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ORIGINAL PAPER

Pit-houses, seasonality, and subsistence resources: an essay from Boyo Paso 2 (ca. 900–700 BP, Sierras of Córdoba, Argentina)

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Abstract

How pre-Hispanic foragers adjusted their foraging and mobility strategies to plant cultivation is a question that drives much of the modern archaeological research. As a result, the spread of food-producing economies during the late pre-Hispanic period from Sierras of Córdoba (Argentina, ca. 1500–360 BP) has been recently defined as a dynamic sociocultural process where a mixed foraging and cultivation economy was accompanied by a flexible and seasonally landscape-use organization. However, the seasonally-sedentary model requires the elaboration of details that has not been specified. In order to enhance the discussion, this paper presents the study carried out on faunal and botanical spring-summer indicators recovered at Boyo Paso 2, an open-air site interpreted as a residential base camp occupied during the growing season (October–April) by people with mixed foraging and cultivation economy. The major aim was to identify reliable biological indicators to assess the season of use of the site based on their ecology. The identification of Rheidae eggshells, small vertebrates, crops, and wild fruits remains, as well as the contextual evidence, supports that Boyo Paso 2 was occupied with a stronger signature in middle spring through early autumn (October–April), when planting, harvesting, and/or wild food were available around the site. Thus, it is concluded that zooarchaeological and archaeobotanical data were critical to understand the dynamic process that has underlain transition from foraging to farming in Sierras of Córdoba, providing data to improve the understanding of residential mobility in archaeological groups where the adoption of crops plants did not necessary lead to fully sedentary farming.

Keywords Zooarchaeology · Archaeobotany · Mobility · Seasonal use · Foraging · Farming

Introduction

Numerous empirically cross-cultural studies demonstrated that human societies are in general quite mobile and trying to divide them into categories of "sedentary" and "mobile" is not always straightforward (Kelly 1992; Kent and Viedrich 1989; Bar-Yosef and Rocek 1998). However, the tendency to simplify ideas about the relationship among subsistence and mobility has led to the widespread assumption that mobility is a defined characteristic of foragers and sedentism of farmers, a relation that many South-Central Andean Formative archeologists took for granted (see Núñez 1974:33; Raffino 1988; Albeck 2000:195; Tartusi and Núñez Regueiro 2001:128). Cultivators naturally must orientate their movement and duration of residence in relation to their crops requirement and pattern of growth. Thus, reduced mobility is commonly assumed among farmers due to the fact that plants enable high predictability in the timing and location of the ripe seed, even when examples of ethnographic and archaeological mobile farmers abound, and these serve as negative cases that disprove this widespread assumption (Arnold 1999; Asouti and Fairbairn 2010; Capriles 2014; Chilton 2002; Darling et al. 2004; Diehl 1997; Graham 1994; Greenfield and Greenfield 2014; Hard and Merrill 1992; Hill et al. 2008; Olivera 2012; Silva and Frank 2013). Moreover, some

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"sedentary" horticultural societies even exhibit a broader range of variation in the degree of residential permanence and move more frequently than many hunter-gatherers (see Kelly 1992; Kent and Viedrich 1989). So, the assumption that increased sedentism and agricultural dependence directly covary is not demonstrated and requires further evaluation. In this respect, archaeologists know less about mobility and sedentism than they think (see Rocek 2013). Maybe some aspects of mobility are closely related to agricultural dependence, and some others are not, being the relation likely to be more complex than it was previously suggested. Thus, archaeologists need to construct more useful approaches than a simple polarization of mobile forager vs sedentary farmer societies.

For example, during decades most archaeological interpretations of the late pre-Hispanic period from Sierras of Córdoba (Argentina, ca. 1500–360 BP) assumed that the adoption of farming ca. 1500 years BP quickly derived in a high reliance on domesticated plants, some type of not well-defined camelid herding, and a sedentary way of life in year-round pit-house villages (Aparicio 1939; Berberián 1984; Canals Frau 1953; González 1943; Montes 2008; Outes 1911; Serrano 1945), resembling those archaeological cases observed in many places around the world during the Neolithic or Formative Transition. It was ignored that evolutionary change is not unidirectional, and switching foraging by people who previously practiced cultivation was a common behavior in the past (Layton et al. 1991). Fortunately, the archaeological interest in how late pre-Hispanic people adjusted their foraging and mobility strategies to plant cultivation has increased over the last years, fielding a spectrum of farming and foraging strategies that discredited this rigid normative point of view. Now, the late pre-Hispanic situation was at odds with the conventional wisdom about cultural evolution, and the replacement of foraging by farming anticipated in most culture evolution schemes did not occur in Sierras of Córdoba. For instance, the absence of evidence of year-round residences and the low investment in farming fields, as well as other archaeological indicators, support this new model (Medina et al. 2014a, 2016, 2018). Conversely, the evidence suggests that late pre-Hispanic people developed a mixed foraging and cultivation economy, where flexibility was one of its defining traits (Medina et al. 2014a). Late pre-Hispanic hunting, for example, was centered about the pursuit of guanaco (*Lama guanicoe*) plus small game (Medina et al. 2019a; Medina and Pastor 2012). Pottery and maize and other crops farming were also extensively used but within broad-spectrum foraging base looking forward to increasing the productivity per unit of time and space and included high residential mobility (Medina et al. 2016, 2018; Pastor et al. 2012), being the later defined as frequent changes in the location of co-residential group across the year (sensu Diehl 1997). Thus, foraging for wild resources and residential mobility continued being important activities, while farming was seasonally abandoned when most profitable wild resources were available in the landscape. The development of a diversified economy, in consequence, was accompanied by a high residential mobility, co-residential group fission-fusion mechanisms, and the abandonment of crop field to forage, where the local resource abundance was weighed in terms of the regional foraging potential (Medina et al. 2016; Pastor et al. 2012). Evidence of herding domesticated *L. glama* was still weak due to the difficulty to distinguish between camelid species from bones and was not taken into account until having more concrete evidences than rock art and sixteenth century chronicles (see Medina et al. 2014b).

According to this model, late pre-Hispanic villages or base camps may reflect few extended family reoccupations during the growing and planting season (October–April) to do on-site farming, harvesting wild fruits, and small game hunting activities (Medina et al. 2014a; Pastor et al. 2012). When harvest and storage activities finished, co-residential groups dispersed across the landscape to forage resources that were distributed heterogeneously, collected information about their socio-environment, and maintained the socio-political fluidity upon which they depended. Therefore, it is proposed that the late pre-Hispanic people made a seasonal and diversified use of the landscape, where the social unit for food production, consumption, and landscape occupation was the nuclear family, which adjust settlement location, group size, or the mix of farming and foraging to changing circumstances (Medina et al. 2014a, 2016; Pastor et al. 2012). Many variables can affect this basic equation over a long period, including the cost of moving, the regional population density, and social boundaries, as well as spatial and annual variation in foraging opportunities and farming constrains. Thus, a mosaic of foraging and farming pattern is also predicted among the broad temporal scale of the late pre-Hispanic period that did not involve all the region's people in the same way. In other words, as some people occupied farmsteads during the growing and planting season, other small groups may have continued to be mobile to forage or occasionally settled in semi-permanent villages (6–12 months) when conditions were good for farming (Medina et al. 2016; Recalde and López 2017).

