Access to maize (*zea mays*) & its manipulation in hunter-gatherer contexts in central Argentina (c 3000-2500 bp)

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Abstract

Domesticated maize (*Zea mays*) was adopted and dispersed across central Argentina by hunter-gatherer communities between c 3000-2500 BP. Primary archaeobotanical evidence for this adoption is derived from two archaeological sites (Quebrada del Real 1, Cruz Chiquita 3) which show the manipulation, processing, and consumption of maize without evidence for other practices of food production. This local case study is integrated into the broader contemporary macro-regional context of southern South America. We analyze and discuss the historical trajectories of hunter-gatherer societies, the dispersion of cultigens including maize, and the mechanisms involved in the expansion of the agricultural frontier.

1 Introduction

The process of agricultural dispersion in central Argentina (figure 1) remains a poorly understood and sparsely researched subject. This is in spite of the certainty that this process took place during pre-Hispanic times according to both archaeological and ethnohistoric evidence (Berberián 1999; Bixio et al 2010; González & Pérez 1972; Laguens & Bonnín 2009; Outes 1911; Serrano 1945).

One important question is related to the origins and dispersion of agriculture in the region. Two types of hypotheses or explanatory proposals have been advanced: 1) those involving an exogenous process linked to the arrival of immigrating populations from a neighbouring region such as northwestern Argentina (NOA), or the Chaco plains of the modern province of Santiago del Estero (González & Pérez 1972; Montes 2008) (figure 1) where groups of sedentary agriculturalists already existed; and 2) as a local process of development and transformation of hunter-gatherer societies (Berberián 1999; Laguens & Bonnín 2009).

In either case, it has been assumed that the dispersion/adoption of agriculture was a relatively rapid and automatic phenomenon, given the alleged adaptive advantages with the potential for a profound re-

