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Morphological and material variability in bone harpoon heads and stemmed points from the Lower Paraná Basin (Argentina) in the Late Holocene

Variabilité morphologique et matérielle des têtes de harpons et pointes pédonculées en os du bassin inférieur du Paraná (Argentine) au cours de l'Holocène tardif

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Abstract: The earliest archaeological record currently available for human populations of the Lower Paraná wetland dates back to 2400 years before present (BP). Beginning around 1100 BP, Lower Paraná populations engaged in a process of intensifying resource exploitation, which fostered territorial behaviors and ethnic diversity. This process is reflected in material variability suggesting the presence of distinct archaeological units within hunter-gatherer and horticulturalist groups. Due to the scarcity of lithic raw materials, most tools were crafted from bone and antler from local fauna with typical morphological groups of artefacts, and limited design variability. Bone industry was initially described as metrically homogeneous; however, recent analyses reveal a greater-than-expected degree of morphological variability. We propose that, in addition to a shared body of knowledge and practical skills among hunter-gatherer groups, technological diversity arose from innovations linked to ethnic segmentation.
In this study, we examine the selectivity of raw materials in relation to the morphological variability of two specific tool types: harpoons and stemmed bone points. Traditionally, raw material identification has relied on morphological and anatomical criteria and comparisons with curated reference collections. Here, we combine taxonomic identifications made using comparative morphology with ancient protein analysis—Zooarchaeology by Mass Spectrometry (ZooMS)—to inform reconstructions of raw material sourcing more accurately. Our findings indicate that morphological variability cannot be explained solely by differences in raw material selection. Cervidae (deer) is the most well-represented taxa within the Lower Paraná wetland tool assemblages, and the prevalence of bone rather than antler for harpoon crafting may suggest intentional selection. In the case of stemmed points, almost all the identifications correspond to camelid, a rare taxon in the area, including one item from island context. Our results raise new questions about the interaction between material culture, resource availability, and social dynamics among hunter-gatherer and horticulturalist groups.
Keywords: Morphological variability, taxonomic identification, bone technology, South America, Argentine lowlands, projectile points, ZooMS.

Résumé : Les plus anciens vestiges archéologiques actuellement disponibles concernant les populations humaines des zones humides du Bas Paraná remontent à 2400 ans avant le présent. Ces premières populations semblent avoir entamé un processus d'intensification de l'exploitation des ressources animales, mais c'est à partir d'environ 1100 ans avant le présent que l'on observe un processus plus marqué d'intensification de l'exploitation faunique, accompagné d'une territorialisation progressive et d'une complexification des interactions sociales. Ces dynamiques, mises en évidence par les recherches archéologiques, se reflètent dans la culture matérielle, en particulier dans la variabilité des artefacts en os, et permettent de définir des unités archéologiques distinctes parmi les groupes de chasseurs-cueilleurs et, plus tard, parmi les groupes d'horticulteurs guaranís.

La rareté relative des matériaux lithiques dans les milieux insulaires et deltaïques a conduit à la fabrication de la majorité des outils, et particulièrement des armes, à partir d'os et de bois de cervidés prélevés dans la faune locale. Initialement, l'industrie osseuse était considérée comme homogène, caractérisée par quelques types morphologiques à la variabilité formelle restreinte. Néanmoins, des études récentes, s'appuyant sur des approches plus fines de la morphométrie et de l'analyse technologique, mettent en évidence une variabilité morphologique plus marquée.

Nous proposons que cette diversité, au-delà d'un corpus de savoirs techniques partagés entre les différents groupes, découle d'innovations introduites dans un contexte de différenciation sociale et culturelle croissante. Cette différenciation aurait pu se traduire par des choix plus variés dans la décoration, la forme et les modalités de fabrication des artefacts. Les changements observés dans les styles et les morphologies peuvent ainsi être interprétés comme des marqueurs d'identité et comme des vecteurs de distinction entre groupes, dans un contexte d'intensification des réseaux sociaux et des contacts interethniques.

Dans cette étude, nous examinons les choix des matériaux bruts en relation avec la variabilité morphologique de deux types d'outils spécifiques : les harpons et les pointes à pédoncule. Traditionnellement, l'identification des matières premières reposait sur des traits morphologiques et anatomiques ainsi que des comparaisons avec des référentiels modernes. Toutefois, ces approches présentent certaines limites, notamment en raison de la fragmentation des artefacts et de la difficulté à distinguer certaines espèces de grands mammifères sur des bases uniquement morphologiques. Pour dépasser ces contraintes, nous avons combiné l'analyse morphométrique avec une approche biomoléculaire innovante : la zooarchéologie par spectrométrie de masse (ZooMS).