However, the late pre-Hispanic landscape-use organization was only superficially assessed, and the seasonally-sedentary model requires the elaboration of details about whether prehistoric groups lived in intermittently or year-round occupied base camps that have not been specified, even when regional survey and numerous open-air site excavations were carried out (Berberián 1984; Laguens and Bonnín 2009; Medina 2015; Medina et al. 2016; Pastor 2007a; Pastor et al. 2012; Recalde 2008; Recalde and López 2017). In order to enhance the understanding of local and regional mobility, this paper presents the study carried out on faunal and botanical spring-summer indicators recovered at Boyo Paso 2 (Sierras of

Córdoba, Argentina), an open-air site interpreted as a residential base camp occupied during the growing season (October–April) by people with mixed foraging and cultivation economy. Even when the evidence suggests that a wide range of extractive, productive, processing, and maintenance function was carried out, the site presents a number of related hypothetical expectations associated with a seasonally-sedentary lifeway (Medina 2015; Medina et al. 2016, 2017). The identified structures (presumable residential), for example, were built for an anticipated short permanence at site using perishable material and low invest effort (Medina et al. 2016). Those ephemeral organic structures are more consistent with the kind of dwelling constructed by people who do not live in a single location throughout an entire year (Binford 1990; Diehl 1997; Greenfield and Greenfield 2014; Kent and Viedrich 1989; Madsen and Simms 1998; Rocek 2013; Schmader and Graham 2015; Wheaton 2014). Thus, the aim of the article was to identify reliable biological indicators to assess the season of use of the archaeological site based on their ecology and timing of ripe for harvesting. The real question asked here is under which conditions and seasons the Boyo Paso 2 assemblages were formed in an averaged perspective. It is expected that food remains discarded on Boyo Paso 2 were dominated by middle spring-to-early autumn seasonally available resources, providing data to improve the understanding of residential mobility in archaeological groups where the adoption of crops plants did not necessary lead to fully sedentary farming, a pattern commonly observed ethnographically but difficult to identify from the archaeological record.

The site

Boyo Paso 2 is an open-air site located at 1160 m.a.s.l. in eastern Salsacate Valley (Fig. 1). It is surrounded by slope circumscribed organic-rich soils suitable for precipitation-dependent farming and a nearly closed xerophytic forest dominated by small trees with edible fruits (*Prosopis* spp., *Geoffroea decorticans*, *Condalia microphylla*, etc.; sensu Giorgis et al. 2011), which also support a low diversity of small-sized mammals (*Mazama* sp., *Pecari tajacu*, *Dasypodidae* spp., and caviomorph rodents, sensu Bucher and Abalos 1979). Above 1350 m.a.s.l. and at the limit of the foraging radius of Boyo Paso 2, the upper mountain grassland range is formed. Climate-related agents make cultivation not suitable there, but grasslands supported large-sized ungulate prey for Boyo Paso 2 hunters such as *L. guanicoe* (Medina and Rivero 2019). Currently, the rainfall in Sierras of Córdoba is conducted mostly in high spring and early autumn (October–April), with a mean annual precipitation that amounted 800–600 mm, determined the annual cycle of biomass grow (Bridarolli and Di Tada 1996), and structured the use of most important economically resources. However, it is possible that during the late pre-Hispanic period, the mountain environment presented a higher productivity than the present one due to the subhumid/temperate climate, milder winters, and higher rainfall (Carignano 1999; Piovano et al. 2009).

The horizontal excavation on Boyo Paso 2 revealed two overlaying archaeological floors formed by unprepared packed sediments that appeared to have been fire-altered by multiple on-floor hearths (Table 1). In brief, these living floors have post-molds and abundant domestic refuse in plan, including a high diversity of projectile points, residues of such time-consuming activities as pottery making, and the biological debris analyzed here (Figs. 2 and 3). The upper floor was a thin level of compacted sediments less than 2 cm thick. In its southern portion, in close relation with more than 20 post-molds and undefined basin-shaped depressions, a roughly semi-subterranean structure containing a mixture of organic-rich sediments, charcoal, and artifacts was detected. In a few centimeters below the upper floor, the change in the consistency of sediments leads to the lower floor, which presents a feature of unknown use made with 14 cobble-sized stones, basin-shaped depressions, and two post-molds, one of them with the fire-altered (burned) post inside that was selected for dating (Table 1). The reassemblage relations of pottery sherds lead to interpret floors were accumulated by single component occurrences, probably as seasonal-type occupations. However, floors do not have indicators which mark group occupations with different type of subsistence, technology or social organization, being the radiocarbon dates discussed below those expected one for a "component" resulting from similar occupations in a short-temporal archaeological scale. So, the averaged faunal and botanical assemblages offer a viable match and an excellent opportunity to assess the seasonal use of site, where tactics, actions, and decisions were repeated at an evolutionary scale resolution.

The size of the faunal assemblage and the taxonomic identification of animals normally encountered in different habitats, as well as the presence of thousand pieces of flaked stone and pottery, indicate a stay on-site at least for few months. Bone and lithic tool assemblages were dominated by expedient tools manufactured on local lithic raw material and the by-products of the faunal consumption (Medina et al. 2018, 2019b). Non-local raw materials and imported materials as metal artifacts have low proportion and are worked more intensively (Medina et al. 2019b). Pottery vessels were dominated by medium-sized rounded morphologies with a versatile and transportable design that anticipated to different needs (transporting, storage, cooking, etc.), better able to withstand the stress of mobile semi-sedentary lifestyle (Medina et al. 2016). A wide range of subsistence and processing activities is evidenced by both artifacts and food refuses, including farming, foraging wild resources, storing, and grinding. In addition, the fact that many rider bones such