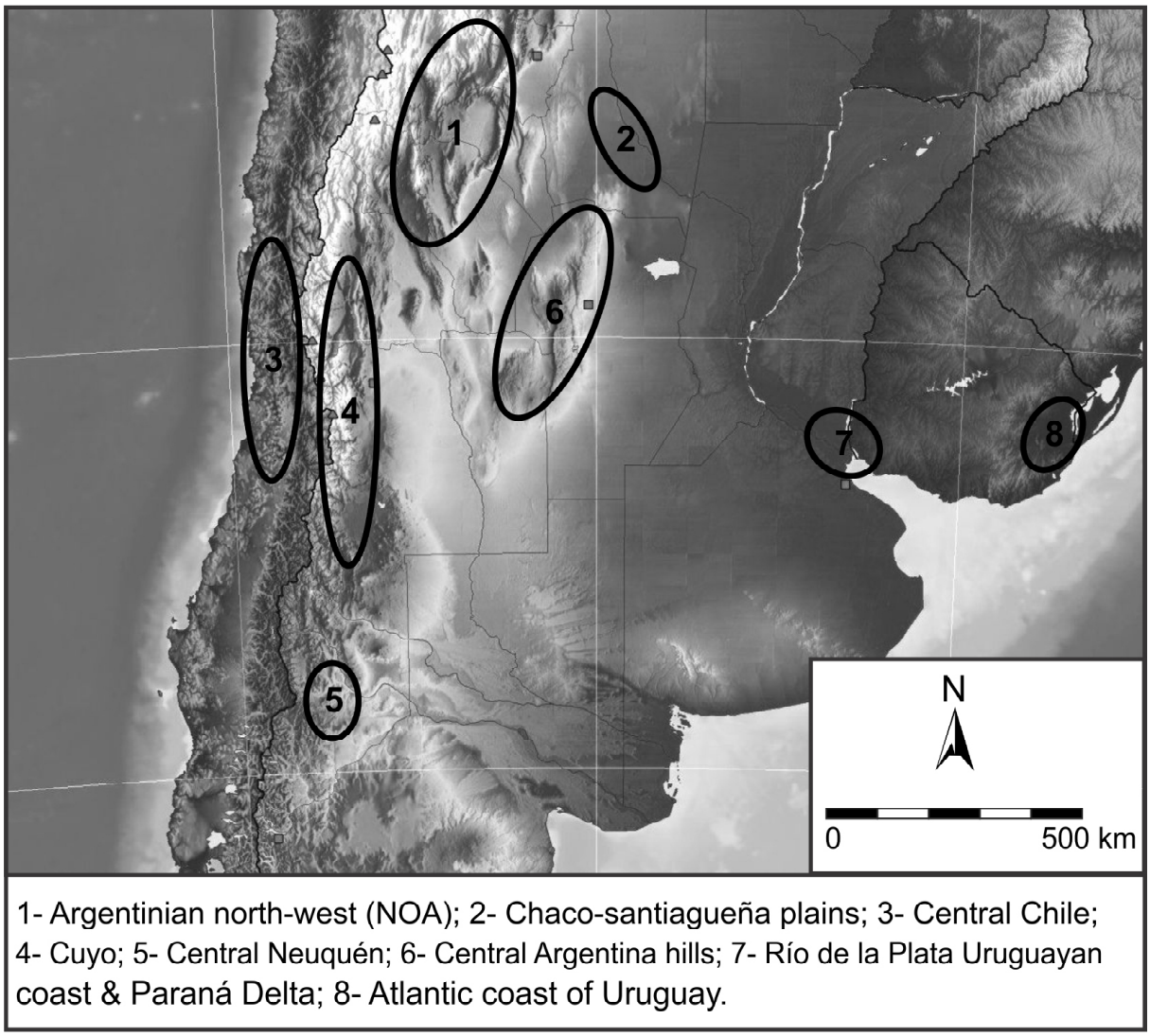

Figure 1 Central Argentina Hills and neighbouring regions with crops in southern South America

structuring of social organization. This socioeconomic transformation is estimated to have occurred between c 2000 and 1500 BP (Berberián 1999; González & Pérez 1972; Laguens & Bonnín 2009).

Research carried out during recent years (Pastor & López 2010; Medina et al in press), focused on various lines of information (settlement systems, technological organization, archaeobotany, stable isotope studies), has, however, led to a more complex perspective. Evidence now available suggests a deeper temporal framework for this process, as well as the adoption of production practices in a non-automatic way, the absence of radical transformations in modes of living, and the active and diverse participation of local hunter-gatherer populations. Archaeobotanical evidence of the adoption of maize by hunter-gatherers is provided here from the sites of Quebrada del Real 1 and Cruz Chiquita 3. The analysis of phytoliths, starch grains and the content of human dental tartar contribute to a wider discussion of the process of adoption of cultigens by hunter-gatherers in the region.

2 Materials and methods

We have recently documented two archaeological contexts that reveal access to maize in the central Argentina region at relatively early dates and by groups with a hunter-gatherer economy. Quebrada del Real 1 is a cave site located in the Pampa de Achala area in a high-altitude pasture landscape (c 1900 amsl); a location poorly suited for crop cultivation (figures 2 & 3) (Rivero et al 2008–2009). This site presents a long sequence of occupation beginning at c 7400 BP and extending until the late Holocene (c 1000–500 BP).

The site's component 2, dated by radiocarbon to 2950 ± 90 BP (LP-2042; charcoal), presents characteristics similar to those of other contemporary hunter-gatherer contexts in the same micro-region (Rivero 2009). These similarities consist, for example, of a tech-

