Journal of Archaeological Science: Reports 21 (2018) 413–421

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Late Holocene plant use in the Sierras Pampeanas of Argentina: Evidence from phytoliths and starch grains

Verónica Lalinde Aguilar[a,*], Guillermo Heider[b], Rafael Curtoni[a], Mariangeles Borgo[b], Jorge O. Chiesa[c], Gabriela Ramos[d]

[a] INCUAPA-CONICET, Facultad de Ciencias Sociales, UNICEN, Argentina
[b] CONICET-CCT SAN LUIS, Facultad de Cs. Físico, Matemáticas y Naturales, UNSL, Argentina
[c] Facultad de Cs. Físico, Matemáticas y Naturales, UNSL, Argentina
[d] Facultad de Ciencias Sociales, Universidad del Centro de la Provincia de Buenos Aires (UNICEN), Argentina

ARTICLE INFO

Keywords:
Archaeobotany
Knapped artifacts
Late Holocene
Domestic and wild resources
Pampean Mountains of Argentina

ABSTRACT

Archaeobotanical studies carried out in the southern Sierras Pampeanas of Argentina (San Luis Province) are reported, which add new information about the presence of cultigens in the area during the late Holocene and the variety of wild species used in this period. The presence of starch grains of *Zea mays* (corn), *Cucurbita* sp. (squash), undifferentiated tubers, and *Phaseolus* sp. (beans), as well as phytoliths of Panicoideae, Chloridoideae, Arundinoideae, Bambuseae, Cyperaceae, Asteraceae, Arecaceae and woody dicotiledons are documented from analyses on knapped tools. The obtained data allow discussing the diversity of the resources utilized and the importance of cultigens in prehispanic times in a context that is currently considered the southern limit of prehispanic food production economies.

1. Introduction

Ever since the archaeological research of González (1952, 1960), the Sierras Pampeanas of Argentina have been considered an archaeological region with its own characteristics, distinguishable from the northwest of Argentina and from other areas. In this context, even today it is proposed that the historical trajectories of local groups are related (Berberián et al., 2013; Laguens and Bonnín, 2009). However, there is a lack of balance regarding archaeological data between the two main sectors of the Sierras Pampeanas, namely Sierras de Córdoba and Sierras de San Luis (Cattaneo et al., 2013; Heider and Curtoni, 2016).

Sierras de Cordoba has been the focus of a profuse research on domestic and wild vegetables, their importance on human diet and intensification processes, among other issues (Berberián and Roldán, 2001; López and Recalde, 2016; Medina and Pastor, 2006; Medina et al., 2016, 2017; Pastor, 2007). The lines of evidence used have been varied: colonial documents from the 16th century that report an agricultural system based on maize, beans, quinoa, squash and peanuts (Berberián, 1987; Medina et al., 2009; Piana de Cuestas, 1992; among others), complemented with the collection of locust bean (*Prosopis* spp.) and chañar (*Geoffroea decorticans*) (i.e. Castro Olañeta, 2006; Pastor, 2007). Additionally, bioarchaeological studies with stable isotopes and osteo-dental paleopathological research have indicated the existence of a diet rich in carbohydrates and C4 plants (i.e. Bordach et al., 1991; Fabra et al., 2006). These developments, together with the sharp increase in regional work, the development of micro-botanical analyses and new radiocarbon dates, have produced significant advances. Lately, open-air residential-agricultural archaeological sites (traditionally considered sedentary) have been rethought in terms of their dynamics of occupation, chronology and articulation with productive spaces, as well as the role they played in the context of socio-political processes in the region (Medina et al., 2016).

In the mountain portion of San Luis, however, the evidence for prehispanic use of vegetable resources during the late Holocene is almost exclusively indirect, and was obtained in the late twentieth century (Heider and Curtoni, 2016). Wild resources are hardly mentioned in the literature and agriculture has traditionally been considered as a possibility based on the identification of residential bases in potentially cultivable land, the presence of milling instruments (mortars and conanas), lithic axes and ceramic pots, and the identification of small open-air archaeological sites that have been interpreted as crop fields (Gambier, 1998).

The earliest evidence for the processing and consumption of maize in the Sierras Pampeanas of Argentina dates back to the final Holocene, approximately 2500 years BP (Pastor et al., 2012). In terms of

* Corresponding author.
E-mail addresses: veronica.lalinde@soc.unicen.edi.ar (V. Lalinde Aguilar), rcurtoni@soc.unicen.edu.ar (R. Curtoni), chiesa@unsl.edu.ar (J.O. Chiesa).

https://doi.org/10.1016/j.jasrep.2018.08.025
Received 6 December 2017; Received in revised form 3 August 2018; Accepted 13 August 2018
2352-409X/

agricultural practices, archaeological discoveries of cultivated plants, including pumpkin (*Cucurbita* sp.), quinoa (*Chenopodium quinoa*), beans (*Phaseolus vulgaris* and *Phaseolus lunatus*) and maize, became more abundant only after 1100 years BP. However, maize and crops in general were not a main subsistence resource (Pastor and López, 2011). Recent research has shown the high incidence of wild plants in the subsistence of late societies, with cultigens occupying a secondary role in the diet (López, 2015; Medina et al., 2011; Medina et al., 2016; among others).

This paper reports the results of an archaeobotanical study on knapped artifacts obtained from the excavation of the Alero Dupuy and La Vertiente sites, located at the Sierras de San Luis (San Luis province). Their significance is discussed within the framework of the subsistence strategies of the human groups that inhabited central Argentina in the late Holocene. Specifically, based on the archaeobotanical evidence, we discuss the used taxa and their importance in economic terms. The approach is novel in two respects: on the one hand, the application of archaeobotanical methodologies to knapped artifacts has been scarce in Argentina (Álvarez et al., 2009; Escola et al., 2013); on the other hand, the studied area has no research history related to the discussion on the southern boundaries of pre-Hispanic food production and the currently proposed models (Gil et al., 2014; Heider and López, 2016; Medina et al., 2016, 2017; among many others).

2. Study cases and their paleo-environmental context

The materials analyzed (knapped tools) were recovered from excavations of two archaeological sites (Alero Dupuy and La Vertiente) located in the central-north area of the San Luis province (Fig. 1). The geomorphological context corresponds to the southern foothills of Sierras de San Luis, with outcrops of igneous and metamorphic rocks of the Palaeozoic basement. Due to its location, the area comprises an ecotone between the phytogeographic provinces of the Chaco (Serrano district and dry Chaco district) and the Espinal (Caldén district and Algarrobo district) (Soriano et al., 1992). The former is characterized by the predominance of *Schinopsis haenkeana*, with less presence of species such as *Lithraea ternifolia*, *Fagara coco*, *Celtis chichape*, *Acacia caven*, *Aspidosperma quebracho-blanco*, *Schinus areira*, *Prosopis torquata*, *Jodina rhombifolia*, *Ruprechtia apetala*, *Acacia visco* and *Chorisia insignis*. Among the grasses, the most important genera are *Stipa* and *Fastuca*. In the Espinal, however, the genus *Prosopis* predominates, species such as *Prosopis nigra*, *Prosopis alba*, *Celtis spinosa*, *Prosopis caldenia*, and *Geoffroea decorticans* are common and the more frequent grasses are *Trichloris crinita*, *Elionurus muticus*, *Schizachyrium consanguineum*, *Setaria mendocina*, *Setaria globulifera*, *Stipa gynerioides*, *Stipa tenuissima*, *Stipa tennis*, *Poa lanuginosa* and *Poa ligularis* (Cabrera, 1971).

Paleoclimatic studies are well developed in the San Luis province. In a macro-regional context, this area occupies part of the South American Arid Diagonal. Two climate groups -Pampean and Patagonic- can be distinguished on the sides of this Diagonal (Piovano et al., 2009). During the middle Holocene this mountain range presented humid conditions (Chiesa et al., 1997). At approximately 3500 BP, there was a reduction in rainfall, and since then, conditions similar to the current ones have been observed. However, the studies by Strasser et al. (2010) show locally wetter conditions in the highland pampas than in the piedmont during the final Holocene.