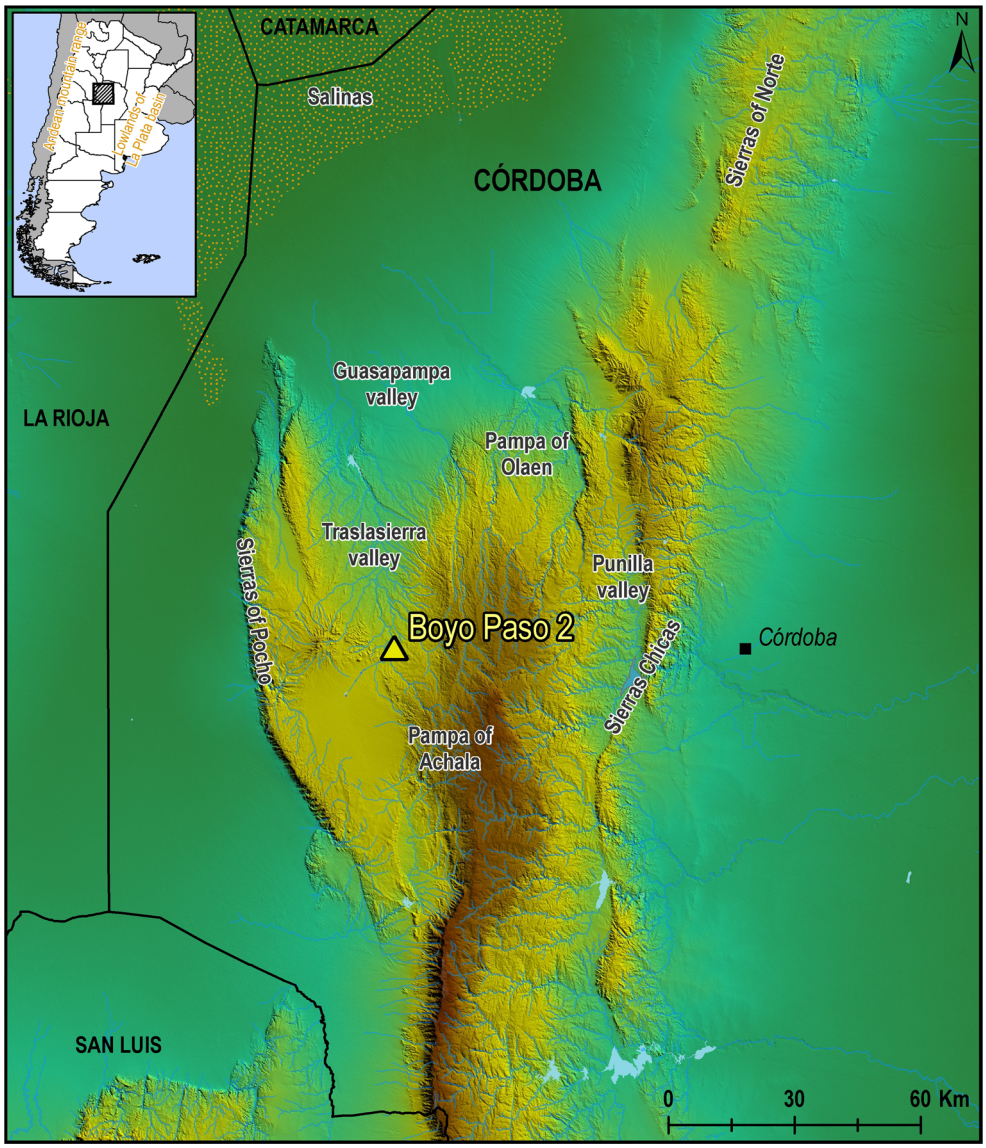

Fig. 1 Geographic location of Boyo Paso 2 (Sierras of Córdoba, Argentina)

as carpals, tarsals, and metapodials came to rest in the assemblage, the low percentage of whole phalanges, the extreme fragmentation, and high frequency of cut marks and impact scars (Medina et al. 2019a) would seem to argue against the faunal assemblage having formed simply as an adjunct of kill site or butchery station. The uniformity of bone-weathering stage, with an assemblage dominated by the Behrensmeyer (1978) stage 2, implies that most elements were contributed

Table 1 Radiocarbon dates from Boyo Paso 2 (Sierras of Córdoba, Argentina)

Stratigraphic unit	Material dated	^{14}C years	Sigma	Lab. code	Calibrated age
Upper archaeological floor (37–40 cm)	Wood charcoal	750	70	LP-2932	549–744 BP
	Phaseolus vulgaris	866	39	AA110929	658–908 BP
	Zea mays	878	18	AA110928	716–774 BP
	Wood charcoal	1060	50	LP-3122	796–987 BP
	Wood charcoal	1500	80	LP-3107	1261–1538 BP
Lower archaeological floor (49–56 cm)	Wood charcoal	870	50	LP-3577	666–808 BP
	Wood charcoal	970	40	LP-3567	757–924 BP

The calibration of 14 C ages was done using Calib Rev. 7.0.1 (Reimer et al. 2013)

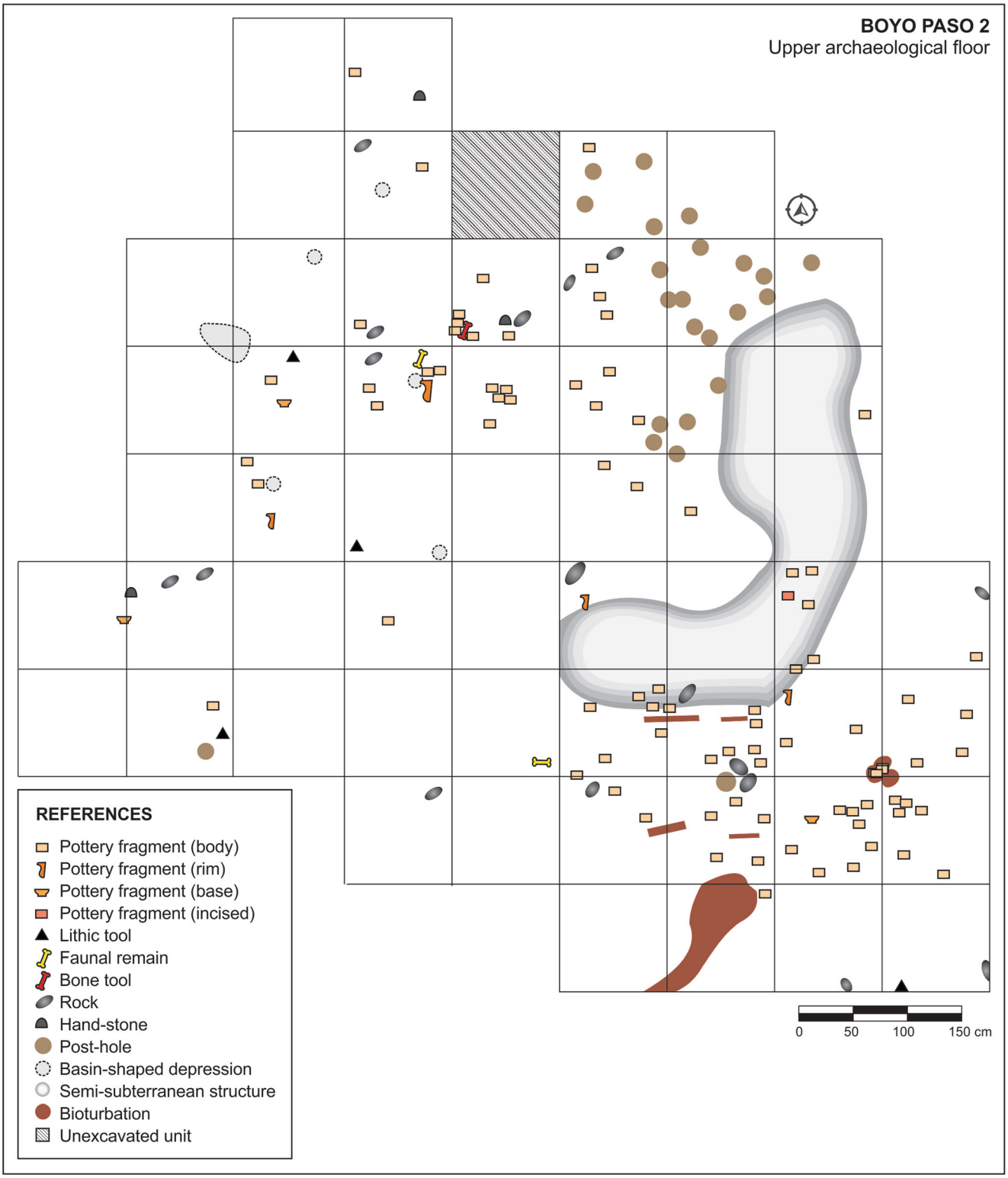

Fig. 2 Plain view of the upper archaeological floor of Boyo Paso 2 with the excavation units, post-molds, and key features

over short-term occupational events and that hiatus of no more that 2 or 6 years occurred after the bones were buried (Medina et al. 2019a). The presence of habitational structures like pit-houses, brush huts, or windbreaks was inferred by the detection of post-molds (Figs. 2 and 3). However, they overlap and do not form a pattern that can be traced to identify the shape or size of the structures, which at the moment continue being undefined. Although the random distribution

