Research Article

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Microwear and Plant Residue Analysis in a Multiproxy Approach from Stone Tools of the Middle Holocene of Patagonia (Argentina)

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Abstract: This study aims to evaluate the functionality of a sample of lithic tools from a multiproxy perspective. The artifacts come from a mid-Holocene hunter-gatherers' occupation of the La Mesada site in Patagonia. The perspective involves the examination of use-wear traces, hafting wear, and organic micro-residues. The experimental program that supports this perspective is presented. Use-wear traces and organic residues were recognized in the distal portion of the archaeological artifacts. Meanwhile, some tools, in the proximal and middle portion, present alterations attributable to hafting in combination with animal and vegetable residues. The production sequence of a particular artifact design is discussed, with distinctive aspects regarding regional trends. Practices related to plant management were identified that allow the evaluation of mobility circuits and interchange mechanisms of these societies.

Keywords: hunter-gatherers, lithic technology, plant residues, Patagonia, multiproxy approach

1 Introduction

The studies carried out to identify the functionality of archaeological lithic artifacts covered two lines of analysis that were developed historically in parallel, use-wear analysis and the study of residues of plant and animal origin. For the latter, it was previously pointed out that rigorous methodological validations were rarely applied during the past century, and it was warned about the bias errors that can be generated when drawing conclusions from indicators derived from the application of singular approximations (Anderson-Gerfaud, 1980; Grace, 1989; Lombard & Wadley, 2007; Mansur, 1984; Shanks et al., 2005; Zurro & Gadekar, 2024, among others). However, in the last two decades, the approaches that combine both mentioned lines, together with other methodologies to accurately evaluate the use of artifacts in plant processing have increased (Ciampagna, Cueto, Lema, & Capparelli, 2020; Clemente, Risch, & Zurro, 2002; Hayes, Fullagar, Mulvaney, & Connel, 2018; Lombard & Wadley, 2007).

We consider that the study of plant management in hunter-gatherer societies forms a key line for evaluating changes and trends in collection, transportation, exchange, and consumption practices, including conditioning and transformation of lithic artifacts. In continental and insular Argentine Patagonia, all these subjects have been addressed from archaeobotany based on the study of macro-remains, artifacts, and filling

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structures made from plants and micro-residues (Berihuete Azorín, 2010; Caruso Fermé, 2012; Ciampagna, 2015; Cueto & Andreoni, 2016; Pérez de Micou, 2002; Piqué i Huerta, 1999). Particularly in the continental sector of this region, the density of archaeobotanical evidence decreases from north to south. The province of Santa Cruz has the least amount and variability of plant remains, with its lowest expression in the Central Plateau. This could be due, on the one hand, to a lower environmental availability of plants since the vegetation decreases in density, diversity, and height both from north to south, and from the Atlantic coast and the mountain range towards the interior of the plateau (Ciampagna, 2015). Additionally, methodological issues since archaeobotanical studies in the province are relatively recent (Caruso Fermé & Aschero, 2020; Ciampagna, Molares, Ladio, & Capparelli, 2021). Also, it could be attributed to social factors that imply differences in the post-harvest practices (Ciampagna, 2015).

The few archaeolobotanical macro-remains recovered from continental Patagonia made it possible to identify, up to the present, a restricted range of use categories that are predominantly for fuel, but also for food, medicinal, and technological uses (Caruso Fermé, 2012; Ciampagna, 2015; Cueto & Andreoni, 2016). There has been a recent emphasis on the study of micro-residues from lithic milling artifacts, ceramic sherds, and coprolites allowed for the broadening of the discussion on use categories (Ciampagna et al., 2021).

The studies that combine the analysis of use-wear traces and the examination of vegetal micro-remains on archaeological artifacts in continental and insular Argentine Patagonia, although scarce, constitute a valuable source of evidence to increase such understanding of the modes of use of plants, the selection criteria, techniques involved in the different stages of their conditioning and transformation, and the contexts in which they were carried out (Álvarez et al., 2009; Cueto, 2015; Mansur, 1984). The functional analysis of lithic artifacts has a long history in the region, both in the continental portion (Castro, 1994; Cueto, Frank, & Castro, 2017; Lynch, 2016; Mansur, 1984; Paunero, Castro, & Reyes, 2007) and in the insular segment (Álvarez et al., 2009; De Angelis, 2015). If we focus on the continental Central Plateau of Santa Cruz, general trends and particular characteristics were recognized for some archaeological periods, registering changes and continuities in the way of using instruments. Such characteristics arise from the use-wear analysis of archaeological instruments from different sites (Cueto, 2015; Cueto et al., 2017; Lynch, 2016). These indicate that the processing of wood was inferior to that of other substances, such as leather, meat, and bone, during the final Pleistocene first peopling of the southern tip of the continent. Along the early Holocene an increase in its processing is recorded, reaching values next to those of leather, the most exploited substance (Cueto, 2015; Lynch, 2016). For later occupations assignable to the middle Holocene, wood is among the most worked material together with bone and leather. Here, the first traces attributable to the hafting of compound instruments generated by intermediaries made of wood also appeared (Cueto et al., 2017; Paunero et al., 2007). Finally, in the late Holocene occupations, wood occupies the second place behind bone (Cueto, 2015).

Consequently, we wonder if it is possible to identify which plants were processed with lithic artifacts, for what purpose, and in what way these works were done, if wood was used to haft the instruments, also when and in what areas these technological practices occurred. To answer these questions, we are developing a line of work aimed at identifying both use-wear traces and micro-residues of plant origin on lithic artifacts. The first step was to design an experimental program aimed at identifying and characterizing the use-wear traces and the plant residues adhered to the rim, edges, and active surfaces of the pieces used to process wood in order to generate a reference base. Methodology and protocols of this program were published by Ciampagna et al. (2020), and a brief synthesis is given here. From this reference base, we are able to deepen the examination of the production and consumption strategies of lithic artifacts as well as the practices of collection and use of plant species implemented by the hunter-gatherer societies that inhabited the Central Plateau.

Our objective in this article is to use the experimental program as a reference base, to evaluate the functionality of an archaeological assemblage of artifacts corresponding to the mid-Holocene occupation of the La Mesada site located in La María archaeological locality at the Central Plateau of Santa Cruz (Figure 1a) through a multi-proxy perspective that combines the use of wear analysis and plant residue identification.

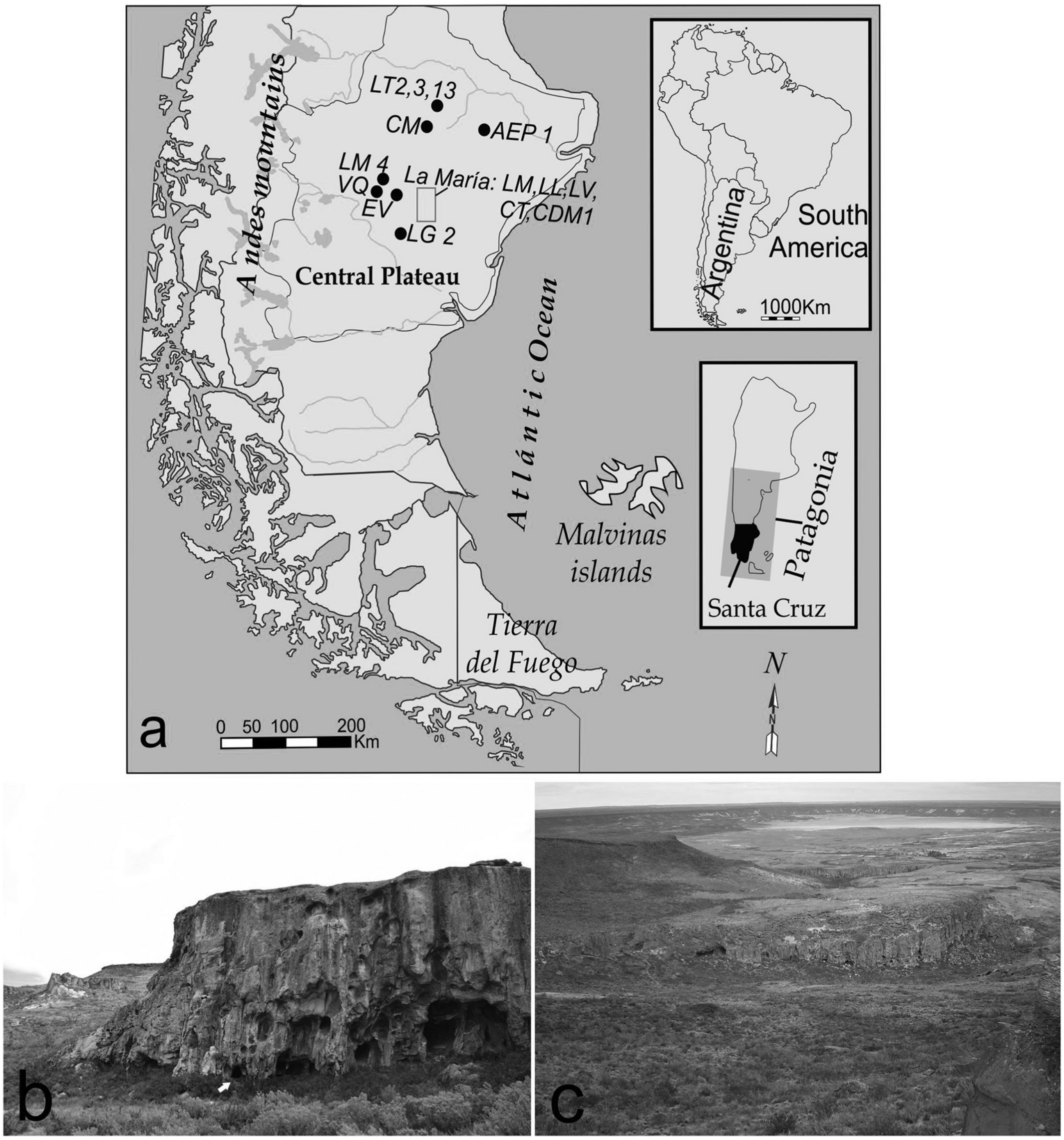

Figure 1: (a) Study region. Sites: LT: Los Toldos 2, 3, 13; CM: Cueva Maripe; AEP1: Alero El Puesto 1; LM4: La Martita 4; VQ: Viuda Quenzana; EV: El Verano; LM: La Mesada; LL: La Lavandería; LV: La Ventana; CT: Cueva Túnel; CDM1: Casa del Minero 1; LG2: La Gruta 2. (b) La Mesada. (c) Landscape, plateaus, canyons with caves, shallows, and lagoons.

1.1 Background

1.1.1 Woodworking in Indigenous Societies According to Documentary Sources of Patagonia

Approaches that include ethnohistorical, ethnographic, and ethnoarchaeological perspectives provide an additional access window to interpret the collection and processing practices of plant organs, through lithic instruments, in all their complexity (Clemente et al., 2002; Hayes et al., 2018; Pérez de Micou, 2002). Many of these products are entirely consumed as food, medicine, and fuel, generating little archaeological evidence. Consequently, the lithic artifacts used in their processing are a key to finding out what work was done and how the artifact operated. Likewise, to what particular type of site and/or activity area are these practices linked; which members of the community carried them out (gender and age); and even estimating the volume of use of each plant.

Research that combines these approaches, based on documentary sources from the sixteenth to the twentieth century, suggests that the Patagonian indigenous societies assigned an important role to plant consumption in its wide sense. They indicate the management of a great diversity of *taxa*, various ways of taking advantage of and the different instruments for processing them (Ciampagna & Capparelli, 2012; Nacuzzi & Pérez de Micou, 1983–1985; Piqué I Huerta, 1999). Here, we will consider the aspects related to the use of wood, one of the materials recognized through use-wear analysis as highly worked-on artifacts. For the continental sector, it is known that to make their huts, Tehuelche groups used logs of Calafate wood (*Berberis* sp.) that were conditioned with lithic artifacts such as the brush in smoothing tasks. Likewise, this instrument was used to prepare – smooth, remove knots, and polish – molle sticks (*Schinus* sp. L.) to make looms (Aguerre, 2000). These groups also used *alerce* – native larch – logs (*Fitzroya cupressoides* [Molina I.M. Johnst.]) for the construction, and *colihue* cane (*Chusquea culeou* E. Desv.) to make spear´s or arrow´s shafts. They manufactured wooden hafts of lithic artifacts with *molle*, *Berberis*, and *Nothofagus* logs, pipes with *Berberis*, cradles with Anacardiaceae, and musical instruments with ñire branches (*Nothofagus antartica* ([G. Forst.] Oerst), among others (Caruso Fermé, Álvarez, & Vázquez, 2011; Ciampagna & Capparelli, 2012).

The insular Patagonian groups used soft and flexible wood from *calafate* (*B. microphylla* G. Forst), rarely harder wood from *chaura* (*Gaultheria mucronata* [L. f.] Hook. & Arn) among others, for making arrow shafts. For bows, they selected *ñire* and *coihue* (*N. betuloides* [Mirb.] Oerst.), whose logs were debarked and chipped down to the stem using scrapers to extract the shavings (Caruso Fermé et al., 2011). The Selk´nam bows were finished by the insertion of longitudinally equidistant awns, attributed to an ornamental ending or to enable it to be held firmly (in Cueto, 2021; Gusinde, 1982).