The two sites where the analyzed material was recovered are contrasting in several ways. Alero Dupuy is a rock shelter located in a sector of xerophilous forest, close to the Pantanillo Stream (a tributary to the Quinto River), at 1154 MASL. After the excavation, two radiocarbon dates were obtained: the first one corresponds to times of Hispanic-Indigenous contact (from coal fragments recovered in the combustion structure dated to 560–280 calBP [LP 2878]), and the second belongs to the middle Holocene, dated to Cal 5570–5010 calBP (taken on a guanaco bone fragment with cut marks [AA 105423]), which places the first occupations of the rock shelter towards the middle Holocene. Alero Dupuy has been described as a multi-activity site with long-term and semi-permanent occupations (Curtoni et al. 2017).

La Vertiente is an open-air site, used for specific activities and located in a small high pampa on the side of the River Conlara, at 1157 MASL. In the lower part of the excavation, a guanaco bone fragment with cut marks was dated to 4900–4540 calBP[1] (AA107246) (Curtoni et al., 2016), also placing initial occupation in the middle Holocene. Occupation during the late Holocene has been proposed from indirect evidence, namely, the presence of ceramics on surface and at the initial levels of the excavation (Curtoni et al., 2016). An additional difference between the two sites is the amount of archaeological material recovered, with half as much evidence as collected in Alero Dupuy (Curtoni et al., 2016). Finally, considering the archaeological evidence recovered in the sites, it has been estimated that hunting of small and medium-sized animals was the main component of subsistence, combined with gathering of wild resources and the exploitation of domestic ones (Curtoni et al. 2016, 2017).

3. Materials and methods

The materials selected for analysis were, in all cases, quartz knapped artifacts (n = 9) (Table 1; Fig. 2). The selection took into account both the stratigraphic position in the excavation and macroscopic analysis once the pieces were clean.

Due to the overall sample size of the sites (144 and 30 artifacts formatted for Alero Dupuy and La Vertiente, respectively), the set from Alero Dupuy was twice as large as that from La Vertiente. The techno-typological analysis was based on the concepts proposed by Aschero (1975–1983) and Aschero and Hocsman (2004). Since there are no functional studies on these raw materials for the region, the primary functions were determined following Hocsman (2006), who postulates that the morphology of the formatted artifacts provides tools to define what would potentially be the best possible use, within the framework of a limited range of actions.

An adaptation of the protocols of Dickau (2005) and Loaiza (personal communication 2016) was used for the recovery of the micro-remains. The first step was a soft wash of the artifacts with deionized water and a toothbrush to remove sediment and allow their description. Following Kealhofer et al. (1999), it was assumed that different methods of sampling provide different types of information, that is, the analysis of the soil around the artifacts produce data concerning the context, and the "artifact sample" obtained directly from the artifacts using sonication provide direct evidence for its use. To avoid contamination, the artifacts were washed with deionized water applied with pressure and using a different toothbrush for each. Subsequently, each instrument was sonicated in deionized water for 5-minute cycles. The liquid containing the residues was concentrated by centrifugation cycles of 15 min at 2500 rpm, eliminating as much water as possible. For the separation of the starch grains, a solution of Zinc Bromide ($ZnBr_2$) with a density of 1,79 g/cm^3 was added to each sample, following the protocol of Dickau (2005). After the extraction of the starch grains the materials with densities greater than 1,79 g/cm^3 (remaining at the bottom of the test tube) were washed by adding deionized water and centrifuging at 2500 rpm for 15 min, then decanting until the layer created by the zinc bromide solution was not visible. This material was used for the extraction of phytoliths. In the particular case of the samples obtained from knapped instruments, deflocculating and sieving of the sediment were omitted, on account of the small amount of phytoliths obtained. The carbonates were removed using hydrochloric acid (HCl) and nitric acid (HNO_3) was added in a hot water bath for the removal of organic matter. After each acid bath the samples were

[1] The dates of both sites were calibrated using CalPal 2016.2 software and the INTCAL 2013 calibration curve.

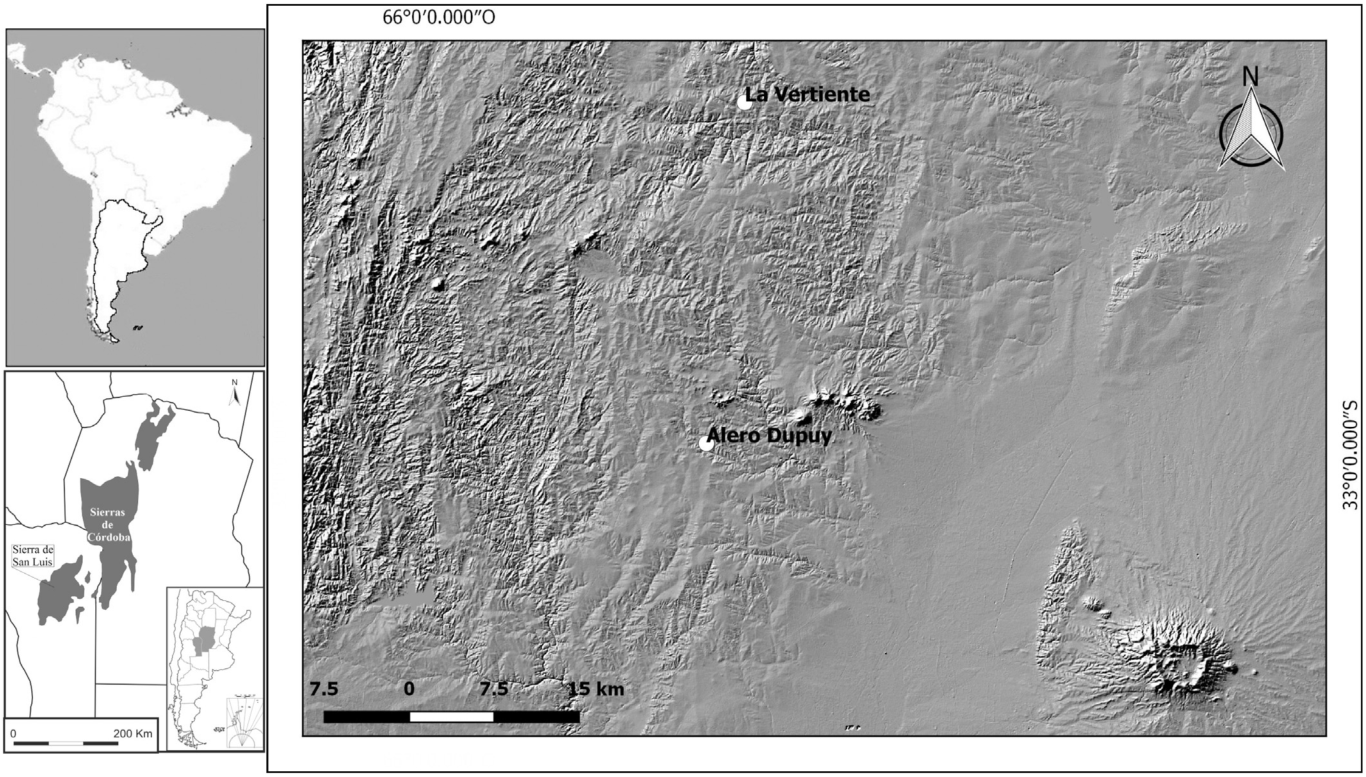

Fig. 1. Sites location.

Table 1
Description of the artifacts.

