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Bone technology among archaic fishers, hunters, and gatherers of the northern and central coasts of Chile's Semi-Arid region

La technologie en os des pêcheurs, chasseurs et cueilleurs archaïques des côtes nord et centrale de la région semi-aride du Chili

Gabriela Bravo

Abstract: Various studies argue that the hunter-gatherer groups that inhabited the northern and central coasts of the Semi-Arid North region of Chile during the Middle and Late Archaic periods (7000–100 B.C.) were part of a cultural unit known as the "Shell fishhook culture". This cultural unit is believed to have occupied more than 600 km of the coastline. Its presence in this vast area is suggested based on typological similarities of certain recovered tools, among which a rich and diverse bone industry stands out. Only at the end of the Late Archaic period did some elements point to an incipient process of internal differentiation between coastal groups in terms of lifestyle and social organization.

Through the review of ancient collections of bone industry and artifacts recovered from recent excavations, we aim to explore in greater depth the notion of an alleged archaic cultural homogeneity along the Semi-Arid North coasts. Beyond typological similarities, the techno-economic study of this industry enables us to evaluate the affinities and differences in know-how and socio-economic aspects of these groups.

Keywords: Maritime adaptation, coastal hunter-gatherer, archaic context, know-how, operational chain, bone industry, Semi-Arid North region.

Résumé : Au cours des périodes de l'Archaïque moyen (vers 8700-4200 ans cal BP) et de l'Archaïque tardif (à partir de ~4200 ans cal BP), le nord semi-aride du Chili a connu une alternance marquée de phases arides et humides. Parmi celles-ci, une période d'aridité particulièrement prononcée a pris place entre 6000 et 3800 ans cal BP. Malgré ces conditions arides prédominantes, les côtes septentrionale et centrale de la région ont été intensivement occupées par des groupes de pêcheurs, chasseurs et cueilleurs. De nombreux sites d'envergure, principalement des amas coquilliers – dont certains ont également été utilisés à des fins funéraires – ont été identifiés sur plus de 600 km de littoral.

Dans ce contexte, plusieurs auteurs ont proposé le développement d'une culture homogène, désignée sous le nom de « Anzuelo de Concha », dont l'origine se situerait dans le désert d'Atacama. Cette proposition repose principalement sur la récurrence de certains types d'outils en pierre taillée et en coquille, ainsi que sur l'existence d'une industrie en os riche et diversifiée.

Au-delà des parallèles typologiques, cet article a pour objectif principal d'évaluer les convergences et les divergences régionales, sur le plan tant social que culturel, entre les groupes habitant la région. Ce travail s'appuie sur une approche techno-économique comparative de la production d'outils en os menée entre les côtes nord et centrale de la région semi-aride.

Cette étude repose sur l'analyse de 470 pièces provenant de 14 sites archéologiques : sept situés sur la côte nord (Punta Totoralillo 1 et 2, Bahía Maldonado 1, 2 et 3, Huasco Norte 1 et Puerto Guacolda) et sept sur la côte centrale (Punta Teatinos, Museo del Desierto–CONAF, La Herradura, Guanaqueros, Quebrada El Romeral, Cruz Grande et Valle El Encanto). Les pièces étudiées, datées des périodes de l'Archaïque moyen et tardif, ont été divisées en deux corpus analytiques distincts selon leur provenance géographique.

Elles comprennent des outils finis, des supports, des déchets de production et des blocs de matière première. La méthode adoptée s'inscrit dans l'approche techno-économique développée dans la tradition française, et adaptée aux matières osseuses par A. Averbouh, puis approfondie par d'autres chercheurs.
Les résultats montrent que, dans les deux zones, une nette préférence est accordée aux os longs de mammifères terrestres, en particulier aux métapodes de camélidés, pour la fabrication des outils. Sur le plan typologique, une relative homogénéité est effectivement observée dans l'équipement destiné à l'exploitation des ressources marines, notamment en ce qui concerne les composants des harpons – tels que les fûts et les barbelures – qui témoignent d'une standardisation morphologique prononcée.
À l'inverse, les outils domestiques, tels que ceux à extrémité appointée, émoussée et en biseau, présentent une variabilité morphométrique et taxonomique plus marquée. Une exception notable est constituée par les compresseurs, identifiés sur la base de macrotraces d'usure. Ces outils ont été retrouvés principalement sur la côte centrale, et dans une moindre mesure sur la côte septentrionale.
La reconstruction des chaînes opératoires révèle un schéma de partition longitudinale des métapodes par rainurage, analogue dans les deux régions. Malgré les différences de conservation et d'effectif entre les assemblages, des similitudes sont observées quant aux matières premières sélectionnées (métapodes de camélidés), aux procédés techniques de transformation – principalement par rainurage bifacial et/ou bilatéral –, ainsi qu'à l'objectif final de cette production : la fabrication de fûts de harpon et de compresseurs façonnés à partir de quarts de métapodes.
Les différents types d'indices, tels que la composition de l'équipement et les ressources consommées, nous permettent de confirmer la présence de groupes fortement ancrés dans les environnements côtiers. Toutefois, en raison des matières premières exploitées, ces populations entretiennent nécessairement des liens avec les espaces terrestres, articulant ainsi les deux milieux au sein de l'industrie en os.
L'acquisition de ces os pourrait résulter de la chasse aux camélidés – très probablement des guanacos, compte tenu de leur taille –, lesquels auraient ensuite été transportés vers les sites côtiers depuis des vallées ou ravins situés à environ 30 km à l'intérieur des terres. Bien que ces animaux ne constituent pas une composante majeure du régime alimentaire, leurs métapodes ont été techniquement exploités, principalement en raison de leurs propriétés mécaniques et morphologiques.
Malgré le nombre limité de pièces, l'approche techno-économique a permis de mettre en évidence un schéma opératoire d'exploitation des métapodes de guanaco largement identifié le long des côtes de la région semi-aride. Dans cette perspective, nous formulons l'hypothèse de l'existence d'un savoir-faire commun sur l'ensemble de ce territoire côtier.
Ces mêmes façons de faire (technologie) et de concevoir les objets (typologie) ont été identifiées dans des régions plus éloignées, comme la côte du désert d'Atacama. Cela suggère l'existence d'une tradition technique partagée par des groupes littoraux dispersés, ayant perduré sur une longue période.
Au-delà de l'éventuelle existence d'une unité culturelle homogène au sens strict, la présence de ce substrat commun pourrait étayer l'hypothèse de réseaux étendus d'interaction et de mobilité le long de l'ensemble de la côte nord du Chili au cours de ces périodes.
Vers la fin de l'Archaïque tardif, certains indices – liés à la différenciation de l'organisation sociale, des modes de vie, des stratégies de subsistance et des pratiques funéraires au sein des communautés locales – suggèrent une fragmentation progressive de ces réseaux à l'échelle de cette macro-région.
Mots-clés : archéologie côtière, adaptation maritime, chasseurs-cueilleurs côtiers, chaîne opératoire, industrie osseuse, contexte archaïque, région du Nord semi-aride.

