

Micrographic Analysis of *Erythroxylum coca*, *Phaseolus vulgaris*, and *Canavalia ensiformis* Samples from the Archaeological Textile Collection of the Museo de La Plata, Argentina

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SUMMARY. The taxonomic status was determined in plant remains found within archeological textile pieces from the Nasca culture, belonging to the Collection of the Museo de La Plata (Argentina). Plant samples were identified as leaves from *Erythroxylum coca* Lam., *Canavalia ensiformis* (L.)DC, and *Phaseolus vulgaris* L. The possible ceremonial value of these pieces is discussed. The diagnostic significance of micrography for the assessment of fragmented, pulverized, or semi-carbonized plant mixture findings is corroborated.

RESUMEN. "Análisis micrográfico de *Erythroxylum coca*, *Phaseolus vulgaris* y *Canavalia ensiformis* de muestras de una colección textil arqueológica del Museo de la Plata". Se determinó el "status taxonómico" de restos vegetales arqueológicos, hallados formando parte de piezas textiles arqueológicas de la cultura Nazca, pertenecientes a la Colección del Museo de Las Plata (Argentina). Las muestras fueron identificadas como hojas de *Erythroxylum coca* Lam., *Canavalia ensiformis* (L.) DC y *Phaseolus vulgaris* L. El posible valor ceremonial de estas piezas es discutido. Se corroboró el valor diagnóstico de la micrografía aplicada a la determinación de mezclas vegetales fragmentadas, pulverizadas o semicarbonizadas que constituyen parte del rescate de materiales etnoarqueológicos.

INTRODUCTION

A great variety of textile samples belonging to different populations from the Pre-Hispanic culture can be found in archeological collections at the Museo de La Plata (Argentina). Hundreds of fabrics were found in the Peruvian coasts and mountains, the Bolivian altiplano and Southern puna, Chilean Northern puna, and Argentine Northern puna, Salta valleys, and Quebrada del Toro.

These fabrics consisted of mantles, orles, shrouds, headdresses, hair bands, ceremonial slings, nets, bags, loincloths, saddlebags, bands, and belts, and were all carefully manufactured.

During our review of the catalogue "Colección de cerámicas, tejidos, herramientas, utensilios, etc. procedentes de las diferentes culturas antiguas del Perú" (Collection of ceramics, fabrics, tools, utensils, etc., from several ancient

cultures of Peru), two different kinds of textile material called our attention. First, three camelid heads with their corresponding necks, but lacking skull and spine. They were desiccated in such a way that only leather and fiber remained. The three heads were ornamented with woolen and cotton tassels and fringes of black, red, white and ocher color. Two of them had originally contained dry leaves and stalks and were sewn in their extremes. The other textile material found was a little woolen bag, which had also contained plant remains.

It is worthwhile denoting here that this material is described in the aforementioned catalogue, though the year of its edition is not specified. It was presumably published during the '40 decade, when the Peruvian Hall was inaugurated under the direction of Dr. Fernando Márquez Miranda as Head of the Archeology

KEYWORDS: Analytical micrography, Archaeology, Camelids, *Canavalia ensiformis*, *Erythroxylum coca*, Perú, *Phaseolus vulgaris*.

PALABRES CLAVE: Analítica micrográfica, Arqueología, Camélidos, *Canavalia ensiformis*, *Erythroxylum coca*, Perú, *Phaseolus vulgaris*.

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Department of the Museo de La Plata. This point deserves special attention since the archeological remains detailed in this catalogue were originally exhibited in that Hall and they are still there, no matter the continuous remodeling it suffered and the change of its name for "New World Archeology Hall".

The only specification registered in the files indicates that camelid heads as well as the little bag were found in the Peruvian coast and were probably manufactured by artisans from the Nasca culture, between the beginning of the Christian Era and IX century.

Despite this possible filiation, the lack of specific data for contextually associating these findings made us organize a bibliographic search, and e-mail contacts with scientific institutions that included photographic material, with the purpose of assessing its cultural and chronological location and the possible functionality of these exceptional samples of textile art. Except for the Peruvian Museo Arqueológico Rafael Larco Herrera, which immediately informed that this material was unknown to them, no other institution answered our questions.