Sample id.	Site	Instrument	Provenance
m13	Alero Dupuy	Single scraper + notched points	E3N7
m14		Single scraper + notched points	D2N3
m15		Single scraper + notched points	D2N3
m16		Single scraper + notch + notch	E3N11
m17		Single scraper on lateral edge	D2N3
m18		Undifferentiated broken artifact with bifacial edge	D2N3
m65	La Vertiente	Undifferentiated artifact with bifacial edge/bifacial edge asymmetrical bevel	Superficial collection
m68		End-scraper broken on frontal/ lateral edge	F1UE1
m69		Notch + knife	F1UE1

centrifuged, decanted and washed by adding deionized water and centrifuging repeatedly. The flotation was carried out with a solution of $ZnBr_2$ with a density of 2,8 g/cm^3, so that phytoliths and other particles of similar densities could be easily extracted with a pipette. The upper layer of the liquid was then deposited in a new test tube, $ZnBr_2$ was removed by washing with deionized water, and the sample was concentrated by centrifuging and then dried in the air with the aid of acetone.

The assemblage medium for the starch grains was distilled water with 10% glycerin. On the other hand, the phytolith plates were assembled by mixing the resulting sediment (in all cases > 0.5 mg) and one milliliter of Entellan. For both types of micro-remains the entire plate was counted. To avoid over-representation of Poaceae, only the short, most representative cells were counted as being more specific to the family or subfamilies (Babot, 2011; Neumann et al., 2017). The appearance of bulliform cells was recorded, but they were not included in the count because of their wide distribution in different families.

The samples were analyzed using an Olympus CX41 microscope, an

Fig. 2. Artifacts. From right to left, top to bottom: m13, m14, m15, m16, m17, m18, m65, m68, m69.

AxioCam ERc5s camera and the Axio vision Rel. 4.8 software. For the identification of phytoliths, the morphotypes described by several authors (i.e. Babot et al., 2017; Erra et al., 2011; Fernandez Honaine et al., 2009; Piperno, 2006, 2009; Pearsall et al., 2003) and the University of Missouri database (Pearsall, 2016) were employed. The starch grains were identified using reference material from the study area, bibliographic material (Babot, 2003; Bonomo et al., 2011; Escola et al., 2013; Giovannetti et al., 2008) and a personal reference collection (Lalinde, 2009). Grain shape and size and the presence or absence of features such as hilum and lamella were considered (Henry et al., 2011).

To avoid contamination, powder free gloves were used at every stage of the process and in each step a control sample consisting of distilled water was processed as the others and observed in the microscope. Consumables and glassware were sterilized using a 5% NaOH and 5% KOH solution (Crowther et al., 2014) and a set with the necessary instruments was labelled for each sample, thus avoiding cross contamination between them (Horrocks, 2005).

4. Results

The analysis of knapped lithic artifacts is summarized in Table 1. As can be seen, in all cases they constitute elements whose primary function corresponds to scraping, cutting off and undifferentiated surfaces. The archaeobotanical study allowed observing domestic and wild vegetal resources, as well as undifferentiated elements.

The domestic resources (Table 2, Fig. 3) are represented by the presence of starches and phytoliths identified as possible maize (cf. *Zea mays*), as well as starch grains of squash (cf. *Cucurbita* spp.) and beans (cf. *Phaseolus* spp.). The identification of cf. *Zea mays* was accounted for by the combined presence of wavy top rondel phytoliths and large polyhedron starch granules with a central linear hilum. Although the granules exceeded the average size (12.69 µm) they were within maximum size values (29.15 µm) (Medina and Salas, 2008). The size ranges of the granules identified as cf. *Zea mays* overlap with the known values for *Prosopis* ssp. (between 10 and 19.99 µm), for which polyhedron, irregular granules with punctate or linear hilum and central cavity have been described (Giovannetti et al., 2008). However, this plant was not considered in the identification since in the project reference collection the starch granules obtained from *Prosopis alba* and *Prosopis nigra* differ greatly from those cited above (See SOM 1). The starches of possible Cucurbitaceous were identified by shape, symmetry, grain size, shape of the hilum and number of facets of pressure following Lalinde (2009). Finally, cf. *Phaseolus* spp. was identified from one of the most common morphotypes of this genus, the reniform morphotype, whose average size can vary between 27 and 57.9 µm depending on the variety. This morphotype usually has an open, elongated hilum that follows the shape of the grain (see Fig. 3g) and on which cracks tend to occur. The grains of this genus are very susceptible to heat in the presence of moisture, rapidly gelatinizing after cooling to look like the grain in the figure (Lalinde, 2009). In some of the starch grains, damage of various types was observed, including cracks, fractures, gelatinization and partial loss of the content (Fig. 4). The raw data set is available in SOM 2.

Several taxa were identified among wild resources, among them phytoliths of the Asteraceae (Piperno, 2006: 196), Arecaceae (*Trithrinax campestris*) (Piperno, 2006: 192–193, Benvenuto et al., 2015), Cyperaceae and Poaceae families. Very small solid globular echinate and solid globular psilate morphotypes were identified as woody dicotyledons (Garnier et al., 2012) and groups of morphotypes representative of the main Poaceae subfamilies (Piperno, 2006: 30–31) present in the study area were found (Table 3, Fig. 5). The Cyperaceae family was represented by the hat-shaped morphotype, common in the leaves (see Pearsall, 2016, recno 430–463). As regard starches, included in this category were those assigned to unidentified tubers (large, elongated and smooth: Hardy et al., 2009) and those that have not been identified yet. In the *unidentified* phytolith category several morphotypes were included, such as tricome, acuminate, bulliform, bulbous, asymmetric trapeziform, rhomboid, orbicular reticulate, irregular scrobiculate, and conical facetate, among others.

Table 2
Identified domestic species. References: AD (AleroDupuy), LV (La Vertiente); S (starch grains); P (Phytoliths).

Site	Sample	Identification		
		cf. *Zea mays*	cf. *Cucurbita* spp.	cf. *Phaseolus* spp.
AD	M13	S		
	M14		S	S
LV	M65	P		
	M69	S		

5. Discussion

The Sierras Pampeanas have traditionally been considered as the southern limit for agricultural practices in South America. In this perspective, the adoption of agriculture would have had notorious consequences in the historical trajectories of local human groups (Laguens and Bonnín, 2009; Serrano, 1945). However, recent archaeological studies have postulated that the hunter-farmer transition had a high dynamism in the Late Prehispanic processes in Sierras de Córdoba. On the other hand, investigations along this line in the southern and western portions of the Sierras Pampeanas (province of San Luis) have not shown the same progress. In fact, archaeological studies of the late Holocene in general, and of subsistence in particular, have been scarce in this area (Heider and Curtoni, 2016) Models on adoption of agriculture have traditionally been based on indirect evidence (i.e. presence of ceramics or grinding artifacts) and two distinctly opposite stages have been distinguished, one of hunter-gatherers or pre-ceramic times and another belonging to sedentary groups with herding activities and pottery technology (Gambier, 1998).

The results obtained here allow us to advance along two related lines: a) verifying the feasibility of obtaining archaeobotanical information in the knapped stone artifacts recovered in central Argentina; b) addressing, for the first time and using direct data, the discussion on late Holocene subsistence strategies in the southern boundary of prehispanic agriculture. Both lines are aimed at rethinking the traditional tendency to consider hunter-gatherer societies or agricultural societies as extremes, ignoring the broad spectrum of behaviors and alternatives that can be found between these two categories (Smith, 2001).

As argued by Babot (2011, 2014), a consequence of such dualistic view is that some artifacts are typically considered as indicators of agricultural activities (grinding artifacts, axes and hoes), and thus the absence of them validates the proposal of subsistence models in which the role of plant resources is not considered. In this way, the functions pre-assigned to certain types of artifacts condition their eligibility to perform specific laboratory analyses, thus creating a bias (Hardy et al., 2009). In fact, only two works carried out in Argentina have inquired about the processing of plants with knapped artifacts based on archaeobotanical analysis (Álvarez et al., 2009; Escola et al., 2013). The present study revealed plant micro-remains in all the artifacts analyzed. Regardless of the micro-remains obtained, their very presence constitutes a clear sign of the unsuitability resulting from a dualistic view. Moreover, evidence can be extracted even when the artifacts are made of non-porous raw materials such as quartz.

