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Hunting technology and prepared landscapes in the South-Central Andes

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HUNTING TECHNOLOGY AND PREPARED LANDSCAPES IN THE SOUTH-CENTRAL ANDES

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Camelid hunting has been a central practice for the social reproduction of human populations who occupied the south-central Andes through time. Among the evidence that contributes relevant information about this subject matter are projectile points and their connection with different weapon systems and the hunting strategies implemented by these groups. In this work, we will present information obtained from an intensive survey realized in two archaeological places of the Catamarca highlands. The projectile points recovered in the fieldwork were analyzed in order to understand the manufacturing techniques and the assignment to different types of weapon and to different historical time periods. Finally, with this information, we will evaluate the different hunting strategies performed by hunters and compare this model with other proposals made in other studies in the same landscape.

KEYWORDS: *Hunting, Projectile points, Landscape, Vicuñas, Technology*

INTRODUCTION

There is a great deal of archaeological evidence of the importance of the exploitation of wild camelids in the south-central Andes for different historical contexts, starting with the first occupations until various historical moments (Aschero *et al.* 1991, 1993–94; Aschero and Martinez 2001; Elkin 1996; Fernández Distel 1986; Haber 2003a, 2003b, 2006, 2007; López 2003, 2006; Martínez 2003; Nuñez 1983; Nuñez and Santoro 1988; Olivera 1997; Pintar 1996; Ratto 2003; Yacobaccio 1988, 2001; Yacobaccio *et al.* 1994, 1997–98; Yacobaccio and Madero 1992, among others). In this sense, some records indicate that since the first occupations in the area, dated from about 12 000 years ago, there is relevant information regarding hunting technology. On sites like Quebrada Seca 3 and Huachichocana III in Argentina, or Tuina I, San Lorenzo or Chulqui in Chile, the weapons which were used would have been atlatl dart and spear throwing, whose projectile points showed two basic designs: one a small triangular limb with a straight base, and the other, big lanceolate limbs, in some cases with the presence of denticulation (Fernández Distel, 1974, 1986; Hocsman *et al.* 2012; Martínez 2003; Núñez 1992). This last design should have replaced the first one during the Middle Holocene, its use being replicated in different sites in the area. In some cases they have straight bases and in others low cut bases, presenting great dimensions and the use of spear throwing as the weapon system. Toward 5000 cal yr BP, the use of these projectile point designs became generalized, increasing the basic forms and using the atlatl as the main weapon system (Babot *et al.* 2013; De Souza 2004; Hocsman 2006; Pintar 2004).

The domestication of animals and plants generated certain changes in the logics of production and reproduction of the local groups in these environments. However, hunting continued to be a relevant practice, incorporating the use of bow and arrows as a weapon system, with projectile points of triangular design, pedunculated or with convex baseline and whose size gradient decreased as the centuries advanced, with a considerable reduction of the size for Inka moments (Chaparro 2009; Elias 2007; Escola 1987; Flores and Wynveldt 2009; Hocsman 2006; Hocsman and Escola 2006/2007).

These data, added to information from other sources, such as for example archaeo-faunal sets, show the relevance of wild fauna for the human population's reproduction through the history of occupation of the south-central Andes, beyond

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some differences around the aim of this practice[1] (Moreno and Revuelta 2010; Olivera 1997; Revuelta 2005; Yacobaccio *et al.* 1997–98).

The recognition of the importance of wild camelids for human societies promoted the development of research lines tending to establish hunting strategies, which were based on the factual basis of projectile points (Aschero and Martinez 2001; De Souza 2004; Escola 1987, 2000; Hocsman 2002, 2006; Hocsman *et al.* 2012; Hoguin 2014; Hoguin and Restifo 2012; Martínez 2003; Moreno 2010, 2012b; Ratto 1994, 2003; Restifo 2013) and the landscape characteristics in which the encounter between preys and hunters should happen.