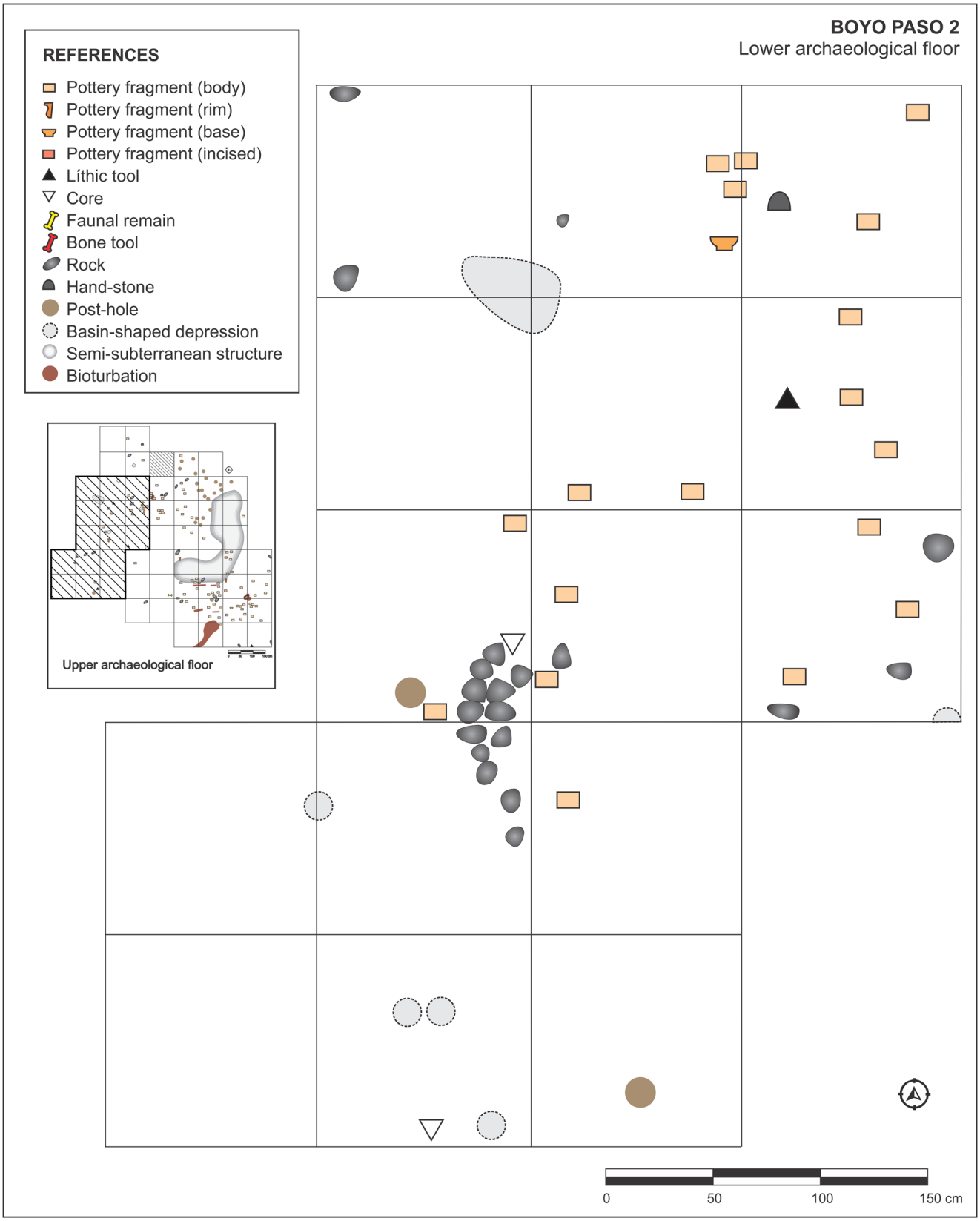

Fig. 3 Plain view of the lower archaeological floor of Boyo Paso 2 with the excavation units, post-molds, and key features

of features on living floors has more in common with brush houses (see Wheaton 2014) than the overemphasized by ethnohistoric approach pitstructures (see Berberián 1984) or drying racks as the described by Kent and Viedrich (1989). The absence of well-defined hearth features makes identification even more difficult, reinforcing the hypothesis that they were not durable habitational residences for long-term occupation. Artifacts that still leave use life left as abandonment stage refuse (Schiffer 1987:98) or as a site furniture behavior (Tomka 1993) were found on the living floors, including bone tools, grinding tools, and pottery vessels, suggesting that people planned to return to this location (Medina et al., 2014a, 2016, 2018). Seven radiocarbon dates have been obtained for the site (Table 1). However, two dates from the upper floor − 1060 ± 50 and 1500 ± 80 year BP- are statically older than those obtained from the lower floor. It is possible that these early dates were outliers or dates made on old wood and were excluded from the analysis, mostly when they were done on undetermined scattered wood charcoals. Most dates overlap roughly, placing the archaeological floors between 900 and 700 years BP and confirming that they were formed over a relatively short period (Table 1) (Medina et al. 2016).

Based on such described evidence, Boyo Paso 2 was interpreted as a seasonally encampment where small groups of people with a mixed foraging and cultivation economy sporadically coalesced to do a wide range of activities. However, only a rough 6 or 7 months medium-term estimation of duration of occupations can be imposed. The identification of ephemeral organic structures and residues of pottery tool manufacturing, an activity that implies stay in a place from several days from several weeks to see the pottery cycle, supports this argument.

Materials and methods

If Boyo Paso 2 was strongly occupied during the growing season (October–April), the late pre-Hispanic people should focus subsistence on such restricted set of specific food resources that were spring-summer seasonal abundant or available at least as to be pursuit, processed, and consumed on-site. Additionally, cool single-seasonal indicators should not be represented. Thus, a specific pattern of archaeobotanical and faunal seasonal available key resources assemblages is expected in Boyo Paso 2, showing that its inhabitants repeatedly focused their subsistence effort on those items.

To test the expectation of spring-summer seasonal occupations, the faunal and macrobotanical remains obtained during the 2013–2018 excavations of Boyo Paso 2 were analyzed, included those hand collected on the archaeological floors and during sieving in 1.5-mm mesh screen. Eggshells were considered the by-products of the initial development stage of bird and were included in the analysis. Every bones, teeth, eggshells, charred seeds, or fruits were identified to it most specific level as possible using reference collections, published atlases, and keys for taxonomic identification. Evidence of *L. glama* was not considered here by the arguments discussed above, and Camelidae bones were tentatively assigned to wild *Lama* cf. *L. guanicoe*. Bone and eggshell remains were quantified using the Number of Identified Specimens per Taxon (NISP, sensu Lyman 2008),[1] also expressed as bone-based NISP and NISP%. The study also considered microfossils (phytoliths and starch grains) found on the active edge of a serrated bone tool recovered on the upper floor (Medina et al. 2018)[2] and palynological data obtained on sediments (Medina et al. 2017).

Seasonal indicators were assigned to autumn-winter or spring-summer based on data about their ecology, timing of ripe, and the length of time resource available for harvesting following Del Papa (2015), Quintana et al. (2002), Instituto Nacional de Tecnología Agropecuaria (2011, 2016), Valdivia et al. (1999), Rapoport et al. (2009), Drewes (2008), Demaio et al. (2015), Barri et al. (2009), Pochettino (2015), Carlini et al. (2016), Fitzgerald et al. (1994), Medina and Pastor (2006), and Quintana and Mazzanti (2011). Resources such as *Lagostomus maximus* were interpreted as a fall-winter available item for food. Conversely, Rheidae eggs, tegu lizard (*Salvator* sp.), armadillos (*Dasypodidae* spp.), cultigens, and wild fruits were considered middle spring-early autumn indicators. However, because humans can mute the evidence for plant seasonality by storing foodstuff prior to consumption or until some burning events occurs, evidence of storing as dehydration by air or sun drying was recorded on plant remains following Cappers and Bekker (2013), Cappers and Neef (2012), Saur Palmieri et al. (2018), Caparelli and Lema (2011), and Arenas and Martínez (2012).