1.1.2 Archaeological and Ethnographic Wooden Artifacts in Patagonian Record

The examination of wooden artifacts, from archaeological and ethnographic collections of Patagonia, also provides information on technical operations followed in the modification of logs. Like the wood fragments of *Berberis* sp. possibly attributable to lithic artifact hafts recovered from the early Holocene occupation of the site Cerro Casa de Piedra 7. There, the beginning of the manufacturing process is recognized from the perimeter cutting of the branch, followed by debarking, roughing, and surface treatment at one end where a bevel cut was made. In this last sector, a mastic was applied (Caruso Fermé & Aschero, 2020). In a harpoon fragment from *Berberis* sp. from the late Holocene occupation of the site Cueva del Negro, parallel striations were identified, possibly made with denticulates (Capparelli, Castro, & Ciampagna, 2009). Also, the wooden haftings of the Tehuelche scrapers recovered in Chubut, one by De Verneau (Mansur, 1984) and another two belonging to the Moreno Ethnographic Collection of the Museum of La Plata, present modifications that suggest the use of different lithic artifacts in cutting, scraping, polishing, and drilling. These show the transversal segmentation of the log initially collected, to generate the adequate size of each base shape (Cueto, 2021), which was debarked and bevelled at both ends on one of its faces, forming oval section preforms. The surfaces of both pieces have longitudinal grooves that Mansur (1984) attributes to scraping with an irregular or slightly denticulated edge, associated with work carried out at different times in the processing of the logs, such as debarking, abrasion of fibers, and polishing. These artifacts have cavities near the ends of the non-bevelled face, suggesting cutting and drilling work, where the lithic scrapers and mastic were inserted.

1.1.3 Multiproxy Approaches for Understanding Plant Processing: General Considerations from Worldwide and Argentine Antecedents

The investigations that combine proxies, such as the identification of use-wear traces and plant residues to evaluate the functionality of lithic artifacts, constitute a fruitful line of study that draws on various approaches (Clemente et al., 2002; Lombard & Wadley, 2007; Rots, 2014). We consider that this kind of study can be defined as multiproxy, because they require the interdisciplinary interpretation of the data obtained. We described in this section some of the pioneer works on these subjects.

Hardy and Garufi (1998) define accurate patterns of "use actions" with experimental artifacts to which they associate wood micro-remains identified at the class and species level. With the purpose of discussing the functionality of archaeological tools combining the identification of organic residues and use-wear traces, they elaborate a wide experimental collection that refers to the processing of logs with artifacts used for carving, cutting, incising, scraping, and brushing.

On the other hand, Rots (2014) highlights the contribution of experimental studies such as the last mentioned, but, in line with Lombard and Wadley (2007), remarks on the necessity to warn about the lack of an evaluation of how the residues are distributed in the artifacts according to their mode of use. Rots (2014) suggests that there are differential methodological developments to identify the instrument hafting and that although macroscopic analysis is valid, the consistency of this determination is due to the combination of microscopic-based functional analysis and residue examination. In addition, she indicates that in order to determine the work carried out with the artifact as well as to recognize the haft from residues, its redundancy and the spatial pattern in which they are arranged must be identified, without relying on isolated findings.

The application of these kinds of studies to archaeological and ethnoarchaeological cases allowed reconstructing work processes on cereals and other vegetables developed with macrolithic instruments – hand and mill – used by the Dogon communities (Clemente et al., 2002). To overcome theoretical-methodological limitations that make it difficult to understand the production processes that make up these instruments, they follow an interpretive model that combines first-hand ethnographic information, the characterization of plant residues, and experimentally generated use-wear patterns. They underline the role played by the ethnographic record of the social context in which these instruments are used, since usually only women manipulate them. This is one of the few ways that allow these activities to be contemplated in the archaeological record and expose their potential in the examination of various work processes with minerals, oils, and animals. The central role experimental studies occupy for multi-proxy approaches is also reflected by Lombard and Wadley (2007), who carried out morphological identification of residues by light microscopy as one of the most reliable sources of information on use. They support that the results from other methods might have been biased by diagenetic changes in chemical composition (Lombard & Wadley, 2007, p. 164). They carried out blinding experimental tests, considering ethnographic data, for the identification of organic residues. Difficulties in their identification, such as distinguishing some from animal and those of vegetable origin, are pointed out. Solutions such as increasing experimentation with residues, examining dust samples from the environment and the sediment matrix in stratigraphy to discern contamination, are suggested.

In Argentina, until the 1990s, analyses that combined these approaches were developed discontinuously (Mansur, 1984), reverting to the present day. Thus, Álvarez and collaborators (2009) propose a combined study, aimed at reconstructing old production processes. They recognized quantitative variability of phytoliths among the artifacts, but did not identify pieces with both, traces of plant use and vegetal residues, a fact that hampered the contrast of the model. From a similar approach, Babot, Cattaneo, and Hocsman (2010) evaluated the function of an assemblage of lithic points and the transformation of their design after use. They identified use-wear traces, tuber and fatty substance residues that allow them to interpret a set of activities. In other cases, the use of experimental and archaeological artifacts was evaluated by combining functional analysis and gas chromatography. In pieces with processing marks, the sampling of bounded sectors of the edges yielded consistent results on the origin of the substances worked, using DESI-MS (Mazzia, Weitzel, & De Angelis, 2016).

In sum, the development of a combined approach will allow us to deepen our knowledge of the specific modes of use of similar lithic artifacts or with small differences in their design. Given that, even recognizing that a class of artifacts was used to scrape wood, this knowledge does not directly inform the kind, sequence, and purpose of the tasks involved. At the same time, the recognition of plant use-wear traces on their own does not provide information on the type of plant or organ processed (De Angelis, 2015; Mansur, 1984). To solve these questions, the need to carry out an experimental program to recognize patterns in the identification of residues of vegetal origin adhered to the lithic artifacts as well as to understand the use-wear traces generated during woodworking was necessary.

1.2 Experimental Program as a Reference Base for Patagonia

We elaborated an experimental collection of lithic artifacts on reddish-brown flint from the La María locality: a rock widely available in the Santa Cruz Central Plateau and representative of most of the archaeological artifacts recovered there. We worked logs of two woody species *Berberis thunbergii* DC and *Neltuma chilensis* (Molina) C.E. Hughes & G.P. Lewis. We made a sample of disaggregated reference material composed of a dissociated cell and tissue remains diagnostic at the genus level, from which the anatomical characterization of the residues recovered from the artifacts was carried out (Ciampagna et al., 2020).

The surface of the artifacts was characterized, using a stereoscopic microscope (SM) and metallographic microscope (MM), prior to their use and consequently free of plant residues. Variables such as appearance, gloss, grain, and homogeneity/heterogeneity were considered (Figure 2a, b, and f). With the artifacts, debarking and scraping work was carried out on fresh wood logs. A scraper was not used and remained as a control artifact. The work carried out on the wood involved transverse movements to the active edge, with different angles of attack and pressure, for a total of 30 min, by manual pressing on logs (Table A1). After 30 min of use, the initial scraping (IS) was carried out, which consisted of the extraction of residues from one-half of the worked edge. The extracted material was analyzed using the optical transmission microscope.

Cleaning procedures were then applied – NaOH at 20%, to remove organic residues; HCl at 10%, to remove carbonates and some inorganic residues; and combining both – to evaluate the incidence of each one on plant residues. After these washes, the final scraping (FS) was performed, taking a sample of residues from the other half of the worked edge (Table A1). The quantification of residues adhered to the pieces before and after the chemical treatment was calculated on the basis of the slide area occupied by the residues removed after the scraping of the edges. The entire sample was subjected to a final wash with a neutral soap solution, and subsequently, the functional analysis of the artifacts was carried out.

As a first result of the experimental program, the anatomical characterization of the dissociated cell types allowed us to recognize the differences between both genera, and after the IS and FS (Table A2). All the artifacts presented residues and plant adhesions on the edges and adjacent internal parts after working for 15 and 30 min. At the macroscopic and SM level, tissue fragments and fiber bundles were identified, especially in *Neltuma* bark, together with adhesions coating the surface of artifacts, stains, and isolated particles (Figure 2c–h).

At the microscopic level, a greater amount of plant residues was observed in artifacts that processed *Berberis* xylem than those that processed *Neltuma* xylem. Among the artifacts that processed bark, in the IS and FS, those that processed *Neltuma* had a higher number of residues compared to *Berberis*. In both species, from bark and xylem, disintegrated cellular elements and tissue fragments were recovered.

The three cleaning procedures partially removed the residues from both species; however, the washing with HCl caused a greater removal of plant residues than the other types of cleaning. None of these cleaning procedures eliminated the totality of the residues, which was observed when identifying the use-wear traces, immediately after FS (Figure 3a and b). Because of that, we removed the rest of the adherences with a final washing with a soap solution before using wear analysis. Regarding plant micro-remains analysis, we removed adherences before cleaning techniques were applied. This is more convenient due to the alterations caused by washing (degraded cell walls, fragmentation) that are similar to those of technological processing of wood with lithics.

After the final washing with soap solution, diagnostic and intermediate diagnostic micropolishes were recognized on all the artifacts. The latter are slightly shinier in appearance and in some cases very shiny, mostly intermediate in thickness with instances of thick development, and rough and smooth in appearance. These traces are distributed as a band parallel to the edge and on the cusps of the microtopography, extending marginally. The polishes that appeared in more sectors and that were more developed were formed in the artifacts used to work *Neltuma* bark and xylem (Figure 3c and d).

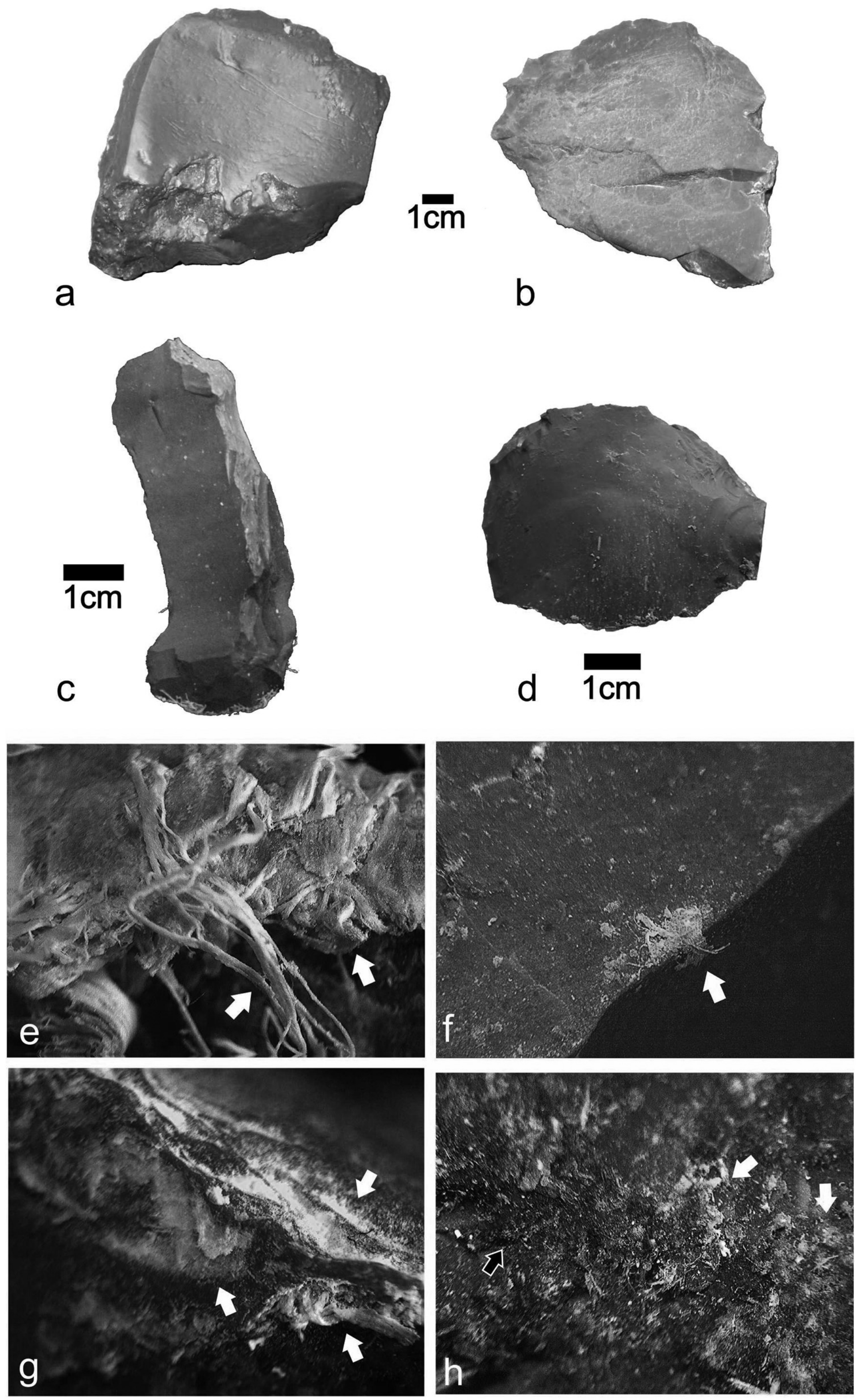

Figure 2: Flint. (a) Cortex: thin, fine grain, wavy topography, smooth, silky appearance and intense shine. (b) and (f) internal surface: smooth and soft appearance, matte shine, very fine and homogeneous grain. (c) and (d) Artifacts No 10 and No 2 with plant residues. SM microphotos: (e) and (f) *Neltuma* bark, 90× and 10×, artifact No 4. *Berberis* 60×: (g) Xylem, artifact No 8. (h) Bark – white arrow, stains – black arrow, artifact No 3.