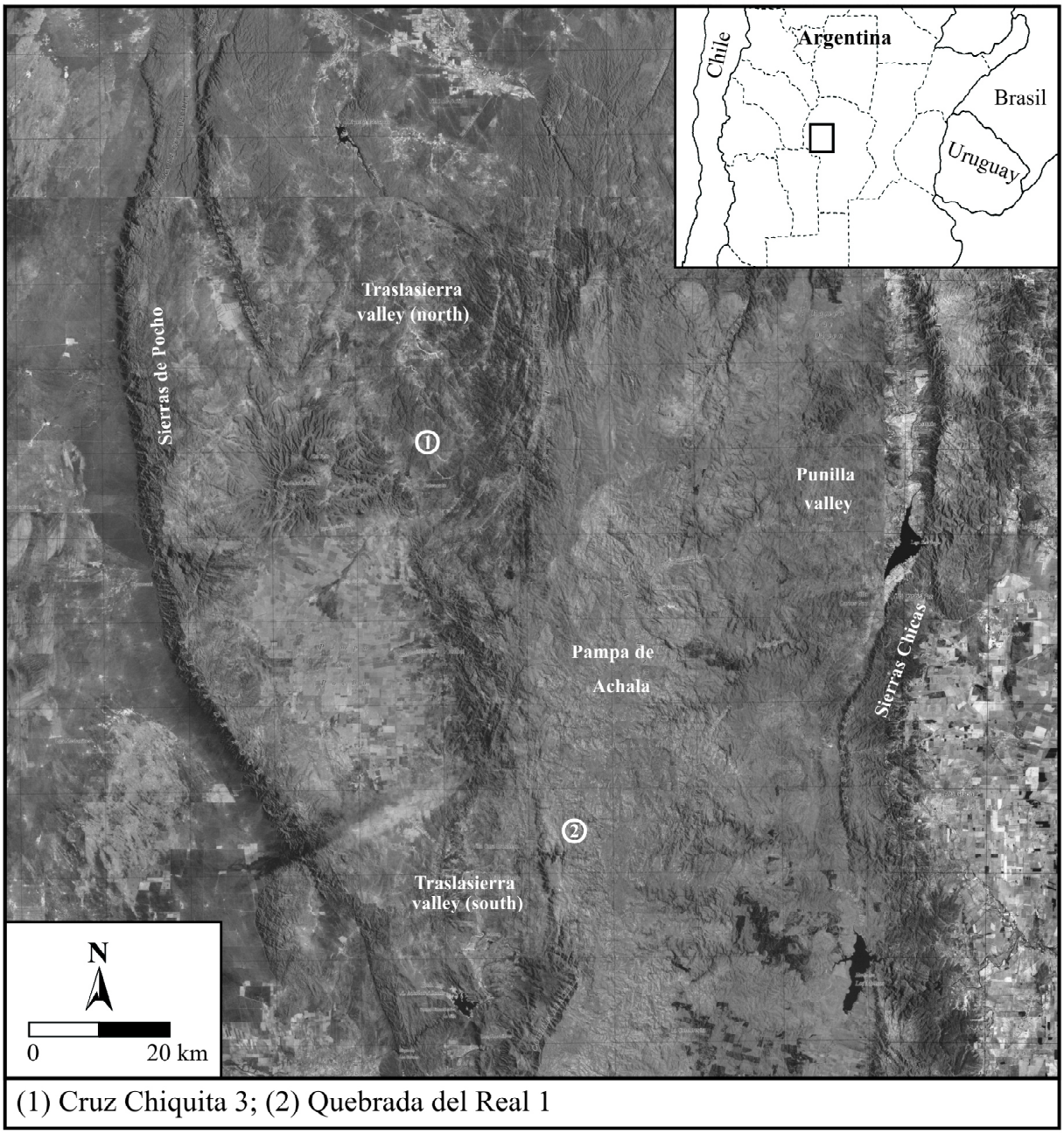

Figure 2 Location of Cruz Chiquita 3 and Quebrada del Real 1 sites, in the central sector of Sierras de Córdoba

nological level that includes the use of stemmed, triangular projectile points with a distinctive design, along with the complete absence of ceramics. During this period, the cave was used repeatedly for intensive food processing and consumption based on artiodactyls native to the site's environment (*Lama guanicoe*, *Ozotoceros bezoarticus*), along with extensive use of small vertebrates, primarily rodents (Caviinae, *Ctenomys* sp.) (Medina et al 2011). The very high density of faunal remains suggests recurring use of the cave by human groups with relatively high numbers as well as intensification of the hunter-gatherer strategy (*sensu* Broughton 1999). In this sense, the extensive use of small animals is a result of a reduction in high-ranked prey density that prompted humans to broaden their prey choice to include small-vertebrates that previously had not been part of the diet (Rivero & Medina 2013). The site also contains a set of 17 grinding mortars created in fixed stones at the entrance to the protected area and the cave interior, and these could have been used for processing plant-based foods.

Information related to the use of plant-based resources is complemented by the discovery of seven pestles (*manos*) in stratigraphic context. These have been created using granitic stone with characteristics (the presence of small holes in the stone matrix)