The presence of plant remains in the three elements (N 163, N 164, and N 238) found in tombs was micrographically analysed in order to find a possible explanation of their meaning.

MATERIAL AND METHODS

Description of the textile material

Catalogue sample N 163 -Collection of the Museo de La Plata- (Fig. 1) is a 36 cm high and 35 cm contour head belonging to a newborn camelid, probably llama, with its leather and

white fibers still preserved. Its 26 cm long neck shows an anterior sewing 10cm long and a cover sewn to the base. The particular characteristic of this piece is its attractive ornamentation. Though the mouth is sewn and not decorated, the eyes and nose cavities are sealed by an embroidery with two pending tassels 35cm long, a thin woolen braid for each eye and one for the nose. Ears are absent and their cavities present two pending tassels similar to the ones described.

The other sample, N 164 (Fig. 2), is 35 cm high and 34 cm contour. The neck in this newborn camelid head is brown, 26 cm long, and differs from the one previously detailed because its base does not present a cover; it is closed and tied with five rounds of camelid fiber. The region corresponding to the mouth and anterior part of the neck shows a marked deterioration. The eyes cavities are closed by two horizontal fringes embroidered in red and white fibers, joined at the nose level by a vertical fringe similarly embroidered. From both ends of each horizontal fringe, two tassels decorated with concentric rhombs are pending and joined by a 2 cm segment. Similar tassels are sewn to the vertical fringe and ear cavities. Brown and white fibers are braided at the end of the small ears. This piece shows rich embroidery in its tassels, which reach 45 cm length.

The third piece with similar features is N 119 (Fig. 3). It is a white camelid head corresponding to a young individual. Though proportions are equivalent to the ones previously described -34 cm high and 35 cm cephalic contour- the neck is shorter -just 18 cm long-, presents an



Figure 1. Head and neck of a newborn camelid, probably llama, with braided tassels.

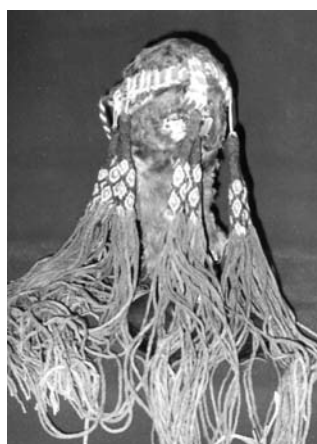


Figure 2. Head and neck of a newborn camelid with profusely embroidered tassels.



Figure 3. Head and neck of a young camelid with braids and tassels.

untidy sewing on one side made with current thread, and the base is closed. The region corresponding to the mouth and nose is closed with one profuse embroidery of black and red fibers, from which a little tassel (15 cm long) and two red and ochre braids (10 cm) are pending. The same ornamentation can be observed in the eyes cavities. One braid from each eye cavity goes to the ears along 9 cm to end in several braids and tassels with similar proportions and ornaments as the ones previously described. The embroidery observed in these tassels is the same as the one shown by the second piece but they are not divided and are considerably shorter. This head is empty, without any filling inside.

Piece N 238 (Fig. 4) is a little knitted bag 11 cm wide and 11 cm high, decorated with knitted fringes in white, light brown, dark brown, ochre and red colors. The fringes alternate with horizontal geometric bands of white and toning-down brown colors. Its upper end is closed with a very thin knitted braid.



Figure 4.
Little knitted coca bag of toning-down colors.

Micrographic analysis

Plant samples analyzed consist of delicately fragmented leaves, dry or semi-carbonized (3-5 mm). The average weight of each sample is about 300 mg (1% of the whole). In order to determine the taxonomic status of these plant remains, different herbarium reference material was consulted: LP (Herbarium of Museo de La Plata), LPE (Herbarium of Museo de Botánica y Farmacognosia "Carlos Spegazzini" de la Facultad de Ciencias Exactas de la Plata), SI (Herbarium of Instituto Darwinion, San Isidro), and R (Herbarium of Jardín Botánico de Rio de Janeiro).