Nos résultats montrent que la variabilité morphologique ne peut pas être expliquée uniquement par la diversité anatomique des espèces choisies. Les harpons sont toujours faits en utilisant des os et des bois de cervidés. Bien que les harpons sans barbelures soient fabriqués en os plutôt qu'en bois de cervidé, le cerf demeure l'espèce la plus couramment utilisée. En revanche, les analyses ZooMS effectuées sur les pointes à pédoncule révèlent des résultats inattendus : presque tous les spécimens ont été confectionnés à partir d'os de camélidés, une espèce pourtant rare dans la région car associée plutôt aux milieux ouverts de la Pampa. Le cas le plus notable concerne une pointe mise au jour sur un site guaraní situé sur une île au cœur du Río de la Plata, ce qui suggère des circulations de matières premières ou des réseaux d'échanges à longue distance.

Ces résultats soulèvent de nouvelles questions concernant l'interaction entre la culture matérielle, la disponibilité des ressources et les dynamiques sociales parmi les groupes de chasseurs-cueilleurs et d'horticulteurs du Bas Paraná à l'Holocène tardif. Les chasseurs-cueilleurs parcouraient de vastes circuits de mobilité, ce qui explique l'utilisation des ressources de territoires plus larges, tout en maintenant des pratiques de sélection spécifiques au bassin du Paraná. Cependant, la présence de camélidés sur une île habitée par des Guaranís soulève des interrogations sur les mécanismes d'acquisition de la matière première : circulation d'objets finis, échanges intergroupes, ou encore déplacements ponctuels dans les zones pampéennes. Ces observations invitent à reconsidérer la place de l'industrie osseuse dans les processus d'innovation, d'interaction et de différenciation sociale au sein des sociétés pré-hispaniques du Bas Paraná.

Mots-clés : variabilité morphologique, identification taxinomique, technologie osseuse, Amérique du Sud, basses terres argentines, pointe de projectile, ZooMS.

INTRODUCTION

The Lower Paraná wetland (fig. 1) has been occupied by various human groups for the past 2400 years BP (Loponte et al., 2012). Starting around 1100 years BP, archaeological evidence suggests an increase in socially-motivated behaviors, such as territorial defense and the development of social identities linked to material culture variability (Loponte, 2020; Ali, 2023). Accordingly, two cultural units have been proposed among the hunter-gatherers of the southernmost sector of this wetland. These units are informally referred to as the Plain Pottery Unit and the Incised Pottery Unit as a convenient way of distinguishing them, yet each displays differences not only in the technical and stylistic features of pottery, but also in the sourcing circuits of lithic raw materials, ornamental artefacts, subsistence strategies, and lifestyle, among other aspects (Loponte, 2008 and 2020; Mazza, 2019a and 2019b; Ali, 2023).

Bone industry also differs significantly between these two units, with decorated bone artefacts found exclusively at sites associated with the Plain Pottery Unit (Buc, 2019). Additionally, a third archaeological unit is recognized, characterised by Guaraní material culture. This unit represents the Amazonian forager-horticulturalists who arrived in the region around 700 years BP (Loponte et al., 2025). Their material record is entirely distinct, encompassing all aspects of the archaeological record, including production waste, blanks, finished objects and style of ceramics, bone and lithic tools, as well as subsistence strategies, settlement patterns and mortuary practices. Lithic raw materials were scarce among hunter-gatherers, and tools were primarily made from bone and antler (Buc, 2012). Guaraní groups, however, had access to lithic raw materials through an extensive social network that reached northern outcrops (Silvestre et al., 2020). Historical chronicles suggest that bone was commonly used for tools and ornaments (Ambrosetti, 1895; Métraux, 1928; Noelli, 1993); but, such artefacts are infrequently recovered from Guaraní archaeological sites (table 1).

In the hunter-gatherer cultural units, bone raw materials came from consumed resources, with subsistence relying primarily on fishing and local mammals such as pampas deer (*Ozotoceros bezoarticus*), marsh deer (*Blastoceros dichotomus*), and coypu (*Myocastor coypus*) (Acosta, 2005; Loponte, 2008 and 2020; Loponte

