Firewood selection strategies for combustion events during Late Holocene hunter-gatherer occupations in South America (Córdoba, Argentina)

Andrés Robledo

Institute of Anthropology of Córdoba, National Council of Scientific and Technical Research / Anthropology Museum and Department of Anthropology, National University of Córdoba, Argentina. Email: and.robledo@gmail.com


1


2

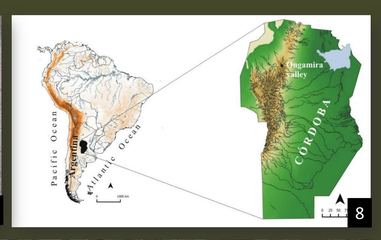

3


4


5


6


7



8

Introduction

Archaeological research about firewood selection for use on fire events allows us to explore the different relations and interactions between humans and the environments in the past. Wood selection criteria may have varied accordingly, among other factors, to woody species availability in different environments and human selection on specific species with particular properties (Thery-Parisot *et al.* 2010). We present here the result of a research project focused on use and management of fire by human groups during Late Holocene occupations (between *ca.* 950 and *ca.* 5700 years BP). We would like to contribute to the understanding of social practices, material relationships and dwelling habits in a changing landscape through time (Robledo 2019). For this reason, 9 sites (Figure 9) were studied with evidence of human occupations and activities associated with 63 combustions events.

The archaeological sites presented in this opportunity belong to the southern region of South America, in the northern sector of the Austral Pampean Hills, Córdoba, Argentina (Figure 8). Ongamira valley is located between 900 and 1300 meters above sea level, and it is over a conglomerate of crystalline basement of Gondwanna which includes a Cretaceous sandstone formation where red rockshelters are formed (Baldo *et al.* 1999) (Figure 1). In eco-regional terms, the area of study belongs to the Gran Chaco, one of the biggest ecosystems of South America with dry glade (Zak *et al.* 2008). Phytogeography composition is dominated by Mountain Woodland Chaco (Cabrera 1976) with xerophytic semi-deciduous forest and the presence of isolated forest, dense thorny shrubs communities, semi-natural grasslands and cultivated lands. Although we can discriminate different phytogeographical communities (woodlands, grasslands and shrubs) in the area, it is also possible to find sectors with ecotonal zones (Figure 2) that were affected by climatic variations (Cioccale 1999).

Human relation with combustion events in archaeological contexts of the region have been limited to particular works of Salvi (2007) for Early Holocene occupations (*ca.* 8000 to 6000 years BP). And López (2006) for prehispanic occupations (Late Holocene) near *ca.* 1000 years BP. Therefore, we hope to contribute to the understanding of human occupation through the study of inhabited places and social practices of management of woody resources by focusing in the ways in which people related to the plants, fire and daily activities during different times in the Holocene.

9

Material and Methods

To achieve this objective, we analyzed charcoal samples from archaeological contexts in 9 sites (see Table 1). During excavations, we were able to identify stratigraphic units (Harris 1991) related to combustions trails (structured hearts and post-burning activities such as cleaning and reoccupations) with other types of material culture implying different activities (manufacturing and use of lithic instruments; consume of local fauna such as *Lama* sp. by the presence of thermal altered faunistic remains, among others).

From the units with combustions evidence, samples of charcoal were separated and quantified in order to perform a description and classification (presence of cracks, barks, xylophages, vitrification, among others). The samples were analyzed under binocular microscope Motic SFC-11 (until 100x) and optics microscopy Nikon EPHIPHOT 200 (until 200x). The description of the diagnostic anatomic characters was made following the list of IAWA (1989) and the form of the data base Insidewood (http://insidewood.lib.ncsu.edu) for angiosperms plants. For an appropriate taxonomic identification, it was necessary to compare with actual samples of wood from the area of study. Therefore, in Robledo (2016:150) a reference collection was constituted with 30 species of Chaco Woodland, along with an anatomic description of each of them; and a gender key to facilitate the identification.