Erythroxylum coca

PERÚ. J. F. Molino (LPE 23); Lima, no collector (LPE 384).

Canavalia ensiformis

ARGENTINA. Province of Buenos Aires: cultured at the School of Agronomy and Veterinary Sciences of Buenos Aires, A. Burkart 2196 (SI)

BRAZIL. State of Rio de Janeiro, Horto Florestal, J.

G. Kuhlman, no number (R 61028); Morro do Mundo Novo, J. G. Kuhlman, no number (R 8586);

PHILIPPINES. Antipolo, Province of Rizal Luzon, M. Ramos 90 (SI).

Phaseolus vulgaris L.

ARGENTINA. Province of Jujuy: Valle del Rio Grande, A. Burkart & N. S. Troncoso (SI 11256); Tomas de Reyes, 1500 m over sea level, A. Burkart & N. S. Troncoso (SI 11203); Department of Tumbaya, in the route to Tilcara, Barcena, 1700 m over sea level, Mulgura et al. 1196 (SI). Department of Valle Grande, A. Burkart & N. S. Troncoso (SI 11582).

Diafanization of leaves was performed with 10% OHK; the cutin was removed ¹; and micro-sections were obtained. Diagnostic histochemical reactions allowed evidence calcium oxalate (hydrochloric acid) and lignin (hydrochloric phoroglucin).

The microscopic analysis was performed with an Iroscope YZ-6 stereomicroscope and an Olympus CH microscope (LM). Original designs were made with the same microscope, equipped with an Iroscope drawing tube.

The terminology proposed by Wilkinson ² was used to describe the cuticle ornamentation. For the epidermis analysis with the scanning electron microscope (SEM) the following technique was used: dry leaves previously hydrated were washed with chloro distilled water and fixed in FAA (96° ethylic alcohol - distilled water - formol - glacial acetic acid) during 48 h. Once in the stereomicroscope, a little piece of material was dissected, dried in filter paper, and mounted on an aluminum stage covered with an adhesive ribbon. Drying up was completed with a spot light. Microscopic analysis and photographs were performed with Jeol JSM-T100 equipment, provided by the Scanning Electron Microscopy Department from the Museo de La Plata.

RESULTS

Stereomicroscopy allowed determines that samples consisted of mixtures with the following components:

Erythroxylum coca Lam. (*Erythroxylaceae*)

Determined in N 163, N 164, and N 238 pieces. Common name: "coca", "yvyra-lumi", "Ypandu", "cocalier", "cuca", "hayo", "khoka", "spadic" ^{3,4}.

Histological components found after light microscopy and scanning electron microscopy were:

Adaxial epidermis without stomata, with

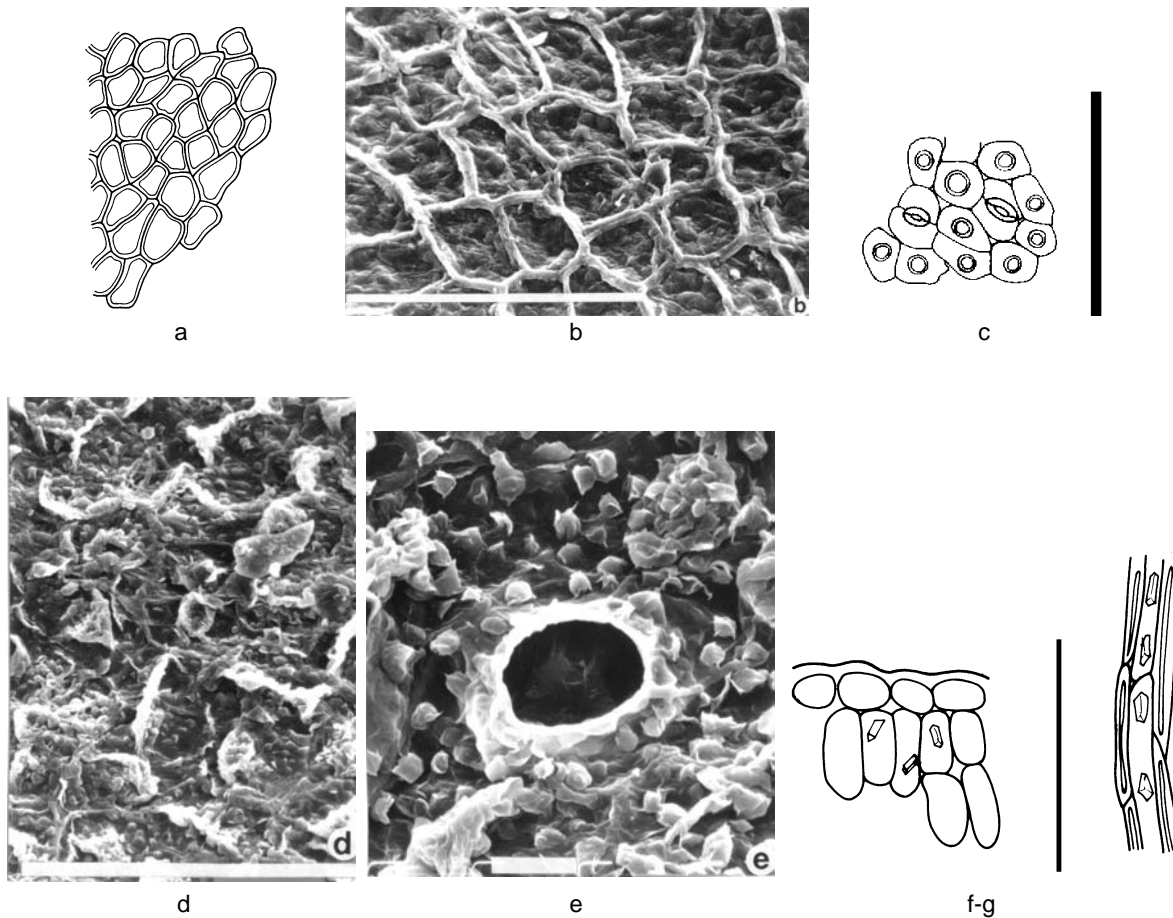


Figure 5. *Erythroxylum coca*. **a** and **b**: adaxial epidermis (with LM and SEM, respectively); **c**: abaxial epidermis (LM); **d**: abaxial epidermis with collapsed papillae and epicuticular wax (SEM); **e**: detail of epicuticular wax and cutted papillae (SEM); **f**: crystals of parenchyma in palisade (LM); **g**: crystal fibers (LM). Bar size: 100 µm (a -d, f, g); 10 µm (e).

polygonal cells of thickened walls (Fig. 5 a and b). Abaxial epidermis with rounded papillae and paracytic stomata (Fig. 5 c and d). SEM: abaxial epidermis with epicuticular wax in shape of granules (Fig. 5 e). Pre-foiliation lines at each side of the medium nerve. Parenchyma in palisade with simple crystals of calcium oxalate (Fig. 5 f). Simple crystals of calcium oxalate around the phloem xylem fascicles, protected by a fiber ring (Fig. 5 g).

Canavalia ensiformis (L.) DC. (*Leguminosae*)

Determined in N 238 piece. Syn. *Dolichos ensiformis* L. DC. Common name: “poroto de los gentiles”, “haba criolla”, “haba de burro”, “fava brava”, “fava contra o mau olhado”, “fava de quebranto”, “feijão de porco”, “feijão bravo”, “feijão de cobra”, “feijão de espada”, “feijão holandês”, “guisante de Tahiti”, “Jack bean”, “Chickasaw Lima”, “Patagonian bean”⁴⁻⁷.

Histological components found after light microscopy and scanning electron microscopy were:

Adaxial epidermis without stomata, interrupted by idioblast pairs containing simple crystals of calcium oxalate (Fig. 6 a and b). Abaxial epidermis with anomocytic to paracytic stomata, interrupted by idioblast pairs containing simple crystals of calcium oxalate (Fig. 6 f and g). Glandular trichomes with a basal cell, uniseriate multicellular base and biseriate multicellular head (Fig. 6 f) in both types of epidermis. Non-glandular trichomes with a short basal cell and a distal one ending as hook or needle, with a predetermined line where it breaks (Fig. 6 c and d) in both types of epidermis. SEM: cuticle formed by long to rounded warts (Fig. 6 e).