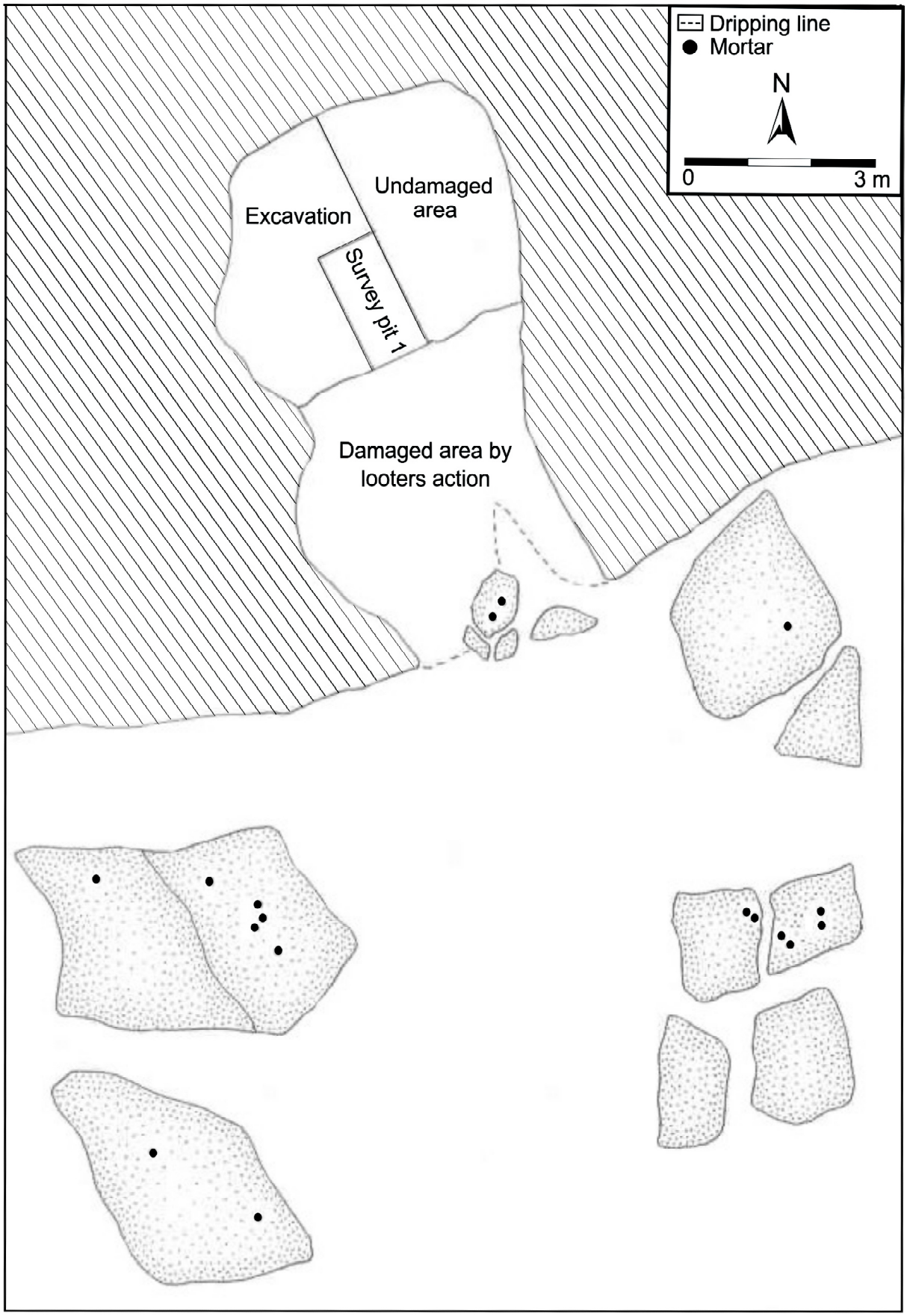

Figure 3 Plane of Quebrada del Real 1 cave site (Pampa de Achala, Córdoba)

that have allowed the analysis of botanical microremains. This analysis was performed by dry scraping an 8 cm^2 area with a pointed instrument. The same size of area was sampled from each of the various artefacts for comparative analysis. The resulting residues were mounted directly onto glass microscope slides to avoid any loss of material. The mounting medium used was immersion oil which provides a good refractive index and allows three-dimensional viewing of the microremains. The samples were analysed using a JPL1350 microscope under transmitted and cross-polarised light. Silica phytoliths, calcium phytoliths and starch grains were recorded. Taxonomic identifications were made through quantitative and qualitative comparisons with bibliographic reference sources (eg, Cortella & Pochettino 1990; Korstanje & Babot 2007; Piperno 2006) and reference collections curated in the Prehistory and Archaeology Laboratory at Argentina's National University of Córdoba.

The second context containing early maize evidence is from the site of Cruz Chiquita 3, an open-air settlement located in a different type of environmental setting at the base of the Traslasierra valley (c 875 amsl) (Pastor 2008). This site is located in a Chaco-type forested environment with optimal potential for collection of forest food products (eg, *Prosopis* spp., *Geoffroea decorticans*) and was therefore occupied repeatedly as a habitation site throughout the Holocene. Here, the presence of maize in a funerary context confirms and expands the evidence for early access to maize in the central region of Argentina.