Second are the investigations which have proposed hunting strategies in the studied area, based on the data provided by the recovered projectile points, prey ethology, the local landscape and the participation of variable numbers of hunters. Aschero and Martinez (2001) suggest, for the early Holocene, three hunting strategies which would have replaced one another through time, based on the information recovered from Quebrada Seca 3 (Antofagasta de la Sierra Department, Catamarca, Argentina). For the period dated around 8660 ± 80 cal yr BP and 8640 ± 80 cal yr BP, hunting strategy from distance in open spaces, is suggest through approach (Churchill 1993), using the atlatl dart as a weapon. This strategy would have been replaced by hunting by interception, which varies in accordance to the use of atlatl (8670 ± 110 cal yr BP and 7350 ± 80 cal yr BP) or spear throwing (7130 ± 110 cal yr BP and 6080 ± 70 cal yr BP). This model is based in the guidance of animals toward narrow places blocking the routes of escape used by animal troops. In order to complement the local relief's characteristics, drivers[2] were used in order to guide the animals, and also parapets or trenches as hiding places. Finally, a third model assumes hunting by ambush with the use of darts as a weapon system (7130 ± 110 cal yr BP and 6080 ± 70 cal yr BP). This model proposes the use of several parapets and the participation of a significant number of people, between hunters and drivers.

A similar proposal was presented by Ratto (2003) at Chaschuil Valley (Tinogasta Department, Catamarca, Argentina) of a hunting technique for the Archaic period based on fixed, compact targets and whose escape was obstructed by guiding the troops to swamps. That strategy is associated with the animal's disadvantage proposed by Churchill (1993). Another possible hunting technique would have been developed in the open valleys, using parapets to hide hunters. These parapets would allow the hiding of hunters until the preys would move within the action range of their weapons. In this model several hunters would have participated, but no drivers.

These models show the necessary articulation between several factors for hunting performance: prey characteristics, relief, resources, numbers of hunters and weapon systems. In both, relevant changes are stated regarding hunting strategies considering the use of different weapons, such as spear throwing, hand spear, atlatl and bow and arrow, which present a historical sequence of use (Moreno 2011). These modifications involve changes in the spaces used to perform the encounter with prey and the presence or absence of architectural features used for hiding, such as parapets. In terms of hunting strategy, following Churchill's (1993) proposal, both models state the use of disadvantage or interception for early moments, replaced by ambush in later moments. Also in both, the change of weapon systems has a great impact on the selected strategy, as also does the incorporation of other variables, such as the use of the landscape or the addition of drivers.

Taking into account a data set obtained at the Salar de Antofalla area (Haber 2006, 2007; Haber and Moreno 2008; Moreno 2010; Moreno and Revuelta 2010; Revuelta 2005) precisely around the relevance of vicuñas in this area, an intense survey was conducted at Antofalla Valley, with the aim of distinguishing the hunting strategy, the weapons used and the historical scale of analysis of this practice (Moreno 2010).

This valley, located in the northwest sector of the Antofagasta de la Sierra department, Catamarca (Figure 1), is one of the valleys which descend toward the Salar de Antofalla, following the water course which is originated in a pair of waterholes located approximately 4100 and 3900 m above sea level and which in its lowest part forms an alluvial fan with an approximate height of 3400 m above sea level, where it disappears in the salt flat. This peculiarity forms marshes around the water course, the rest of the landscape being dry. The principal characteristics of this area are: arid climate, strong temperature differences between day and night, low vegetal coverage, rugged topography with steep slopes, and high altitudes. The rainfalls are principally snowy, predominantly the ones which occur in the higher peaks. The Antofalla Valley has two well-marked hillsides, whose slopes are variable.