Phaseolus vulgaris L. (*Leguminosae*)

Determined in N 163 and N 164 pieces.

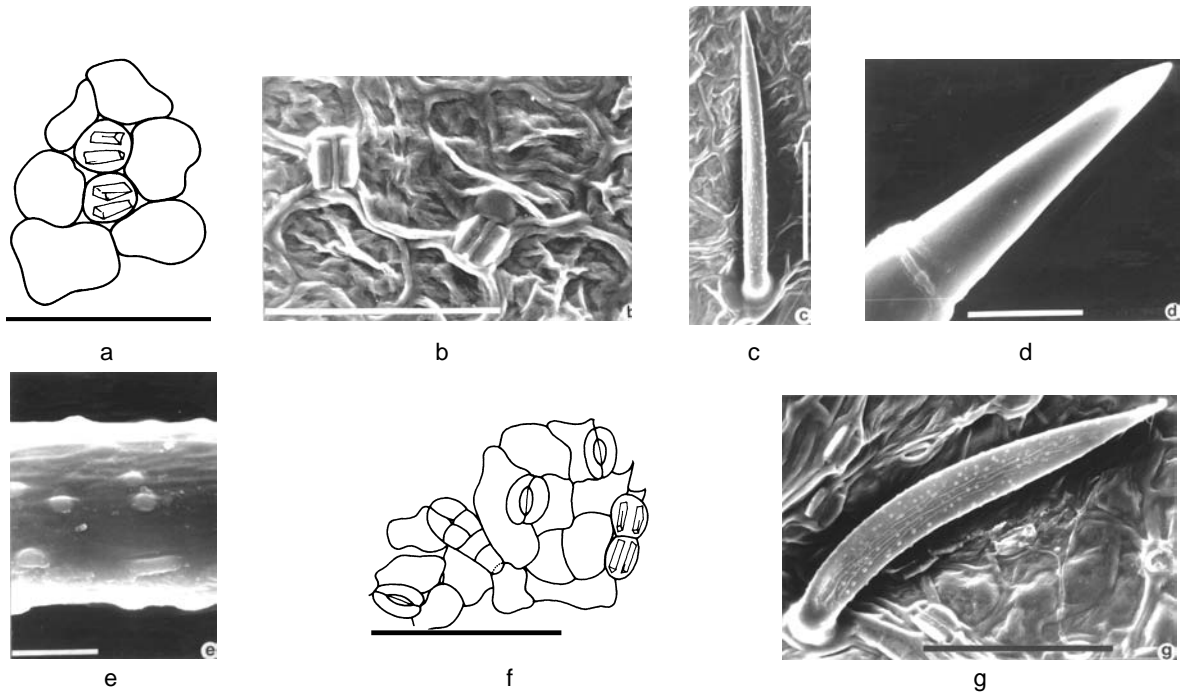


Figure 6. *Canavalia ensiformis*. **a** and **b**: crystal idioblasts from adaxial epidermis (with LM and SEM, respectively); **c**, **d** and **e**: general appearance, detail of acute apex and ornamentation of non-glandular trichomes (SEM); **f**: abaxial epidermis, crystal idioblasts, stomata and glandular trichome (LM); **g**: non-glandular trichome with apex as hook (SEM). Bar size: 100 μm (a-c, f, g); 10 μm (d, e)