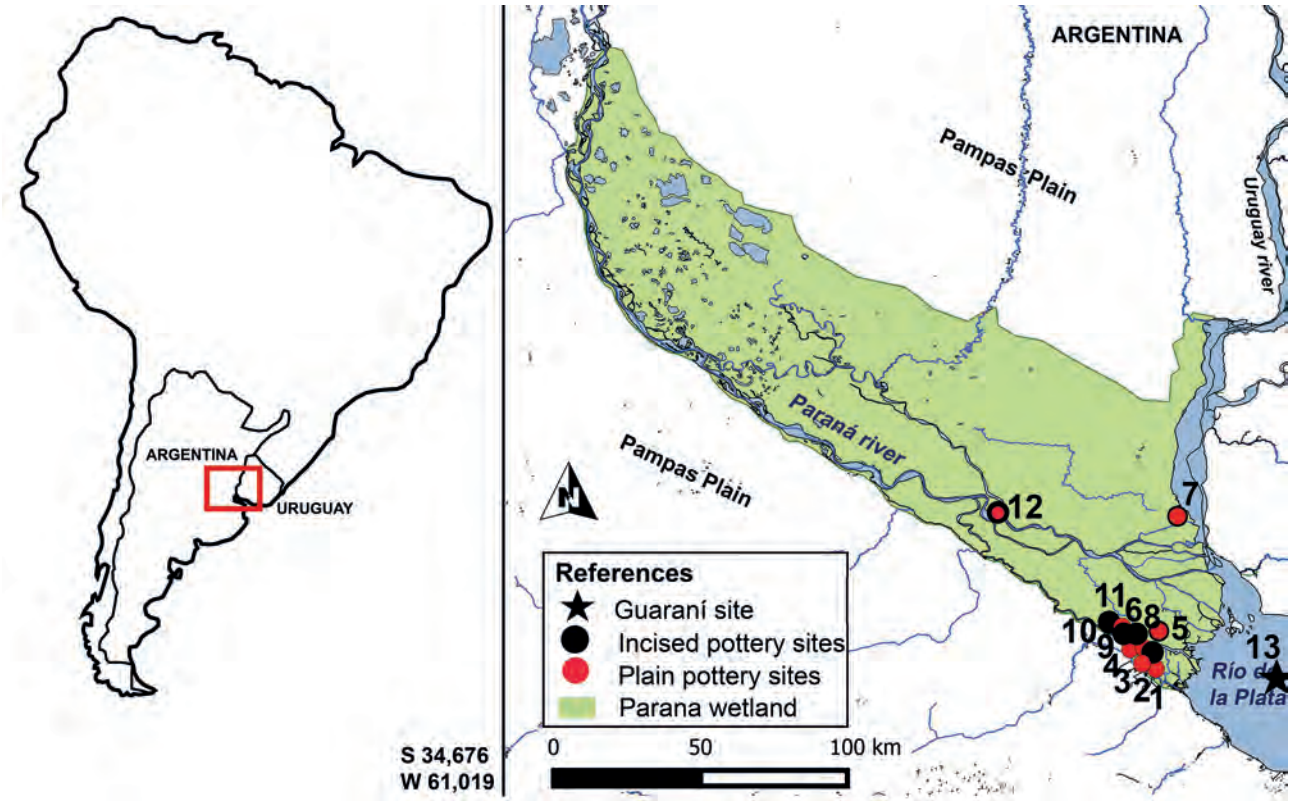

Fig. 1 – Paraná wetland with sites under study: (1) La Bellaca 1; (2) La Bellaca 2; (3) El Espinillo; (4) El Cazador 3; 5) Túmulo 1 Paraná Guazú; (6) Rancho Largo; (7) Cerro Lutz; (8) Punta Canal; (9) Garín; (10) Anahí; (11) Túmulo de Campana 1; (12) Isla Lechiguanas 1; (13) Arenal Central.

***Fig. 1** – Zone humide du Paraná avec les sites en cours d'étude : (1) La Bellaca 1; 2) La Bellaca 2; 3) El Espinillo; 4) El Cazador 3; 5) Túmulo 1 Paraná Guazú; 6) Rancho Largo; 7) Cerro Lutz; 8) Punta Canal; 9) Garín; 10) Anahí; 11) Túmulo de Campana 1; 12) Isla Lechiguanas 1; 13) Arenal Central.*

et al., 2016). These prey species were supplemented by resources from the nearby Pampas plains, including guanaco (*Lama guanicoe*) and rhea (*Rhea americana*) which are occasionally identified in the bone industry (Buc and Loponte, 2016; Acosta et al., 2023). Additional species, such as capybara (*Hydrochoerus hydrochaeris*), various foxes, domestic dogs (*Canis familiaris*), large felids like jaguar (*Panthera onca*) and puma (*Puma concolor*), and river otters (*Lontra longicaudis*), were occasionally used for technological or symbolic purposes (Acosta et al., 2015). While human activities were concentrated in wetlands, grassland species were occasionally accessed through opportunistic hunting or organized logistical expeditions (Buc and Loponte, 2016).