INTRODUCTION

Chile is a geographically elongated country, with a coastline extending approximately 4,200 km in a straight line. This study focuses on the coastal sector of the Semi-Arid North region, which constitutes a transitional zone in hydrological, climatic, and vegetational terms, located between the Atacama Desert and the Mediterranean valleys of central Chile (Maldonado and Villagrán, 2002). Specifically, we studied the coastal and ravine areas between Pan de Azúcar (26°S) and southern Limarí (30°S). This longitudinal gradient results in marked environmental variability, which allows for a clear distinction between the northern and central coastal sectors.

During the Middle (ca. 8700–4200 cal. BP) and Late Archaic (from ~4200–~2000 cal. BP), the region underwent alternating episodes of aridity and humidity. Among these, a particularly intense arid phase occurred between 6000 and 3800 cal. BP. Climatic conditions appear to have stabilized around 2200 cal. BP (Villagrán and Varela, 1990; Veit, 1996; Grosjean et al., 1997; Maldonado and Villagrán, 2006; Cabré et al., 2017; Tiner et al., 2018; Muñoz et al., 2020).

Despite these fluctuations—and particularly the prevailing arid conditions—the northern and central coastal sectors were intensively occupied by fisher-hunter-gatherer groups, with archaeological evidence dating back to ca. 8518 cal. BP (Rivas, 2012). Numerous extensive sites, primarily shell middens, have been identified along more than 600 km of coastline. These sites have been interpreted as residential areas and, in some cases, also served as large-scale cemeteries. Excavations have yielded rich assemblages of malacological, ichthyological, and marine mammal remains (Iribarren, 1956 and 1960; Schiappacasse and Niemeyer, 1964, 1965 and 1986; Alaniz, 1973; Kuzmanic and Castillo, 1986; Cervellino, 1998; Contreras, 2005; Fuentes and Contreras, 2010; Rivas, 2012; Troncoso et al., 2016 and 2024; Pino et al., 2018).

Based on the morphological uniformity observed in tools recovered from these contexts—such as bifacial blades known as *taltaloide*, triangular and lanceolate lithic points, and simple shell fishhooks—a culturally homogeneous tradition, referred to as the "Shell fishhook culture" has been proposed, a notion first introduced by J. Bird (1943 and 1946). This hypothesis suggests a northern origin, likely rooted in the Atacama Desert region and expanding southward along the Pacific coast (Iribarren, 1956 and 1960; Schiappacasse and Niemeyer, 1964, 1965 and 1986; Alaniz, 1973; Kuzmanic and Castillo, 1986; Cervellino, 1998; Contreras, 2005; Fuentes and Contreras, 2010; Rivas, 2012).

Within this framework, the osseous industry—comprising tools associated with the exploitation of marine and littoral resources, as well as domestic activities—has been regarded as key evidence supporting the notion of cultural homogeneity among North Archaic societies. As an essential and widely available component of the region's archaeological assemblages, it also represents a particularly pertinent avenue through which to address this issue. Beyond the apparent typological uniformity of the tools, its technological study allows for the identification of potential regional similarities and differences in the technical and economic choices made by different groups, although this perspective has not yet been formally re-evaluated. In fact, toward the end of the Late Archaic period, certain elements begin to suggest an incipient process of internal differentiation among coastal groups, particularly in terms of lifestyle and social organization (Troncoso and Pavlovic, 2013). This evidence invites a reconsideration of whether similar differences may have also existed among hunter-gatherer groups inhabiting the region.

Moving beyond typological parallels, the primary objective of this article is to evaluate potential socio-economic and cultural affinities or differences among these groups through a comparative analysis of bone tool production between the northern and central coasts.

1. CORPUS AND METHODOLOGICAL APPROACH

To fulfill this purpose, a study was conducted on bone industries from seven sites located along the northern coast and seven from the central coast and adjacent coastal ravines of Chile's Semi-Arid North region. In the northern zone, materials were analyzed from residential areas at Punta Totoralillo 1 and 2, Bahía Maldonado 1, 2 and 3, Huasco Norte 1, and Puerto Guacolda (fig. 1 and table 1). On the central coast, artifacts were analyzed from both habitation sites and large cemeteries, including those at Punta Teatinos, Museo del Desierto–CONAF, and La Herradura (Los Panules, La Cancha, and El Cerrito), Guanaqueros (Cementerio Tierra Negra and Conchal del Pueblo), Quebrada El Romeral (El Pimiento), Cruz Grande, and Valle El Encanto[1] (fig. 1 and table 2). Several of these sites include both funeral and residential components, all of which have been examined. Most were excavated between the mid-1950s and the 1980s, during which faunal remains were not always systematically recovered. Since 2000, new excavations have taken place in different areas, helping to complement and expand the information that was previously unavailable.

A total of 470 artifacts—103 from the northern coast and 367 from the central coast—were analyzed. All specimens come from layers or sectors dated to the Middle and Late Archaic. To evaluate similarities and differences between the two zones, the artifacts were grouped by coast and analyzed as two distinct analytical corpora.