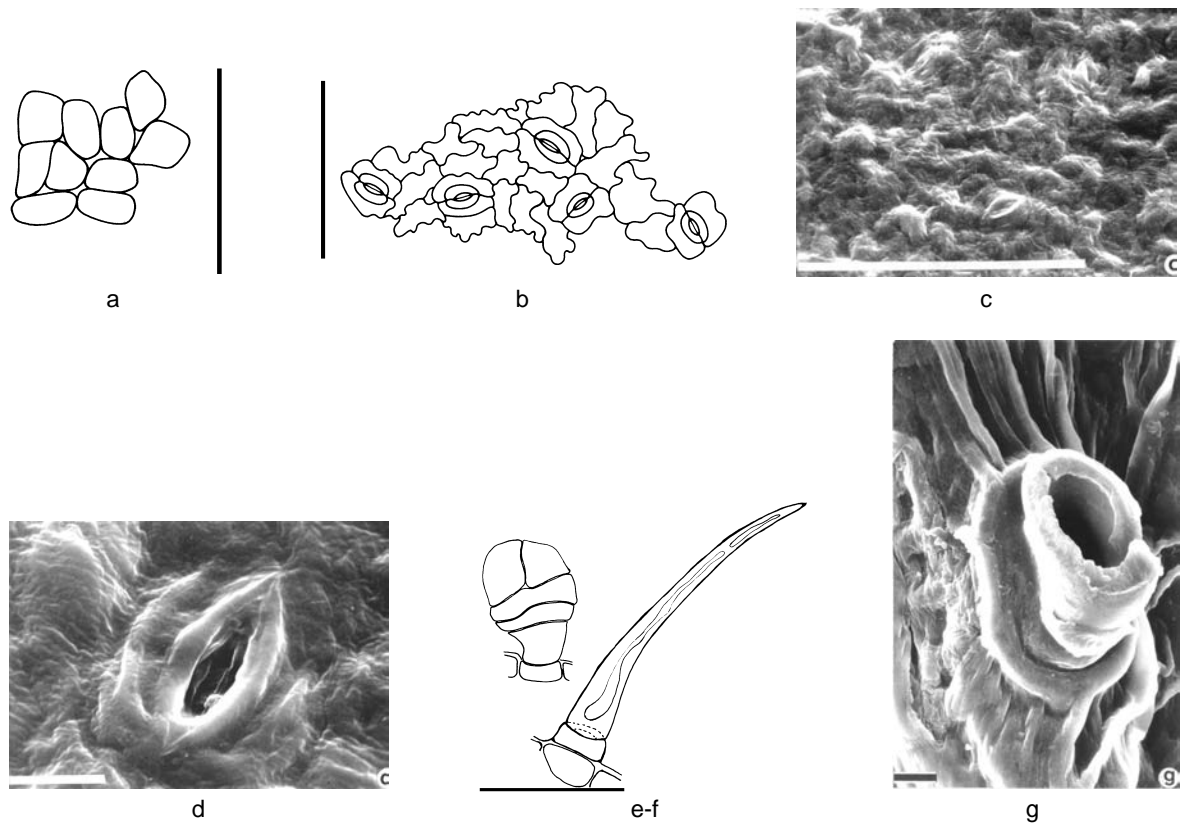


Figure 7. *Phaseolus vulgaris*. **a**: adaxial epidermis (LM); **b** and **c**: abaxial epidermis (with LM and SEM, respectively); **d**: detail of one stoma (SEM); **e**: glandular trichome (LM); **f**: non-glandular trichome (LM); **g**: detail of the base of a non-glandular trichome (SEM). Bar size: 100 μm (a-c, e, f); 10 μm (d, g).

Common name: “poroto”, “poroto de chaucha”, “aifi”, “frijol”, “alubia”, “habichuela”, “caraota”, “pallar”, “favona”, “haricot bean”, “loba”, “French bean”, “kidney bean”, “harriot bean”, “feijão”, “feijão preto”, “feijão-de-vara”, “feijão comum”^{4,5}.

Histological components found after light microscopy and scanning electron microscopy were:

Adaxial epidermis with cells of straight or slightly wavy walls, without stomata (Fig. 7 a). Abaxial epidermis with cells of wavy walls and paracytic stomata (Fig. 7 b). SEM: cuticle with thin striae (Fig. 7 c). Straight non-glandular trichomes with a acute or hooked end in both types of epidermis (Fig. 7 f). SEM: base with radial striae (Fig. 7 g). Clubbed glandular trichomes with globoid head or multicellular biserial ellipse and uniseriate multicellular base, with basal cell in both types of epidermis (Fig. 7 e). Simple crystals of calcium oxalate under adaxial epidermis, at the ribbing level.