The age at death of *Lama* cf. *L. guanicoe*, a species with seasonal birthing pattern, was also explored based on epiphyseal fusion. The high fragmentation of teeth impedes the use of dentition to ascribe age-of-death more closely. It was assumed following Kaufmann (2009) that the presence of bones of early fusion stage indicates a middle-spring-summer use of site, when offspring less than 2–6 months of age were

[1] Although eggshell NISP may be inflated due to their susceptibility to fragmentation, NISP seems appropriate to roughly assess the number of individual eggs in the collection when a broader temporal framework is indicated by radiocarbon dates (approximately 900–700 BP), especially when there is no valid time-averaged technique to determine if a specimen is from the same individual egg as other eggshells unless they were articulated or refitted in the laboratory to control for specimens interdependence (Lyman 2008: 37). The same reasoning apply to bones, bony dermal scutes, teeth, or fragment thereof, mainly when most archaeological deposits such as Boyo Paso 2 were accumulated along decades or thousands of years, averaging human behaviors, and multiple post-depositational processes at coarse grain.

[2] Starch grains were recovered by sonication according to protocol used by Piperno et al. (2000) and identified using reference collection (see Medina et al. 2018).

available in the landscape. Likewise, the relative frequencies of young individual to adults (∑(young individuals/∑ [young individuals + adults]) were used to provide a measure of the age structure of the exploited population. Adults include bone-based NISP of completed fused bones, while young individuals consider unfused and semi-fused bones. Epiphyseal ends and diaphysis fragments that cannot be ascribed to general classes by epiphyseal fusion were assigned to "undetermined" age category.

Results

Most of the identified vertebrate remains in Boyo Paso 2 were year-round resident of Sierras of Córdoba, as *Lama* cf. *L. guanicoe*, *Ozotoceros bezoarticus*, *Mazama* sp., *Lycalope*x sp., *Dolichotis patagonum*, *Ctenomys* sp., Caviinae spp., *Akodon dolores*, *Calomys* cf. *C. venustus*, *Holochilus* sp., *Nothura* sp., *Zenaida auriculata*, *Fulica* sp., *Caracara* sp., and *Cathartes* sp. (Medina et al. 2019a, c: Table 2). However, it was identified the presence of high-resolution seasonal faunal indicators such as *Salvator* sp. bones (NISP = 27) and Rheidae eggshells (NISP = 507) (Fig. 4 and 5a–b). *Salvator* sp. has active behavior only during the 6 or 7 warm months of the year (October to April), where it was captured, processed, and consumed according to the cut marks recorded on bones. Currently, the nesting season of Rheidae is restricted to spring-summer (October–January), and their presence in Boyo Paso 2 confirmed that at least part of the site was occupied during the early wet season or in any case in October before the onset of the heaviest annual rains (Fig. 4). Two Rheidae species were identified: *Rhea* cf. *R. americana* and *Rhea* cf. *R. pennata*. However, most specimens were assigned to *Rhea* sp. (see Medina et al. 2019a, c). Taphonomic attributes as whether the Boyo Paso 2 eggshell specimens are consequence of natural bird nesting; broken eggs used-like containers or human food refuse are ambiguous to determine. However, the absence of intentional human perforation or engraved motifs on eggs, the eggshell density, its association to lithic, pottery and bone artifacts, the presence of two *Rhea* species, and the burned eggshell frequency indicate an unequivocal human food refuse association (Campos et al. 2019; Medina et al. 2019a, c).

On the other hand, few remains of *Zea mays*, *Phaseolus* spp., and pollen of crop weeds or Andean cultivars, as well as charred wild fruits such as *Sarcomphalus mistol*, *G. decorticans*, and *Prosopis* sp. were recorded on anthropic strata (Table 2; Fig. 5c–g). The absence of storing evidences on plant macroremains supports that they were burnt probably shortly after gathering, suggesting that site had to be occupied at least during high spring-to-early fall when planting, harvesting, and/or wild food were available around the site (Fig. 4). Although the taxonomic status of *Oxalis* sp. starch grains recovered on a bone tool requires further investigation (Table 2; Fig. 5h), the edible underground organ of *Oxalis* is available for harvesting since the end of the summer, when it was collected, taken to Boyo Paso 2, and processed for consumption using a bone tool (Medina et al. 2018). The absence of fissures, fractures, and relief alterations on microfossils shows that *Oxalis* tubers were peeled raw shortly after harvesting (Medina et al. 2018:1047), which reinforces the hypothesis of late summer or early autumn site occupation.

The identification of armadillos remains (NISP = 136), mainly represented by bony dermal scutes assigned to *Chaetophractus vellerosus* and *C. villosus*, reinforces this argument because they have a more active behavior during the warm season (Carlini et al. 2016), where their possibilities of capture increase (Fig. 5i). The low frequency of *L. maximus* bone remains (NISP = 1) is consistent with the spring-summer occupation of the site, since this rodent has a more active behavior during cold months which directly impact on its hunting (Quintana and Mazzanti 2011). *Lama* cf. *L. guanicoe* was the most important faunal resource consumed when body size is considered (Medina et al. 2019a). However, the mortality profile of *Lama* cf. *L. guanicoe*, dominated by young individuals < 34–36 months (bone-based NISP = 31)

Table 2 Plant remains recovered at Boyo Paso 2 (Sierras of Córdoba, Argentina)

Family	Identification	Common name	Observations
Poaceae	*Zea mays*	Maize	8 fragments of carbonized grains; 1 fragment of a carbonized cupule; wavy/ruffle top rondel diagnostic of maize cob phytoliths in the serrated edge of a bone tool
Fabaceae	*Phaseolus vulgaris* aff. var. *vulgaris*	Common bean	2 fragments of carbonized cotyledons
Fabaceae	*Prosopis* sp.	Algarrobo	1 fragment of endocarp
Amaranthaceae	Amaranthaceae	Weeds, quinoa, or amaranth?	High percentage of *Chenopodium* sp. and *Amaranthus* sp. pollen grains (50%) in archaeological floor sediments (ca. 1500–750 years BP)
Oxalidaceae	aff. *Oxalis* sp.	Oca, vinagrillo	33 starch grains tentatively assigned to aff. *Oxalis* in the serrated edge of a bone tool
Rhamnaceae	*Sarcomphalus mistol*	Mistol	7 carbonized fruits (incomplete endocarps)
Fabaceae	*Geoffroea decorticans*	Chañar	1 fragment of endocarp