These pieces were analyzed using a techno-economic approach rooted in the French tradition of technology. The methodology was originally adapted from lithic to osseous materials by A. Averbouh in 1998 and has since been further developed through contributions from other scholars (Averbouh and Provenzano, 1998-1999; Averbouh, 2000; Provenzano, 2001; Tejero, 2010; Christensen, 2016; Goutas et al., 2018).

This approach relies on the macro- and microscopic analysis of technical stigmata—marks left on bone surfaces during the manufacturing process. Because a single primary stigma can result from multiple techniques, the analysis also focuses on identifying more subtle traces, referred to as secondary stigmata (sensu Christensen 2016). These are essential for determining the specific techniques employed in the transformation of raw osseous materials. The classification of both stigmata and technical operations follows the updated taxonomy proposed by M. Christensen (2016).

Some experimental tests were carried out, based on theoretical reconstructions previously inferred based on a mental relationship between objects that still retain some technical stigmata, and a limited number of intermediate products. These tests served to observe how the bones reacted to specific techniques and tools, to identify the stigmata they produced, as well as to understand the functioning of certain procedures.

Prior to reading technical stigmata, a taphonomic assessment of the bone surfaces was conducted to evaluate the preservation state of each specimen. This stage is essential, as the condition of the bone directly influences the reliability of the technical information that can be retrieved.

Additionally, the raw materials were identified both anatomically and taxonomically based on diagnostic skeletal elements. The tools were also classified typologically, and macro-wear traces on the active ends were analyzed to associate them with specific gestures and worked materials, following criteria established in previous studies (Semenov, 1964; Arndt and Newcomer, 1986; Bergman, 1987; Maigrot, 1997 and 2003; Pokines, 1998; Tartar, 2003; Pétillon, 2006; Baumann, 2014; Pétillon et al., 2016, among others).

The technological analysis of the osseous industry made it possible to move beyond the finished tool and toward a broader examination of the operational

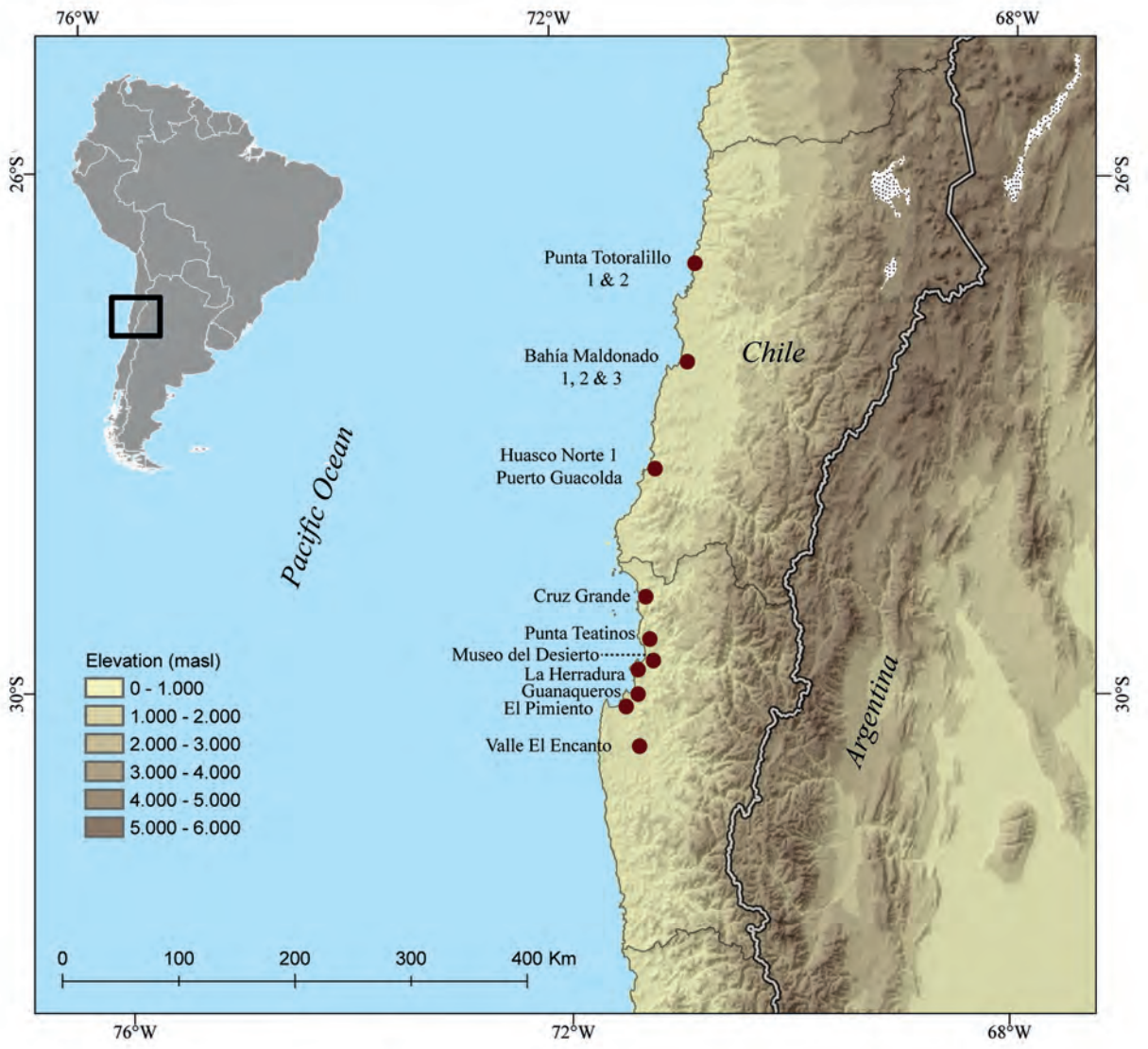

Fig. 1 – Map of the Semi-Arid North of Chile showing the geographical distribution of the archaeological sites analyzed in this study. Northern coast: Punta Totoralillo 1 and 2; Bahía Maldonado 1, 2, and 3; Huasco Norte 1; Puerto Guacolda. Central coast: Cruz Grande; Punta Teatinos; Museo del Desierto; La Herradura; Guanaqueros; El Pimiento; and Valle El Encanto.