For the Guaraní unit, campsites were established almost exclusively on the islands located at the advancing front of the Paraná Delta. As a result, pampas deer are less commonly found, while marsh deer and brown brocket deer (*Mazama/Subulo guazoubira*) are more frequent, along with fishes. Although certain species such as capybara are present at these sites, no camelid remains have been recorded (Acosta et al., 2019).

Among hunter-gatherers, bone industry was traditionally regarded as homogeneous across sites. Different morphological groups were identified including awls and polishers as well as harpoons heads, spear-throwers, socketed and stemmed points (Buc, 2012; Acosta et al., 2021; Buc et al., 2024). In Guaraní contexts, bone tools are rare and marked by certain types of tools such as hooks and different expediency points (Buc, 2017).

However, recent findings reveal greater variability than previously assumed in hunter-gatherer sites. Toggle or detachable harpoons are commonly found in the middle and lower Paraná basin (Pérez Jimeno, 2007; Buc, 2012), and are more recurrent in the Plain Pottery Unit, though they display greater morphological diversity in the Incised Pottery Unit, with a higher proportion of non-spur or non-socket variants. Decorated harpoons, in contrast, are exclusively found in the Plain Pottery Unit, featuring motifs such as X-patterns and transverse lines (Buc et al., 2024).

Most of the harpoon heads have been identified as being made from deer antler in the lower basin of the Paraná River, as well as upstream (Pérez Jimeno, 2007; Buc et al., 2024). Stemmed points are found in lower proportions in hunter-gatherer sites, but also recently, a stemmed point was discovered from the Guaraní Arenal Central archaeological site (Loponte et al., 2025). Morphological variability is observed in larger assemblages, such as those from the northern Paraná Basin (Pérez Jimeno, 2007) and Central Hills (Córdoba in Argentina), where these points have been proposed as arrow-

Archaeological Unit	Archaeological sites	14C yr BP	Lab code	Sampled material	Reference
Plain Pottery Unit	La Bellaca 1 (1)	1100 ± 70	LP-1288	mammalia	Loponte (2008)
	La Bellaca 2 (2)	680 ± 80	LP-1263	*B. dichotomus*	Loponte (2008)
	El Espinillo (3)	1048 ± 38	AA-103655	*M. coypus*	Buc and Loponte (2016)
		1073 ± 38	AA-103652	*B. dichotomus*	
		1046 ± 35	AA-103653	Ampullaria	
	El Cazador 3 (4)	1091 ± 43	AA-103656	*L. guanicoe*	Buc and Loponte (2016)
		1063 ± 46	AA-103657	*L. guanicoe*	
		1031 ± 36	AA-97464	*H. sapiens*	
		921 ± 43	AA-97470	*B. dichotomus*	
	Túmulo 1 Paraná Guazú (5)*	576 ± 42	AA-93215	*H. sapiens*	Bonomo et al. (2011)
	Rancho Largo (6)	1211± 35	LTL-33015	*L. guanicoe*	Loponte et al. (2024a, 2024b)
		1010 ± 45	AA-97459	*M. coypus*	Buc and Loponte (2016)
	Cerro Lutz (7)	1116 ± 45	AA-103643	*H. sapiens*	Buc and Loponte (2016)
		976 ± 42	AA-77310	*H. sapiens*	
		953 ± 47	AA-103648	*S. romanzzofiana*	
		795 ± 42	AA-77311	*H. sapiens*	
		916 ± 42	AA-77312	*C. familiaris*	
		730 ± 70	LP-1711	*H. sapiens*	
Incised Pottery Unit	Punta Canal (8)	900 ± 80	LP-1293	*B. dichotomus*	Buc and Loponte (2016)
	Garín (9)	1360 ± 70	LP-3082	*H. sapiens*	Loponte et al. (2016)
		1060 ± 60	LP-240	*M. coypus*	Loponte (2008)
	Anahí (10)	1020 ± 70	Beta 147108	*M. coypus*	Loponte (2008)
	Túmulo de Campana 1 (11)	1334 ±29	AA-108368	*M. coypus*	Loponte and Acosta (2017)
		1551 ± 26	AA-108369	*B. dichotomus*	
		1633 ± 26	AA-108372	*M. coypus*	
		1656 ± 26	AA-108373	*L. platensis*	
		1669 ± 26	AA-108370	*L. guanicoe*	
		1670 ± 26	AA-108374	*M. coypus*	
		1754±49	AA-100007	*H. sapiens*	
Non determined	Isla Lechiguanas 1 (12)	2267 ± 34	AA-97461	*B. dichotomus*	Loponte et al. (2012)
		2296 ± 34	AA-97467	*B. dichotomus*	
Guaraní	Arenal Central - El Arbolito (13)	360 ± 30	Beta 662866	charcoal	Loponte et al. (2025)
		340 ± 30	Beta 663812	charcoal	
		400 ± 30	Beta 663813	charcoal	
		410 ± 30	Beta 663814	charcoal	
		480 ± 30	Beta 662865	charcoal	
		410 ± 40	LP-2543	charcoal	Capparelli (2014)
		405 ± 35	GrN 5146	charcoal	Cigliano (1968)