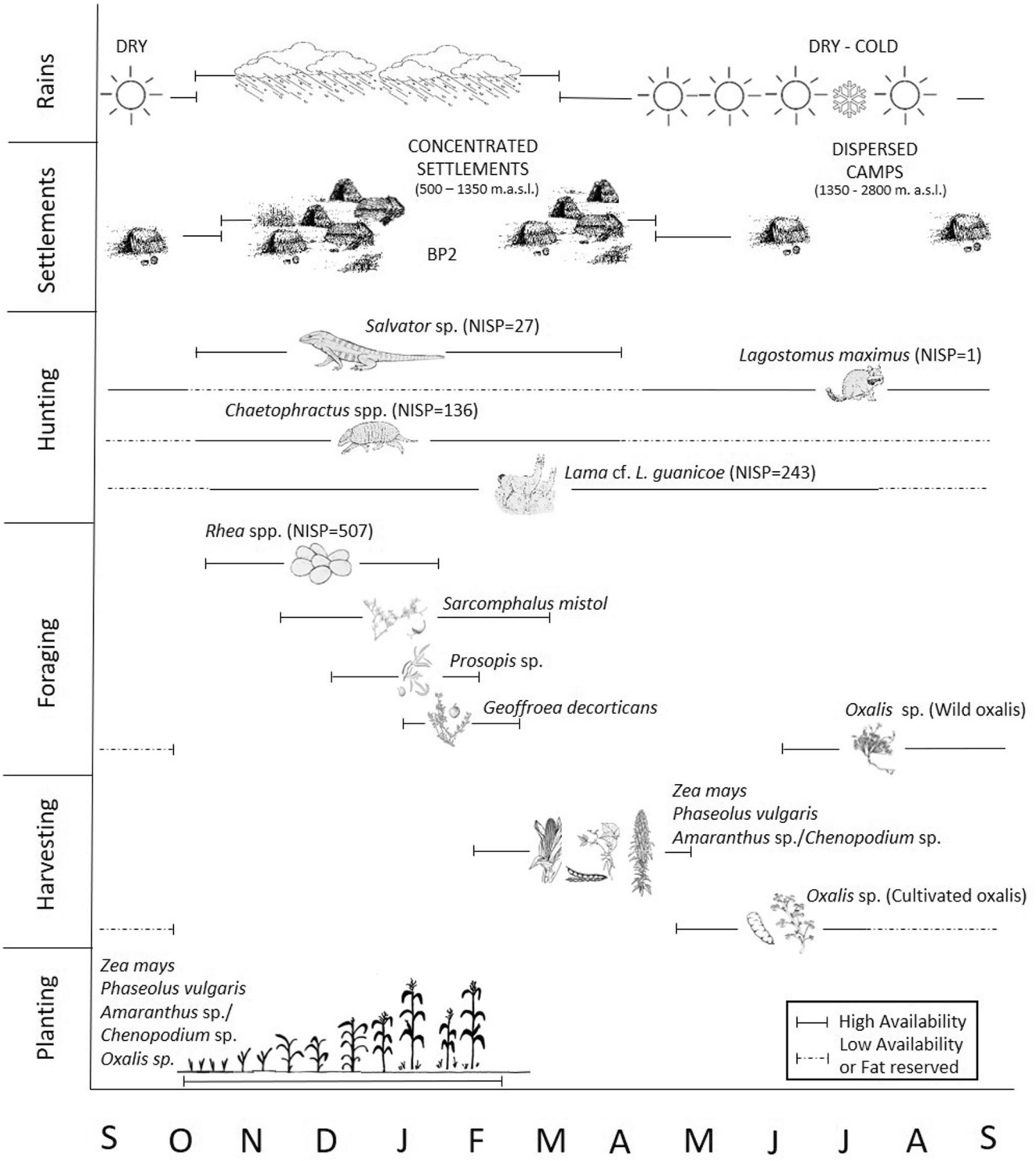

Fig. 4 Schematic model of the ecology, timing of ripe, and the length of time that the faunal and botanical spring-summer indicators recovered at Boyo Paso 2 is available for hunting, trapping, or harvesting

and not by adults (bone-based NISP = 26), did not present an accurate resolution to assess the season of site occupation, mainly because unfused bones of early fusion stage were absent from the assemblage (Fig. 4). Conversely, mortality profile shows at coarse grain that the site was occupied either spring-summer or on a year-round basis and that the creators of the assemblages emphasized capture of large juveniles and adults to optimize the meat taken per kill, pointing out how distance to large game patches affects the hunting decisions of Boyo Paso 2 hunters (Medina and Rivero 2019).

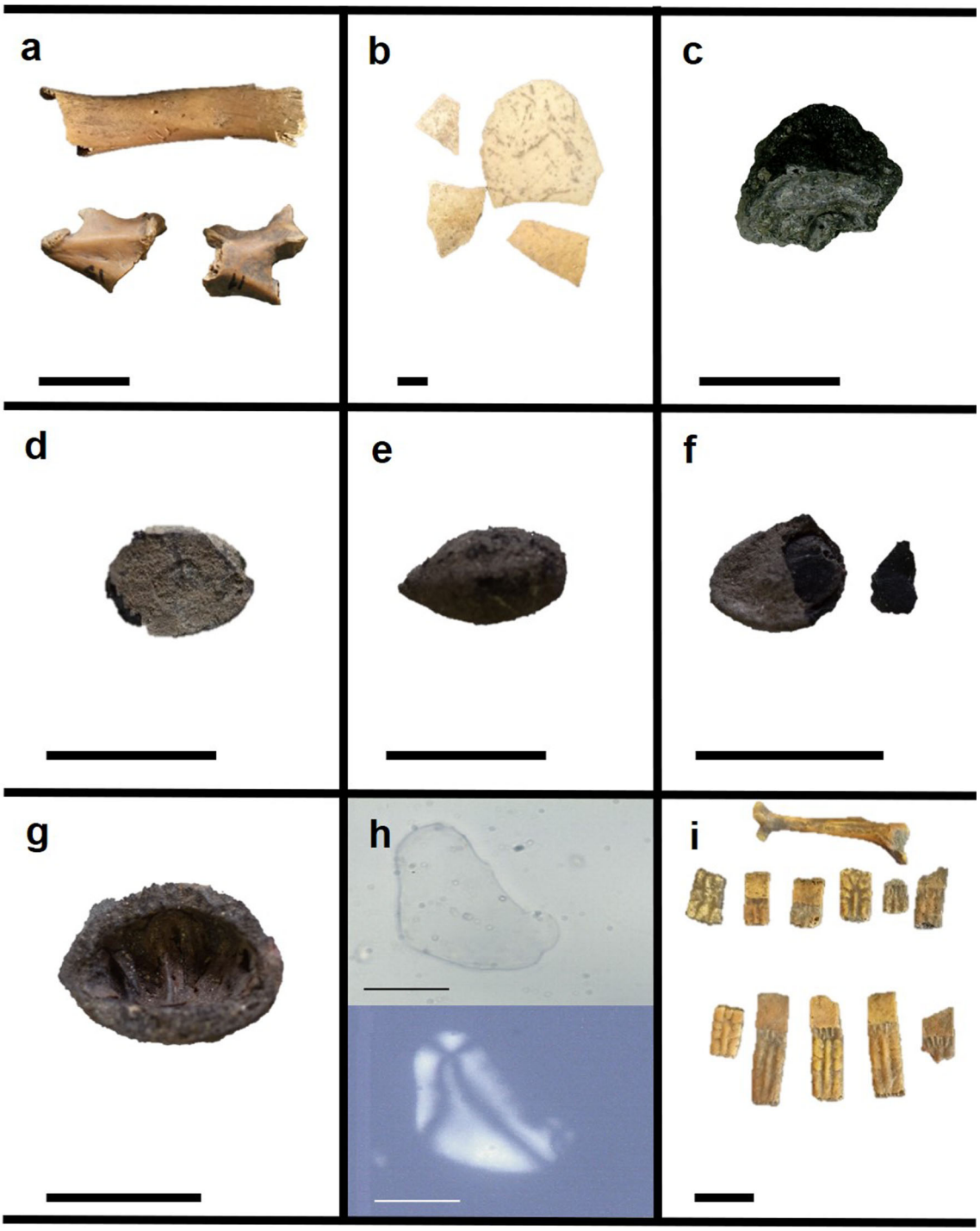

Fig. 5 Faunal and archeobotanical spring-summer indicators recovered at Boyo Paso 2 (Sierras of Córdoba, Argentina): **a** *Salvator* sp. bone remains. **b** Rheidae eggshells. **c** Charred *Zea maize* macroremain (cupule). **d** Charred *Phaseolus* sp. macroremain. **e** Charred *Sarcomphalus mistol* macroremain. **f** Charred *Prosopis* sp. macroremains. **g** *Geoffroea decorticans* macroremain. **h** *Oxalis* sp. starch grain. **i** *Chaetophractus vellerosus* bone and bony dermal scutes remains. (Scala bar in (a-b-d-e-f-g-i) = 10 mm; Sb (c) = 2 mm; Sb (h) = 20 μm)