Regarding subsistence practices, some noticeable differences between the two archaeological sites here analyzed were observed. At the Alero Dupuy site, located in a landscape with relatively more favorable climatic conditions, a greater number of wild species was recorded (Table 3), with only some unidentified morphotypes, Panicoideae spp. and the Chloridoideae spp., present in both sites.

Gramineae constitute the most represented group in the phytoliths. The great variety observed may be accounted for not only by their presence in the environment, but also to their use and consumption. Recent ethnographic and archaeological research has reconsidered the

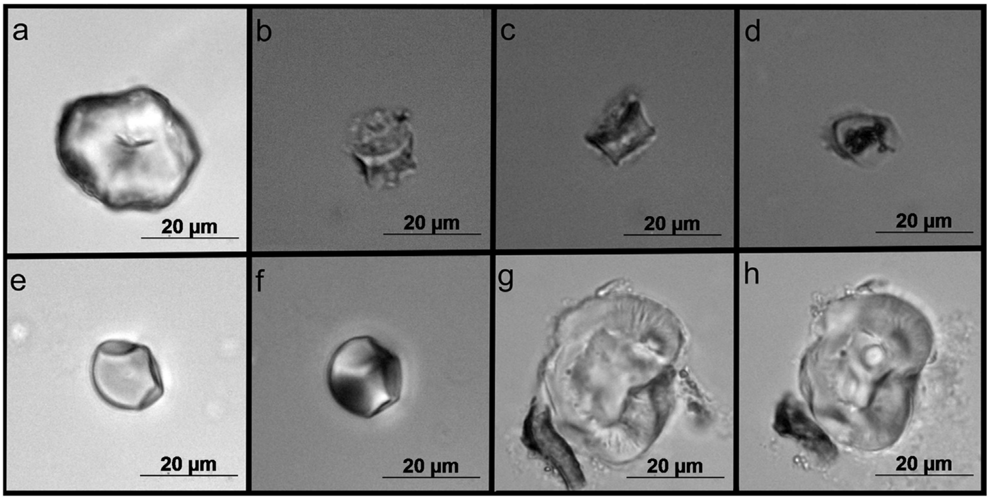

Fig. 3. a: cf. *Zea mays* starch grain; b–d: cf. *Zea mays* wavy top rondel phytoliths; e–f: cf. *Cucurbita* spp. Starch; g–h: cf. *Phaseolus* spp. starch.

role played by grasses in subsistence practices, rather than considering them only as environmental indicators, and have proposed the consumption of species such as *Bromus unioloi* (Heider, 2017; Muiño, 2011; Musaubach, 2014).

In Alero Dupuy a remarkable presence of Cyperaceae was observed; with all the artifacts showing evidence of having being used to process them. In contrast, only one of the artifacts in La Vertiente showed evidence for this family. Cyperaceae are represented by several types of dermal appendages, such as circular or rectangular base cones, found in the epidermis of the leaves and the cane of the plants (Fernandez Honaine et al., 2009). The fact that some species of the genera *Scirpus* and *Cyperus* produce tuberous roots that can be consumed (Babot, 2011), added to their relationship with humid, sunny environments and habitats with anthropic alteration, such as channels and ditches (Reznicek, 2017), make their presence in the artifacts of special interest, since this implies knowledge of the areas where they could be found and possible consumption. The use of Cyperaceae has been archaeologically recorded in neighboring areas at sites such as Gruta del Manzano (Neme et al., 2011) and Arroyo Malo 3 (Llano, 2008), both located west of the study area.

The Arundinoideae and the unidentified Poaceae were present in both sites (n = 3 artifacts in each case) though, considering the sample size analyzed, they can be said to be more represented in La Vertiente. Those Poaceae epidermal cells that were not representative of a specific subfamily were classified as unidentified Poaceae, so they were only considered as indicators of the presence of grasses. On the other hand, Arundinoideae were represented by 8 genera. In this subfamily it was difficult to establish a direct association with environmental conditions, since different species may prefer arid and semi-arid environments (Babot et al., 2017) to humid and temperate ones (Shakoor et al., 2016).

Woody resources were also present in both sites, being more abundant in Alero Dupuy. Both monocotyledons and dicotyledons were identified. Among the former, only *Trithrinax campestris* (Caranday palm) currently exists in the province of San Luis. A review of the ethnographic literature in this regard indicates that the caranday palm has been used as raw material in basketry, in addition to consumption of its fresh fruits (Carosio et al., 2008). At present, this species is found on the western slope of the Sierra de San Luis and Sierra de Los Comechingones, both belonging to the Sierras Pampeanas (Del Vitto et al., 1994). In turn, the presence of dicotyledons was confirmed by the globular psilate and globular granulate morphotypes, though these morphotypes did not allow for more specific identifications. Ethnographically, the use of trees and woody shrubs as fuel, material for construction and raw material for artifacts of different types has been reported in different regions (Carosio et al., 2008; López, 2015).

Asteraceae, Bambuseae and unidentified tubers were observed only in the Alero Dupuy site. Argentina has been proposed as the centre of origin of Asteraceae, since it has 1500 species and more than 200 native

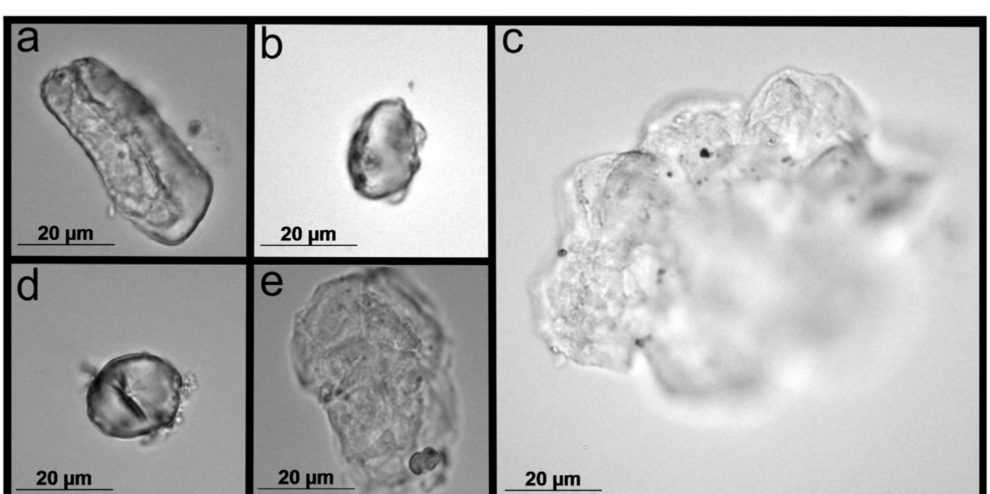

Fig. 4. Damaged starch grains: a. fractured grain, b. pitted grain, c. retrodegradated compound (Hardy et al., 2009), d. fractured grain, e. gelatinized grain.

Table 3
wild resources and unidentified. References: AD (AleroDupuy), LV (La Vertiente); P (Phytoliths); S (starch grains); N/I (unidentified).