We recovered 14976 fragments of charcoal from the 9 sites, but only DR (Deodoro Roca rockshelter) and ONP 1 (Ongamira Natural Park 1) were sites with a larger excavated area. In the first one (Figure 3), we could identify 140 stratigraphic units in thirteen squares of 2 meters each and up to three meters deep. We recovered evidence of hunter gatherers occupations from *ca.* 1900 to *ca.* 4500 years BP (Cattáneo e Izeta 2016).

At the same time, ONP 1 (Figure 4 to 7) is a smaller rockshelter were we identified 86 stratigraphic units in two squares of 2 meters up to half a meter deep in one case, and three meters in the second square. We registered the presence of pottery, dated for first time in the valley in 1905 +/- 20 years BP (SU35 YU7746 – Figure 7) and hunter gatherer occupations from *ca.* 2800 to *ca.* 5700 years BP (Figure 6 – SU85). Other sites such as ONP 3, ONP 4 and The Cave were excavated on squares of 0,5 meters and one meter deep. Instead, for ONP 5, Two Moons 3 and White Wells (Figure 2) we identified stratigraphic units over one meter square and one meter deep. Two Moons 2 was a river ditch profile of 3 meters high in which we identified culture material and a combustion event at 2,5 meters deep dated 4216 +/-21 years BP (YU-7743).

Sites	Chronology	N° of Hearths	N° of Fragments	% Taxonomy Identification	% Alterations sample
DR	1915 +/-45 (SU32 MTC14158) 2944 +/-44 (SU34 YU2291) 3043 +/-37 (SU65 MTC14144) 4562 +/-39 (SU74 AA93739) (among others)	20 Hearths & 4 combustion area	5668	3%	4%
ONP 1	1905 +/-20 (SU35 YU-7746) 2802 +/-20 (SU59 YU-7744) 5782 +/-20 (SU82 YU-7751)	18 Hearths & 9 combustion area	8237	8%	5%
ONP 3	No dates	1 combustion area	14	21%	36%
ONP 4	2538 +/-20 (SU2 YU-7747)	2 combustion area	94	1%	2%
ONP 5	942 +/-20 (SU3 YU-7749) 2971 +/-21 (UE9 YU-7748)	3 Hearths	243	18%	16%
The Cave	2592 +/-20 (LG2 YU-7745) 3029 +/-20 (LG3 YU-7742)	2 combustion area	147	18%	0%
Two Moons 2	4216 +/-21 (YU-7743)	1 combustion area	1	0%	0%
Two Moons 3	With no dates / Related to ca. 1500 years BP.	1 Hearths	103	17%	7%
White Wells	With no dates / Related to ca. 1500 years BP.	2 Hearths	469	22%	7%

Table 1 – Anthracological samples by sites with chronology (SU: Stratigraphic Unit). number of hearts registered, number of fragments in each site, percent of taxonomic identification and alterations of the sample (cracks, xylophages, vitrification, presence of resin, fungi and sand).

Figure 10.- Archaeological sample from ONP 1 - ID 2515 (SU39) – *Prosopis* sp. A- Transversal view. B- Tangential Radial view. C- Tangential Longitudinal view.

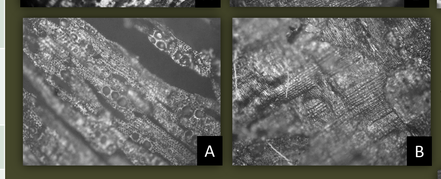


Figure 11.- Archaeological sample from ONP 1 - ID 4149 (SU35) – *Acacia* sp. A- Transversal view with presence of cracks. B- Tangential Radial view.