Discussion

Boyo Paso 2 illustrates the complex dynamic of site formation, features, and material culture associated with mixed foraging and cultivation economies, a category for which archaeology currently lacks of sufficient archaeological understanding and merits further research. Faunal, archaeobotanical, and contextual data documented on-site

corresponds to expectation for a seasonal base camp site generated by highly mobile groups who occupied base camps at least for few months (Binford 1990; Diehl 1997; Kent and Viedrich 1989; Schmader and Graham 2015) and suggests that late pre-Hispanic people occupied Boyo Paso 2 ca. 900–700 BP to do a wide range of domestic activities. Moreover, the material culture follows the expectations of a settlement pattern left by groups that were organized as seasonal or occasional food producer and used the site as a seasonal base camp, indicating some type of tethering or redundancy in the structure of mobility.

The relatively large amount of eggshell remains suggests that the eggs of large-sized flightless birds played a key role in late pre-Hispanic seasonal life, mostly when they are the earliest wild resources available for foraging at the beginning of the agricultural calendar (October) when other foraging opportunities across the mountain landscape were low (Medina et al. 2011). Although Rheidae eggs played an ancillary role when compared with ungulate preys, their economic importance cannot be understated by the argument recently mentioned or when the high predictability, nutritional values, and low-capture cost of eggs are considered (Barri et al. 2009; Medina et al. 2011; Navarro et al. 2001; Navarro et al. 2003). On the other hand, the occasional capture of *Salvator* sp. and armadillos led to increase the meat intake and diversify subsistence. These reptiles and medium-sized mammals are attractive seasonal resources for site inhabitants, basically because their predictable availability and easy capture with simple weapons, a situation which should stimulate this opportunistic predation by different age and sex groups (Quintana et al. 2002; Del Papa 2015). Moreover, their carcasses contain a high proportion of meat, fats, and other essential elements for life, i.e., iron and potassium (Stahl 1982).

The few macrobotanical and microfossil plant remains found on Boyo Paso 2 naturally biased the seasonally and subsistence model toward animal resources and their exploitation. However, they indicate that early foraging effort on eggs was followed by planting diverse crop plants at least, including maize and bean. Andean cultivars as *Oxalis* tubers and *Chenopodium* spp. or *Amaranthus* spp. were probably also cultivated, especially when *Oxalis* microfossils were detected and Chenopodiaceae-Amaranthaceae dominate the pollen assemblage (Medina et al. 2017). The identification of maize cob and cupules implied that maize had not been shelled or ground prior to its arrival at site, suggesting that these domesticates were probably grown and processed on-site rather than obtained through long-distance transport, a situation partially confirmed by pollen analysis (see Medina et al. 2017). Crops requirements must also overbalance losses of local plant and animal food resources that cannot be tapped if long-distance movements are undertaken. So, the absence of durable and obvious agricultural features as terraces, retaining walls, or irrigation ditches near the site implied a low-investment extensive cultivation in patches of wilderness that remained more or less untended until the harvest time. In consequence, the minimal labor investment in agricultural pursuit does not seriously constrain the group's mobility and the time investment into other subsistence activities which provide the bulk of the overall diet as foraging. Thus, after the crops had been planted and before the harvest of ripe cultigens, Boyo Paso 2 inhabitants might take advantage of *Prosopis* sp., *G. decorticans*, and *S. mistol* that ripened clump in patches during middle summer and would have been gathered surrounding the site or in the lower altitude forest located 20 km north of the site, perhaps by a task-specific group or families that journeyed there and back on the same day or few days after. Considering that the amount of calories that can be extracted from *Prosopis* sp., *G. decorticans*, and *S. mistol* is high and that they are predictable, highly productive, and storable resources (Demaio et al. 2015), it is conceivable that they were perhaps an important source of food, even when few archaeological remains were recorded on Boyo Paso 2. However, Recalde and López (2017) and Medina et al. (2009) have reported the importance of *S. mistol*, *Prosopis* spp., and other wild fruits for late pre-Hispanic subsistence despite their relative sensitive to depositional conditions, even recording their past use for delayed consumption. Wild or cultivated *Oxalis* tubers ripened typically in late summer-early autumn. Thus, if the microfossils were cultivated *Oxalis*, tubers were harvested from farming plots and peeled after the harvest of other crops or wild fruits were completed. Something different occurs if the microfossils were assigned to wild *Oxalis*, because it had a more dispersed distribution, and once the tubers had ripened, they were available for their collect to the spring, being an excellent famine food for the end of the winter-to-early spring, when animal fats were scarce and caloric needs had to be offset by input of plants as these tubers rich in carbohydrates or Rheidae eggs.

Most of the plant taxa identified in Boyo Paso 2 were available in efficiently harvestable quantities only from a limited amount of time. Yet, to assess the season of site use from the season of plant availability is an inferentially complex task, mainly because food storage can undermine any attempts to use the ecological information of flora to infer the season of use of the site (Diehl and Herr 2011). In other words, storable foods may be consumed during months following those in which they were harvested, even though they ripen during relatively narrow window of time. For example, maize and bean can be harvested as edible green corn or pod in December–January but finally harvested in March–April for food or to be stored for a delayed consumption. In the context of the landscape-use model, if no reliable evidence of storage is found on plant remains, it is expected that maize and bean occurred only in sites occupied during high spring-

early autumn as Boyo Paso 2, even when their occurrence in assemblages requires to be interpreted along with other seasonal high-resolution evidences as Rheidae eggshells. On the other hand, *S. mistol*, *G. decorticans*, and *Prosopis* sp. are arboreal fruits that ripen from January to April. Ripening time varies though the area where they are found, being efficiently harvested for a few weeks immediately following maturation and accounted for the absence of these berries or pods during autumn-winter season. Although the small sample size of wild fruits, the seasonal-use arguments are reinforced by the absent of storage evidence in the few recovered endocarps. Finally, *Oxalis* yielded ripe tuber for food as the end of the summer, when could be harvest, processed and consumed. However, wild *Oxalis* tubers may persist underground through the following spring, where they are an excellent famine food for times when foraging opportunities decline seriously on Sierras of Córdoba (Medina et al. 2011), albeit they are more costly to pursuit due to their less clump distribution than the cultivated species. Both options lead to infer that Boyo Paso 2 was occupied at the growing season.