DISCUSSION

The presence of camelids in several Andean contexts, not only in the coast but also in mountains, has been a constant finding along the different cultural periods.

For Inkas (1100-1470 AD) they were part of State interests and of everyday life in rites and ceremonies. They were represented in rupestrian art, in some local ceramic styles as in Inca Pacajes, and also in sculptural art, in some stone or metal idols, or those from mollusk valves found in high areas⁸. Llama conopas and illas, camelid sculptures containing coca leaves, had a sacred meaning in rites and ceremonies invoking the fertility of a flock or a sown land^{9,10}.

During Tiwanaku period (900-1200 A.D.), the importance given to camelids is undeniable. They were used as means of transportation, food, fiber source for textiles, and in rites. Llama and alpaca mummies, killed by a hit in the head, and naturally desiccated, were found in the site called El Yarál (Moquegua, Peruvian South coast) from Chiribaya culture (950-1350 A.D.), between the end of Tiwanaku and the beginning of the Late Intermediate periods. These mummies, most of them young males of no more than two years old, had been buried under the floor of large rooms, in low wells, beside offerings such as cuyes (Guinea pigs), turquoise and *Spondylus* beads from Ecuador, silver plates, marine valves, feathers, fishbones, corn, coca leaves and sticks wrapped in thread

and camelid fiber¹¹. Another significant finding is the one registered at Chiribaya Alta, a site near and contemporary to El Yarál, where 140 llama mummies were found similarly sacrificed.

Though camelids origin is located in Andes highlands and they seem to have been domesticated there¹¹⁻¹³, they were used earlier in the coast. In this sense, camelid findings of ritual use during Early Horizon period (1200-400 B.C.) were documented at Templo de las Llamas, in Valle del Virú, where four burials of sacrificed camelids, probably llamas, were found. Some of these animals had their legs tied up and others had a harness around the neck, behind the ears¹⁴. The ritual use of camelids is also documented in several tombs excavated at Huanchaco and Moche sites. In Pirámide del Sol, findings of camelid bones represent ceremonial feasts¹⁵. In Huaca de la Cruz, also in Valle del Virú, two headless llamas were found inside the tomb of a warrior priest and the entire body of a llama in another tomb¹⁴. At Pampa Grande, Moche ceremonial site (570-670 A.D.) in Valle de Lambayeque, evidence of camelid ritual sacrifices was found. They were young animals intentionally placed in the upper part of Huaca Fortaleza, the central pyramid of the site¹⁵.

In the South coast, the existence of camelids is evidenced not only in ritual burials but also in the perfection of textile art in which cotton replaced fiber (Paracas Necrópolis). In Valle de Nasca, recent findings at Cahuachi proved the existence of llama collective burials including offerings. At the “Recinto de los camélidos” 64 llamas were exhumed. Most of them were adult individuals but there were also fetuses and females. They were all in very good condition and woundless, which suggests that these animals had died from asphyxia. They were laying on their side, in East direction. Many of the bodies wore necklaces made with human bones or textile huinchas, and *Spondylus* and cuyes (*Cavia sp.*) chaquiras offerings. According to radiocarbon analysis, all the llamas had been buried at the same moment, as central part of a group of sacrifices. Radiocarbon dating performed on fragments of a “mate” associated to one of the camelids indicated an antiquity around 1660 ± 40 B.P.¹⁶.

Among offerings associated to llama ritual burials, coca represented for the Andean culture one of the most significant and frequent ritual elements. High ceremonial significance was given to it in familiar and communal rites, and reached State level among Inkas. Regarding its



Figure 8. Mochica ceramic of an individual holding a little pot in one hand, and a stick to extract llipta in the other. In figure at right, see that a little coca bag is hanging from his neck and over his back.