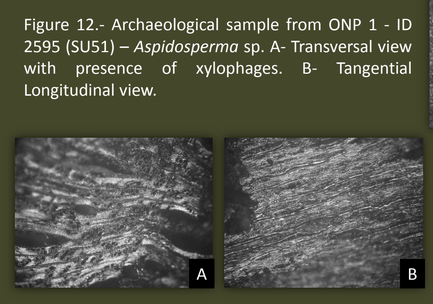


Figure 12.- Archaeological sample from ONP 1 - ID 2595 (SU51) – *Aspidosperma* sp. A- Transversal view with presence of xylophages. B- Tangential Longitudinal view.

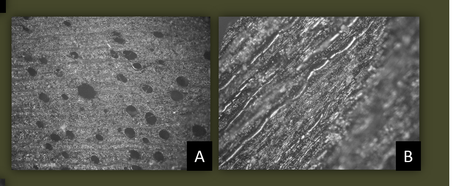
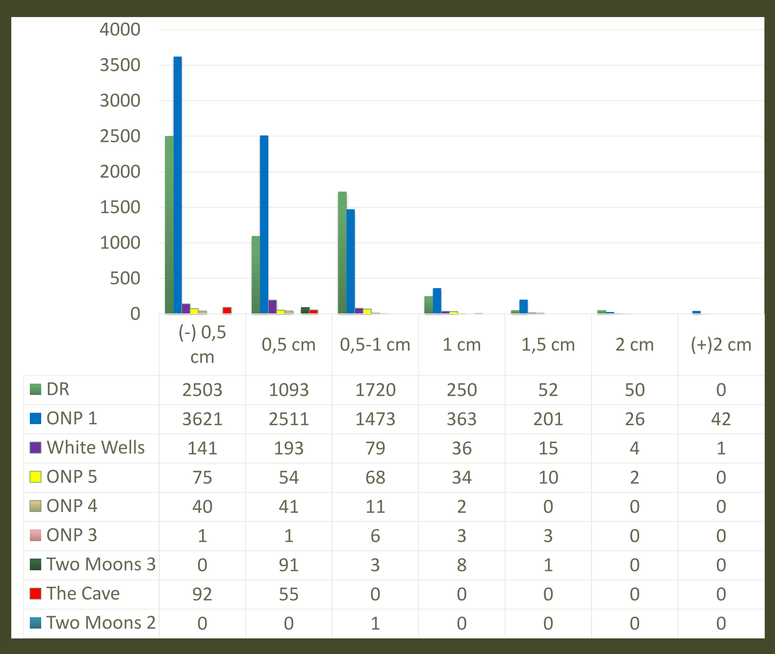


Figure 13.- Archaeological sample from ONP 1 - ID 7193 (SU85) – *Castela* sp. A- Transversal view with presence of cracks. B- Tangential Longitudinal view.



	(-) 0,5 cm	0,5 cm	0,5-1 cm	1 cm	1,5 cm	2 cm	(+)2 cm
DR	2503	1093	1720	250	52	50	0
ONP 1	3621	2511	1473	363	201	26	42
White Wells	141	193	79	36	15	4	1
ONP 5	75	54	68	34	10	2	0
ONP 4	40	41	11	2	0	0	0
ONP 3	1	1	6	3	3	0	0
Two Moons 3	0	91	3	8	1	0	0
The Cave	92	55	0	0	0	0	0
Two Moons 2	0	0	1	0	0	0	0

Figure 14 – Charcoal fragments separated by size and archaeological site.

Results

From the combustions events registered (see Table 1), we observed the presence of small and flat types of structured hearts, most of the times associated with ashes and thermoaltered sediment and almost all of them with areas of discard of fauna remains and lithic ensemble (see Figure 7, SU 35, for reference). In some cases, we registered stratigraphic units characterized as combustion areas, which could have mean activities made after the fire such as cleaning, or taphonomic process when the structure was buried. The number of samples recovered from each combustion event varied depending on the size and the integrity of the stratigraphic unit identified (Figure 14).