Site	Sample	Identification										
		Cyperaceae	Asteraceae	Arecaceae	Panicoideae	Chloridoideae	Arundinoideae	Bambuseae	Unidentified	Poaceae N/I	Tuber N/I	Woody dicot
AD	M13	P	P		P	P	P	P	S		S	P
	M14	P			P	P		P	S		S	P
	M15	P			P	P	P	P	S	P		
	M16	P		P	P	P		P	S	P		
	M17	P		P	P	P	P	P	S	P		
	M18	P		P	P	P	P	P	S			
LV	M65	P			P	P	P		S	P		P
	M68			P	P	P	P		S	P		
	M69				P	P	P		S	P		

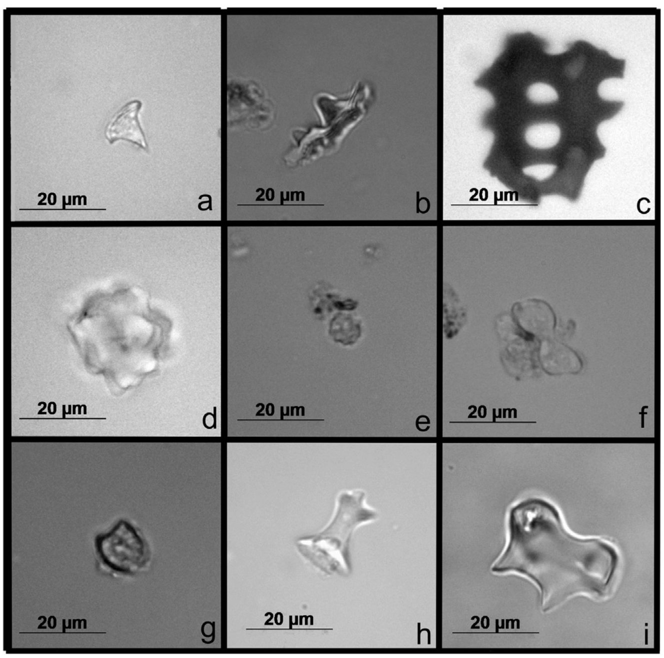

Fig. 5. Phytoliths of wild resources. a–b: Cyperaceae hat-shaped morphotype; c: Asteraceae: Opaque plate w/perforations; d: Arecaceae, globular echinate morphotype, with size, shape and decoration like the reported by Benvenuto et al., 2015; e: woody dicotyledons, f–i: *Poaceae*.

genera (Del Vitto and Petenatti, 2009), with 12 tribes present in San Luis, where several species are used in folk medicine, among them *Acanthospermum austral*, *Bacharis articulata*, *Coniza bonariensis*, *Cyclolepsis genistoides* and *Gaillardia megapotamica* (Katinas et al., 2007). The Bambuseae are represented in the province by a single species, *Leersia Hexandra*, which blooms and fructifies in spring and summer (Rosa et al., 2005), and are considered typical of temperate tropical areas (Garnier et al., 2012).

Finally, the consumption of tubers such as sweet potato (popularly known as "*batata*") is documented by ethno-historical references in the Pampas mountains and plains (López, 2007; Heider and López, 2016; Musaubach, 2014). However, it is possible that the popular name "*batata*" does not refer to *Ipomoea batata*, but rather to *Boerhavia diffusa*or *Prosopanche americana*, which the criollos of Northwestern Chaco presently call "*batata ´e cuchi*" and whose subterranean fruits are also consumed nowadays (Scarpa, 2012). The starch grains belonging to tubers did not correspond to *Ipomoea batata*, therefore, comparison materials of more species with underground edible organs available in the area should be obtained.

Among domestic resources, only corn was identified in both sites, based on the observation of wavy top rondel phytoliths and starch grains. Beans and squash starch grains were only identified in Alero Dupuy. These three species constitute the typical food production triad in archaeological sites in central Argentina (Yacobaccio and Korstanje, 2007). Although they have been previously identified in the Sierras Pampeanas (Berberián et al., 2008; López, 2011, 2015; Medina et al., 2008; Pastor et al., 2012, among others), peanuts (*Arachis hypogaea*), quinoa (*Chenopodium quinoa*) and coca (*Erythroxylum coca*) were not recorded in the sample here analyzed.

The presence of maize has been recorded in the southern plains of the province of San Luis and squash has been identified in the mountain sector of the La Angostura site. In the plains, phytoliths and starch grains of corn have been identified in grinding stone artifacts, indicating only the consumption of this vegetable (Heider and López, 2016). On the other hand, the identification of Cucurbitaceae from a seed recovered during the excavation of the La Angostura site, together with further indirect evidence such as the amount of grinding stone artifacts, pottery fragments and projectile point typology present in the sites, allowed Gambier (1998) to propose the presence of an agro-pastoral period.

The set here identified shows the manipulation of an important group of vegetables, including domestic species. However, in the archaeological sites, apart from grinding artifacts, no other evidence of agricultural technology has been identified (Curtoni et al. 2017). The importance of hunting in the economy is reflected in the variety of species exploited during the late Holocene (Gómez et al., 2016; Curtoni et al. 2017). Transferring the expectations of the agro-pastoral model proposed by Gambier (1998) to the occupations of the area may lead to underestimating some particularities of other kinds of interactions between human groups and plants, such as harvesting, protection, cultivation of non-domesticated species, promotion and eradication (Harlan, 1992). Moreover, the exchange mechanisms and the consequent possibility of obtaining goods and resources from other regions could have led to the use of plants by groups that did not harvest, care or produce them (Babot, 2011).

The archaeobotanical record identified shows a landscape inhabiting situation where the hunter-gatherer/farmer duality does not account for the particularities of the local groups. This claim is supported by the identification of domesticated resources in groups where hunting was the main component of subsistence during the final Holocene (Gómez et al., 2016). On the other hand, the wild species identified in knapped artifacts, specifically the wild grasses, would account for the harvesting of pastures for consumption in a broad sense (Escola et al., 2013). Furthermore, the presence of tubers and Cyperaceae allows verifying the consumption of species traditionally not considered in the archaeological bibliography, although recently identified in neighboring areas (Musaubach, 2014; Heider and López, 2016).

Moreover, although the climate and soil characteristics do not favor the preservation of wood in the archaeological record, the identification of micro-remains of woody species provides evidence for the importance it may have had in a wide range of activities, for instance, as supports for different types of handles and in housing construction, among other uses. Similarly, the identification of stem and leaf phytoliths of *Trithrinax campestris* indicates that, independently of the form of income of this non-local resource (exchange, seasonal mobility), its presence reflects a possible use of caranday palm for basketry production. In addition to the ethnographic evidence, the use of the caranday palm has been proposed indirectly, from the negative imprint as decoration of ceramic pots at the Pampean region (Rocchietti, 2012).

The existence of an intensification processes aimed at the implementation of agricultural practices has been proposed for the neighboring areas located north of the Sierras Pampeanas and in Central west Argentina (Pastor and Berberián, 2007; Neme and Gil, 2008). However, the latest interpretations of the data following Smith (2001) propose a low level food production economy which, at least for the last 1500 years, combined harvesting of a broad set of wild and domestic plant species, hunting, small-scale domestic production and seasonal mobility between valley sectors and highland pampas (Medina et al., 2016; Chiavazza and Mafferra, 2007; Gil et al., 2018; Aschero and Hocsman, 2011; Giovannetti et al., 2015, among others). More and more studies in different continents show the consumption of plants cultivated by hunter-gatherer groups (Freeman, 2007, Planella et al., 2011, Aceituno and Loaiza, 2018, among many others). We believe that the archaebotanical data presented in this paper could represent, in part, a similar scenario, in which the identification of a wide variety of wild and domestic plants is associated with evidence of hunting activities. The Alero Dupuy site seems to particularly reflect the development of a mixed economy that combines the use of a wide diversity of plants resources with the exploitation of a broad spectrum of animals, since a lower diversity of animal and plant resources were recorded In La Vertiente.

Although stone axes have not been recovered in the sites excavated so far, the fact that they are mentioned in the bibliography on the area (Gambier, 1998; Vignati, 1951) and their presence in museum collections make it possible to speculate that the cultivation of plants took place at some point, possibly at a small scale. However, further research including more sites and artifacts should be necessary to determine whether domestic resources were cultivated in the area or obtained by exchange.

A gradual, though not always definitive, incorporation of domestic elements to the diet is an attractive option for an archaeological record where residence mobility is reflected (Curtoni et al., 2016, 2017a, 2017b). Analysis of a greater number of sites and artifacts should be necessary to provide a more definitive answer to this point.

6. Final considerations

The data presented here demonstrates the relevance of the analysis of botanical micro-remains in knapped artifacts as a proxy in the study of human-plant interaction. This implies an extension of the range of activities related to the processing of plants that can be observed in the archaeological record. Likewise, the simultaneous exploitation of wild and domestic resources was proved, suggesting a mixed economy of low level food production, in which some domestic resources (corn, beans and squash) were probably consumed. The cultivation of these plants in the area, however, has yet to be proven.