Figure 9. Mochica ceramic representing the face of a man with an "acullico" in his mouth.

ceremonial use, Polo de Ondegardo observes:

"...Por hacer reverencia a las peñas que quieren mochar o adorar, les echan aquella coca mascada, la cual se halla de fresca echada cada día en muchas peñas por los caminos que tengo dichos, y asimismo la hallaron echada por las puertas de casa de un demonio que ellos llaman Pachacama...". ("In their wish for venerating the stones they want to adore, they throw on them that chewed coca, found fresh every day on the stones of the ways I always walk, which they have found at the entrance of the house of a devil that they call Pachacama...")¹⁷.

In Moche ceramics, the representation of wounded warriors with some coca (acullico) in their mouth is shown through the puffy aspect of one of the cheeks. Also, the use of coca was represented by little bowls in one hand of the individual and a stick in the other that was used to take off the llipta. This substance helped extract alkaloid contents from coca leaves (Fig. 8 and 9). Furthermore, coca leaves have been found in bags or chuspas present in tombs, also represented in ceramic pots.

CONCLUSIONS

Although pieces analyzed in our work are unique for their characteristics, and their contextual association is unknown, the fact of having been found in tombs allows us consider them as ceremonial elements. Contrary to camelid burials aforementioned, in which bodies have been found desiccated or mummified, these pieces have been only left with their leather and filled with *Erythroxylum coca* and *Phaseolus vulgaris* leaves. This fact proves their ceremonial characteristic as far as coca use is concerned. Since these individuals were fetuses or young animals, we can conclude that they were used as ritual elements when invoking cattle fertility.

Currently, aboriginal communities from Northwest Argentina and South Bolivia maintain their ceremonies in which animals, though not sacrificed, are ornamented with woolen tassels of varied colors pending from their ears. This is an Andean tradition coming from the Moche period, evidenced in some ceramic pots. By the end of XIX century, Ambrosetti¹⁸ described that inhabitants from Valle Calchaquí (Argentina) *"...guardan y consideran también como Illas parte de la lana de la primer vicuña que cazan en el año; lo mismo hacen con la del primer huanaco, el primer cuero de chinchilla que matan, las plumas de ciertas aves, etc. Todo esto lo conservan en ataditos con algunas hojas de coca y los consideran como talismanes efficacísimos. En las mismas condiciones guardan las cabezas de los animales que cazan..."* ("... keep and consider as Illas some wool from the first vicuña hunted in the year; they do the same with the one from the first guanaco, a leather piece from the first chinchilla killed, the feathers of certain birds, etc. They keep all this in little bundles with some coca leaves and consider them as highly effective talismans. Heads from hunted animals are kept under the same conditions...").

After this analysis we can conclude that the presence of llamas within funerary contexts, associated to coca offerings, had a propitiating ritual meaning, maintained along different cultures and within different backgrounds.

The empty piece represents an actual mystery. The untidy sewing it presents makes us suppose that something happened with its content before its arrival at the Museo of La Plata.

N 238 textile piece deserves a special consideration. Though this little coca bag from Nasca tombs was part of funerary elements, the presence of coca leaves associated to *Canavalia en-*

siformis leaves (also called pallar de los gentiles) has significant meaning because makes us suppose they could have been chewed or smoked together. Though data are not available about its probable hallucinating effect, only activity is registered neurotoxic and convulsant of the extracts of seeds ¹⁹. The seeds of a related species, *Canavalia maritima* (Aubl.) Thouars ("frijol de playa"), is smoked in the coasts of the Gulf of Mexico as substitute for *Cannabis sativa* L. "marihuana" ²⁰. Its use as sacred hallucinogen by early populations has not been proved, but seeds from this species have been found in tombs at Oaxaca and Yucatán (México), and in Perú ²¹.

Finally, we must denote here that microscopic analysis of botanical samples allowed the assignment of the "taxonomic status" for *Erythroxylum coca* Lam., *Canavalia ensiformis* (L.) DC., and *Phaseolus vulgaris* L., found in early archeological contexts. This supports what other authors ^{9,22,23} reported on the diagnostic significance of microscopy for the typification of plant mixtures, either fragmented, pulverized, or semi-carbonized, as part of the finding of archeological material.

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