During analysis, samples of minus 0,5 cm were considered unidentifiable which means that nearly 70% (N=10512) of the fragments couldn't be anatomically descripted due to the absence of diagnostic characteristics. Taxonomic identification was made on 686 fragments (5 %) of the sample. In table 1 we can observe the number of fragments per cite and the percentage of fragments identified. We were also able to characterize different charcoal alterations or presence of diagnostic characteristics in 5% (N=818) of all the samples analyzed (see Table 1 and 2). Table 2 shows alterations due to the use of fire, such as a majority presence of cracks in 325 fragments (see Figure 11), most of them from ONP 1, follow by White Wells and DR sites. Also from vitrification in 111 samples (see Figure 13), 83 from ONP 1; and 19 samples with presence of compressed vessels in transversal plane. About presence of xylophage (see Figure 12), we registered 55 samples, of which OPN 1 has 45 fragments. Furthermore, we observed the presence of fragments with knots in 34 fragments (none of them were identifiable). Plus, 152 fragments with complete circumference of the branch in the transversal plane (the majority of them with 0,5 cm and less), most from DR site (N=95) follow by ONP 1 (N=42).

In addition, we registered the presence of tylosis on vessels (N=5) and fungi in 55 fragments, most of them from ONP 1 (N=36) and White Wells (N=15) sites. About the external part of the fragments, we registered the presence of sand in 57 of the samples, the majority from ONP 1, suggesting the action of post-depositional process. And 6 fragments from OPN 1 presented roots in vessels, associated with a highly organic soil.

About taxonomic identification, from 686 charcoal fragments, 24 taxa were determined (Figure 15). Five of them we were not able to associate with a specific family or gender due to lack of reference taxonomic information. The rest belongs to 14 families of Chaco Serrano Forest. Due to a greater sample analyzed, OPN 1 and DR are the sites with higher variability of taxa determined, 21 and 18, respectively. Follow by OPN 5 with 13 and White Wells with 7. Last, OPN 3, Two Moons 3 and OPN 4 with 2 and 1 taxa each. From Two Moons 2 and The Cave, no taxa were determined.

About the species (see Figure 15), we can group them in four: First, families with a higher representation in the archaeological contexts such as FABACEAE (*Acacia* sp., *Prosopis* sp., *Geoffroea* sp., *Cercidium* sp., and *Senna* sp.), ANACARDIACEAE (*Lithraea* sp., *Schinopsis* sp., *Schinus* sp.). A second group follow by SIMAROUBACEAE (*Castela* sp.) and RUTACEAE (*Zanthoxylum* sp.) were actuals specimens can be found in the valley, and the family APOCYNACEAE (*Aspidosperma* sp.) which is not local at the moment. Third, a group of species with less representation such as CANNABACEAE (*Celtis* sp.), RHAMNACEAE (*Condalia* sp. and *Ziziphus* sp.), SANTALACEAE (*Jodina* sp.), NYCTAGINACEAE (*Bougainvillea* sp.) and ZYGOPYLLACEAE (*Porliera* sp.).

Site/Alterations	Total Fragments	Cracks	Xylophage	Vitrification	Compressed Vessels	Knots	Complete Circumference	Tylosis	Fungi	Sand	Roots	Total
DR	**5668**	25	3	0	0	0	95	0	0	0	0	**123**
ONP 1	**8237**	240	45	83	15	25	42	4	36	52	6	**548**
ONP 3	**14**	0	0	0	0	0	1	0	0	1	0	**2**
ONP 4	**94**	1	0	0	0	0	0	0	0	0	0	**1**
ONP 5	**243**	17	2	6	3	5	3	1	4	1	0	**42**
The Cave	**147**	0	0	0	0	0	0	0	0	0	0	**0**
Two Moons 2	**1**	0	0	0	0	0	0	0	0	0	0	**0**
Two Moons 3	**103**	9	1	5	1	0	0	0	0	0	0	**16**
White Wells	**469**	33	4	17	0	4	11	0	15	2	0	**86**
Total	**14976**	**325**	**55**	**111**	**19**	**34**	**152**	**5**	**55**	**56**	**6**	**818**

Table 2 - Anthracological samples with presence of cracks, xylophages, vitrification, compressed vessels, knots, a complete circumference in transversal view; and presence in vessels of resin, fungi, sand or roots.