The main contribution of this work is to provide the first archaeological direct evidence for domestic plant resources at more than one degree south latitude from the current agricultural frontier in South America. Additionally, this work intends to include the area of San Luis province in the macro-regional discussion, in the understanding that contributing new evidence may reflect local characteristics of subsistence practices at the ecotone zone. Here, the duality of terms such as hunter-gatherer/farmer or artifacts for agricultural use vs. other types of artifacts may hinder the understanding of the dynamics of the native peoples who inhabited the agricultural frontier during the late Holocene. Along these lines, it is necessary to increase the number of studies on archaeological artifacts, as well as on the paleo-climatic conditions of the area. In this way, more elements for the macro-regional discussion on mobility and subsistence strategies can be incorporated.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2018.08.025.

Acknowledgements

The investigations are carried out thanks to the support of the EU INCUAPA CONICET of the Faculty of Social Sciences of the National University of the Centre of the Province of Buenos Aires, and of the PICT 0290 of the National Agency of Scientific and Technological Promotion of the MINCyT. To the government of the Province of San Luis, Ministries of Culture, Environment and Tourism for the support for carrying out field work. It was also supported by the Archaeology Laboratory of the University of Antioquia, which facilitated the use of the Microbotanical Laboratory for the analysis of micro-remains. We appreciate revision of the manuscript by staff from Instituto de Lenguas, National University of San Luis. Also we appreciate the comments of all the reviewers that help to improve this work.

References

Aceituno, F.J., Loaiza, N., 2018. The origins and early development of plant food production and farming in Colombian tropical forests. J. Anthropol. Archaeol. 49, 161–172.

Álvarez, M., Zurro, D., Briz, I., Madella, M., Osterrieth, M., Borrelli, N., 2009. Análisis de los procesos productivos en las sociedades Cazadoras-recolectoras-pescadoras de la Costa Norte del Canal Beagle (Argentina): el sitio Lanashuaia. In: Salemne, M., Santiago, F., Álvarez, M., Piana, E., Vázquez, M., Mansur, M.E. (Eds.), Arqueología de la Patagonia. Una mirada desde el último confín. Editorial Utopías, Ushuaia, pp. 903–917.

Aschero, C., 1975–1983. Ensayo para una clasificación morfológica de artefactos líticos aplicada a estudios tipológicos comparativos. Apéndices A y B. MS. Cátedra de Ergología y Tecnología. Informe Conicet. FILO-UBA.

Aschero, C., Hocsman, S., 2004. Revisando cuestiones tipológicas en torno a la clasificación de artefactos bifaciales. Temas de Arqueología. AnálisisLítico 7–25.

Aschero, C.A., Hocsman, S., 2011. Arqueología de las ocupaciones cazadoras-recolectoras de fines del Holoceno Medio de Antofagasta de la Sierra (Puna Meridional Argentina). Chungará (Arica). 43(ESPECIAL). pp. 393–411.

Babot, M.D.P., 2003. Starch grain damage as an indicator of food processing. In: Phytolith and Starch Research in the Australian-Pacific-Asian Regions: the State of the Art. PandanusBooks, Canberra, pp. 69–81.

Babot, M.D.P., 2011. Cazadores-recolectores de los Andes centro-sur y procesamiento vegetal: una discusión desde la puna meridional argentina (CA. 7.000–3.200 AÑOS AP). Chungará (Arica) 43, 413–432.

Babot, M.D.P., 2014. Grinding, processing, settlement and mobility in hunter-gatherers of the southern puna of Argentina (ca. 7400–3200 years BP). In: Pintar, Elizabeth (Ed.), Hunter-Gatherers from a High-Elevation Desert: People of the Salt Puna. BAR, Oxford, pp. 169–200.

Babot, M.D.P., Musaubach, M.G., Plos, A., 2017. An archaeobotanical perspective in the study of inflorescence phytoliths of wild grasses from arid and semi-arid environments of Argentina. Quat. Int. 434, 129–141.

Benvenuto, M.L., Honaine, M.F., Osterrieth, M.L., Morel, E., 2015. Differentiation of globular phytoliths in Arecaceae and other monocotyledons: morphological description for paleobotanical application. Turk. J. Bot. 39 (2), 341–353.

Berberián, E., 1987. Crónicas del Tucumán. Siglo XVI. Editorial Comechingonia, Córdoba.

Berberián, E., Roldán, F., 2001. Arqueología de las Sierras Centrales. In: Historia argentina prehispánica. 2. pp. 635–691.

Berberián, E., Pastor, S., Rivero, D., Medina, M., Recalde, A., López, L., Roldán, F., 2008. Últimos avances de la investigación arqueológica en las Sierras de Córdoba. Comechingonia 11, 135–164.

Berberián, E., Bixio, B., Bonofiglio, M., Heider, G., López, L., Gonzalez Navarro, C., Medina, M., Pastor, S., Recalde, A., Rivero, D., Salazar, J., 2013. Los primeros pobladores de las sierras de Córdoba. In: Berberián, E. (Ed.), En Los pueblos Indígenas de Córdoba, 3° edición. Universitas, Editorial Científica Universitaria, Córdoba (127 p).

Bonomo, M., Aceituno, F.J., Politis, G.G., Pochettino, M.L., 2011. Pre-Hispanic horticulture in the Paraná Delta (Argentina): archaeological and historical evidence. World Archaeol. 43 (4), 554–575.

Bordach, M., Mendonça, O., Español, V., 1991. Características antropofísicas de los antiguos habitantes del Embalse de Río Tercero (Pcia. de Córdoba). Comechingonia 7, 49–61.

Cabrera, A.L., 1971. Fitogeografía de la república Argentina. Bol. Soc. Argent. Bot 14 (1–2), 1–42.

Carosio, M.C., Junqueras, M.J., Andersen, A., Abad, S.M., 2008. Árboles y Arbustos Nativos de la Provincia de San Luis. San Luis Libro, Argentina.

Castro Olañeta, I., 2006. Transformaciones y continuidades en el sistema indígena colonial. El pueblo de indios de Quilino a fines del siglo XVII. Alción Editorial, Córdoba.