Excavations at this site revealed a simple burial without well-defined edges and covered by a layer of stones. Inside were the remains of an adult male individual in a flexed position without any adornments or accompanying objects (figure 5). AMS radiocarbon dating situates this burial chronologically at 2466 ± 51 AP (AA68146; bone collagen). In this case, an analysis of the dental remains was performed for extraction of botanical microremains using a procedure similar to the one described above. Dental tartar was scraped using a pointed metal instrument and mounted directly onto microscope slides for observation at 100 and 400x.

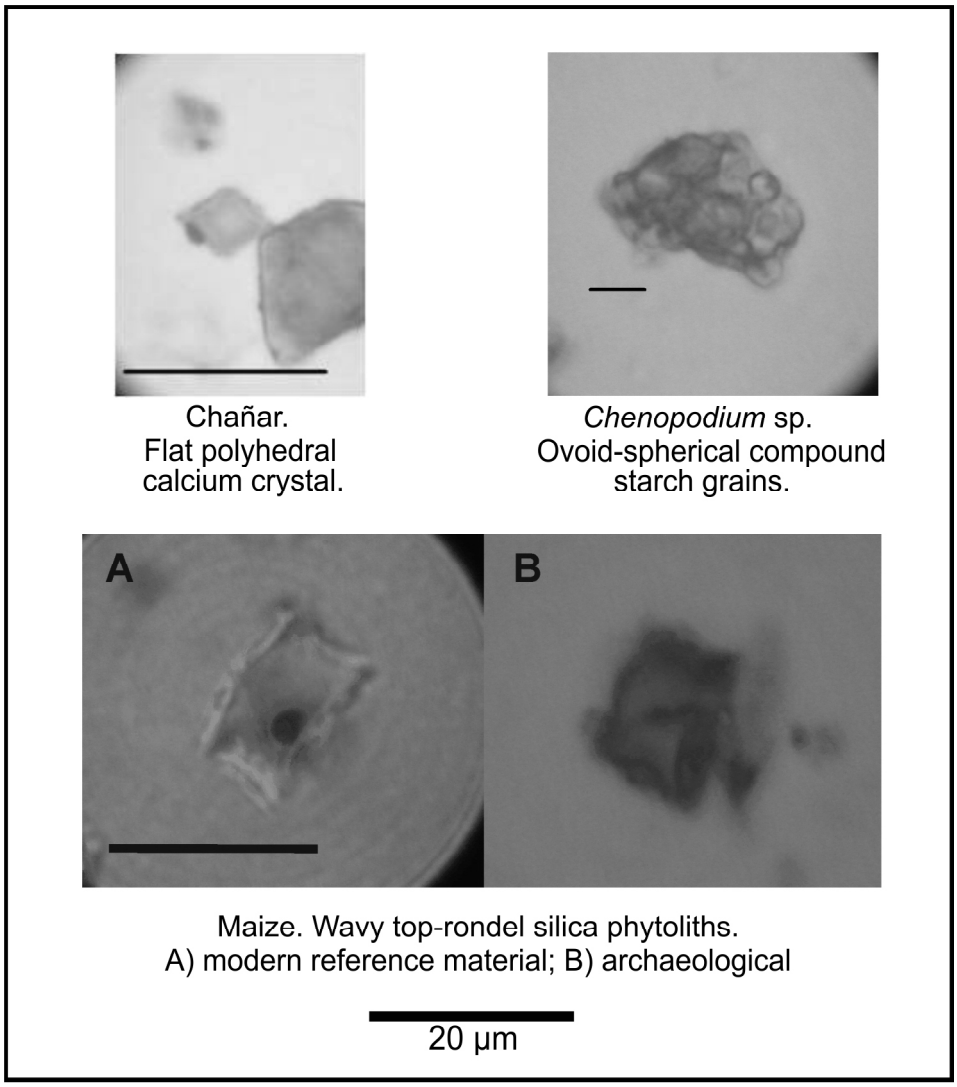

Figure 4 Botanical microremains from Quebrada del Real 1 site

3 Results

The taxa identified in the pestles (*manos*) of Quebrada del Real 1 included *Zea mays* (maize) based on the presence of silica phytoliths with a wavy top-rondel morphotype (characterised by a circular-oval base with an undulating upper portion