***Fig. 1** – Carte du nord semi-aride du Chili indiquant la distribution géographique des sites archéologiques analysés dans cette étude. Côte septentrionale : Punta Totoralillo 1 et 2 ; Bahía Maldonado 1, 2 et 3 ; Huasco Norte 1 ; Puerto Guacolda. Côte centrale : Cruz Grande ; Punta Teatinos ; Museo del Desierto ; La Herradura ; Guanaqueros ; El Pimiento ; et Valle El Encanto.*

sequence—from the acquisition of raw materials to their eventual discard. This approach enabled the identification of each group's technical know-how, along with their specific technical and economic choices, which could then be compared on a regional scale.

2. RESULTS

2.1. Preservation of the bone industry

The most frequent taphonomic agents affecting both northern and central coastal bone assemblages are concretions and root activity, although their intensity and impact differ. Concretions—found on 62.1% of the northern assemblage and 65.9% of the central—obscure technical traces and can lead to surface detachment. Root marks are also prevalent (73.8% in the north, 33.8% in the center), sometimes fully covering active ends. Fragmentation (68%) and weathering are more pronounced in the northern assemblage (31.3%), likely due to trampling, extreme aridity, low sedimentation rates, and prolonged exposure in open-air contexts.

In contrast, the central coast assemblage exhibits excellent preservation, with over 55% of the artifacts complete and showing mostly light weathering. This favorable condition may be related to the depositional context: many of the artifacts were buried immediately as funerary offerings, which limited their exposure to atmos-

		Northern coast				
		Residential site		?	Fishing and foraging station	Total
Type	**Category/Site**	**Punta Totoralillo**	**Huasco Norte**	**Puerto Guacolda**	**Bahía Maldonado**	
Domestic tools	Pointed tools	2	-	1	1	4
	Blunt or round end tools	2	1	2	4	9
	Lateral bevel	1	-	-	-	1
	Compressors	2	-	-	1	3
Hunting and fishing tools	Barbs	4	-	2	1	7
	Harpoon shafts	2	2	32	4	40
Undetermined	Tubular objects	-	2	-	-	2
	Fragments	5	1	-	1	7
	Undetermined	1	-	-	1	2
Subtotal		**19**	**6**	**37**	**13**	**75**
Type	**Category/Site**	**Punta Totoralillo**	**Huasco Norte**	**Puerto Guacolda**	**Bahía Maldonado**	**Total**
Other products	Blocks	-	1	-	-	1
	Blanks	-	4	1	2	7
	Waste products	5	3	-	2	10
	Undetermined	6	-	-	4	10
Subtotal		**11**	**8**	**1**	**8**	**28**
Total		**30**	**14**	**38**	**21**	**103**

Table 1 – Summary of the types of objects and products recovered from the northern coast.
Tabl. 1 *– Synthèse des types d'objets et de produits mis au jour sur la côte septentrionale.*

pheric agents and contributed to their better preservation. These differences underscore the impact of climate and site function on the preservation of bone artifacts.

2.2. Raw materials and faunal composition

In both areas, osseous industry was primarily manufactured from the bones of terrestrial mammals, particularly camelids. On the northern coast, these account for 87.6% of the assemblage, with 20% specifically identified as camelids, while birds, marine mammals, and indeterminate remains are less frequently represented. On the central coast, terrestrial mammals represent 60.5% of the assemblage, of which 19% corresponds to camelids. These animals are followed by birds (33.8%) and marine mammals (3.6%). In both regions, long bones—especially metapodials—were preferred for the manufacture of various tools and ornaments. However, taxonomic diversity is higher on the central coast, whereas in the north, a smaller number of elements could be identified, possibly due to the fragmentation of the specimens.

In contrast, vertebral faunal assemblages from archaeological sites such as Punta Totoralillo, Bahía Maldonado, Huasco Norte, Punta Teatinos and Museo del Desierto reveal a different pattern. In these few coastal sites where faunal remains were studied, ichthyological remains dominate, particularly jack mackerel (*Trachurus symmetricus*), with lesser amounts of snoek (*Thyrsites atun*), conger eels (*Genypterus* sp.), and small-eyed flounder (*Paralichthys microps*). These are followed by marine mammals (especially Otariidae and other pinnipeds), as well as seabirds such as cormorants (Contreras, 2005; Rivas, 2012; Troncoso et al., 2024; see also endnote 2). In contrast, camelid remains are scarce in sites such as Punta Totoralillo, Huasco Norte 1 and Bahía Maldonado (Contreras, 2005; Rivas, 2012; Troncoso et al., 2024; see also endnote 3), suggesting that terrestrial hunting was not a primary activity in these contexts.

2.3. Composition of the assemblages

Along the coasts of Chile's Semi-Arid North region, bone objects represent the predominant technical category, accounting for 85% of the assemblage on the central coast and 73% on the northern coast. A notable difference between these assemblages lies in the quantity of material recovered, as the central coast yielded three times as many pieces—possibly due to more extensive archaeological research in that area and better preservation. To a lesser degree, both regions also yielded other technical products, such as raw material blocks (2% on the central coast and 1% on the northern coast), blanks (3% and 7%), and pro-