Cattaneo, G.R., Izeta, A.D., Takigami, M., 2013. Primeros fechados radiocarbónicos para el sector B del sitio Alero Deodoro Roca (Ongamira, Córdoba, Argentina).
Chiavazza, H., Mafferra, L., 2007. Estado de las investigaciones arqueobotánicas en mendoza y sus implicancias en la arqueología histórica. Revista de arqueología histórica argentina y latinoamericana 127–152.
Chiesa, J., Strasser, E., Barbosa, O., Tognelli, G., Lartigue, C., 1997. Suelos palustres y diatomeas del holoceno del rio Cañada Honda. Sierra de San Luis. Argentina. Actas VIII Congreso Geológico Chileno. Universidad Católica Del Norte, pp. 312–316.
Crowther, A., Haslam, M., Oakden, N., Walde, D., Mercader, J., 2014. Documenting contamination in ancient starch laboratories. J. Archaeol. Sci. 49, 90–104.
Curtoni, R.P., Gómez, G., Borgo, M., Lalinde, V., Martínez, V., Dupuy, P., Oliván, A., Ramos, G., 2016. Arqueología en sierras y llanuras de San Luis. In: Actas del XIX congreso nacional de arqueología argentina. Serie Monográfica y Didáctica, vol. 54 (Tucumán).
Curtoni, R., Borgo, M., Lalinde, V., Martínez, V., Gómez, G., Heider, G., Chiesa, J., Dupuy, P., Oliván, A., Ramos, G., 2017a. Archaeological research in the sierras and plains of the province of San Luis: advances in the characterization of the archaeological record of the Middle and Late Holocene. Anales de arqueología y etnología 72 (2), 167–182.
Curtoni, R., Gómez, G., Borgo, M., Chiesa, J., Lalinde, V., Martínez, V., Oliván, A., 2017b. Investigaciones arqueológicas en el sitio Alero Dupuy, provincia de San Luis. Revista del Museo deAntropología 10, 43–50.
Del Vitto, L.A., Petenatti, E.M., 2009. Asteráceas de importancia económica y ambiental: Primera parte. Sinopsis morfológica y taxonómica, importancia ecológica y plantas de interés industrial. Multequina 18 (2), 87–115.
Del Vitto, L.A., Petenatti, E.M., Nellar, M.M., Petenatti, M.E., 1994. Las áreas naturales protegidas de San Luis, Argentina. Multequina 3, 141–156.
Dickau, R., 2005. Resource Use, Crop Dispersals, and the Transition to Agriculture in Prehistoric Panama: Evidence from Starch Grains and Macroremains (Doctoral dissertation). Temple University.
Erra, G., Zucol, A.F., Kröhling, D.M., 2011. Análisis fitolítico de la Formación Tezanos Pinto (Pleistoceno tardío-Holoceno temprano) en el sector noroeste de su área de distribución en la provincia de Entre Ríos (Argentina). Revista mexicana de ciencias geológicas 28 (3), 398–412.
Escola, P.S., Hocsman, S., Babot, M.D.P., 2013. Entre las residencias y los campos de cultivo. Relaciones de la Sociedad Argentina de Antropología 38, 83–110.
Fabra, M., Laguens, A., Demarchi, A., 2006. Inferencias paleodietarias a paritr de evidencias isotópicas en poblaciones humanas del sector austral de las Sierras Pampeanas durante el Holoceno Tardío. Resúmenes del Taller Arqueología e Isótopos Estables en América del Sur, Malargüe.
Fernandez Honaine, M., Zucol, A.F., Osterrieth, M.L., 2009. Phytolith analysis of *Cyperaceous* from the Pampean region, Argentina. Aust. J. Bot. 57 (6), 512–523.
Freeman, J.C., 2007. Energy, Intensification, and Subsistence Change: Hunter-Gatherer Earth Ovens and Alternatives to Plant Domestication in Central Texas. The University of Texas at San Antonio.
Gambier, M., 1998. Arqueología de la sierra de San Luis. In: Instituto de Investigaciones Arqueológicas y Museo, Facultad de Filosofía, Humanidades y Artes. Universidad Nacional de San Juan.
Garnier, A., Neumann, K., Eichhorn, B., Lespez, L., 2012. Phytolithtaphonomy in the middle-to late-Holocene fluvial sediments of Ounjougou (Mali, West Africa). The Holocene 23 (3), 416–431.
Gil, A., Giardina, M., Neme, G., Ugan, A., 2014. Demografía humana e incorporación de cultígenos en el centro occidente argentino: explorando tendencias en las fechas radiocarbónicas. Revista Española de Antropología Americana 44 (2), 523–553.
Gil, A.F., Menéndez, L.P., Atencio, J.P., Peralta, E.A., Neme, G.A., Ugan, A., 2018. Estrategias Humanas, Estabilidad Y Cambio En La Frontera Agrícola Sur Americana. Lat. Am. Antiq. 29 (1), 6–26.
Giovannetti, M.A., Lema, V.S., Bartoli, C.G., Capparelli, A., 2008. Starch grain characterization of Prosopischilensis (Mol.) Stuntz and P. Flexuosa DC, and the analysis of their archaeological remains in Andean South America. J. Archaeol. Sci. 35 (11), 2973–2985.
Giovannetti, M., Lantos, I., Ratto, N., 2015. Identificación de almidones de maíces catamarqueños: aplicación a dos casos arqueológicos. Comechingonia 19 (2), 235–255.
Gómez, G.N., Chiesa, J.O., Lalinde, V., 2016. Preliminary zooarchaeological analysis of Dupuy Rockshelter (La Toma, San Luis Province, Argentina): faunal and paleoenvironmental tendencies related to geoarchaeological and phytoarchaeological evidence. Quat. Int. 391, 51–60.
González, A.R., 1952. Antiguo horizonte precerámico en las Sierras centrales de la Argentina. RunaV 1-2, 110–133.
González, A.R., 1960. La estratigrafía de la gruta de Intihuasi. Revista del Instituto de Antropología de la Universidad Nacional de Córdova 1.
Hardy, K., Blakeney, T., Copeland, L., Kirkham, J., Wrangham, R., Collins, M., 2009. Starch granules, dental calculus and new perspectives on ancient diet. J. Archaeol. Sci. 36 (2), 248–255.
Harlan, J., 1992. Crops and man. American Society of Agronomy, Nueva York.
Heider, G., 2017. Los recursos vegetales de los Rankülches en la Frontera Sur. Revista TEFROS 15, 7–25.
Heider, G., Curtoni, R.P., 2016. Investigaciones arqueológicas en la Provincia de San Luis: a 150 años de sus inicios, historia y perspectivas. Revista del Museo de Antropología 9 (1), 35–48.
Heider, G., López, L., 2016. El consumo de recursos vegetales silvestres en grupos cazadores recolectores del norte de pampa seca (San Luis y Córdoba, Argentina). Mundo de Antes 10, 00.
Henry, A.G., Brooks, A.S., Piperno, D.R., 2011. Microfossils in calculus demonstrate consumption of plants and cooked foods in Neanderthal diets (Shanidar III, Iraq; spy I and II, Belgium). Proc. Natl. Acad. Sci. 108 (2), 486–491.
Hocsman, S., 2006. Producción Lítica, Variabilidad y Cambio en Antofagasta de la Sierra -ca.5500-1500 AP (Doctoral dissertation). Universidad Nacional de La Plata, La Plata.
Horrocks, M., 2005. A combined procedure for recovering phytoliths and starch residues from soils, sedimentary deposits and similar materials. J. Archaeol. Sci. 32 (8), 1169–1175.
Katinas, L., Gutiérrez, D.G., Grossi, M.A., Crisci, J.V., 2007. Panorama de la familia Asteraceae (=Compositae) en la República Argentina. Boletín de la Sociedad Argentina de Botánica 42 (1–2), 113–129.
Kealhofer, L., Torrence, R., Fullagar, R., 1999. Integrating phytoliths within use-wear/residue studies of stone tools. J. Archaeol. Sci. 26 (5), 527–546.
Laguens, A.G., Bonnín, M., 2009. Sociedades indígenas de las Sierras Centrales: arqueología de Córdoba y San Luis. Editorial Universidad Nacional de Córdoba.
Lalinde, V., 2009. Colección de referencia para la identificación de almidones arqueobotánicos (Degree monograph). Department of Anthropology, Universidad de Antioquia, Medellín.
Llano, C., 2008. El registro arqueobotánico en el sitio Arroyo Malo 3, alto valle del Atuel, Mendoza, Argentina. Intersecciones en antropología 9, 133–143.
Loaiza, N., Personal communication, march 10 2016
López, M.L., 2007. La Producción de Alimentos en las sociedades prehispánicas tardías de Córdoba. Revista Electrónica de Arqueología 1, 12–31.
López, M.L., 2011. El consumo de pseudocereales entre los pueblos prehispánicos: estudio de macro y micro restos de quinoa de contextos arqueológicos del último milenio en dos regiones circumpuneñas (Doctoral dissertation). Universidad Nacional De Córdoba.
López, M.L., 2015. Prácticas culinarias como medio para la reproducción social de los grupos prehispánicos de las sierras de Córdoba. In: Salazar, Julián (Ed.), Condiciones de posibilidad de la reproducción social en sociedades prehispánicas y coloniales tempranas en las Sierras Pampeanas (República Argentina). Centro de Estudios Históricos Prof. Carlos S.A. Segreti, Córdoba, pp. 177–212.
López, M.L., Recalde, M.A., 2016. The first quinoa (ChenopodiumquinoaWilld) macrobotanical remains at Sierras del Norte (Central Argentina) and their implications in pre-Hispanic subsistence practices. J. Archaeol. Sci. Rep. 8, 426–433.
Medina, M., Pastor, S., 2006. Chacrasdispersas.Una aproximación etnográfica y arqueológica al estudio de la agricultura prehispánica en la región serrana de Córdoba (Argentina). Comechingonia 9, 103–121.
Medina, J.A., Salas, J.C., 2008. Caracterización morfológica del gránulo de almidón nativo: Apariencia, forma, tamaño y su distribución. Revista de ingeniería 27, 56–62.
Medina, M.E., Grill, S.C., López, M.L., 2008. Palinología arqueológica: su implicancia en el estudio del prehispánico tardío de las sierras de Córdoba (Argentina). Intersecciones en antropología 9, 99–112.
Medina, M.E., López, M.L., Berberián, E.E., 2009. Agricultura y recolección en el Tardío Prehispánico de las Sierras de Córdoba (Argentina): el registro arqueobotánico de C. Pun. 39. Arqueología 15, 217–230.
Medina, M., Pastor, S., Apolinaire, E., Turnes, L., 2011. Late Holocene subsistence and social integration in Sierras of Córdoba (Argentina): the South-American ostrich eggshells evidence. J. Archaeol. Sci. 38 (9), 2071–2078.
Medina, M.E., Pastor, S., Recalde, A., 2016. The archaeological landscape of Late Prehispanic mixed foraging and cultivation economy (Sierras of Córdoba, Argentina). J. Anthropol. Archaeol. 42, 88–104.
Medina, M.E., Grill, S., Fernandez, A.L., López, M.L., 2017. Anthropogenic pollen, foraging, and crops during Sierras of Córdoba Late Prehispanic Period (Argentina). The Holocene 27 (11), 1769–1780.
Muiño, W., 2011. La etnobotánica médica del área de transición pampeano Cuyana. Bonplandia 20 (2), 353–369.
Musaubach, G., 2014. Estudios Arqueobotánicos en sociedades cazadoras-recolectoras de ambientes semiáridos Análisis de microrrestos vegetales en contextos arqueológicos de Pampa Occidental (Argentina) (Tesis Doctoral Inédita). Universidad de Buenos Aires, Doctorado de la Facultad de Filosofía y Letras.
Neme, G., Gil, A., 2008. Biogeografía humana en los Andes meridionales: tendencias arqueológicas en el sur de Mendoza. Chungará (Arica) 40 (1), 5–18.
Neme, G.A., Gil, A.F., Garvey, R., Llano, C.L., Zangrando, A., Franchetti, F., Michieli, C.T., 2011. El registro arqueológico de la Gruta de El Manzano y sus implicancias para la arqueología de Nordpatagonia. Magallania (Punta Arenas) 39 (2), 243–265.
Neumann, K., Fahmy, A.G., Müller-Scheeßel, N., Schmidt, M., 2017. Taxonomic, ecological and palaeoecological significance of leaf phytoliths in West African grasses. Quat. Int. 434, 15–32.
Pastor, S., 2007. Arqueología del Valle de Salsacate y pampas de altura adyacentes (Sierras Centrales de Argentina). Una aproximación a los procesos sociales del período prehispánico tardío (900-1573 d.C.) (Tesis doctoral inédita). FCNyM, Universidad Nacional de La Plata, La Plata.
Pastor, S., Berberián, E., 2007. Arqueología del sector central de las Sierras de Córdoba (Argentina): Hacia una definición de los procesos sociales del período prehispánico tardío (900–1573 DC). Intersecciones en antropología 8, 31–47.
Pastor, S., López, L., 2011. Consideraciones sobre la agricultura prehispánica en el sector central de las Sierras de Córdoba (Argentina). Arqueología de la Agricultura: Casos de Estudios en la Región Andina Argentina. Editorial de la Universidad Nacional de Tucumán, San Miguel de Tucumán, pp. 208–233.
Pastor, S., Medina, M., Recalde, A., López, L., Berberián, E., 2012. Arqueología de la región montañosa central de Argentina. Relaciones de la Sociedad Argentina de Antropología 37, 89–112.
Pearsall, Deborah M. 2016. Phytoliths in the Flora of Ecuador: The University of Missouri Online Phytolith Database. [http://phytolith.missouri.edu]. With contributions by Ann Biddle, Dr. Karol Chandler-Ezell, Dr. Shawn Collins, Dr. Neil Duncan, Bill Grimm, Dr. Thomas Hart, Dr. Amanda Logan, Meghann O'Brien, Sara Stewart, Cesar