Table 1 – Radiocarbon dates from sites under study. Lab Code: LP-La Plata, Beta-Beta Analytic Inc., AA: Accelerator Mass Spectrometry Laboratory, GrN: Groningen Radiocarbon Laboratory.
*The assignment of this site to this unit is preliminary and remains subject to ongoing investigation.

Tabl. 1 *– Datations radiocarbone des sites en cours d'étude. Lab Code : LP-La Plata, Beta-Beta Analytic Inc., AA : Accelerator Mass Spectrometry Laboratory, GrN : Groningen Radiocarbon Laboratory.*
** L'attribution de ce site à cette unité est provisoire et reste en cours de vérification.*

heads used in interpersonal violence, alongside hunting activities (Medina et al., 2025). Camelid metapodials are particularly well-suited for crafting stemmed points due to their dense shafts with flat surfaces, which provide ideal raw material for creating long, flat tools. These raw materials are widely used in other sectors of Argentina, also for crafting these types of points as well as others (Scheinsohn, 2010; Medina et al., 2025). In contrast to elastic antler, these are rigid bones designed to withstand high pressure without deforming (Scheinsohn, 2010).

We understand material culture as the product of a network of social interactions, where individuals produce objects following established technical traditions (Gosselain, 2000). When social networks begin to diversify, as may have occurred among the hunter-gatherers of the Lower Paraná wetland approximately 1100 years ago, morphological and stylistic changes tend to occur more immediately than technical ones. Early stages in the operational sequence, including manufacturing processes and raw material selection, are typically more stable and resistant to transformation (Gosselain, 2000). A few centuries after these processes of social segregation or differentiation began, Guaraní Amazonian forager-horticulturalist groups arrived in the area, increasing competition for space and resources. In this study, we analyse the morphological variability of two types of bone artefacts (harpoons and stemmed flat points) to evaluate whether stylistic variability is influenced by the selectivity of raw materials on a taxonomic level. In tandem with morphology-based taxonomic identifications, we utilize Zooarchaeology by Mass Spectrometry (ZooMS; Buc et al., 2026) to create more informed representations of taxonomic diversity within bone industry assemblages.

1. SAMPLE AND METHOD

In this study, we focus on two morphological groups of point arms: harpoon heads and stemmed points (fig. 2). Our analysis includes all items recovered from hunter-gatherer archaeological sites in the Paraná wetland that are curated at the Instituto Nacional de Antropología y Pensamiento Latinoamericano and the Museo de Ciencias Naturales de La Plata. Other published items stored in local museums could not be accessed for direct examination.

The assemblage comprises seven harpoons from the Incised Pottery Unit (sites: Punta Canal, Garín, Anahí, and Túmulo de Campana Site 1) and 30 harpoons from the Plain Pottery Unit (sites: La Bellaca Site 1, La Bellaca Site 2, El Espinillo, El Cazador Site 3, Túmulo 1 del Paraná Guazú, Rancho Largo, and Cerro Lutz). Stemmed points are six: one from the Incised Pottery Unit (Anahí), one from the Guaraní Archaeological Unit (Arenal Central), and the remaining four from the Plain Pottery Unit (La Bellaca Site 2, Rancho Largo, and El Cazador Site 3).

First, we analysed the morphological variability of each group. Harpoon heads were divided into spur and no-spur or socketed harpoons; among the spur variants there are different types of spurs: blunt, bifurcated, and sharp (Buc et al., 2024). Small harpoons are segregated based on size, being both spur and no-spur variants (Acosta et al., 2024). Both in socketed or small harpoons, indeterminate bones and possible camelid bones have been suggested (Buc et al., 2024). Indeterminant identifications are a result of the use of epiphyses as a natural socketed base. Small-sized harpoon heads are proposed to have been made from bone, and difference in size could reflect variations in the selected raw materials, possibly as part of training tools for children or as points crafted for hunting specific species (Acosta et al., 2024). While the design is proposed to have been used primarily for large lentic fish, the possibility of its use for terrestrial hunting cannot be ruled out (Buc et al., 2024).