		Central coast							
		?	Cemeteries/Residential sites					Residential site	Total
Type	**Category/Site**	**Cruz Grande**	**Punta Teatinos**	**Museo del Desierto**	**La Herradura**	**Guanaqueros**	**Valle El Encanto**	**Quebrada El Romeral**	
Domestic tools	Pointed tools	-	7	4	4	4	2	1	22
	Blunt or round end tools	-	4	6	1	4	2	1	18
	Lateral bevel	-	3	-	-	-	-	-	3
	Compressors		7	3	2	12	-	-	24
	Retouchers	-	-	1	-	-	-	-	1
Hunting and fishing tools	Fishhooks	-	-	-	1	1	-	-	2
	Barbs	-	9	-	28	16	-	-	53
	Composite sinker-hook: weight	-	2	-	1	4	-	-	7
	Harpoon shafts	-	9	-	8	10	-	-	27
	Atlatl hook?	-	1	-	-	-	-	-	1
Ornamental elements	Beads	-	-	6	107	6	1	-	120
	Decorated bevel	-	-	-	-	1	-	-	1
	Plaques	-	2	-	-	-	-	-	2
Undetermined	Blunt or ogival end tools	-	3	1	-	2	-	-	6
	Tubular objects	-	2	-	-	-	-	-	2
	Fragments	-	2	1	4	7	1	2	17
	Undetermined	-	-	-	-	1	-	-	1
Subtotal		**0**	**51**	**22**	**156**	**137**	**6**	**4**	**307**
Type	**Category/Site**	**Cruz Grande**	**Punta Teatinos**	**Museo del Desierto**	**La Herradura**	**Guanaqueros**	**Valle El Encanto**	**Quebrada El Romeral**	**Total**
Other products	Blocks	4	1	1	1	-	-	-	7
	Blanks	-	4	-	-	4	-	5	13
	Waste products	-	10	5	-	9	1	1	26
	Undetermined	-	4	1	-	8	1	-	14
Subtotal		**4**	**19**	**7**	**1**	**21**	**2**	**6**	**60**
Total		**4**	**70**	**29**	**157**	**88**	**8**	**10**	**367**

Table 2 – Summary of the types of objects and products recovered from the central coast.
***Tabl. 2** – Synthèse des types d'objets et de produits mis au jour sur la côte centrale.*

duction waste (7% and 9%), all of which were essential for reconstructing one of the most recurrent technical schemes along the littoral zone of Semi-Arid North region. The northern coast exhibits a higher proportion of undefined products (10%, compared to 3% on the central coast), a difference likely attributable to the more advanced fragmentation and weathering affecting the sites in that region.

Regarding the identified equipment, as noted in the earliest studies of the region, a certain typological similarity can indeed be observed between the bone tools from the northern and central coasts. However, this similarity is limited to specific elements of the toolkit used for littoral resource exploitation, particularly the components of harpoons employed in the hunting of marine mammals or large fish. Along the region's coasts, harpoons are composite weapons consisting of several independent components, including barbs and harpoon shafts (fig. 2a and 2b-2c, respectively). These elements were manufactured from the long bones of terrestrial mammals—specifically, in the case of the central shaft, from quartered camelid metapodials. Both tool types exhibit notable consistency in terms of morphology, maximum width, and thickness. In contrast, the harpoon shafts display greater variability in length depending on the inten-

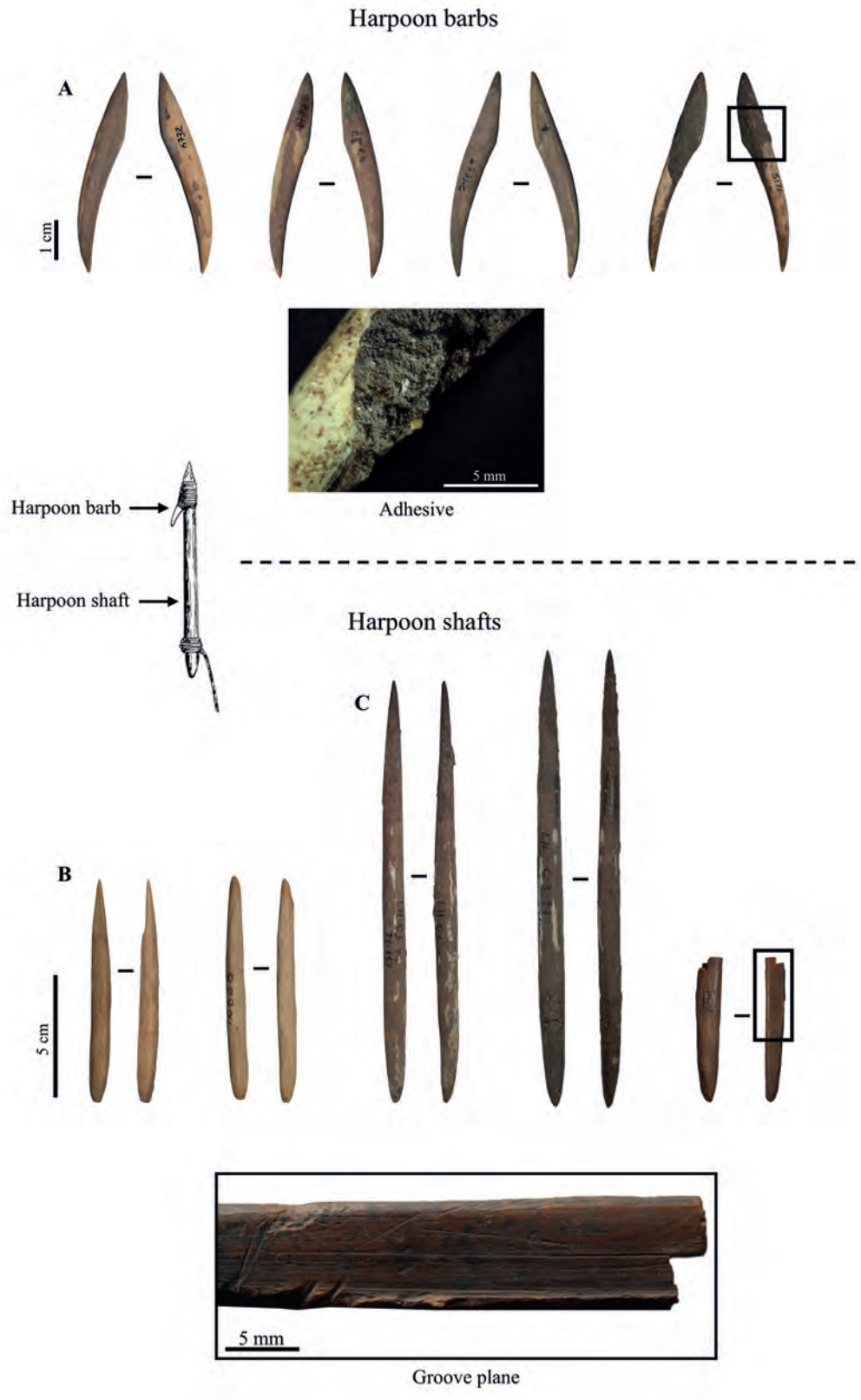

Fig. 2 – Maritime and littoral hunting and fishing equipment used by Archaic groups of the Semi-Arid North: A) Harpoon barbs oriented according to their intended use. Details of adhesive observed on some specimens, used to secure the attachment to the harpoon shaft; B) Harpoon shafts from the northern coast; C) Harpoon shafts from the central coast. Detail of stigmata produce by grooving technique.