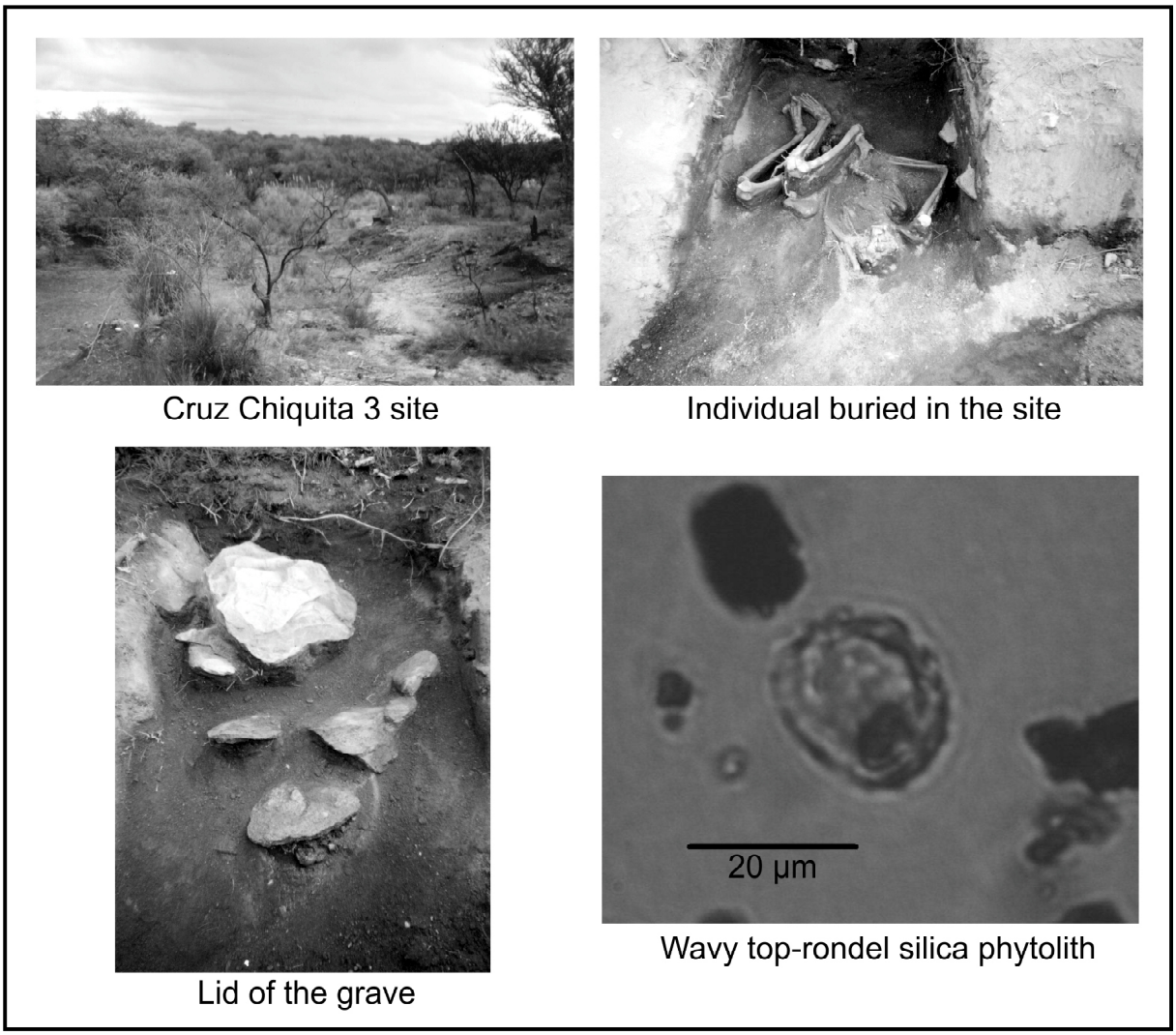

Figure 5 Funerary context from Cruz Chiquita 3 site

and measuring around 20 µm) which are related to the maize cob. Microfossils from *Geoffroea decorticans* (chañar) were also identified consisting of calcium phytoliths with a polyhedral morphotype (flat polyhedral calcium crystals, varying in size between 10 and 15 µm which illuminate when observed under cross-polarized light). Also recorded were starch grains from *Chenopodium* sp. (ovoid-spherical compound grains with diameter varying between 10 and 20 µm which under cross-polarized light do not allow discernment of the extinction cross or the smaller grains of which they are composed) (figure 4).