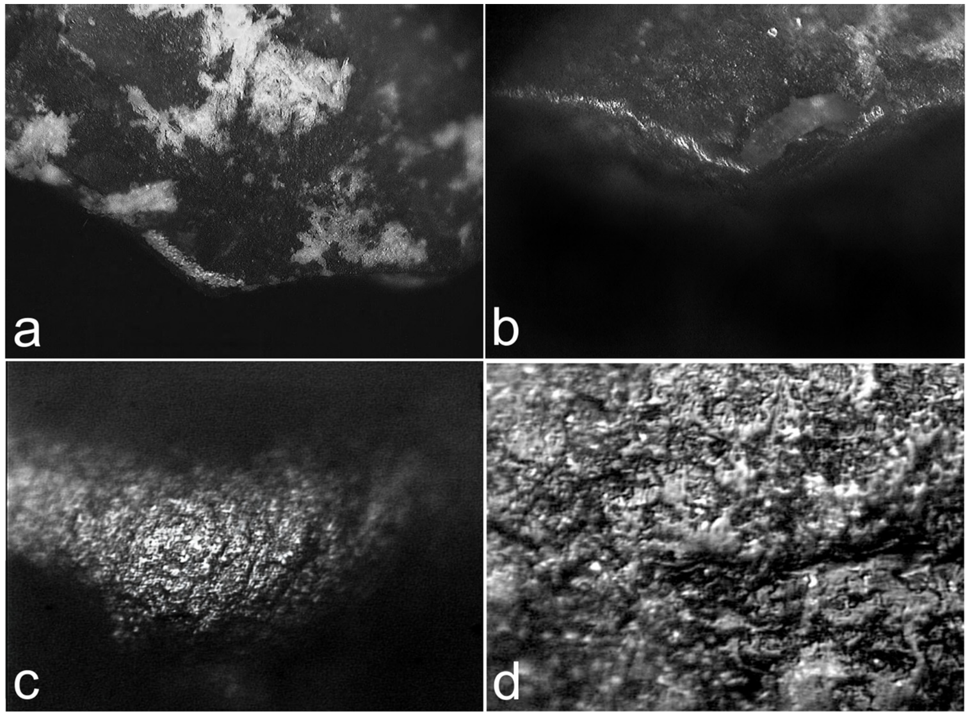

Figure 3: Polishes and residues associated (150×), then 30 min work, of (a) *Berberis* xylem, artifact No 8. (b) *Neltuma* bark, artifact No 4. (c) and (d) Micropolish by scrape *Neltuma* bark – artifact No 10 – and xylem – artifact No 7 –, 300×, from Ciampagna et al., 2020.

2 Regional Setting: Characteristics and Evidence of Mid-Holocene Occupation of the Central Plateau of Santa Cruz

The Central Plateau of Santa Cruz is a region of volcanic origin (Figure 1a–c). It presents a landscape interrupted by canyons, hills, valleys, and endorheic basins. Modern climate is arid and vegetation corresponds to a steppe with shrub and sub-shrub steppe. There is a diversity of fauna, in which guanaco (*Lama guanicoe*) and rhea (*Pteronemia pennata*) populations stand out. It has a large availability of lithic raw materials with a homogeneous distribution (Cueto, 2015). The region presents large formations of acid ignimbrites with caves and rock shelters. These preserve evidence of hunter-gatherer societies from the final Pleistocene to recent historical times. The plateau has hundreds of sites with rock art and open-air deposits (Cueto, 2015; Miotti & Salemme, 2004).

The mid-Holocene in this region was characterized by an arid climate. Contexts in stratigraphy attributable to this period are distributed in 14 sites – Figure 1a (Cueto, Iparraguirre, & Paunero, 2020). It has been proposed that hunter-gatherers had reduced residential mobility. Subsistence was based on hunting guanaco, indicating a specialized strategy. It has also been claimed that consolidation of regional social networks occurred, facilitating the long-distance movement of goods and information (Miotti & Salemme, 2004).

2.1 Lithic Technology of Mid-Holocene at Central Plateau

The lithic assemblages exhibit a higher artifactual density than in previous periods (Hermo & Magnin, 2012). The groups mainly used local siliceous raw materials (e.g., flint, chalcedony) of very good quality and increased the exploitation of allochthonous obsidian. The blades increased either in number among the debitage or as a base form for making tools. They manufactured a greater diversity of tool classes, among which short-edged scrapers predominate (Cueto et al., 2020). For their manufacture, they applied flaking and bifacial reduction techniques, although few bifacial tools were found in stratigraphy, in addition to projectile points (Skarbun, 2011). This would be linked to the differential discard of these instruments, abandoned outside the caves due to changes in the use of space. For the first time, they made use of boleadora balls, intended for hunting (Hermo & Magnin, 2012). To a lesser extent, they performed heat treatment, specifically to produce knife-like instruments (Frank, 2016).

In general, the instruments have unifacial modification and the design of long sharp-angled edges. They required a production strategy with little labor investment. Those instruments made on blades or laminar supports show a tendency to regularize more than one edge (Cueto et al., 2020; Skarbun, 2011). Based on technomorphological criteria, it was proposed that Middle Holocene blade technology was not a consequence of a need for raw material maximization, as raw materials are abundant in the region. On the contrary, it is proposed that the blades, being versatile and flexible, offer different ways to be used (Hermo, 2008). Thus, for the scrapers, which show modifications such as a decrease in size and a preference for laminar, standardized base forms, it was proposed that a change in the way of grasping, which requires their hafting, might have occurred (Durán, 1987). From a technological perspective that includes functional examination, it was shown that the production of blades was part of a standardized sequence that made it possible to use natural edges or retouch them to produce mainly knives and scrapers (Cueto et al., 2017). It was even found that some of the latter were used in multiple functions and that they were not hafted. Other distal scrapers were used for grinding bones, tanning skins, and processing wood. Some of these also possess hafting evidence on the lateral blades and on their surfaces (Cueto et al., 2017, 2020; Paunero et al., 2007). These studies suggest that human groups would have taken advantage of the wide range of possibilities offered by blade technology. This pattern contrasts with the use given to scrapers elaborated on flakes that have at least one retouched lateral edge, which does not show traces of either use or hafting. This artifact class constitutes a minor group within the assemblages (Cueto et al., 2017). For these, it was proposed that the regularization of their lateral edges would be linked to a technological style by which they sought to obtain rectangular module designs similar to those elaborated on blades (Castro, 1994).

It is considered that hafted distal scrapers, made on blades, would have required a sequence with a greater investment of work due to the manufacture and incorporation of the haft. In this sense, it was suggested that possibly the laminar design of these artifacts and that some of the functions in which they would be used demanded a change in the way they were gripped, making it necessary to use them with a haft (Cueto et al., 2020; Paunero et al., 2007). For this reason, we propose here to analyze, from a multiproxy perspective, a sample of scrapers potentially hafted, from the La Mesada site (La María archaeological locality), in order to evaluate their functional identity in terms of work performed and the presence/absence of hafting devices.

2.2 La María Archaeological Locality and the Mid-Holocene Occupation of La Mesada Site

La María (Figure 1a) is situated in the southern sector of the central plateau. It has appropriate characteristics for the settlement of groups such as slopes and lagoons, which act as fauna attractors and mineral raw materials. Here, the pollen record shows a shrub community dominated by the Asteraceae subf. Asteroideae and *Colliguaja integerrima* from 5,190 years 14C BP to recent times. La María has mid-Holocene contexts in multi-component cave-type sites: La Mesada, Cueva Túnel, Cueva de La Ventana, and Casa del Minero 1 (Cueto, 2015).

La Mesada is located in the La María Quebrada sector (Figure 1b). It contains a long canyon and a temporary riverbed. The evidence suggests frequent and redundant use over time, since the Late Pleistocene, when open-air camps would have been established. The cave has a surface area of 12.50 m^2, and its opening is oriented to the southeast. The mid-Holocene occupation – Stratigraphic Units 5 and 6 – has a date of 4,500 ± 40 BP. It has fine sand and pebble sediment, hearth lenses, lithic artifacts, and a faunal assemblage that includes burned fragments (Cueto, 2015). Guanaco and large mammal predominate with good weathering conditions and processing evidence (Bottari & Valiza Davis, 2019).

The lithic assemblage is abundant (n = 1,837). The most commonly used raw material was flint. From the cores found at the site, mainly flakes and to a lesser extent blades and laminar flakes were obtained. Among the flint and chalcedony debitage, flakes dominate, followed by more than 20% of blades and laminar flakes. While for the rest of the raw materials the laminar module supports dominate. Laminar base forms were selected for the manufacture of flint tools and other widely used rocks (e.g., chalcedony). The assemblage has 115 instruments, among which scrapers stand out (n = 46, 40%), followed by knives, flakes and retouched blades, among others, with less than 16%, respectively. Most of the scrapers (n = 31) were made on blades, have a short distal edge, and have both lateral edges regularized. The unbroken scrapers have mostly small (2–3.99 cm) and medium (4–5.99 cm) size; long (2 or >) modulus/long width, and to a lesser extent regular; and wide modulus/medium thickness (4.9–2.8), followed by thick (2.7 o <) and thin (5 or >). In the assemblage, the two to three regularized edges were interpreted to be due to a conditioning to facilitate manual grasping or hafting (Skarbun, 2011). Six of the unbroken mentioned scrapers were selected for analysis in this article.

3 Materials and Methods

For the purpose of this work, we took a sample of six scraper-class artifacts from the mid-Holocene occupation of the La Mesada site to be analyzed under a multiproxy perspective (Table 1, Figure 4). The scrapers were selected based on integrity, technical, morphological, and functional criteria. The six were unbroken artifacts whose design was compatible with that proposed as suitable for hafting or on which evidence of this type of device was found, in contemporary assemblages. These instruments have a short distal edge, a laminar module, and retouching on one or both lateral edges. Also, the most representative raw materials of the assemblage (flint and chalcedony) were prioritized in the selection criteria, together with the presence of adhered sediments.

For residue analysis, two samples per artifact were extracted before washing them, in order to prevent plant remains removal and/or alteration. The first was obtained from the distal portion, which involves a blade and adjacent surfaces on the dorsal and ventral sides. The second was obtained from the proximal and middle portion, considered the manual grappling or hafting sector. This involves the lateral edges/rims (right and left, in dorsal view of the artifact) and the adjacent surfaces on the dorsal and ventral face, and the butt sector. Both portions were scraped for 20 s, with a new plastic stick washed with 100% sodium hypochlorite. For each subsample, an average of 25.21 μL of dry material was extracted (Table 2), suspended in 50% glycerol in a centrifuge tube, and then spread over microscope slides with a micropipette with disposable tips and sealed with a cover slip. Two control samples of the site occupation sediment were analyzed (Table 2). One was close

Table 1: Scrapers, technological features

No	Base form	Measurement (cm)			Edge					
					Distal		Left		Right	
		Length	Width	Thickness	Length	Angle	Length	Angle	Length	Angle
342	Flake with parallel awn	3.6	2.4	0.6	2.5	69	3.1	43	2.6	37
357	Blade	4	2	0.7	2.3	67	3	36	3	48
365*	Long flake	3.7	2.9	0.9	2.2	66	2.8	56	2.8	36
589	Blade	4.9	2.5	0.4	3.3	71	2.5	40	4	39
611**		4.4	2.8	0.9	4.6	79	3	74	3.2	56
731***		3.6	1.8	0.5	1.7	77	1.7/1.5	55/37	2.5	45

*chalcedony, **left rim, without retouch; ***left edge has retouched and natural segments. Angle type: acute oblique (30–46°), acute very oblique (46–69°), abrupt oblique (70–85°).

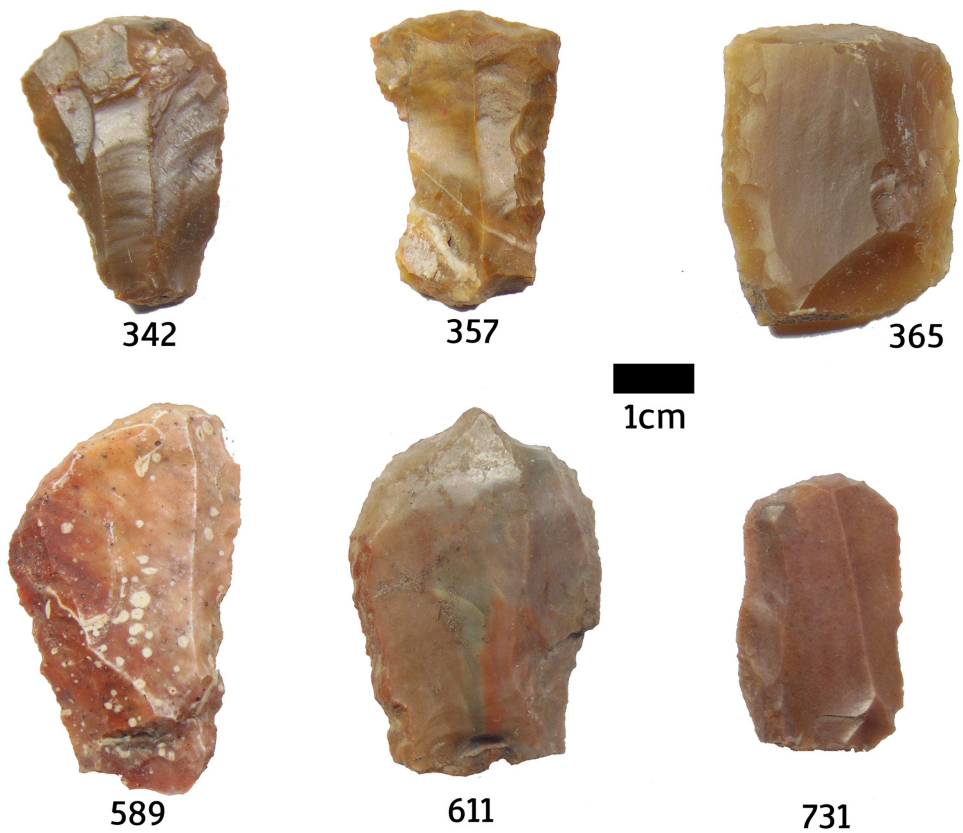

Figure 4: Archaeological studied artifacts, dorsal view.

to the cave mouth, the other to the innermost grid of the site. Chemical treatment of the sediment samples was avoided, as suggested by Coil, Korstanje, Archera, and Hastorf (2003) in order to allow recovery of many microfossils with the least possible damage. These samples were suspended and treated in the same way than the residue samples. All the slides were scanned under a light microscope with polarized light Leica DM/LM, and photographed with a Toup 5MgPx camera. Sample recovery and slide mounting were carried out in a room free of any food substances (Mercader et al., 2017) and inside an acrylic box specially arranged for the extraction of microremains. All manipulation of the fragments was performed without gloves – since industrial maize starch is frequently found in this kind of accessories in Argentine – but with washed hands. Disposable laboratory supplies were first tested to prevent cross-contamination, they were washed with distilled water, and the sample was scanned under a light microscope to ensure that it was starch free.