Stemmed points can be classified into three types based on their shoulders: adjacent or short straight shoulders, long barbs, and one obtuse shoulder (according to Medina et al., 2025). Points with short shoulders exhibit rougher surfaces, whereas barbed variants are well-polished. One of the points is decorated on both sides (fig. 2e).

Based on the observed morphological variability, we evaluate the heterogeneity of raw material selection. Morphological identification was performed when possible, and ZooMS analysis was used to refine taxonomic identifications, especially for no-spur or small harpoons where visual examination proved inconclusive. Detailed ZooMS results have recently been published by N. Buc and colleagues (2026).

2. RESULTS

2.1. Harpoon Heads

As shown in table 2, all spur harpoons (blunt, bifurcated, or sharp) were made from deer antler. In contrast, no-spur harpoons and smaller items were identified as indeterminate or likely made from camelid bone by morphological traits. However, ZooMS analysis performed on six of the seven non-determined items refined the identification in five cases, identifying markers consistent with Cervidae (deer species).

2.2. Stemmed Points

Morphological identification of taxon or element was not possible for the stemmed points. A longitudinal groove is observed in three cases that could correspond to medullary canal from a metapodial (fig. 2e and fig. 2i), but any long and flat element could be used for the other items such as tibias or radii. All six stemmed points were submitted for ZooMS analyses, resulting in five identifications of probable *Lama* sp. bone, including llama (*Lama glama*), guanaco (*Lama guanicoe*), alpaca (*Lama pacos*), and vicuña (*Lama vicugna*), and one of Cervidae (table 2).

