae Spiked Cross	Panicoideae Bilobate	Burnt Panicoideae Bilobate	Panicoideae Polybate	Sloped Bilobate	Burnt Sloped Bilobate	Poaceae Keeled Bilobate	*Aristida*-type Bilobate	Oryzoideae Scooped Bilobate	Trapezoidal Curved	Chloridoideae Saddle	Bambusoideae Collapsed Saddle	Poaceae Rondels/ Trapezoids	Poaceae Tall Rondel	Blocky Rondel with	Poaceae Fringed Rondel	Suborbicular with	Granulate Polygonal Platelet with Central	Cyperaceae Conical Bodies	Cyperaceae Burnt Conical Body	Cone with Dendritic	Heliconia Trough Body	Asteraceae Opaque Perforated Plate	Cylindrical with Central	or Crushed Decoration	Top, Decorated	type Nodulose	Zingerbales-type Druse	Arecaceae Globular Echinate	Arecaceae Conical Echinate (Hat-Shaped)	Globular Granulate	Globular Psilate	*Manihot*-like Secretory Cell	Sclereid	Irregular with Narrow Processes	Brown Verrucate	Hair Cell	Dendritic Rectangular	Dendritic Body	Orbicular Plano-Convex Verrucate	Irregular Partitioned Platelet	Blocky Laminated	Unidentified	Total
Camellón 1	B-10-061	0-5	1		1	5	3		177										4	25				1	1				1	2	3	2		2		1		4	1												234
	B-10-062	5-10	3		1	6	1		196							4			5	31				1	2	1			5			2				5	3	2	3												271
	B-10-063	10-15	2		3	1	3		180							3			3	33				1	6				3		12	5				2		3					4								264
	B-10-064	15-20	5	2	3	4	1		51	36	1	65	27	1	2				23	9	3	6		1	2		2		2	7	2		2	1		40	1	9	1												309
	B-10-065	20-25	2		3	3	1		136									1		31				2	3				2	1	3	23				12		2					1								226
	B-10-066	25-30	2		3	6			30	28	1	42	29	2	1	1			35	7		10		1	6		4		1	3	1			1		22	6	6	1			1									250
	B-10-067	30-35	3		5	1	3		148							1		2		31				1	5	2			1	1	1	13				5	1	5	1												230
	B-10-069	40-45	6		7	9	4		43	40		37	51	1	1	1		1	22	20	5				5		7		4	1		1	1	1		19	3	2	1			1									294
	B-10-071	50-55	2		4	7	3		36	39	3	29	81	1	1	4		1	17	16		1			3	5	3		8	1		3		1		12	3	11	2			1									298
	B-10-073	60-65	6		3	13	2		29	35	1	51	68	1	1			3	21	11	1	2		1	4	1	10		2	1	2	1				15	4	9	1			4									303
	B-10-075	70-75	3		3	12	2		65	31	1	37	38		2	4	2	3	50	19		6			4				2	1			1	1		7	23	7													324
	B-10-077	80-85	1	1	2	3	5		67	34	3	17	31	1	3	1	1	1	17	22	1	3			1	1	14		5	1		1				16	1	10	1		1	1									267
	B-10-082	105-110	1		1	4	3		40	25	1	13	17			1	3	1	44	23		6			2		11		7	1		2		1		26	6	44	1			1									285
	B-10-087	130-135	2		1		3		47			7	4			3		1	17	20		2					1		4	3		3				64	89	1	3			1									276
Channel 1	B-10-088	0-5	4	1	5	14	3		85	34	1	59	24	1					5	22		3		1	5	4			2	1	1	6				18	4	2													305
	B-10-089	5-10	2		5	11	3		52	28	2	53	34	1	1	3	1		16	22	1	4		3	10	2	6	5	3	3	1	7				26	7	2	1												315
	B-10-090	10-15	7	1	2	15	2		66	21	3	54	31	2		10			20	25	2	4		4	16	1	8	2	4	1	3	2		1		14	3	6													330