Fig. 2 *– Équipement de chasse et de pêche maritime et/ou littorale des groupes de la période archaïque du Nord semi-aride : A) barbelures de harpons orientées selon leur utilisation. Détail de l'adhésif, observé sur certains exemplaires, utilisé pour fixer la pièce au fût du harpon ;B) fûts de harpons de la côte septentrionale ; C) fûts de harpons de la côte centrale. Détail du pan de sillon produit par rainurage.*

sity of use, with several specimens exhibiting fractures on the distal-medial end attributable to functional wear.

Another category identified in the Semi-Arid North region corresponds to domestic equipment, composed of pointed, blunt, and beveled-end tools systematically manufactured from the long bones of terrestrial mammals, particularly camelid metapodials. Unlike the equipment associated with marine exploitation, this category exhibits considerable morphological and metric variability within each of the three tool groups, on both the central and northern coasts (fig. 3.1).

A notable exception within this category is a specific type of tool identified through macroscopic use-wear analysis, which revealed numerous compressors manu-

Fig. 3 – Domestic equipment of the Archaic groups of the Semi-Arid North. 1) Tools with pointed active end: A. Specimen from the northern coast; B. Objects from the central coast made from camelid metapodials. 2) Compressors with rounded or blunt active ends: A) Tools from the northern coast; B) Objects from the central coast. Detail of macroscopic use-wear traces. Top: sliding striations and faceting on the active end. Bottom: striations on the tip.

***Fig. 3** – Équipement domestique des groupes archaïques du Nord semi-aride. 1) Outils à extrémité active appointée : A) spécimen provenant de la côte septentrionale ; B) objets de la côte centrale fabriqués à partir de métapodes de camélidé. 2) Compresseurs à extrémité active mousse ou arrondie : A) outils de la côte septentrionale ; B) objets de la côte centrale. Détail des macro-traces d'usure. En haut : stries de glissement et façettage sur le front. En bas : stries sur l'extrémité active.*

factured from metapodials—found to a lesser extent on the northern coast (fig. 3.2a) and predominantly on the central coast (fig. 3.2b). The traces observed, such as faceted and striated tips and sliding striations, indicate that these tools were used for pressure retouching of lithic pieces, possibly related to the *façonnage* of the numerous projectile points recovered at coastal sites.

2.4. Techniques and schemes reconstitutions

The sorting of fauna remains enabled the identification of additional informative technical products. These elements provide evidence of various techniques and procedures that allowed us to reconstruct a longitudinal partitioning by grooving of camelid metapodials. Among these products, we distinguish raw materials blocks (N = 7), blanks (N = 10), production waste (N = 14), as well as tools (N = 48).

The technical transformation of camelid metapodials was primarily aimed at producing tools particularly from metapodial quarters, by making use of the bones' straight structure and mechanical strength (Scheinsohn and Ferretti, 1995). These characteristics made them suitable for manufacturing tools that were not only long and slender, but strong.

The initial preparation of the metapodials involved the removal of the epiphyses through direct hacking, possibly using large flakes or stone blocks, which are commonly found along the coasts of the Semi-Arid North. As observed in our experimental tests, this first transformation allowed for a more controlled partition by eliminating the most robust areas of the bone, where fractures were more likely to deviate (fig. 4a and 4b).

The partition was subsequently performed through grooving, by carving longitudinal grooves along the faces and/or edges of the metapodial using a lithic tool or flake with a beveled edge (fig. 4c and 4d). The bones were subsequently divided by a procedure that remains unidentified and left no visible traces on the surface. Given the limited number of intermediate products, it has not yet been possible to determine whether grooving was applied simultaneously across the bone or if an initial partition was followed by a successive division.

Metapodial quarters were the most frequently used blanks, shaped through abrasion with stones of varying grain size to produce harpoon shafts and compressors. Metapodial halves were also employed, though less commonly, for the manufacture of tools with rounded active ends, shaped using similar techniques.

Some tools exhibit evidence of repair, carried out through scraping or abrasion, aimed at extending their use-life. Additionally, the recycling of broken objects has been documented, for instance, harpoon shafts repurposed as compressors.

Finally, on certain occasions, tools that had been effectively used were deposited as offerings or discarded in the large shell middens that are abundant along the coasts of the Semi-Arid North. An overview of these various stages is presented in fig. 5.

3. DISCUSSIONS

Thus far, based on the equipment and resources consumed, we can confirm the presence of hunter groups strongly rooted in coastal environments. However, considering the exploited raw materials, they are necessarily connected with terrestrial spaces, articulating both environments in the bone industry. The acquisition of these bones may have resulted from the hunting of camelids—most likely guanacos, due to their size—which were then transported from other areas to the coastal sites under study. Although these animals were indeed present at the archaeological deposits, they did not constitute a significant component of the diet of these communities. On the contrary, they played an important role as raw material, possibly due to the morphological and mechanical properties of their metapodials, as previously discussed.

The challenges posed by our study corpus, primarily composed of finished objects, were relatively overcome through experimental testing. The comparison of archaeological and experimental traces, together with production waste, enabled the identification of a few additional technical products within the faunal assemblage.