Evidence of dry season occupations (high autumn to winter) are not archaeologically clear, even when Boyo Paso 2 was also probably used intermittently or occasionally visited for raw material provisioning at a broad temporal scale. Conversely, overall data indicates that the most probable season of occupation for Boyo Paso 2 was the middle spring-to-early autumn (October–April), when eggs were available, small-to-medium-sized vertebrates were more active, the crops ripen, and wild resources were abundant near the site. The collection of eggs of *Rhea* sp. was easier during the middle spring (October) when they were most likely utilized as a key food source (Campos et al. 2019; Medina et al. 2011, 2019c). The few recovered botanical specimens, whether wild or domesticated, also indicate site occupation from October through April. During this period, the identified crop and wild plants are in the process of fruiting and seed dispersal in Sierras of Córdoba (Demaio et al. 2015; Medina and Pastor 2006). The climate also appears to have been much humid during the site occupation span than it is currently in this area (Carignano 1999; Piovano et al. 2009), potentially extending the wet season by one or more months (April and May). The availability of animal and plant food sources during only a few months of the year may help to explain why the site was occupied during this season, focusing activities around the planting, foraging, and processing of these resources. These activities were carried out independently of whether the plants were cultivated or wild, mostly when the absence of diagnostic features on macroremains and microfossils makes the specific level identification difficult. Plant and animal prey processing is clearly evident in the tool assemblages of Boyo Paso 2 that include ground stones or fragment of thereof, ceramic vessel to cook a wide variety of foodstuff, basketry, a diversity of projectile point designs, and cutting tools known to be used to pursuit and process carcasses, seeds, and tubers as well as other by-products of a broad-spectrum diet (Medina et al. 2009, 2018, 2019d).

Given the wet season occupations of Boyo Paso 2, the inhabitants appear to have moved to the site to do a wide range of activities, including collecting and processing seasonally resources which were potentially consumed or stored on-site for delayed consumption. When harvest and stored activities finished in early fall, co-residential groups abandoned the site and dispersed across the landscape. During this time of the year, it is initially proposed that food consumption relied on stored food partially transported from summer hamlets and foraging wild resources, mainly upper mountain grassland range ungulates at the peak of weight after a summer of productive grazing (Medina et al. 2016).

The identification of *Lama* cf. *L. guanicoe* bone remains also suggests that the inhabitants of Boyo Paso 2 would have to send special task groups to hunt these ungulates in the upper mountain grassland range located over 10 km from the base camp (Medina et al. 2019a; Medina and Rivero 2019). It is evidenced in faunal assemblage that hunting forays respond to the cost of hunting *L. guanicoe* by reducing transportation load at kill sites, carrying high-ranked body part of carcass to Boyo Paso 2, but also forcing hunters to be selective to kill adult or subadult individuals and avoiding newborns (Medina et al. 2019a), a situation that would explain the absence of early-stage fusion bones that are sensitive indicators of spring-summer site use (Kaufmann 2009). Moreover, the focus on local lithic and bone raw materials for tool manufacturing also points out the restricted territoriality of the groups occupying Boyo Paso 2 (Medina et al. 2019b; Medina et al. 2018), even when they conserve a seasonally use of the landscape and different ecological settings were utilized through the year.

Conclusion

It was proposed that late pre-Hispanic people blended plant cultivation with foraging wild food, switching subsistence strategies as resources became seasonally available. Within this framework, the above data and contextual evidence recovered on Boyo Paso 2 constitute a strong body of evidence to support that late pre-Hispanic base camps were formed by middle spring-to-early autumn seasonal occupations (Medina et al. 2014a, 2016). Evidence draws from Boyo Paso 2 was also consistent with a multi-purpose activity site or base camp occupied during the growing season. Rheidae eggshells were the most common food items that denote a spring-summer occupation, following by the *Salvator* bone remains, wild fruits, and cultigens. The combination of

S. mistol, *G. decorticans*, *Prosopis* sp., and cultigens suggests that the site was occupied shortly after the agricultural harvest occurred, when the site was abandoned and reoccupied years later. It was this co-residential group fission-fusion mechanism and the abandonment of site which explains the poor macrobotanical preservation in Boyo Paso 2, due to the less rapid middens accumulation at more intermittently occupied sites that expose organic matter to the element for longer periods before burial and decrease the likelihood preservation (see Rocek 2013). Given that Boyo Paso 2 is remarkably low in plant preservation possibilities, faunal evidence is considerable important for understanding seasonal past foraging and mobility in the region.

Interestingly, the evidence suggests that Boyo Paso 2 inhabitants were exploiting upper mountain grassland range, farming plots, and Sierra Chaco wild fruit patches simultaneously during site occupation. Food consumption activities involved the use of maize, bean, and probably some type of Andean crops as tubers or starchy seed annual plants identified at family level by pollen studies. The occupations also entailed the use of eggs, *Prosopis* sp., *G. decorticans*, and S. *mistol* berries as well as the hunting or trapping of *Salvator* lizards and other small vertebrates, which were foraged during the interval between crop planting and crop harvesting. Hunting *L. guanicoe* and cervids occurred as well, but small game and eggs were the regularly consumed faunal resources that supply the protein needs (see Medina et al. 2019a).

Evidence of Boyo Paso 2 occupation after the rainy season is ambiguous and fails to support the existence of year-round occupation based on negative evidence. Thus, it is argued that co-residential groups who occupied the site dispersed across the landscape to focus the foraging efforts on wild ungulates, mainly when post-harvest interval from May to September was the preferred season for hunting large-game. The best supported interpretations are based on more than one indicator, and paradoxically, the major evidence that supports the spring-summer occupation and the autumn-winter abandonment of Boyo Paso 2 is the flimsy house architecture, only identified by slightly depressed packed floors and few post-molds, that are most consistent with the kind of dwelling constructed by people who did not live in a single location throughout an entire year (Diehl 1997; McGuire and Schiffer 1983). Something similar occurred with the disposal of trash on floors directly around habitational features and not at a certain distance, a site layout often associated with impermanent site use (see Rocek 2013).

Results are also consistent with paleoecological and settlement pattern survey data obtained in recent years. For example, the distributional site analysis carried out on the upper mountain grassland range indicates that the main occupational strategy was related to the short-term use of rock shelters, combining family and communal level organization for hunting wild ungulates (Medina et al. 2016; Pastor 2005, 2007b; Pastor and Medina 2005). The recovered assemblages pointed that the occupation of these environment focused on the hunting of wild ungulates, with dense concentration of their bone elements on-sites. The absence of warm seasonal use indicators assesses that hunting was undoubtedly scheduled around the intervals in which dense stand of wild food and crops needed to be harvested and processed quickly, when ungulate preys were at their peak of weight. The absence of any cultigens conclusively rules out the use of these sites were on a May to September basis but also indicates an unexpected few reliance on stored crop plants over winter months. Thus, the upper mountain grassland range hunting would have played a key role during the cold seasonal co-residential group dispersion.

Given the confluence of the evidence described above, it seems more likely that Boyo Paso 2 was relatively occupied as a base camp during the warm months of the year. Zooarchaeological and archaeobotanical data presented here were critical to understand the dynamic process that have underlain transition from foraging to farming in Sierras of Córdoba, which would constitute a model to interpret other archaeological cases where fluidity across economic models remained relatively invisible according to the existing terminology. However, the moot point of this interpretation is whether or not the human occupation for 6 or 7 months leaves the same material correlates than a sedentary year-round occupation, especially due to the presence of potentially storable plants and that the resolution of the archaeological record is rarely adequate to truly evaluate it. Despite the high spring-to-early autumn occupations of Boyo Paso 2 require to be corroborated with more robust evidences in a site that today continues being excavated, this should not be an impediment to communicate results to scientific community interested in mobility among prehistoric mixed economies and its material correlates. Thus, the results are expected to increase the archaeological knowledge of the relation among economy, mobility, and material culture in societies that developed flexible subsistence and mobility patterns, especially when their study was left aside due to the priority to analyze how the adoption of crop plant cultivation quickly derived in a completely sedentary farming, while foraging and residential mobility were assumed as complementary activities.

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