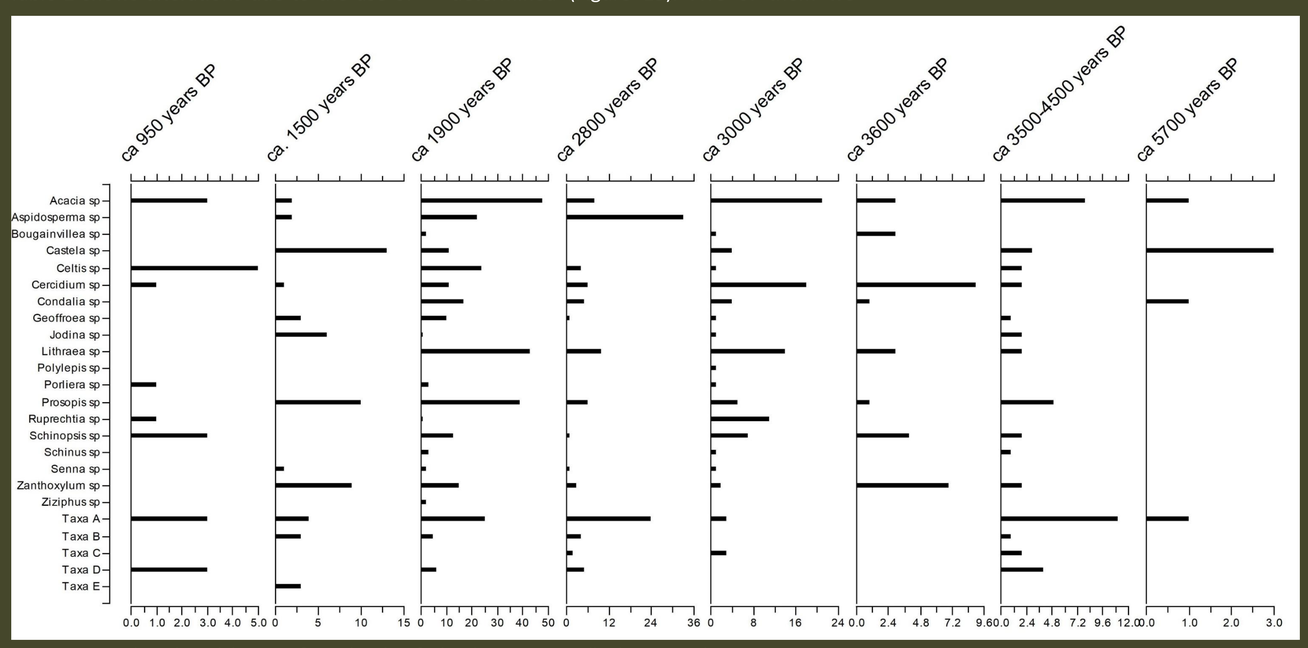


Figure 15 – Anthracological diagram of samples identified in the Ongamira valley by temporality

Final Comments

Humans' relation with fire could have involved particular strategies of gathering and selecting firewood in areas where they had knowledge of finding what was necessary. Their everyday life implied moving through paths and routes leading to places where they knew what to find. These places were connected with their capabilities of being apprehended, the transmission of human knowledge about plants and the situational contexts that required a specific firewood.