The residues obtained were compared with reference material from the herbarium, xylotheque and micro-remains collection of the GIADA (Archaeobotany Group of the Archaeology Division of the Natural Sciences La Plata Museum), directed by Dr. Capparelli. The diagnostic features were recorded following standard protocols and the nomenclature of the IAWA List of Microscope Features for Hardwood and Softwood Identification (Richter, Grosser, Heinz, & Gasson, 2004; Wheeler, Baas, & Gasson, 1989), the ICPT et al. (2019), and the ICSN (2011). Hardwood residues were tested against quali and quantitative characters of the woody plants of the area descripted by Franch, Ciampagna, Mansur, Zubimendi, and Capparelli (2022); Bambusoideae (from now on canes), following Luo et al. (2019); and softwood residues, against the eight native species of Argentina (Zuloaga & Morrone, 1996), from which *Fitzroya cupressoides* and *Austrocedrus chilensis* (Roig, 1992) are the only ones where latewood thick-walled tracheids are present. Other published diagnostic characters from Ciampagna et al. (2020) and Giovannetti, Lema, Bártoli, and Capparelli (2008) were considered. *Bos taurus* tendons were cut to have references of the fresh material. Animal and plant tissue (carbohydrates) were differentiated by staining the slide with an Iodine-potassium iodine solution (Lugol).

Table 2: Lithic artifacts analyzed, use-wear and residues

No			Distal	Middle and proximal
342	Functional analysis	Microscopic	Leather polishing, or.TR	**Lat.e:** resin polishing or. L.; possible polished wood and or. TR associated with simple and superimposed scars; polishing or. TR y L. associated with scar; indet. bright polished or. TR; polished -leather or wood- on edge retraction; rim rounding and associated scars. **D.S:** wood polishing, or. Oblique
		Macroscopic	Shine or. TR. and associated scars; continuous and discontinuous scars; edge rounding	**Lat.e:** continuous and discontinuous scars, different morphology, length, thickness and or.; large multiple scar, or. TR. and oblique. **Ventral surface:** scars in internal sector on awn of crack, or. TR
	Residue analysis	Microscopic	(15.22 µL) **Plant r.**: entangle balls of gymnosperm thick-walled late (compression) wood Trch. of *Fitzroya cupressoides* or *Austrocedrus chilensis* (Patagonian birch/ cedar) 10–18 µm width, 2.6–10.4 µm lumen (*n* = 2); closely folded gymnosperm thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis* 10 µm width (*n* = 1); single (some very ripped) gymnosperm thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* (11.5–24.3 µm in the wider part, 3.9–9 µm lumen, one tapering and pointed and other square ending) (*n* = 3); single (some very ripped) gymnosperm earlywood Trch. of *F. cupressoides* or *A. chilensis* 45 µm width (*n* = 1); wood? (*n* = 1); vessel element similar to those of 357 M1 but narrower, 60 µm width, with inner pit aperture length of 3–5 µm, cf. Bambusoideae (*n* = 1); Fbr. cf. *Chusquea* sp. 10 µm width; vessel element with long tails? (*n* = 1)	(30.55 µL) **Plant r.:** a piece of gymnosperm latewood (lenticular pit aperture) associated to one gymnosperm thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* (*n* = 1); thread made of two elements of gymnosperm thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* (one element it is a fiber folded on itself S twisted, which is Z wrapped by another single fiber) (*n* = 2); single/twice (some s spun or fragmented) gymnosperm thick-walled late (and compression) wood Trch. of *F. cupressoides* or *A. chilensis* (*n* = 8); gymnosperm earlywood Trch. with irregularly organized pits (one associated to a gymnosperm thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis*) (*n* = 2); gymnosperm earlywood compression Trch. (*n* = 2); 2 contiguous gymnosperm axial parenchyma cells (*n* = 1); rondel silicophytholith of Poaceae (*n* = 1)
357	Functional analysis	Microscopic	Wood polishing or. TR	**Right edge:** very small isolated scars (<1.5 mm), different morphology, some associated with generalized polishing. **D.S:** awn rounding with polished hard substance; straight fracture on the right side, indet. generalized polishing next to fracture, or. TR; parallel to subparallel striae, or. oblique to the major axis of the artifact.
		Macroscopic	Edge retraction	**R.E:** simple and stepped scars. **Platform sector:** scars.
	Residue analysis	Microscopic	(20.66 µL) **Plant r.:** gymnosperm thick-walled late (compression) wood Trch. (5–7 µm in the narrow and 15–16 µm in the wider part, 1.2–5.4 µm lumen, one tapering and pointed and other square ending) of *F. cupressoides* or *A. chilensis* (*n* = 5); gymnosperm earlywood Trch. 18–27 µm width (*n* = 2); parenchymatic gymnosperm wood cells with dense contents (*n* = 1); vessel element of 200 µm width and 350 µm length approx. with the inner pit aperture length of 4.5–5 µm cf. Bambusoideae (*n* = 1); scalariform vessel plates cf. Bambusoideae; tracheary xylem element with spiral thickenings cf. Asteraceae (*n* = 1); starch grain of *Neltuma* sp. (Type A1b, *sensu* Giovannetti et al., 2008): simple, ovoid irregularly faceted, size 19.04 × 16 µm, eccentric elongated	(20.77 µL) **Plant r.**: pieces of gymnosperm earlywood with Cupressaceae cross field pitting of *A. chilensis*, Trch. 34–40 µm width, uniseriate and irregularly organized pits of 18–24 µm size, 6 cells ray height (*n* = 2); a piece of gymnosperm earlywood (excepted *A. araucana*) (*n* = 1); a thread (one Trch. with folded and twisted extreme, Z wrapped by another Trch.) made of gymnosperm thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* associated to one of the previous pieces of earlywood (13–18 µm in the wider part, 5–9 µm lumen) (*n* = 1); single gymnosperm thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* (13–23 µm in the wider part, 5–11 µm lumen, one tapering and pointed and other square

(Continued)

Table 2: *Continued*

No			Distal	Middle and proximal
			hilum, extinction cross with curved homogeneous arms (n = 1). **Animal r.:** connective fibers (tendon fascicle/subfascicle?) (n = 2)	ending) (n = 8); **Animal r.**: connective fibers (tendon fascicle/subfascicle?) (n = 1)
365	Functional analysis	Microscopic	Leather polishing or. TR.	Without alterations
		Macroscopic	Rectangular scars. Very small scars (<0.5 mm); general alteration of the edge –jagged aspect-, edge retraction.	**Lat.e:** shine TR edge or.; bright spot; isolated small scars; generalized rim alteration; awn retraction; broken edge projections.
	Residue analysis	Microscopic	(19.11 µL**) Plant r.:** gymnosperm thin-walled latewood Trch. (one with cuts in the wall) (n = 2); gymnosperm thick-walled late (and compression) wood Trch. (only the tapering and pointed ending) of *F. cupressoides* or *A. chilensis* (10.6 µm in the wider part, 1.3 µm lumen (n = 1)	(21.00 µL**) Plant r.:** piece of gymnosperm earlywood with Cupressaceae cross field pitting of *A. chilensis*, Trch. 44 µm width, uniseriate and irregularly organized pits, pits of 21–26 µm size, 14 cells ray height (n = 1); gymnosperm thick-walled late (compression) wood almost whole Trch, (one with folded tapering ending-thread?; one tapering and pointed ending; one can be guess square ending) of *F. cupressoides* or *A. chilensis* (15.8 µm width, 7.9 µm lumen; 14.5 µm in the wider part, 4 µm lumen; 14.5 µm width, 6.6 µm lumen; 18.4 µm width, 2 µm lumen respectively) (n = 4); entangle ball of gymnosperm thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis* with cuts in the wall (n = 1); gymnosperm thin-walled latewood Trch. with pointed ending and irregularly organized pits (46.4 µm width, 32.5 µm lumen; 11.8 µm width, 6.6 µm lumen) (n = 2); gymnosperm thick-walled late (and compression) wood Trch. (only the tapering and pointed ending) of *F. cupressoides* or *A. chilensis* (18.4 µm width, 2 µm lumen) (n = 2); gymnosperm compression wood (n = 1)
589	Functional analysis	Microscopic	Polished hard substance or. TR	**Lat.e:** diagnostic polishes by contact with wood, longitudinal extension; bright spots; indet. polishes on edge protrusions, distributed in a band parallel, medium thickness and shiny
		Macroscopic	Edge retraction	**Lat.e:** isolated and continuous scars
	Residue analysis	Microscopic	(16.00 µL) **Plant r.**: entangle balls of gymnosperm thin and thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis* (n = 5); single gymnosperm thin and thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis* (n = 4); tapering ending of gymnosperm thin -walled latewood Trch (n = 1); eroded gymnosperm latewood (n = 1); scalariform plate cf. Bambusoideae (n = 1) 59.2 µm width and 223.7 µm length; starch grain of *Neltuma* sp. Type B2 (sensu Giovannetti et al., 2008): simple irregularly faceted, size 22.61 × 20.23 µm, open, punctate, central hilum with star-shaped fissures, central extinction cross with straight homogeneous arm	(53.7 µL) **Plant r.:** piece of gymnosperm earlywood with thin and thick-walled Trch. of *A. chilensis* (with uniseriate pits of 22–24 µm size similar to those of pieces 357, 365) (n = 1); thread made of two elements of gymnosperm thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis)* (it is a fiber with a very long tapering ending folded on itself and Z twisted) (n = 4); gymnosperm thin and thick-walled early and latewood Trch. and sieve tubes of *A. chilensis* (n = 1); gymnosperm compression wood (n = 2); gymnosperm wood in TS with square Trch. of 22 µm width and 7.5 µm height (n = 1); gymnosperm thin and thick-walled early and latewood Trch. of *F. cupressoides* or *A. chilensis*, some very ripped, other in zig-zag, other just the tapering ending (n = 19); gymnosperm

Table 2: *Continued*

No			Distal	Middle and proximal
				thin-walled latewood Trch., one associated to crystals (*n* = 4); vessel elements and Fbr. cf. Bambusoideae: 175.9 µm width, 427.6 µm length, intervessel pits small (*n* = 1); vessel elements from 40 to111 µm width and 400 µm length, with intervessel pits of 9 µm size, mainly reticulate, scarce helical thickenings, simple transversal perforation plaque cf. *Neltuma* sp. (*n* = 2); epi-mesoc. (*n* = 1), and endoc. tissues (*n* = 1) and Stom. (*n* = 2) of *Neltuma* sp.; starch grain cf. *Alstroemeria* simple oval to ovoid, 30.95 × 25 µm wide, centric stellate hilum with central cavity, "broad long" fissures and granular surface, central extinction cross, with homogeneous curved arms and high refringence (see Ciampagna et al., 2021) (*n* = 1); pentacolpate pollen grain (*n* = 1). **Animal r.**: single wool, imbricated scales (one of 9.2 µm diameter and other of 12.2 µm diameter and 3.7 µm medulla, IM 30% of *Lama guanicoe* (*n* = 2); micro-bone? (*n* = 1)
611	Functional analysis	Microscope	Leather polishing or. TR; edge rounding	**R.E:** indet. brightness or. L.
		Macroscope	Edge retraction	Isolated scars
	Residue analysis	Microscope	(25.8 µL**) Plant r.**: early (compression) wood Trch. uniseriate and irregularly organized pits of 18–24 µm of *A. chilensis* (similar size to middle/proximal part of pieces 357, 365, 589) (*n* = 3); gymnosperm thin-walled earlywood Trch. with irregularly organized pits of 8.8 µm size, some ripped and fragmented of *F. cupressoides*) (less probable *A. chilensis)* (*n* = 4); gymnosperm thick-walled latewood Trch, very long tapering and pointed endings, some ripped, of *F. cupressoides* or *A. chilensis* (*n* = 4); gymnosperm thick-walled latewood Trch. of *F, cupressoides* or *A. chilensis* (*n* = 2); thread made of two elements of gymnosperm thick-walled late (compression) wood Trch of *F. cupressoides* or *A. chilensis* (it is a fiber with a very long tapering ending, some fragments are folded on itself and Z twisted and other fragments are Z or S closely twisted/wrapped), some 18 µm width and 600 µm length (*n* = 3); Fbr. cf. *Chusquea* (both ending square, shorter than 760 µm, brown spots) (*n* = 1); vessel element, ripped, 60 µm width, polygonate pits 6 µm size, with radial cells cf. *Neltuma* sp. (*n* = 1). **Animal r.:** egg? indet. (*n* = 1)	(24.6 µL**) Plant r.**: earlywood Trch. with uniseriate pits of 12 µm size and irregularly organized pits of 8.8 µm size of. *A. chilensis* or *Fitzroya cupressoides*, some very ripped and fragmented (*n* = 4); thread of gymnosperm thick-walled latewood Trch. (one element folded on itself and Z wrapped one half by the other, 20 µm width and 1,200 µm length, different extremes) (*n* = 1); gymnosperm thin-walled latewood Trch. (some associated to eroded wood, others s spun) (*n* = 5); gymnosperm sieve tube (*n* = 1); eroded wood/bark? (*n* = 2); gymnosperm compression Trch. from earlywood, very ripped and fragmented (*n* = 2); starch grain cf. *Neltuma* sp Type B2 (sensu Giovannetti et al., 2008): simple irregularly faceted, 17.82 µm long and 14.28 µm wide, open, punctate hilum, central extinction cross with straight homogeneous arms and high refringence (*n* = 1); Indet. (*n* = 4). **Animal r.**: protective guanaco hair (cf. those from the leg) (*n* = 1); tendon/connective tissue (*n* = 5)
731	Functional analysis	Microscope	Wood polishing or. TR; edge rounding and retraction	**Lat.e:** wood polishing, L. and oblique or., with striae, associated with scars; scars associated with bright spots; indet. polished -leather or wood-associated with scars; oblique striae next to scar
		Macroscope	Isolated and continuous scars, thin, other thick with abrupt termination	**Lat.e:** very small scars, continuous and discontinuous, some abrupt termination. **L.E:** jagged aspect

(Continued)

Table 2: *Continued*

No			Distal	Middle and proximal
	Residue analysis	Microscope	(23.6 µL) **Plant r.:** gymnosperm thick-walled latewood Trch. of *A. chilensis* or *F. curpressoide*, (some s or z spun, some fragmented) (n = 3); gymnosperm thin-walled latewood Trch. (some very ripped or fragmented, only tapering endingsin some cases) (n = 3); vessel element with scalariform thickenings, 22 µm width cf. *Nothofagus* (see Franch et al., 2022); Indet. (n = 5). **Animal r**: absent	(20.88 µL**) Plant r.**: gymnosperm thick-walled latewood Trch. of *A. chilensis* or *F. cupressoides*, (one z spun, one fragmented) (n = 3); gymnosperm thin-walled latewood Trch. (some very fragmented) (n = 2); vessel element 47 µm width and 129 µm length, rounded pits with round aperture, oblique simple plates, cf. Bambusoideae (n = 1); vessel with helicoidal thickening, 47 µm width and 129 µm length, cf. *Adesmia/Berberis* (Franch et al., 2022); eroded wood? (n = 1). **Animal r.:** egg? (n = 1)
C.S.1	Residue analysis	Microscope	(29.2 µL**) Plant r.**: vessel element Indet., Fbr. Indet. (with and without bordered pits); starch grain Indet, simple, ovoid, 18.88 µm length and 14.28 µm width, slightly eccentric, open, punctate hilum, slightly eccentric extinction cross with homogeneous arms	
CS.2		Microscope	(55 µL**) Plant r.**: vessel element Indet	

Lat.e: lateral edges; R.E: right edge; L.E: left edge; D.S: dorsal surface; TR: transversal; L: longitudinal, or.: orientation relative to rim/edge; indet.: indeterminate; C.S.: control sediment; r.: residues; Fbr. Fibers: Trch.: gymnosperm tracheids: Fbr.: fibers with or without distinctly bordered pits; Par: parenchyma; Epic.: epicarp; Endc.: endocarp; Stom.: stomatal apparatus; tendon = dense regular and fibrous connective tissue; connective tissue = amorphous connective tissue.