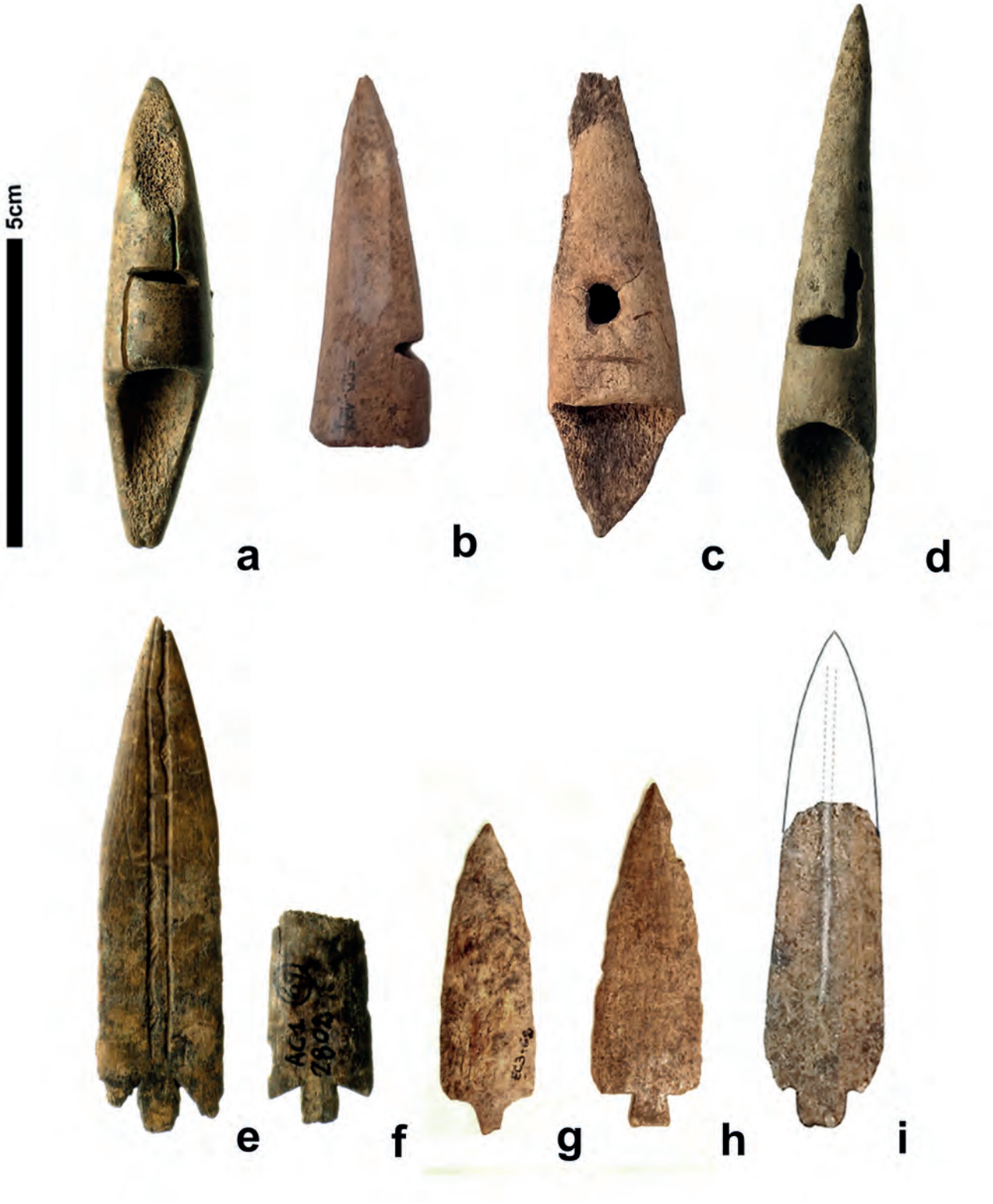

Fig. 2 – Examples of the morphological groups analysed: a) Blunt-spur harpoon head; b) No-spur harpoon head; c) sharp-spur harpoon head, d) Bifurcated-spur harpoon head; e) Decorated barbed stemmed point; f) Barbed stemmed point; g) Stemmed point with obtuse shoulders; h) Stemmed point with straight shoulders and bifurcated stem; i) Barbed stemmed point with longitudinal channel (reconstruction taken from Loponte et al., 2025, fig. 16)

Fig. 2 – *Exemples des groupes morphologiques analysés : a) tête de harpon à ergot émoussé ; b) tête de harpon sans ergot ; c) tête de harpon à ergot acéré ; d) tête de harpon à ergot bifurqué ; e) pointe pédonculée barbelée décorée ; f) pointe pédonculée barbelée ; g) pointe pédonculée à épaulement obtus ; h) pointe pédonculée à épaulement droit et pédoncule bifurqué ; i) pointe à pédoncule barbelée avec canal longitudinal (reconstitution d'après Loponte et al., 2025, fig. 16).*

Tool type	Archaeological Unit	Type	Original Sample Identifyer	Morphological ID	ZooMS ID	Reference
Harpoons	Incised Pottery	blunt spur	PC1	Cervidae	n/a	Buc et al. 2024
		bifurcated spur	A41	Cervidae	n/a	Buc et al. 2024
		socketed	A102	Camelidae	Bovidae/Cervidae	Buc et al. 2025
		socketed	TC1	Cervidae	n/a	Buc et al. 2024
		non determined	G16	Cervidae	n/a	Buc et al. 2024
		non determined	G27	Cervidae	n/a	Buc et al. 2024
	Non determined	small harpoon	IL1-3	indeterminate	indeterminate	Buc et al. 2025
	Plain Pottery	blunt spur	LBII 143	Cervidae	n/a	Buc et al. 2024
		blunt spur	LBI 8	Cervidae	n/a	Buc et al. 2024
		blunt spur	EE7	Cervidae	n/a	Buc et al. 2024
		blunt spur	EE 26	Cervidae	n/a	Buc et al. 2024
		blunt spur	EC3 178	Cervidae	n/a	Buc et al. 2024
		blunt spur	RLA 5	Cervidae	n/a	Buc et al. 2024
		blunt spur	EC3 216	Cervidae	n/a	Buc et al. 2024
		blunt spur	EC3 238	indeterminate	n/a	Buc et al. 2024
		bifurcated spur	LBII 46	Cervidae	n/a	Buc et al. 2024
		bifurcated spur	T1PG-3189	Cervidae	n/a	Buc et al. 2024
		sharp spur	CL 86	Cervidae	n/a	Buc et al. 2024
		socketed	EC3 137	indeterminate	indeterminate	Buc et al. 2025
		socketed	EC3 139	Cervidae	n/a	Buc et al. 2024
		socketed	EC3 190	Cervidae	Cervidae	Buc et al. 2025
		socketed	EC3 195	Cervidae	n/a	Buc et al. 2024
		small harpoon	LB2 146	Cervidae	Cervidae	Buc et al. 2025
		small socketed harpoon	EC3 285	Camelidae	indeterminate	Buc et al. 2025
		small harpoon	LB2 56	indeterminate	Cervidae	Buc et al. 2025
		non determined	LBII 8	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 20	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 25	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 43	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 45	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 138	Cervidae	n/a	Buc et al. 2024
		non determined	LBII 145	Cervidae	n/a	Buc et al. 2024
		non determined	EC3 41	Cervidae	n/a	Buc et al. 2024
		non determined	EC3 45	Cervidae	n/a	Buc et al. 2024
		non determined	EC3 191	Cervidae	n/a	Buc et al. 2024
		non determined	EC3 247	Cervidae	n/a	Buc et al. 2024
		non determined	EC3 210	Cervidae	n/a	Buc et al. 2024
Stemmed points	Incised Pottery	barbed	A69	indeterminate	Lama sp.	Buc et al. 2025
	Plain Pottery	barbed	LB2 124	indeterminate	Lama sp.	Buc et al. 2025
		short shoulders	RLA 1	indeterminate	Lama sp.	Buc et al. 2025
		short shoulders	EC3 179	indeterminate	Lama sp.	Buc et al. 2025
		obutse shoulders	EC3-62	indeterminate	Cervidae	Buc et al. 2025
	Guaraní	barbed	El Arenal 1	indeterminate	Lama sp.	this paper