In contrast to the faunal resources, the *chañar*, and the *Chenopodium* sp., the maize could not have been gathered in the area near the site or in adjacent microenvironments. There is also a lack of evidence for its local cultivation during this period. On the contrary, maize would have been an exotic good, probably obtained through participation of the hunter-gatherers in extra-regional exchange networks which included links with agricultural societies. The structural development of these large-scale networks was a distinctive process during this time period as evidenced in this site context and others by the presence of siliceous stone of extra-regional provenience and marine snail shells (González 1960; Menghin & González 1954). One of these shells, excavated from the same component at Quebrada del Real 1, has been modified to make it usable as a hanging pendant (Rivero et al 2008–2009).

As in the case with the pestles from Quebrada del Real 1, silica phytoliths with wavy top-rondel morphology were observed in the funerary context of Cruz Chiquita 3, taxonomically identified as *Zea mays* (maize) in agreement with the reference material (see Piperno 2006) (figure 5).

4 Discussion

It is important to note that this early evidence for the processing and consumption of maize in central Argentina exists in the absence of concrete indications of local agricultural production as well as in the absence of appreciable socioeconomic transformations in the archaeological record. Other innovations only appear gradually and during more recent time periods. For example, around 2000 BP changes in projectile point design were related to the introduction of the bow. Notable diversification in these points, however, only appears after c 1100 BP including the use of new types of lithic and organic (bone) materials and their discovery in contexts associated with interpersonal violence as well as hunting activity. Also, only limited use of ceramic technology is seen between c 2000 and 1500 BP in contrast to the more generalised use, not only for creation of containers (figurines, spindle whorls, whistles), seen after this date (Austral & Rocchietti 1995; Bixio et al 2010).

In terms of agricultural practices, discoveries related to the processing and consumption of cultivated plants, including taxa other than maize (eg, *Cucurbita* sp., *Phaseolus vulgaris* var *vulgaris*, *Phaseolus lunatus*, cf *Chenopodium quinoa*), become abundant only after 1100 BP. Contexts directly related to local cultivation also become evident then, with the crops grown including maize and beans (Pastor & López 2010). In contrast to the developments seen in other regions of southern South America (eg, Babot 2011; Beovide 2011; Bonomo et al 2011; Gil 1997–1998; Iriarte 2007), in the low mountain ranges of central Argentina no other cultigens have been recorded in association with maize prior to c 1500 BP, including beans, which because of their starchy characteristics tend to be integrated into a typical food complex of pre-agricultural systems (Smith 1992).

During the time period considered here, corresponding to parts of the first millennium BC, sedentary agricultural societies existed in various types of environments in NOA (Albeck 2000; Olivera 2001). In the case of the flat Chaco plains of the province of Santiago del Estero the oldest contexts related to agricultural groups have been found to be fairly recent at c 1600 BP (Togo 2007). Evidence also exists, however, for considerably earlier manipulation, processing and perhaps cultivation of maize. For example, in Antofagasta de la Sierra, an Andean location in the Puna environmental region, microremains of maize associated with a grinding stone have been identified in a context dated to c 4500 BP (figure 1) (Babot 2011).

In west-central Argentina, to the south of the NOA region (figure 1), research regarding the dispersion of maize has taken place based upon archaeobotanical information and to a greater degree isotope analysis (Gil et al 2010). Botanical remains are relatively common and are found in most contexts that post-date c 1500 BP. For earlier times, there are materials from the site of Gruta del Indio (southern Mendoza province) dated between c 2200 and 2000 BP which in addition to maize also present evidence for beans and quinoa. With respect to stable isotope information, a sample representing numerous individuals (n=104) has been evaluated with diverse proveniences and dates between c 6000 and 300 BP. In contrast to the expectations generated by other lines of information, these results do not support models based upon a continual and progressive dispersion of maize from north to south. In general, C4 resources (probably maize) would only have occurred to a significant degree in the diets of the more northern populations (31–32° S) and during time periods later than c 1000 BP. In the more intermediate latitudes (33–35° S), mixed diets would have been predominant although with a scarce incidence of C4 plant foods while at southern latitudes (38–40° S) only C3 resources would have been consumed. The variability existing among individuals, however, is appreciable within the same location and time frame especially in the middle latitudes associated with temporary fluctuations in the importance of C4 resources. In accordance with the information available, an early introduction of maize between c 3000 and 2000 BP can be proposed, essentially in the eastern plains and with little dietary importance. The significance of maize as a resource increases later, but always under conditions where it has a limited occurrence in the diet and with marked spatial-temporal and inter-individual variability. The sole exceptions to this pattern would be seen in the latest, most northern populations which are the only ones that would have undergone an irreversible process towards a greater dietary importance for maize after c 1000 BP (Gil et al 2010).