The functional study of the scrapers was carried out with a Union ME-D MM and SM, and they were photographed with a Motic S6 camera. Edges/rims and dorsal and ventral surfaces of the distal, middle, and proximal portions were examined. The lithic artifacts were washed manually with a neutral soap solution to remove the remaining residues. The presence/absence of macro and micro use-wear traces – rounding and/or retraction of the edge, scars, striae – were recorded. For their identification as well as for the recognition of the polishes, various characteristics were considered – e.g., brightness, regularity, thickness, distribution, surface features – suggested by Cueto (2015) and Mansur (1984). In addition, the presence/absence of macroscopic – scars, striae, and rounding – and microscopic – polishing, scars, striae and bright spots – hafting traces were recorded, following the proposal of Rots (2008) and own experimental references (Cueto, 2021). Their distinction is based on precise traits, on the importance of a particular type of wear, on its recurrence and distribution, and the association between different traces – e.g., scars and shiny spots or striae, shiny spots and striae. These are clear hafting indicators, which are restricted to the part of the tool opposite the edge used, with a marked limit between both sectors (Rots, 2008). The residual and functional analyses were carried out as a blind test.

4 Results

The multiproxy examination made it possible to recognize use-wear traces exclusively in the distal portion of the scrapers. In contrast, in the proximal and middle portion, alterations and use-wear marks of the polished type, bright spots, and scars were recognized. Scarcely presence of animal and abundant plant residues, some with possible signs of anthropic modification, were found as follows (Table 2).

4.1 Examination of the Distal Portion

The use-wear traces and the residues of the edges of the distal portion of all the scrapers indicate that they would have been used to process mainly substances of animal origin such as leather (n = 3) and of vegetable origin such as wood (n = 2), while an edge was used to process an indeterminate hard substance.

There are three artifacts (342, 365, and 611) that have leather processing use-wear traces. These show a development with a transverse orientation to the edge. It is distributed as a band parallel to the edge, although it is also found in isolated points, on cusps of the microsurface, and within the scar negatives. This polishing has a rough appearance with sectors characterized by parallel semi-spherical holes and/or surface grooves, perpendicular to the edge, features, that provides a discontinuous appearance to its surface. These traces present an intermediate thickness, a slightly reflective appearance that varies between a dull shine in the chalcedony artifact (365) to a slightly shiny one in the flint artifacts. At SM, these edges show continuous and discontinuous scars that are very small with the retraction of some segments of the edge and the characteristic rounding of the work in transverse actions.

These three edges have exclusively plant microresidues – except for one with egg microresidues, in piece 611. The remains belong mainly to softwood (n = 26), although vessels and fibers assignable to canes in pieces 342 (Figure 5n) and 611 (n = 3) and one cf. *Neltuma* sp. vessel in piece 611 were present (Figure 6a). Softwood remains are present in the three pieces and consist on entangled balls, together with ripped and fragmented sections (part of the body and tapering pointed endings) of thin and thick-walled early and latewood tracheids and compression wood of *Fitzroya cupressoides* and *Austrocedrus chilensis*; furthermore, three fragments of a thread made of two elements of thick-walled latewood tracheids of *F. cupressoides* or *A. chilensis*, Z and S twisted/wrapped were found in piece 611.

Two other artifacts (357 and 731) have traces attributable to wood processing (Figure 7a and b). These microtraces present sectors with diagnostic development and orientation transversal to the edge. They are distributed as a thin band on the edge and also manifest in more internal points, on ridges, and associated with

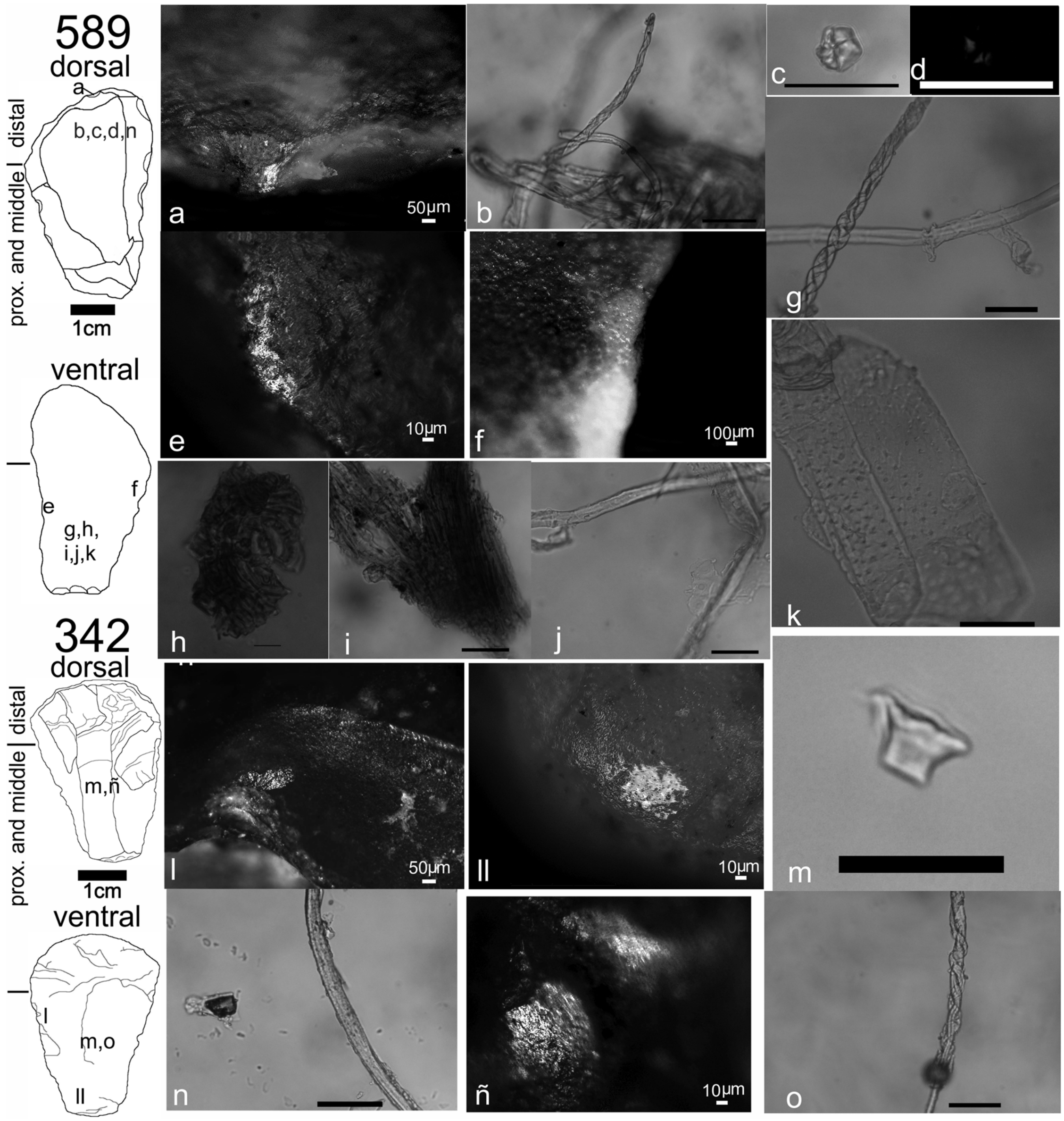

Figure 5: Artifacts 589 and 342, type of evidence and location. (a) polishing point by hard substance, 150×. (b) entangle balls of thin and thick-walled late (compression) wood Trch. of *Fitzroya cupressoides* or *Austrocedrus chilensi*s. (c) and (d) *Neltuma* sp. starch grain. (e) bright spots from contact with wood, 300×. (f) polish possibly from friction with mineral particles, 300×. (g) thread of thin and thick-walled latewood Trch. of *F. cupressoides* or *A. chilensis* Z twisted, (h) *Neltuma* sp. stomatal apparatus, (i) mesocarp tissue, (j) *A. chilensis* Trch. associated with sieve tubes, (k) vessel cane, (l) indeterminate polishing associated with scar, 150×; (ll) resin polishing, 300×; (m) Poaceae rondel silicophytolith, (n) fiber cane; (ñ) wooden polishing, 300×; (o) thread made of two elements *F. cupressoides* or *A. chilensis* Trch. (b–d, g, m–n, and o, scale 50 µm).

small scars. Portions of the 731-scraper edge exhibit numerous scars and microfractures, rounding, and shrinkage. The polishing has a smooth and thick appearance, and forms lobes. These are very bright clear reflective surfaces. At SM, these edges show continuous and isolated scars, some of them thick and with abrupt endings.

The edges mainly record plant microresidues, except for two connective fiber remains in piece 357. The microresidues of both pieces are softwood (n = 12) and hardwood (n = 2), while vessels and plates assignable to cane were present only in piece 357 (n = 2) (Figure 7d). Softwood remains consist of parenchymatic cells and single thin and thick-walled late (compression) wood tracheids of *F. cupressoides* or *A. chilensis* – some S or Z

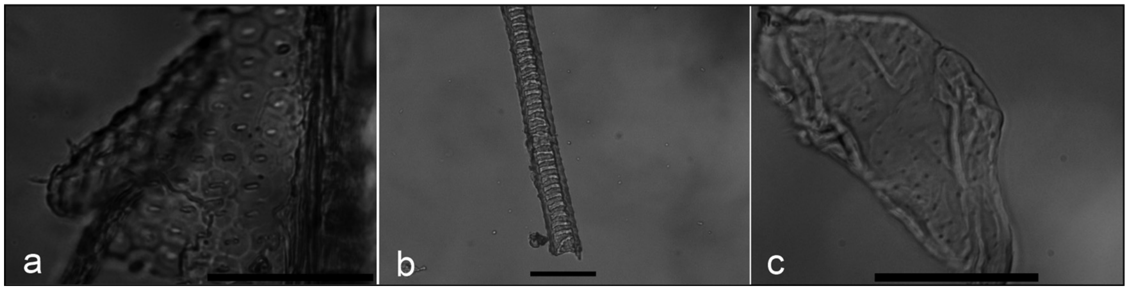

Figure 6: Artifacts 611 and 731. Vessels of (a) cf. *Neltuma* sp., (b) cf. *Nothofagus* sp., and (c) cf. *Adesmia*/*Berberis* (scale 50 μm).