Table 2 – Results on taxonomical determination including ZooMs analysis.
***Tabl. 2** – Résultats de la détermination taxinomique incluant l'analyse ZooMs.*

Though ZooMS cannot currently conclusively differentiate between all members of the *Lama* genus (Buckley et al., 2009; Welker et al., 2016), geographical and archaeological evidence suggests that the stemmed point identified as *Lama* sp. is most likely *Lama guanicoe* (guanaco).

3. DISCUSSION

Harpoon heads—including spur, non-spur, and smaller variants—were all identified as being made from Cervidae bone or antler. Previous studies suggested that non-spur harpoons might have been crafted from camelid bone but, ZooMS analysis identified no evidence of camelid material and instead confirmed that all harpoons were made from Cervidae bone/antler. As noted elsewhere, *Blastocerus dichotomus* and *Mazama/Subulo guazoubira* exhibit similar protein marker profiles and cannot currently be differentiated with ZooMS, although the latter is considerably smaller to perform regular harpoons (Buc et al., 2026). The source of projectile points, which could not have been identified by morphology due to large transformation of bone raw material, was largely identified by ZooMS as *Lama* sp. which is consistent with previous taxonomic determinations for larger stemmed point assemblages (Medina et al., 2025).

In hunter-gatherer sites, camelid bones might have been sourced from logistical parties to the contiguous Pampa Plains or through occasional incursions of animals into the wetland (Buc and Loponte, 2016). However, the context at Arenal Central presents a more complex scenario. The site is located on an island where *Lama guanicoe* could not have entered naturally, the species is absent from faunal remains, and the Guaraní bone industry appears so limited that it seems unlikely to have supported either the exchange of bone raw materials or the crafting of points at the site. Furthermore, this is the first stemmed point found in such a context, adding to the uniqueness of the discovery. Stemmed points are well known for continental hunter-gatherers. The morphology and raw material of the Guaraní point aligns with a broader assemblage of stemmed points found in the continental portion of the Low Paraná wetland (Oliveira de César, 1895; Lothrop, 1932; Loponte, 2008; Buc, 2012), as well as in the Middle Paraná (Pérez Jimeno, 2007; Loponte and Ottalagano, 2023), the northern Chaco region (Rusconi, 1933; Reichlen, 1940; Wynveldt et al., 2020), and the central highlands of Argentina (De Aparicio, 1925; Serrano, 1945; Díaz et al., 2015; Rivero et al., 2019; Medina et al., 2025).

CONCLUSION

The analysis of stemmed points and harpoon heads from the Low Paraná wetland provides critical insights into the material choices and technological practices of past societies. The identification of *Lama* sp. (most likely guanaco) and Cervidae (deer) materials highlights the importance of raw material availability and the strategic use of local and non-local resources. While deer antlers were the primary material for crafting harpoons due to their elasticity and suitability for diverse hunting tools, bones were also used, potentially as a secondary resource when antler material was unavailable (Buc et al., 2021) or contexts where bone was preferable. For example, camelid metapodials were selectively utilized for stemmed points, offering structural advantages for flat and stiff points, where plastic deformation was not necessary during use. This bone has been widely used in South America as raw material (Scheinsohn, 2010; Christensen et al., 2018).

The presence of a camelid bone stemmed point at Arenal Central—a site located on an island where *Lama guanicoe* could not have naturally occurred and where no bones of this taxa are found—raises significant questions about mobility, exchange networks, and inter-ethnic conflict. The possibility that this point was transported through trade or introduced during a conflict emphasizes the complexity of social interactions in the region.

Furthermore, the morphological consistency of these tools across vast regions, from the Low Paraná wetland to the northern Chaco and central highlands, underscores a shared technical tradition, likely shaped by environmental adaptations and cultural exchanges. Future research should focus on refining ZooMS analyses and expanding comparative studies to deepen our understanding of the interplay between material culture, resource availability, and social dynamics in these contexts.

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