In other regions such as central Chile and central Argentina (figure 1), stable isotope studies reveal a similar perspective since C4 resources would have

had a sporadic occurrence in the diet after c 2000–1800 BP followed by more consistent use after about 1000 BP (Falabella et al 2007; Laguens et al 2009). Again, a marked inter-individual variability must be noted as well as spatial and temporal variation with early cases where $\delta^{13}C$ shows enriched values and later cases where values decrease. Mixed diets predominate with little significance for C4 resources except in the latest samples from periods after c 1000 BP which on average present the most enriched $\delta^{13}C$ values.

Beyond the limited dietary importance of maize as a crop plant, which has been established in part by stable isotope studies, what is certain is that maize was effectively known and manipulated across a broad macro-region of southern South America and from relatively early times. Archaeobotanical data provides more specific information on this point. For example, towards the south of the Cuyo region in the province of Neuquén (39° S) (figure 1), maize remains have been identified from around 2000 years ago. Recent studies have documented a funerary context with the burial of a young woman along with some associated grinding tools from which diagnostic microremains of maize have been recovered (Lema et al 2012).

To the east of the low mountains of central Argentina, in the Paraná Delta, maize starch grains were recorded in post-1000 BP archaeological contexts. Groups of this period developed a mixed economy based on fishing, hunting, gathering and horticulture including beans, squash and probably cassava (*Manihot esculenta*) (Bonomo et al 2011). This way of life and economic organisation could be established centuries earlier although there is not still firm archaeobotanical data to support this speculation. Near the Paraná Delta, on the shores of the Río de la Plata in Uruguay, micro-remains from the cob and kernels of maize have been identified at sites dated to between c 2700 and 2300 BP (Beovide 2011). Even further east, on Uruguay's Atlantic coast the earliest contexts containing silica phytoliths from this species are older still dating to the period of 4200–3500 BP (figure 1) (Iriarte 2007).

Consideration of this macro-regional perspective for southern South America, during the period discussed here between the end of the middle Holocene and the beginnings of the late Holocene helps to address questions related to the dispersion of maize (and probably other cultivated plants) as well as to the interactions between hunter-gatherer and agricultural populations. The evidence suggests that the expansion of the agricultural frontier was accompanied by flexible and variable patterns of development and transformation of the diverse local societies. In the case of the low mountain ranges found in central Argentina, these transformations took place in a slow and gradual form. Maize would have been incorporated early on (c 3000 BP) in a clearly hunter-gatherer context with indications of the development of very long-term strategies oriented towards manipulation and perhaps cultivation of domesticated plants. This would have been the case with plants in the *Chenopodium* taxa as their presence suggests not only knowledge and maintenance of areas where these plants grow wild, but also the implementation of processing techniques that made the consumption of their seeds possible. In terms of maize, the information currently available is not sufficient to allow full evaluation of its importance in the diet, although no element of the evidence would support the assumption that its importance was high. However, information available at the macro-regional and sub-continental level invites consideration of other dimensions, for example, the ritual significance of this exotic resource in numerous contexts (Babot 2011; Gil 1997–1998; Nuñez et al 2009; Staller 2007).

For the region discussed here, agriculture involving maize as well as other crops such as beans, pumpkins, and probably quinoa, was only incorporated in late contexts (c 1100 BP). Even then small-scale production would have been involved, complementing a sustained process of intensification of hunter-gatherer practices, in continual growth until the end of the pre-Hispanic period (Pastor & López 2010). Therefore, assumptions should be discarded that involve the immediate adoption of agriculture in the central region of Argentina, high levels of agricultural production, and the potential for transformation of social and economic structures. The patterns identified here and more widely contradict the idea of the introduction of agriculture as part of a 'Neolithic' or 'Formative package' associated with the movement of immigrant populations. Instead, we see strong continuities in hunter-gatherer communities as well as the incorporation of innovations such as crops but gradually as part of conservation strategies of traditional ways of life.

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