	B-10-091	15-20	8		1	7	1		79	42	1	56	24	2	1	5			28	22	2	5		6	11		6	1	2	1	1	1	1			14	2	2													332
	B-10-092	20-25	5	1	5	7	6		84	45	4	30	31	1	1	7		3	30	20		5		8	15	9	15	1	10	1	3	3				6	4	3						1	1						365
	B-10-093	25-30	2		4	14	5		71	20	2	18	7	1	1	13	2	1	42	43	4	18		5	11	6	4		7	1	6	11	1	1		10	2	6				1			2			1		1	344
	B-10-094	30-35	9	1	6	32	4		107	46	2	21	8	1	1	7	2	3	63	30	3	17		6	16	9	2		16	3	8	5	1			14	6	6	1	1					3					2	462
	B-10-096	40-45	5		1	7	2		89	45	2	19	16	2	1	7		4	42	38	1	11		3	12	1	11		17	16	1	3	1			26	1	16	1				1		2						404
	B-10-098	50-55	3		3	7	2		53	44	1	21	47	1		1		1	25	47		12		2	4		2		18	41	3	1				36	3	35	3			1			1						418
	B-10-100	60-65	1		1	4			37	44		12	28	1		3		1	29	30				2	3	1			9	6	1	1				31	4	49	3												301
	B-10-102	70-75	2		3	6	1		52	46		21	33			1		1	32	29	4			3	7		5		5	6		2				20	2	27													308
	B-10-104	80-85	1			2			32	23	1	14	24			4			24	36		2			3	1			13	6		5		2		59	1	26													279
Camellón 2	B-10-106	0-5	1	4	5	14	3		46	24	1	44	16			7	5	1	17	30	1	3		1	4	2	1		1	1						3	2	2	1			1				1					242
	B-10-108	10-15	1	1	2	9	2		46	27	1	61	45	2	1	4			21	29		5		1	7	4	6		4	1	1	2		1		3	5	4				1				1				1	299
	B-10-110	20-25			1	1	1		37	22	2	82	66	2	1		1		13	24	1	2		1	5	1	4		1	1		1		1		4	2	1				1				1	1				281
	B-10-112	30-35	4			7			45	31	1	94	77			2		1	10	24	1	3		1	2	1	3		3	1		1		1	1	6	4	1	1				1			1					328
	B-10-114	40-45	1			2			20	47	2	24	105				2	1	9	37	2	2			1	1	1		1	1		1				14	1	12	1			1									289
	B-10-118	75-85			1	2			27	39		20	47					1	6	50	1					1			2	2						42	2	28	1			1									273
Channel 2	B-10-120	0-5	7		6	17	2	21	75	14	4	24	6	4		4	4	1	11	59	8	7		4	16	11			1	1				1		2	3	1				2				1					317
	B-10-121	5-10	11		5	12	5	2	75	42	3	15	13	6	1	3			9	71	3	1		7	24	9	1		1	1	1					3	2	2	1			1				3					333
	B-10-122	10-15	1		3	10	1	1	62	22	2	27	20	3				1	2	75	3			3	30	4		1	1	1				1		5	1	1	2							1					284
	B-10-123	15-20	3	1	1	11	1	1	71	43	1	19	8	1		2		1	10	54	7			1	14	4	1		4	1		1				2	1	2	1			1				1				2	271
	B-10-124	20-25							37	48	1	27	20	1	1			1	7	69	1			1	18	3			2	1		2				10	1	6				2				1				1	261
	B-10-126	30-35	4		2	4	2		47	42	2	44	55						1	63				1	9	1	1		8	1						10	1	17	1			1				1				1	319
	B-10-128	40-45				2	1		28	64	1	28	45						3	42	3				2				5	3		1				21	1	11	1			1				1					264
	B-10-132	Surface A	4	2	1	15	4	1	54	17	1	63	25	4		2			7	42	1		6	1	4	13	1		1	1	1	1				5	2	1				1		1			1		4	5	292

	B-10-133	Surface B	5	2	3	11	2	1	47	27	1	48	27			4			10	51			1	1	4	5	3		2		1		1			5	2			1									1		266
	B-10-134	Surface C	3		2	21	1		60	24	1	61	29	1		5	2	1	7	51	1		3	1	9	5	4		2	1		1	1			4	4	2	1							2				1	311

Table 2: C-Fraction raw phytolith counts and totals.

	Cat #	cm BS	Asteraceae Opaque Perforated Plate	*Thalia*-type Granulate Cylindrical with Central Conical Protuberance	Marantaceae-type Decorated Cylindrical with Central Protuberance	Brown Verrucate	*Dichorisandra*-type Trapezoidal Polygonal Plate	*Scirpus*-type Sinuous Suborbicular with Central Protuberance	*Cyperus/Kyllinga* Granulate Polygonal Platelet with Central Protuberance	Large Globular Echinate	Large Globular Granulate	Irregular With Narrow Processes	Large Nodulose Globular	Irregular Faceted	Epidermal Tissue	Hair Base	Mammiform Platelet	Bispherical Body	Angularly Crenate Elongate	Irregular Partitioned Platelet	Pilate Tracheid	Irregular Dendritic	Blocky Laminated	Unidentified	Total
Camellón 1	B-10-061	0-5	17	10		6			1							1									35
	B-10-062	5-10	19	14		6					1														40
	B-10-063	10-15	6	8		9																			23
	B-10-064	15-20	16	2										1	1									1	21
	B-10-065	20-25	9	20		1			1																31
	B-10-066	25-30	28			2																			30
	B-10-067	30-35	13	1		2																			16
	B-10-069	40-45	60	3		1					1	2	1											5	73
	B-10-071	50-55		1		1																			2
	B-10-073	60-65	21																						21
	B-10-075	70-75	15							1															16
	B-10-077	80-85	13																						13
	B-10-082	105-110	2																						2
	B-10-087	130-135								1														1	2
Channel 1	B-10-088	0-5	19	33	1	1		1	8			1	3				3	2	2	1				1	76
	B-10-089	5-10	29	138		2			18								7	1	1						196
	B-10-090	10-15	60	64		7		8	26			1	1				38								205
	B-10-091	15-20	39	26		6			10			1	6			1	28								117
	B-10-092	20-25	47	37		6		1	16			4	1				4				1				117
	B-10-093	25-30	103	90		4			5				1				3								206
	B-10-094	30-35	204	71		3			1																279
	B-10-096	40-45	152	11		1																			164
	B-10-098	50-55	75																						75
	B-10-100	60-65	17																						17
	B-10-102	70-75	10																						10
	B-10-104	80-85	3																						3
Camellón 2	B-10-106	0-5	3						1																4
	B-10-108	10-15	6															1							7
	B-10-110	20-25	10																						10
	B-10-112	30-35	7			2																			9
	B-10-114	40-45	5																						5
	B-10-118	75-85	1																						1
Channel 2	B-10-120	0-5	3			2		4	6		1		2				9								27
	B-10-121	5-10	3			1		5	23			1					15					5			53
	B-10-122	10-15	3					1	10								6					9		1	30
	B-10-123	15-20	2					1	8			1					1					3		1	17
	B-10-124	20-25	2			1			1													1			5
	B-10-126	30-35				1																			1
	B-10-128	40-45	1																						1
	B-10-132	Surface A	6			1	12		10														13	1	43
	B-10-133	Surface B	4			1								1		1	2								9
	B-10-134	Surface C	10	1				1	3					1			1		1					1	19

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