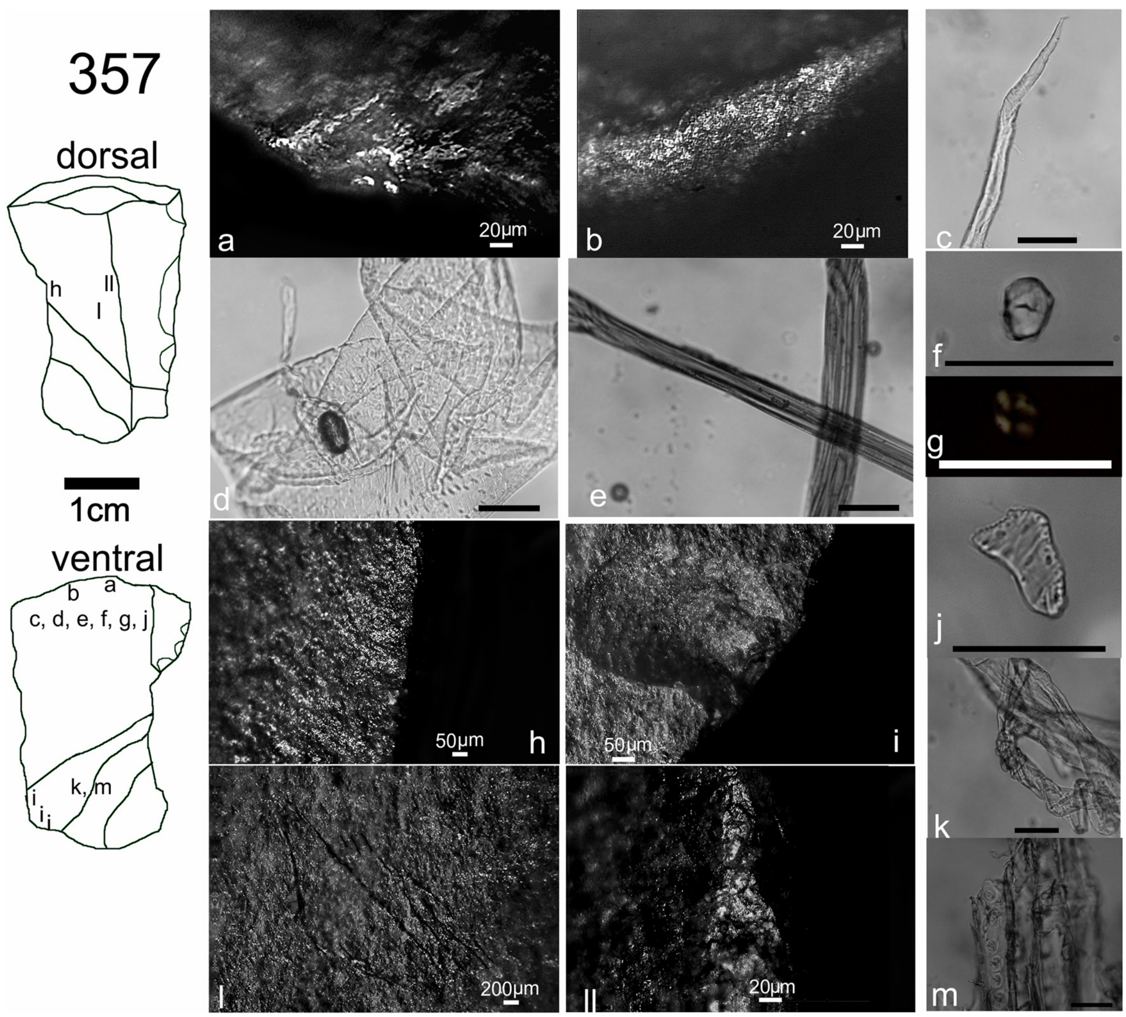

Figure 7: Artifact 357, type of evidence and location. (a) and (b) Polish by scraping wood, 200×. (c) Latewood gymnosperm Trch. (d) cf. Bambusoideae vessel, (e) tendon fascicle, (f) and (g) *Neltuma* sp. starch grain, (h) Indeterminate generalized polishing, 150×, (i) Scar, 200×, (j) cf. Asteraceae vessel, and (k) thin- and thick-walled late (compression) wood Trch. of *F. cupressoides* or *A. chilensis*, (l) sub-parallel striations, 75×, (ll) rounding and polishing on the dorsal ridge, 200×, and (m) crossing field pitting of *Austrocedrus chilensis* (c–g, j–k, m scale 50 μm).

spun, very ripped, fragmented, or only tips present – (Figure 7c); hardwood remains to cf. Asteraceae (piece 357, Figure 7j) and cf. *Nothofagus* (piece 731, Figure 6b) vessels. In artifact 357 a *Neltuma* sp. simple starch grain was also present (Figure 7f and g).

Artifact 589 presents indeterminate processing traces for the substance, with a transverse arrangement to the edge. These are located within flaking negatives and on ridges. In one sector it presents continuity as a band parallel to the edge. In other sectors, the traces develop on very reflective clear minerals, making their characterization difficult. There are a few polished points that have a thick and slightly shiny appearance, features that suggest similarities with polishes originating from the work of hard substances such as wood (Figure 5a). The edge exhibits trapezoidal and elongated scars with a simple or tapered termination. This artifact has exclusively plant microresidues. Softwood remains predominate (n = 11), and consist of entangled balls, tips, and single thin and thick-walled late (compression) wood tracheids of *F. cupressoides* or *A. chilensis* (Figure 5b). A cane vessel plate and a *Neltuma* sp. simple starch grain (Figure 5c and d) were recovered.

4.2 Examination of the Proximal and Middle Portion

Scraper 342. On the right edge, it shows bright polishing points associated with scars, in one of these points the trace is thick like wood polishing and has a development with a transverse orientation to the edge. Other points exhibit indeterminate polishes that are arranged transversely and longitudinally to the edge and are located inside and outside the scars (Figure 5l). In turn, the edge has isolated scars and rounded sectors. In the proximal sector near the butt, there is a longitudinally oriented resin polishing point (Figure 5ll). This has a smooth, thick, slightly shiny appearance and homogeneously covers the microsurface. On the left edge, it has overlapping scars, microfractures, and bright spots. There is a longitudinally oriented polishing point associated with a scar and a leather or wood polishing point on the edge retraction. On the dorsal surface, there is an obliquely oriented wooden polishing point (Figure 5ñ). Exclusively plant microresidues were found. All except one Poaceae silicophytolith (Figure 5m) are softwood remains (n = 14). Among them, a piece of *F. cupressoides* or *A. chilensis* latewood and two fragments of a thread made of two elements (one element it is a fiber folded on itself S twisted, which is Z wrapped by another single fiber, Figure 5o) of thick-walled late (compression) wood tracheids of *F. cupressoides* or *A. chilensis* stand out. Gymnosperm parenchymatic cells, compression wood tracheids, and single thin and thick-walled early and latewood tracheids of *F. cupressoides* and *A. chilensis* – some s spun or fragmented – were found.

Scraper 357. On the dorsal surface, in the left sector, next to the fracture, there is indeterminate generalized polishing of transverse orientation (Figure 7h). Also, there are parallel to sub-parallel striations (Figure 7l), obliquely oriented to the technical axis of the artifact. The central ridge has rounding and an indeterminate polishing (Figure 7ll), possibly due to contact with a hard substance such as wood, due to its volume and shine. On the remnant of the left edge (not affected by the fracture) in the proximal sector there are isolated scars (Figure 7i), some associated with generalized polishing. On this portion, all microresidues, except one animal connective fiber (Figure 7e), are of plant softwood origin (n = 12). Among them, three pieces of gymnosperm earlywood, two belonging to *A. chilensis* (Figure 7m), stand out, and are associated with a fragment of a thread made of two elements (consisting of one fiber, with the extreme folding on itself and twisted, which was Z wrapped by the other fiber) of thick-walled late (compression) wood tracheids of *F. cupressoides* or *A. chilensis* (Figure 7k). Single thick-walled latewood tracheids of *F. cupressoides* or *A. chilensis* were also found.

Scraper 365. At the microscopic level, it does not show significant alterations. The SM examination of the left edge revealed bright spots, one with a transverse orientation, isolated scars, generalized alteration of the edge, and retraction of the ridge. The right edge has isolated scars. Exclusively plant microresidues from softwood (n = 10) were found. A piece of *A. chilensis* earlywood associated with single thick-walled late (compression) wood tracheids of *F. cupressoides* or *A. chilensis* with endings folded on itself stands out. One entangled ball, together with ripped and fragmented tapering pointed endings of thin-walled latewood tracheids of *F. cupressoides* or *A.* chilensis, together with compression wood are also recovered similarly to the distal part.

Scraper 589. On the lateral edges, there are bright spots that refer to polishing due to contact with wood (Figure 5e). In general, on the protrusions of the edge there are indeterminate polishes with a band distribution, intermediate thickness, and very bright. It is possible that they originated from friction with hard substances such as mineral particles (Figure 5f). In the proximal left sector, next to the butt, there are polishes due to contact with wood, which extend longitudinally more than 3 mm. Microresidues from plant (n = 37) and animal origin (n = 3) are recovered. Although plant origin is diverse, 32/37 belong to softwood. Among them, a piece of *A. chilensis* earlywood associated with fragments of thread made of two elements of thick-walled latewood tracheids of *F. cupressoides* or *A. chilensis,* with very long tapering ending folded on itself and Z twisted (Figure 5g), stands out. Also, single thin and thick-walled latewood tracheids of *A. chilensis* together with ripped and fragmented endings – some associated with sieve tubes and crystals (Figure 5j), as well as gymnosperm wood in transverse section and compression wood are found. Together with, compression wood is also recovered similarly to the distal part. Also, one vessel element was assignable to cane (Figure 5k), and a pair of vessel elements together with a fruit fragment with epicarp, meso and endocarp tissues and an epidermis fragment with its stomatal apparatus were identified as *Neltuma* sp. (Figure 5h and i). In addition, one simple, starch grain was identified as cf. *Alstroemeria*, and one pentacolpate pollen grain remains indeterminate (Table 2). Animal residues consisted of two single wools with imbricate scales similar to those of *Lama guanicoe* and one possible microbone.

Scraper 611. The right edge has few points of indeterminate brightness with a longitudinal orientation. The left edge in the proximal sector has large polishing points that develop parallel to the edge, formed by friction with resin. Microresidues from plant (n = 19) and animal origin (n = 6) are recovered. Those of plant origin are all from softwood except from a simple, cf. *Neltuma* starch grain (Type B2 of Giovannetti et al. 2008) (Table 2). Earlywood tracheids of *F. cupressoides* or *A. chilensis* associated with a fragment of thread made of two elements (one element folded on itself and Z wrapped by the other) of thick-walled latewood tracheids of the same species origin stand out. Also, thin-walled latewood tracheids – some s spun – compression wood, sieve tubes, and possibly eroded bark fragments were recovered. Animal residues consisted of a protective hair with elongate imbricate scales cf. those of *Lama guanicoe* leg, and whole and broken isolated and connective tissue fibers.

Scraper 731. The lateral edges have wooden polishing points with oblique and longitudinal orientation, with striae, associated with scars. There are isolated and continuous scars, some associated with bright spots. The right edge has indeterminate polishing points – leather or wood – associated with scars, and oblique striae next to a scar. The dorsal face ridges do not show significant damage. All microresidues, except one possibly egg, are of diverse plant origins (n = 7). Cane, soft, and hardwood remains were present as follows. Thick-walled latewood tracheids of *F. cupressoides* or *A. chilensis* – some z spun – were recovered, together with single thin-walled latewood tracheids. A vessel assignable to cane and another one cf. *Adesmia*/*Berberis* sp. were also found (Figure 6c).

Regarding the control sediment, for the same amount of sample selected as that recovered in the artifacts, the residues are scarce. In the control sediment 1, there is correspondence with some residues recovered from the artifacts. Among them, are a vessel element, a ground fiber and a thick-walled latewood tracheid, and a simple indeterminate starch grain (Table 2). In contrast, in control sediment 2, only one indeterminate vessel element was identified.

5 Discussion and Conclusions

The multiproxy approach, applied in a segmented manner on two portions of the instruments, requires integrating its results to evaluate the technological operations of the manufacturing processes and the use of these lithic artifacts. These are linked to the design of artifacts, the conservation of residues, and the strategies of supply and use of wood.

The use-wear traces identified in the distal portion indicate that three scrapers (342, 365, and 611) were used to process the skins. These substances would have been obtained from the prey that entered the site or the camps possibly located at the entrance of the La María Quebrada canyon, among which the guanaco predominates. With these artifacts, work related to cleaning, kneading, and scraping skins was carried out, which implies a transverse movement. These tasks are associated with the initial and final stages of preparation of the skins for the manufacture of goods. It is possible that these scrapers were used recurrently in these tasks, this is due to the development that the polishes present in terms of extension, location, and thickness, and the magnitude of the macroscopic alterations. The three artifacts present abundant plant microresidues from which softwood (at least *Fitzroya cupressoides* and/or *Austrocedrus chilensis*) predominate, followed by remains assignable to canes commonly used in Patagonia to make spear's or arrow shafts (Caruso Fermé et al., 2011; Ciampagna & Capparelli, 2012). The presence of entangled balls of ripped and very fragmented fibers (similar to the observed in the experimental program) let us suppose that these remains are the result of brush/polish on this kind of wood, although no microtraces were identified that indicate this work. This could be due to the fact that very soft tissues (low densities of softwood in the study by Richter et al., 2004; Roig, 1992) or immature tissues in the case of canes (softer than the mature ones) were processed, which possibly did not produce microwear; but also because leatherworking could have hidden the previous work with this type of wood. *Neltuma* sp. vessel in piece 611 would suggest the contact of the edge with hardwood logs for a very short time since it does not record microtraces of hardwood (as those presented in the experimental program). Although there is no evidence of debarking activities from the plant microresidues, it is probable that the egg recovered could have been contained in bark rugosity. These edges were likely used to process softwood or occasionally contacted softwood when used to remove ropes or twisted tendon cords on hafted artifacts. It is interesting to note that the chalcedony artifact (365) only shows softwood work from the microresidues, which could be related to the greater fragility of this rock with respect to flint.

The use-wear traces identified in the distal portion of two other scrapers (357 and 731) indicate their recurrent use in wood processing. This is inferred by the polish development and by the continuity and morphology of the macroscopic alterations. The presence of cane, soft, and hardwood microresidues on the edges is consistent with the substances to which the use-wear traces refer. In particular, softwood is represented in both artifacts by xylem at least of *F. cupressoides* and/or *A. chilensis*. The vessel element of cf. Asteraceae and the starch grain cf. *Neltuma* in 357 suggests the processing of xylem, and probably bark, of these taxa – taking into account that starch grains are common in latewood and bark (Castro, 2009). This fact is supported by the diagnostic development and the high gloss of their polishes, similar to those recorded in the experimental artifacts used to process *Neltuma chilensis* logs. In artifact 731, the presence of a vessel element of cf. *Nothofagus* sp. stands out.

With these artifacts, the circumference of the log would have been modified longitudinally by means of scraping, with a movement transverse to the edge. In general terms, these practices can be linked to the modification of logs for technological purposes, as was documented for *Neltuma* and *Nothofagus* in Patagonia, used for making hafts, bows, instruments, and cradles (Caruso Fermé et al., 2011). Although Asteraceae is the family with the most mentioned historical uses in Patagonia, mainly medicinal (Ciampagna & Capparelli, 2012), there are no reports up to now about its wood use. The presence of animal residues in the distal sector of 357 pieces, especially tendon fibers, could be due to remains of the fixings used for their hafting. They would have reached this sector due to breakage or wear.