Veintimilla, and Dr.Zhijun Zhao. (Accessed 6 June 2016).
Pearsall, D.M., Chandler-Ezell, K., Chandler-Ezell, A., 2003. Identifying maize in Neotropical sediments and soils using cob phytoliths. J. Archaeol. Sci. 30 (5), 611–627.
Piana de Cuestas, J., 1992. Los indígenas de Córdoba bajo el régimen colonial (1570–1620). Dirección General de Publicaciones de la Universidad Nacional de Córdoba, Córdoba.
Piovano, E., Ariztegui, D., Sylvestre, F., Córdoba, F., 2009. Lacustrine evidence of anti-phase distribution of moisture in Southern South America during the Neoglacialperiod. In: AGU Fall Meeting Abstracts.
Piperno, D., 2006. Phytoliths: A Comprehensive Guide for Archaeologist and Paleoecologist. Altamira Press.
Piperno, D.R., 2009. Identifying crop plants with phytoliths (and starch grains) in central and South America: a review and an update of the evidence. Quat. Int. 193 (1), 146–159.
Planella, M.T., Scherson, R., McRostie, V., 2011. Sitio El Plomo y nuevos registros de cultígenos iniciales en cazadores del Arcaico IV en alto Maipo, Chile central. Chungará (Arica) 43 (2), 189–202.
Reznicek, A.A., 2017. Cyperaceous. Encyclopædia Britannica. https://www.britannica.com/plant/Cyperaceae, Accessed date: 22 November 2017.
Rocchietti, A., 2012. Arqueología del arte: el imaginario formativo en la Sierra de Comechingones (Córdoba, Argentina). Rupestreweb. http://www.rupestreweb.info/caliz.html (acceso 10 septiembre 2016).
Rosa, E., Bianco, C., Mercado, S.E., Scappini, E.G., 2005. Poáceas de San Luis. Editorial Universidad Nacional de San Luis.
Scarpa, G., 2012. “Palos, yuyos, pencas, bejucos y pastos”: Los nombres de las plantas y su clasificación etnobotánica por los criollos del Chaco Semiárido Norte (NE Salta-W Formosa). Etnobotánica en zonas áridas y semiáridas del Cono Sur de Sudamérica 117–144.
Serrano, A., 1945. Los Comechingones. Serie Aborígenes Argentinos I. Instituto de Arqueología, Lingüística y Folklore de la. Universidad Nacional de Córdoba, Córdoba.
Shakoor, S.A., Bhat, M.A., Soodan, A.S., 2016. Taxonomic demarcation of *Arundodonax* L. and Phragmiteskarka (Retz.)Trin.exSteud. (Arundinoideae, Poaceae) from phytolith signatures. Flora 224, 130–153.
Smith, B.D., 2001. Low-level food production. J. Archaeol. Res. 9 (1), 1–43.
Soriano, A., León, R., Sala, O., Deregibus, V., Cauhépé, M., Scaglia, O., Velásquez, C., Lemcoff, J., 1992. Río de La Plata Grasslands. In: Coupland, R.T. (Ed.), Ecosystems of the World. Natural Grasslands. Introduction and Western Hemisphere. Elsevier, Holanda, pp. 367–407.
Strasser, E., Fernandez, J.E., Marchevsky, E., Oisteriech, M., Perino, E., 2010. Geoquímica mediante FRX de silicofitolitos extraidos de poáceas, suelos y paloesuelos holocénicos-San Luis_ argentina. XII Latn American Seminary of analysis by X-Ray Techniques-SARX 2010. Puebla, Mexico. XRF-P-10. pp. 125.
Vignati, M.A., 1951. Placas grabadas de la provincia de San Luis. Comunicaciones Científicas de Museo de La Plata 5, 1–3.
Yacobaccio, H., Korstanje, M.A., 2007. Los procesos de domesticación vegetal y animal. Relaciones de la Sociedad Argentina de Antropología 32.