Although these latter items were limited in number, the techno-economic approach nevertheless allowed us to reconstruct a broadly shared operational sequence for the exploitation of guanaco metapodials along the coasts of the Semi-Arid North region. These similarities include the technical objective of *débitage*—the production of quartered blanks—their economic purpose, namely the manufacture of compressors and harpoon shafts and overarching strategies for managing osseous raw materials, primarily guanaco metapodials. Based on this evidence, we propose the existence of a shared know-how in the exploitation of bone resources across this coastal territory.

These same ways of "doing" and "seeing" have been identified in more distant regions, such as the coast of the Atacama Desert. In this area, although only harpoon shafts have been studied under this approach, a general similar exploitation scheme has been documented for their production, one that involves the use of the same raw materials, as well as comparable methods and procedures (Ballester, 2020). This supports the idea of a shared cultural and technical tradition among distant groups distributed along the coast—one that persisted over a long period of time.

Regardless of whether a cultural unity existed, the presence of a shared substrate could support the notion of extensive networks of interaction and mobility across the broad coastal region of northern Chile during the Middle and Late Archaic periods, as previously noted (Troncoso et al., 2023). These interactions are further evidenced by the circulation of specific objects - such as *taltaloide* bifaces and shell fishhooks - primarily recovered along the northern coast of the Semi-Arid region, and to a lesser extent along the central coast.

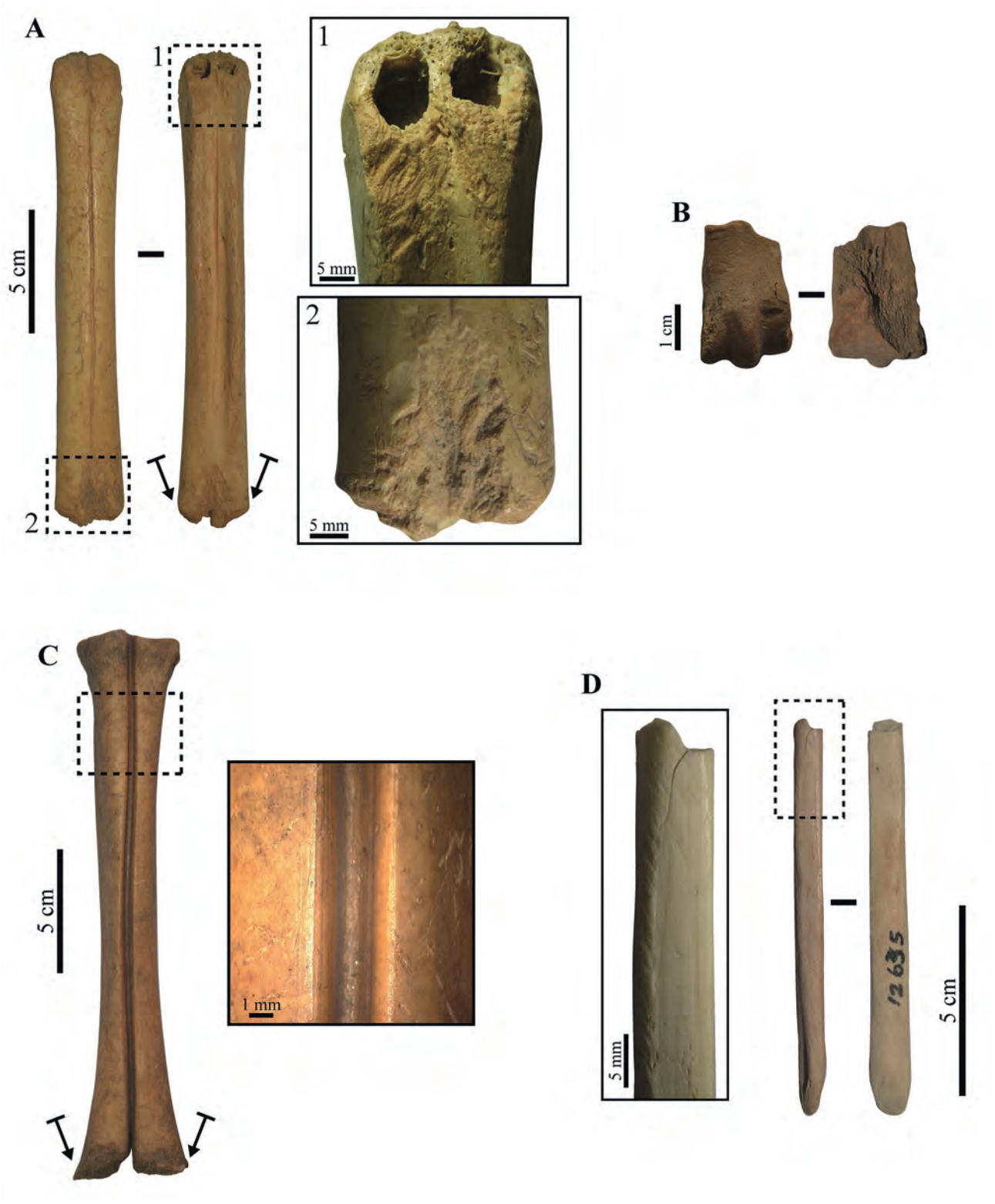

Fig. 4 – Technical products showing evidence of longitudinal partitioning —either successive or multiple— by grooving: A) Raw material block from the central coast. Camelid metapodial. Details of cutting planes, notches, and fractures produced by hacking; B) Waste production from the northern coast. Camelid metapodial condyle with few visible notches; C) Raw material block from the central coast. Camelid metacarpal. Detail of the stigmata produced by grooving, with striated planes and a V-shaped form; D) Blank in the process of transformation. Quartered metapodial. Detail of the grooving plane, partially covered by diagonal striations from abrasion.