Scraper 589 shows microwear evidence assignable to the processing of dry wood, related to the lower intensity of gloss that the polishes of specific sectors have. Plant microresidues are similar to those of the distal part of piece 357. Softwood is represented by entangled balls, ripen fiber, and tips of *A. chilensis* and/or *F. cupressoides* thin and thick-walled late (compression) wood tracheids. One cf. Bambusoideae plates and one *Neltuma* starch grain were also recovered. The assemblage suggests softwood and cane working together with hardwood debarking. Although the edge has other indeterminate substance traces that could correspond to the same work depending on its location and distribution, there are aspects of them that suggest that they would be the product of the work of animal soft tissues. Thus, the indeterminacy of these traces would be due to the longer work time required for their diagnostic development against more resistant substances and to the low brightness of this type of polishing (Cueto, 2015).

The integral evaluation of the proximal and middle portion of the artifacts allows us to infer that a subset of four scrapers was hafted (342, 357, 611, and 589), and that another two, with disparate evidence, could have been hafted. These are assigned to two distinguishing degrees of probability, a major (artifact 365) and a minor (artifact 731).

The first subset of artifacts featured hafts made of wood. This is inferred from the traces on both lateral edges and on some of the dorsal and ventral surfaces, or next to the butt, and as a result of the associated plant residues: pieces of softwood and fragments of threads made from thick-walled late (compression) wood tracheids of *A. chilensis* or *F. Cupressoide*s.

The diagnostic polishes would have been generated by friction or pressure with the substances that made up the hafting device – wood, leather, resin – or that correspond to the detachment of the lithic artifact – mineral particles. The polishing points would be attributed to contact with wood, leather, and others undetermined. It stands out that polishing points are usually associated with scars or receding rim segments. Also, they register other alterations – scars, bright spots, and rounding – that by themselves and because they appear isolated are less diagnostic for hafting.

In addition, the four artifacts have xylem residues. In 357 and 589 *A. chilensis*, wood was used to make the hafts and in artifacts 342 and 611 *A. chilensis* or *F. cupressoides*, while the fruit tissue of *Neltuma* sp. could come from the distal edge (589). Poaceae phytolith 342 of the middle/proximal part might be a migration resulting from green cane cleaning in the distal part. The hafting devices on 357, 611, and 589 would have had fixations made of tendons. They also have other animal residues such as wool fibers and hair, some assignable to *Lama guanicoe*.

Another subset (365, 731) combines evidence suggesting the likelihood of the scrapers hafting, although they present less quantity and variety of traces and with a lower degree of diagnosis.

For 365, the possibility is configured from a series of traces on its rims. They are bright spots, some with a defined orientation, isolated scars, generalized alteration of the edge and retraction of the ridge. Here, we associate a fragment of *A. chilensis* with a possible wooden haft and fibers similar to the threads of tracheids but just folded which are difficult to identify as anthropic modification. Scraper 731 is less likely to have been hafted. Although its rims have traces that could be linked to this device, such as wood polishing, striations, and association with scars, including several associated with bright spots. Some scars can be attributed to taphonomic alterations, the dorsal face ridges do not show significant damage, and the residue corresponds to vessel elements assignable to cane and cf. *Adesmia/Berberis,* and pieces of wood were absent.

The results of the multiproxy examination allow us to discern some technological aspects. Within the dominant class of instruments, scrapers, those made on blades have design elements at the level of the active edge – distal – that distinguish them from the rest of the artifacts. These tend to be short and, based on the analyzed sample, with high angles abrupt and very oblique. Instead, for these characters, their lateral edges/rims match the general patterns of the assemblage. The length of the active edge is attributed to the restriction imposed by the width of the chosen base shape, but the choice of the distal end, over the lateral edges, would be linked to the search for an artifact design that facilitates its gripping. Likewise, this search would be evidenced in the irregular finish of the lateral edges, discontinuous in some cases, or combined with natural edge segments, and with lower angles than the active edge. These would have been modified in this way to adapt them to the haft and reduce the impact that the natural rims with a very sharp bevel could generate on leather or tendon bindings, or on the leather cloths used to cushion contact with the wood of the haft. We also consider that an attempt was made to adapt the general shape of these scrapers, configuring instruments with a length/width module: long and medium, and analogous in terms of width/thickness module: medium, except for one (589) which is thin. This would be explained by an extraction carried out on the dorsal face of the base form, carried out to thin the support. Similar treatment to that of three other scrapers (342, 365, and 611). All refer to the adequacy of the proximal and middle portion of the base form, for its connection with the haft.

This research suggests that a class of scrapers of a particular design was developed and used, that was hafted or had this possibility. These artifacts required a manufacturing sequence with greater labor investment, a fact that distinguishes it from the regional pattern for the period. However, it has similarities with the patterns followed regarding the kind of support used, the type of raw material, and the secondary modification on one of its faces, by flaking techniques. The identification of this sequence confirms the hypothesis that suggests the hafting of distal scrapers made on the blade, at least for a segment of them. This corresponds to one of the ways in which blade technology has been taken advantage of based on the versatility and flexibility that it offers.

We attribute the proper preservation of plant and animal residues in the artifacts to the environmental conditions in which the site is located, where there is little annual rainfall and a very dry and arid climate. These conditions favor the preservation of even starch grains (Ciampagna et al., 2021). The presence of charcoal and the state of conservation of the bone remains in the layer reinforce the premise that it was well preserved. However, the presence of antifungal substances and resins like those present in *A. chilensis* and *F. cupressoides* (Castro, 2009; Olate, Vélez, Greslebin, & Schmeda-Hirschmann, 2015) might have favored preservation and the adherence to the lithic pieces and them to be overrepresented against cane and hardwood.

Regarding the origin of the plants identified, we consider that they could correspond to the local and non-local areas according to the vegetation units inferred for the study period. Thus, the groups would have selected *Berberis* and *Adesmia* logs that came from spaces near the site in the framework of their daily activities. These, in turn, processed logs of *Neltuma*, a shrub that would be absent from the central plateau during the middle Holocene, and that would come from a non-local area attributable to the shrubby steppe of the San Jorge Gulf, near the Atlantic coast. This is located at a minimum distance of 195 km from the site. In addition, they used logs of canes (i.e., *Chusquea culeou*), *A. chilensis* and *F. cupressoides*, characteristics of Andean forests that developed between 39°50′ and 43°30′ south latitude during this period (Miotti & Salemme, 2004). The two latter correspond to a non-local landscape located at a minimum distance of 500 km. The redundant presence of compression softwood could account for the use of flag trees like those of the face of the Andean mountains rather than of those from the proper Valdivia rainy forest (Roig, 1992). We consider that the circulation of non-local species towards the central plateau would have occurred through mechanisms such as exchange and, to a lesser extent, direct supply. Both could have developed in the context of population growth and an increase in temporary/annual mobility circuits among hunter-gatherer societies. Logs or other organs could have been transported from these plants, as in the case of *Neltuma* and *Chusquea*, or already configured hafts integrating composite artifacts or ready to haft an artifact, as in the case of *Austrocedrus* or *Fitzroya*, whose wood is between light to medium soft. Its choice stands out given that near the site there are species such as *Schinus* or *Berberis*, which were used to make hafts, according to ethnographic data. Although the whole wooden hafts were not recovered in La Mesada, neither in other continental nor insular sites of Argentine Patagonia (except for one), this could be due to the fact that they were part of the personal equipment of some members of the groups, constituting a preserved artifact, conceived to last after the replacement of the lithic segment and easy to transport to other places. They could also have been easily discarded in the hearth when no longer useful. Non-favorable environmental conditions, such as in the case of humid forest areas of Tierra del Fuego (see Franch et al., 2022; Piqué I Huerta, 1999, for more detail), might also have affected the preservation of wood from archaeological hafts in insular Patagonia. Instead, the first evidence of archaeological wooden hafts for mid-Holocene Patagonia from plant residues analyses presented here stands out and is consistent with the first record of hafts, made in *Berberis*, recently reported from the early Holocene occupation of Cerro Casa de Piedra 7 site (Caruso Fermé & Aschero, 2020).

In sum, this approach allowed the discerning about the functionality and hafting of a particular scraper design. Even recognizing the limitation of the sample in terms of the number of scrapers evaluated, the richness and diversity of the results obtained are high and singular. It allowed us to clarify the production sequence of the artifacts and identify that it has distinctive aspects regarding regional technological trends, for the period. Practices linked to plant management by hunter-gatherers were recognized. The use of wood from vegetation units distant from the landscape where the site is located, stands out. This invites us to reflect on the mobility circuits and exchange mechanisms that these societies maintained. Furthermore, the results will be contrasted with the examination of other instruments and experimental program applied in softwood and canes, to recognize patterns of use, manipulation, and design, and to evaluate technological change.

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Data availability statement: All data generated or analyzed during this study are included in this published article. The supplementary material (Appendix) contains detailed results of use-wear and residue analysis of the sample analyzed, and also contains plant cell types recovered from dissociated material and residues recovered from the experimental test, as references, from Ciampagna et al., 2020.

References

Aguerre, A. (2000). *Las vidas de Pati en la toldería Tehuelche del Río Pinturas y el después*. Buenos Aires: Facultad de Filosofía y Letras.

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 M. Salemme, F. Santiago, M. Álvarez, E. Piana, M. Vázquez, & E. Mansur (Eds.), *Arqueología de Patagonia: Una mirada desde el último confín* (pp. 903–917). Ushuaia: Utopías.

Anderson-Gerfaud, P. (1980). A testimony of prehistoric tasks: Diagnostic residues on stone tool working edges. *World Archaeology*, *12*(2), 181–194.

Babot, M., Cattaneo, R., & Hocsman, S. (2010). ¿Puntas de proyectil o cuchillos? Múltiples técnicas analíticas para una caracterización funcional de artefactos arqueológicos. In S. Bertolino, R. Cattáneo, & A. Izeta (Eds.), *La arqueometría en Argentina y Latinoamérica* (pp. 127–134). Córdoba: Facultad de Filosofía y Humanidades.

Berihuete Azorín, M. (2010). *El papel de los recursos vegetales no leñosos en las economías cazadoras-recolectoras. Propuesta para el estudio de su gestión: El caso de Tierra de Fuego (Argentina)*. (Unpublish doctoral dissertation). Departamento de Prehistoria, Universidad Autónoma de Barcelona, Barcelona, España.

Bottari, C., & Valiza Davis, C. (2019). Los restos óseos del sitio arqueológico La Mesada (Meseta Central de Santa Cruz): Una aproximación tafonómica. *Comechingonia*, *23*(2), 111–133. doi: 10.37603/2250.7728.v23.n2.27490.

Capparelli, A., Castro, A., & Ciampagna, M. L. (2009). Descripción macroscópica e identificación anatómica de un fragmento de instrumento en madera (¿arpón?) hallado en el Sitio Cueva del Negro (Costa Norte de Santa Cruz). In M. Salemme, F. Santiago M. Álvarez, E. Piana, M. Vázquez, & E. Mansur (Eds.), *Arqueología de Patagonia: Una mirada desde el último confín* (pp. 433–444). Ushuaia: Utopías.

Caruso Fermé, L. (2012). *Modalidades de adquisición y uso del material leñoso entre grupos cazadores-recolectores patagónicos (Argentina). Métodos y técnicas de estudios del material leñoso arqueológico*. (Unpublish doctoral dissertation). Departamento de Prehistoria, Universidad Autónoma de Barcelona, Barcelona, España.

Caruso Fermé, L., & Aschero, C. (2020). Manufacturing and use of the wooden artifacts. A use-wear analysis of wood technology in hunter-gatherer groups (Cerro Casa de Piedra 7 site, Argentina). *Journal of Archaeological Science Report*, *31*, 1–9. doi: 10.1016/j.jasrep.2020.102291.

Caruso Fermé, L., Álvarez, M., & Vázquez, M. (2011). Análisis arqueobotánico de piezas de madera del extremo austral americano. *Magallania*, *39*(1), 223–242. doi: 10.4067/S0718-22442011000100014.

Castro, A. (1994). *El análisis funcional de materiales líticos por medio de la observación microscópica de huellas de uso: Un modelo alternativo de clasificación tipológica*. (Unpublish doctoral dissertation). Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina.

Castro, A. (2009). *Corteza, Especies leñosas de los bosques Andino Patagónicos Argentina*. Buenos Aires: Editorial L.O.L.A.

Ciampagna, M. L., Molares, S., Ladio, A., & Capparelli, A. (2021). Starchy food from a potsherd found in a Late Holocene hunter-gatherer site in Argentinean Patagonia: Towards the visibility of wild Underground Storage Organs. *Vegetation History and Archaeobotany*, *30*, 89–105. doi: 10.1007/s00334-020-00818-7.

Ciampagna, M. L., Cueto, M., Lema, V., & Capparelli, A. (2020). Caracterización de microresiduos vegetales en artefactos líticos empleados para procesar maderas. Resultados experimentales y casos arqueológicos de Patagonia. *Relaciones de la Sociedad Argentina de Antropología*, *45*(2), 401–426.

Ciampagna, M. L. (2015). *Estudio de la interacción entre grupos cazadores recolectores de Patagonia y las plantas silvestres: El caso de la Costa Norte de Santa Cruz durante el Holoceno medio y tardío*. (Unpublish doctoral dissertation). Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina.

Ciampagna, M. L., & Capparelli, A. (2012). Historia del uso de las plantas por parte de las poblaciones que habitaron la Patagonia continental Argentina. *Cazadores Recolectores del Cono Sur Revista de Arqueología*, *6*, 45–75.

Clemente, I., Risch, R., & Zurro, D. (2002). Complementariedad entre análisis de residuos y trazas de uso para la determinación funcional de los instrumentos macrolíticos: Su aplicación a un ejemplo etnográfico del país Dogón (Mali). In I. Clemente, R. Risch, & J. Gibaja Bao (Coord.), *Análisis funcional: Su aplicación al estudio de sociedades prehistóricas* (pp. 87–96). Oxford: Archaeopress.

Coil, J., Korstanje, M. A., Archera, S., & Hastorf, C. (2003). Laboratory goals and considerations for multiple microfossil extraction in archaeology. *Journal of Archaeological Science*, *30*, 991–1008.

Cueto, M., Iparraguirre, A., & Paunero, R. (2020). Estrategias de producción de artefactos en la Unidad 4, –Holoceno medio- del sitio Cueva 1 de Cerro Tres Tetas. *Revista del Museo de Antropología*, *13*(1), 81–88. doi: 10.31048/1852.4826.v13.n1.24171.