Furthermore, ubiquity analysis made on the taxa identified by stratigraphic unit shows that *Acacia* sp., Taxa A and *Lithraea* sp. (all 11%) are the most frequent species used in combustions events. A second group can be made by species with 6 or 7 percent of representation such as *Aspidosperma* sp., *Castela* sp., *Cercidium* sp., *Prosopis* sp. and *Schinopsis* sp. The rest of the species are frequent between the values of 5 to 1 percent. This could mean that some species represent a higher value of importance or are more available in the environments during all Holocene, considering their representation in almost all the temporal components (Figure 15). With the exceptions made on *Aspidosperma* sp. and *Cercidium* sp., both are taxa frequents in drier environments and sandy soils which can be found a 50 kilometers northwest of Ongamira valley nowadays. About use of specific species, FTIR analysis on the residues found on the basis of projectile points shows similar values of the resin obtain by *Cercidium* sp.

Looking to firewood selection through time (Figure 15) we observe a high number of species selected, probably gathered most of them nearby the sites. In addition, we observe a tendency of some species more represented by number of fragments and recurrence through time. Specially taking into account that around *ca.* 1900 years BP pottery was incorporated in their way of life. We could infer that although changes in technology were present, in some way this did not mean a change in some of the other social practices, such as the use of fire (Robledo 2019).

Due to a multidimensional landscape, people dwelled in Ongamira rock shelters in relation with places where they could obtain the necessary elements to perform their activities such as tool manufacturing, cooking, establishing social relationships, among others. This means that by studying fire event evidences we could contribute to understand about people's connection to places and activities in the past.

Bibliography

Baldo E., J. Saavedra, C. Rapela, R. Pankhurst, C. Casquet & C. Galindo. 1999. Geochronological synthesis of the lower Paleozoic evolution of the South Western edge of Gondwana in the Pampeans Hills, Argentina. Hispanic Geological book of Abstracts, 32: 17-28.

Cattáneo, G.R. & A.D. Izeta (Ed) 2016a. Archaeology in Ongamira valley, 1st ed. Córdoba: National University of Córdoba.

Cioccale M. 1999. Climatic fluctuation in the Central region of Argentina in the last 1000 years. Quaternary International 62: 35–47.

Cabrera, A. 1976. Phytogeographical regions of Argentina. 2 ed. Argentine Encyclopedia of Agriculture and Gardening. ACME, Bs As.

López, M. L. 2006. Uses of wood fuel resources in the high pampas: the cases of Río Yuspe 11 and Río Yuspe 14. Book of abstract of X National Congress of Students in Archaeology, Mendoza, 2006.

Harris, E. 1991. Principles of Archaeological Stratigraphy. Barcelona, Editorial Critica

IAWA. 1989. List of microscopic features for hardwood identification. E.A. Wheeler, P. Baas & Grason Eds. 1989. IAWA Bull. 10: 219-332

Picornell Gelabert L., 2012. Vegetable landscape and pre-historical and proto-historical communities in Mallorca and Menorca (Illes Balears). An approach from anthracology. Doctoral Thesis, Bacerlona University: pp. 387.

Robledo A., 2016. Anthracological studies in the combustions places of Deodoro Roca Rockshelters– Ongamira (Córdoba), South American Archaeology Series 25. Archaeopress. ISBN 9781784913441.166 p.

Robledo A., 2019. Archaeology in the Ongamira valley (Departments of Ischilín and Totoral, Córdoba, Argentina) Landscapes and places of holocenic hunter gatherer societies. Doctoral Thesis in Anthropological Sciences, Philosophy and Humanities Faculty, National University of Córdoba.

Salvi V. F. 2007. The archeobotanical record on the site Arroyo el Gaucho I during the Early Holocene (8000-6000 AP) (Achala Pampeans, Córdoba). Comechingonia Virtual 1:1-11.

Théry-Parisot I., L. Chabal & J. Chzavzes. 2010. Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal assemblages, in archaeological contexts. Paleaogeography, Palaeoclimatology, Palaeoecology 291, 142-153.

Zak M., M. Cabido, D. Cáceres & S. Díaz. 2008. What drives accelerated land cover change in central Argentina? Synergistic consequences of climatic, socioeconomic and technological factors. Environmental Management, 42: 181–189.