***Fig. 4** – Produits techniques témoignant d'une partition longitudinale (successive ou multiple) par rainurage : A) bloc provenant de la côte centrale. Métapode de camélidé. Détail des pans de coupe, fonds d'entaille et fractures liées à l'entaillage ; B) déchet de la côte septentrionale. Poulie de métapode de camélidé avec des fonds d'entaille peu visibles ; C) bloc de la côte centrale. Métacarpe de camélidé. Détail du sillon produit par rainurage, avec des pans striés et un fond en « V » ; D) support en cours de transformation. Quart de métapode. Détail du pan de rainurage partiellement recouvert de stries diagonales dues à une abrasion.*

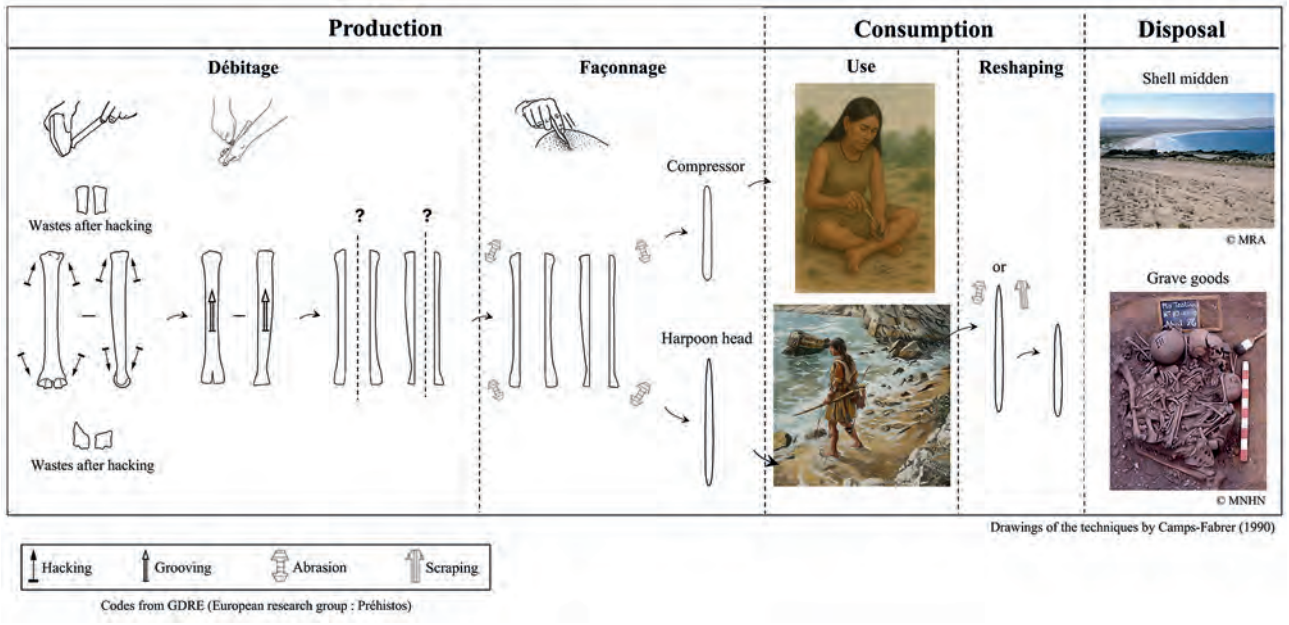

Fig. 5 – Operational scheme for the exploitation of camelid metapodials by Archaic groups of the Semi-Arid North of Chile.
***Fig. 5** – Schéma opératoire de l'exploitation des métapodes de camélidés par les groupes archaïques du nord semi-aride du Chili.*

Toward the end of these periods, however, such networks appear to have diminished across this macro-region, as increasingly evident differences in social organization, settlement patterns, subsistence strategies, and funerary practices emerged among the communities that inhabited the area. This transformation would be particularly valuable to investigate in greater depth.

CONCLUSIONS

The techno-economic analysis of the bone industry along the northern and central coasts of Chile's Semi-Arid North region reveals a broadly shared know-how in the transformation of camelid metapodials, particularly for the production of harpoon shafts and compressors. The recurrence of similar operational sequences and raw material preferences suggests convergent technical strategies among groups inhabiting a vast coastal territory. Despite the limited dietary role of camelids in some areas, their bones were highly valued, underscoring a dynamic articulation between terrestrial and maritime spaces. The identification of comparable technical schemes in more distant regions, such as the Atacama Desert coast, strengthens the hypothesis of a long-standing technical tradition.

The persistence of these practices over millennia—despite environmental fluctuations and potential demographic shifts—suggests the existence of stable mechanisms for the transmission of know-how, possibly maintained through extensive networks of interaction, materialized as seasonal mobility, intergroup contact, or the exchange of information.

To deepen our understanding of the cultural and socio-economic implications of these shared practices, future research could follow two complementary lines: the study of additional residential sites along the northern coast of the Semi-Arid region, and the integration of other assemblages—such as lithic and shell industries—as well as social spheres, including burial practices, settlement data, and subsistence strategies from across the territory. Combined, these approaches have the potential to reveal new dimensions and offer valuable insights into technological organization, its transmission over time, interaction patterns, and the long-term resilience of Archaic coastal traditions.

NOTES

1. In the coastal ravines, Valle El Encanto stands out, located about 30 km inland. This site presents characteristics similar to those found on the coast, for example Quebrada El Romeral (Troncoso et al., 2016). These would have been residential camps where grinding hollows and rock paintings have been recorded, together with remains indicating the exploitation of coastal resources such as scallops, surf clams, and tools made from shells of Choromytilus chorus (Rivera et Ampuero, 1964, 1969; Pascual et al., 2019). Owing to these features, which link it to coastal populations, Valle El Encanto has been included in this analysis.
2. See also R. González – *Análisis Ictiológico Conchal 1, 2 y 3, Sector Bahía Maldonado, Comuna de Caldera, Región de Atacama*, excavation report, Informe proyecto «Arqueología Bahía Maldonado», 2024, manuscript in possession of the author, 26 p.
3. See also F. Vera – *Resultados preliminares del análisis zooarqueológico y tafonómico del sitio Bahía Maldonado, Conchal 1, 2 y 3 (Región de Atacama, Chile)*, excavation report, Informe proyecto «Arqueología Bahía Maldonado», 2023, manuscript in possession of the author, 13 p.

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