Cueto, M. (2015). *Análisis de los procesos de uso de artefactos líticos en sociedades cazadoras recolectoras. Ocupaciones correspondientes a la transición Pleistoceno/Holoceno, Meseta Central de Santa Cruz*. Oxford: BAR Publishing.

Cueto, M. (2021). Estudio experimental del proceso de manufactura de enmangues tehuelches elaborados en madera. In *Resúmenes del VIII Congreso Nacional de Arqueometría. Técnicas científicas aplicadas a las materialidades y ambientes del Pasado* (pp. 95–96). Palpalá: Instituto de Datación y Arqueometría.

Cueto, M., & Andreoni, D. (2016). Análisis preliminar de la gestión de restos vegetales en ocupaciones Pleistoceno final/Holoceno temprano en la meseta central de Santa Cruz. In F. Mena (Ed.), *Arqueología de la Patagonia: De mar a mar* (pp. 430–440). Coyhaique: Ciep, Ñire Negro Ediciones.

Cueto, M., Frank, A., & Castro, A. (2017). A contextual approach of functional analysis: Cases from Patagonia Argentina. *Quaternary International*, *442*(Part A), 67–79. doi: 10.1016/j.quaint.2016.03.019.

De Angelis, H. (2015). *Arqueología de los cazadores-recolectores de la faja central de la Isla Grande de Tierra del Fuego*. Buenos Aires: Sociedad de Antropología Argentina.

Durán, V. (1987). Estudio tecno-tipológico de los raspadores del sitio El Verano-Cueva 1. Patagonia Centro Meridional, Santa Cruz, Argentina. *Anales de Arqueología y Etnología*, *41/42*, 129–163.

Franch, A., Ciampagna, M. L., Mansur, E., Zubimendi, M., & Capparelli, A. (2022). Colección de referencia de maderas para el estudio del registro antracológico del litoral atlántico Patagonia Sur de la República Argentina (provincias de Santa Cruz y Tierra del Fuego). *Darwiniana*, *10*(1), 193–227. doi: 10.14522/darwiniana.2022.101.1020.

Frank, A. (2016). Tratamiento térmico de artefactos líticos en Cerro Tres Tetas 1, meseta central de Santa Cruz, Patagonia Argentina. In F. Mena (Ed.), *Arqueología de la Patagonia: de Mar a Mar* (pp. 367–378). Coyhaique: Ediciones CIEP y Ñire Negro.

Giovannetti, M., Lema, V., Bártoli, C., & Capparelli, A. (2008). Starch grains characterization of *Prosopis chilensis* (Mol.) Stuntz and *P. flexuosa* DC, and the analysis of archaeological remains in Andean South America. *Journal of Archaeological Science*, *35*, 2973–2985.

Gusinde, M. (1982). *Los indios de Tierra del Fuego. Los Yámana*. (Vol. I), Buenos Aires: Centro Argentino de Etnología Americana.

Grace, R. (1989). *Interpreting the function of stone tools*. Oxford: BAR Publishing.

Hardy, B., & Garufi, G. (1998). Identification of woodworking on stone tools through residue and use-wear analyses: Experimental results. *Journal of Archaeological Science*, *25*, 177–184.

Hayes, E., Fullagar, R., Mulvaney, K., & Connel, K. (2018). Food or fibercraft? Grinding stones and Aboriginal use of *Triodia grass* (spinifex). *Quaternary International*, *468*(Part B), 271–283. doi: 10.1016/j.quaint.2016.08.010.

Hermo, D. (2008). *Los cambios en la circulación de las materias primas líticas en ambientes mesetarios de Patagonia. Una aproximación para la construcción de los paisajes arqueológicos de las sociedades cazadoras-recolectoras*. (Unpublish doctoral dissertation). Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina.

Hermo, D., & Magnin, L. (2012). Blade and bifacial technology in Mid-Holocene occupations at Deseado Massif, Santa Cruz province, Argentina. *Quaternary International*, *256*, 71–77.

ICPT (International Committee for Phytolith Taxonomy), Neumann, K., Strömberg, C. A. E., Ball, T., Albert, R. M., Vrydaghs, L., & Cummings, L. S. (2019). International code for phytolith nomenclature (ICPN) 2.0. *Annals of Botany*, *124*(2), 189–199. doi: 10.1093/aob/mcz064.

ICSN. (2011). *The International Code for Starch Nomenclature*. http://fossilfarm.org/ICSN/Code.html. Accessed 27 May 2021.

Lombard, M., & Wadley, L. (2007). The morphological identification of micro-residues on stone tools using light microscopy: Progress and difficulties based on blind tests. *Journal of Archaeological Science*, *34*, 155–165. doi: 10.1016/j.jas.2006.04.008.

Luo, J., Lian, J, Liu, R., Zhang, S., Yang, F., & Fei, B. (2019). Comparison of metaxylem vessels and pits in four sympodial bamboo species. *Science Report*, *9*, 10876. doi: 10.1038/s41598-019-47419-7.

Lynch, V. (2016). *Estudio Comparativo de la Producción y Uso de Artefactos Líticos en el Macizo del Deseado (Santa Cruz, Argentina)*. Oxford: BAR Publishing.

Mansur, E. (1984). *Prehistorie de Patagonie. L´industrie ´Nivel 11´ de la province de Santa Cruz (Argentine) Technologie lithique et traces d ´utilisation*. Oxford: BAR Publishing.

Mazzia, N., Weitzel, C., & De Angelis, H. (2016). De usos y recursos. Análisis funcional y de sustancias grasas mediante cromatografía gaseosas sobre artefactos líticos tallados. *Revista del Museo de Antropología*, *9*(2), 37–50. doi: 10.31048/1852.4826.v9.n2.14454.

Mercader, J., Abtosway, M., Baquedano, E., Bird, R., Dıez-Martın, F., Domínguez-Rodrigo, M., ... Walde, D. (2017). Starch contamination landscapes in field archaeology: Olduvai Gorge, Tanzania. *Boreas*, *46*, 918–934. doi: 10.1111/bor.12241.

Miotti, L., & Salemme, M. (2004). Poblamiento, movilidad y territorios entre las sociedades cazadoras-recolectoras de Patagonia. *Complutum*, *15*, 177–206.

Nacuzzi, L., & Pérez de Micou, C. (1983–1985). Los recursos vegetales de los cazadores de la cuenca del Río Chubut. *Cuadernos del Instituto Nacional de Antropología*, *5*(10), 407–423.

Olate, V. R., Vélez, M. L., Greslebin, A., & Schmeda-Hirschmann, G. (2015). *Phytophthora austrocedri* Elicitates Changes in Diterpene Profile of *Austrocedrus chilensis*. *Molecules*, *20*(8), 15084–15097.

Paunero, R., Castro, A., & Reyes, M. (2007). Estudios Líticos del componente medio del sitio Cueva 1 de Cerro Tres Tetas, Santa Cruz, Argentina: Implicaciones para construir patrones de distribucion artefactual y uso del microespacio. In F. Morello, F. M. Martinic, A. Prieto, & G. Bahamonde (Eds.), *Arqueología de Fuego Patagonia. Levantando piedras, desenterrando huesos…y develando arcanos* (pp. 613–622). Punta Arenas: CEQUA.

Pérez de Micou, C. (2002). *Plantas y cazadores en Patagonia*. Buenos Aires: Facultad de Filosofía y Letras.

Piqué i Huerta, R. (1999). Producción y uso del combustible vegetal: Una evaluación arqueológica. *Treballs D'Etnoarqueologia* (Vol. 3). Barcelona: Universidad Autónoma de Barcelona.

Richter, H., Grosser, D., Heinz, I., & Gasson, P. (Eds.). (2004). IAWA List of Microscopic features for softwood identification. *IAWA Journal*, 25(1), 1–70.

Roig, F. (1992). Comparative wood anatomy of southern South American Curpressaceae. *IAWA Bulletin*, *13*(2), 151–162.

Rots, V. (2008). Hafting traces on flint tools. In *"Prehistoric Technology" 40 years later. Functional Studies and the Russian Legacy Interpreting Stone Tools* (pp. 75–84). Oxford: BAR Publishing.

Rots, V. (2014). What method to study hafting? The potential of use wear residue analysis confronted. In C. Lemorini & S. N. Cesaro (Eds.), *An integration of the use-wear and residue analysis for the identification of the function of archaeological stone tools* (pp. 27–41). Oxford: BAR Publishing.

Shanks, O., Hodges, L., Tilley, L., Kornfeld, M., Lou Larson, M., & Ream, W. (2005). DNA from ancient stone tools and bones excavated at Bugas-Holding, Wyoming. *Journal of Archaeological Science*, *32*(1), 27–38.

Skarbun, F. (2011). *La organización tecnológica en grupos cazadores recolectores desde lasocupaciones del Pleistoceno final al Holoceno tardío, en la Meseta Central de Santa Cruz, Patagonia*. Oxford: BAR Publishing.

Wheeler, E., Baas, P., & Gasson, P. (1989). List of microscopic features for hardwood identification with an Appendix on non-anatomical information. *IAWA Bulletin*, *10*(3), 219–332.

Zuloaga, F. O., & Morrone, O. (Eds.). (1996). Catálogo de las Plantas Vasculares de la Argentina: Pteridophyta, Gymnospermae y Monocotyledoneae (excluyendo Poaceae). *Monographs in Systematic Botany from the Missouri Botanical Garden*, *60*, 1–332.

Zurro, D., & Gadekar, C. (2024). Is it worth it? A review of plant residue analysis on Knapped lithic artifacts. *Lithic Technology*, *49*(1), 63–80. doi: 10.1080/01977261.2023.2188343.

Appendix

Table A1: Plant cell types recovered from dissociated material (translated and modified from Ciampagna et al., 2020)

	Berberis	***Neltuma***
Xylem	Helical thickenings in vessel elements present, diagonal simple perforation plates, intervessel pits alternate. Helical thickenings in ground tissue fibers. Body of the ray cells procumbent and square marginal cells	Vestured pits, diagonal and horizontal simple perforation plates. Long fibers with simple to minutely bordered pits. Ray width 1–3 cells; 2–3 cells per parenchyma strand. Prismatic crystals aligned in septate fibers. Rays all procumbent cells
Bark	Helical thickenings in ground tissue fibers. Fibers without crystals. Perforate sclereids of festooned and smooth walls. Sieve elements with their companion cells Ray width 5–6 cells. Parenchyma cells with contents. Phelloderm cells with beaded walls. Rounded stone cells	Long septate fibers very thick-walled. Rhomboid crystals aligned in septate fibers. Sieve elements including companion cells tangentially arranged

Table A2: Plant residues recovered from experimental tests

Artifact no	IS	FS
1	Ground tissue Fbr. with helical thickenings (xyl., phlo.); festooned and smooth walled scl. C. and tissues (xyl., phlo.); festooned epidermis C. and stomata; beaded wall polygonal C. tissues (xyl.); phellem C. (bark); starch grain without damage (xyl., bark)	Alternate pitted vessels (xyl.); ground tissue Fbr with helical thickenings and ripped walls (xyl., phloem); fragmented scl. C. (xyl., phloem.); phellem thin walled C. (bark.); square C.; starch grain without damage (xyl., bark)
2	Rectangular or square body ray C. (xyl.); Fbr.; fragment, bent smooth walled scl. C. (phlo.); sieve elements (phlo.); phellem thin walled C. (bark.); body ray C. (xyl); beaded walled long C. tissue (bark)	Scl. C. (bark); Fbr. (xyl, bark); alternate pitted vessels, some of them with degraded walls (xyl.); square and procumbent ray C. (xyl.)
3	Broken and ripped Fbr. (xyl, phlo.); bent ground tissue Fbr. with helical thickenings and distinctly bordered pits (xyl, phlo); festooned and smooth walled scl. C. (bark); par. C. (phlo.); scl. C. (bark); alternate pitted vessels (xyl)	Long scl. C. with damage walls (bark); procumbent ray C.(xyl.); scl. C. (bark)
4	Square scl C. (bark); alternate and opposite pitted vessels (xyl); thin walled phellem C. (bark); long, broken Fbr. (xyl. Phlo.); crystals	Broken, bent septate Fbr. with crystals (xyl., phlo.)
5	Square body ray C. (xyl.); ground tissue fibers with helical thickenings; broken, twisted, ripped and short Fbr. (xyl., phlo); scl C. (bark); vessels with simple plates	Ripped and twisted Fbr. (xyl.); thick walled C, fragmented tissues; alternate pitted vessels (xyl.); scl. C. (bark)
6	Broken Fbr (xyl., phlo.); broken vessels (xyl.); ray C. (xyl.)	Broken Fbr. (xyl., phlo.)
7	Broken, long ripped Fbr. (xyl., phlo.)	Broken Fbr. (xyl., phlo.); scl. C. (bark); fragmented vessels (xyl)
8	Fbr. (xyl, phlo); intervesel alternate pits (xyl); lithic fragments	Fbr. (xyl., phlo.); lithic fragments.
9	Ground tissue fibers with helical thickenings (xyl., phlo.); broken and twisted Fbr. (xyl., phlo.); vessels with helical thickenings (xyl.), alternate intervessel pits (xyl.)	Broken Fbr. (xyl., phlo.); alternate pitted broken vessels (xyl); ripped and broken tissues, scl. C. (bark)
10	Broken and ripped Fbr (xyl,); scl. C. (bark); crystals (xyl); phellem (bark)	Fbr. (xyl.); crystals ripped walls of tissues; festooned Scl. C. (bark); par. C
11	Thin- to thick-walled broken and ripped Fbr. (xyl., phlo.); broken vessels (xyl.), alternate intervessels pits (xyl.)	Broken Fbr. (xyl., phlo.); ripped and degraded tissues

Cell types recognized (and their potential correspondent tissues). Abbreviations: Fbr: fibers; Xyl: Xylem; Phlo: phloem; Par.: parenchyma; C: cells (translated and modified from Ciampagna et al., 2020).