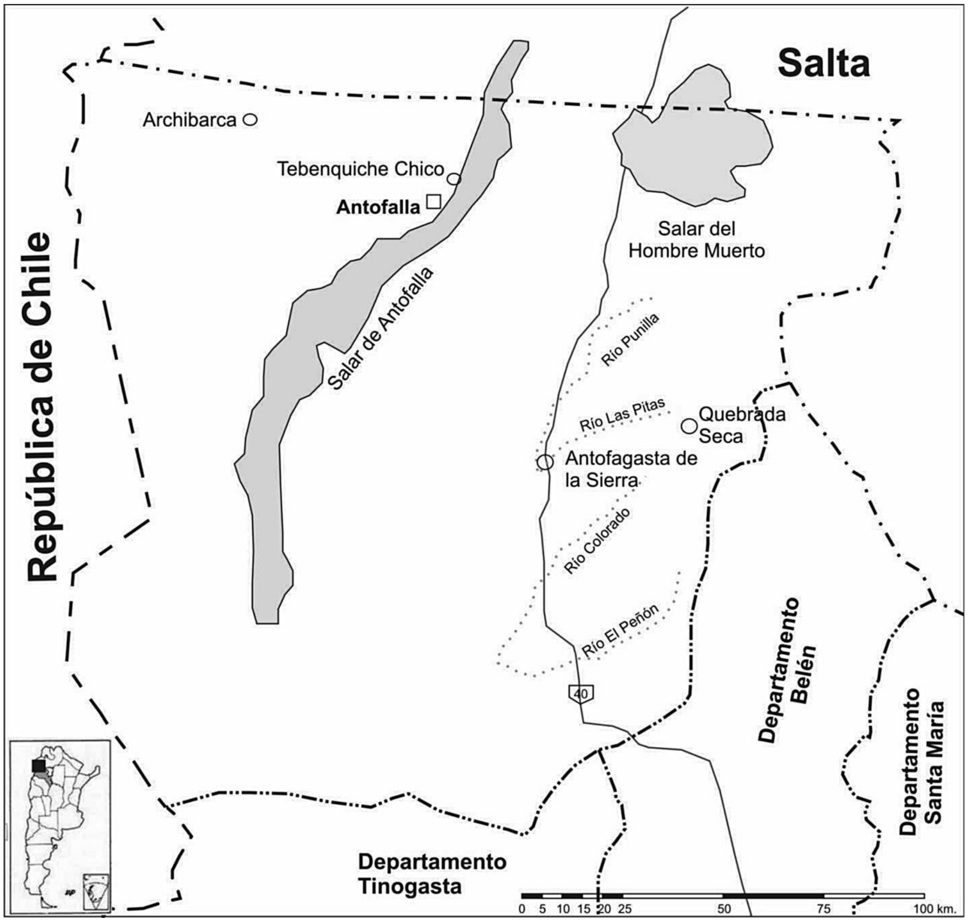

FIGURE 1. Antofagasta de la Sierra department map where the Antofalla Valley and Quebrada Seca are located (Modified from Aschero 2000).

In some places they are very steep, and in others rather mild (Figure 2).

The intensive survey performed assumes a

> careful observation of the landscape, performed by archaeologists with the purpose of finding remains of past deposits and where it is important, as much or more the recovery of archaeological information, the register of the environmental conditions and the general characteristics of the land, beyond mere deposits. (Criado Boado 1999: 98, translated by the author)

In this sense, all of the cultural transformations as well as their linkage with the local landscape and the available resources are important. The cultural modifications, named register units, were differentiated according to three principal types: structures, material dispersions, and isolated findings.

The survey in Antofalla was developed along an area of 40 km², 3301 register units being found, which are analyzed in detail in other papers (Moreno 2010, 2011, 2012a, 2012b, 2013).

The obtained information is linked with a multiplicity of social practices and historical times. A large number of structures and materials regarding hunting practices were recorded. The linkage between structures, weapons, preys, and hunters was the basis for the construction of the concept of a "hunting landscape," understood as a space constructed with the purpose of anticipating the actions of possible preys and, in this way, achieving more possibilities of success for hunters. This landscape construction shows a great knowledge of the local relief and also of the ethologic characteristics of the potential preys—mainly, in this case, wild camelids.

PREY ETHOLOGY

Considering that the main prey predatded by hunters would be wild camelids, we present the behavioral characteristics of the vicuña, which is,

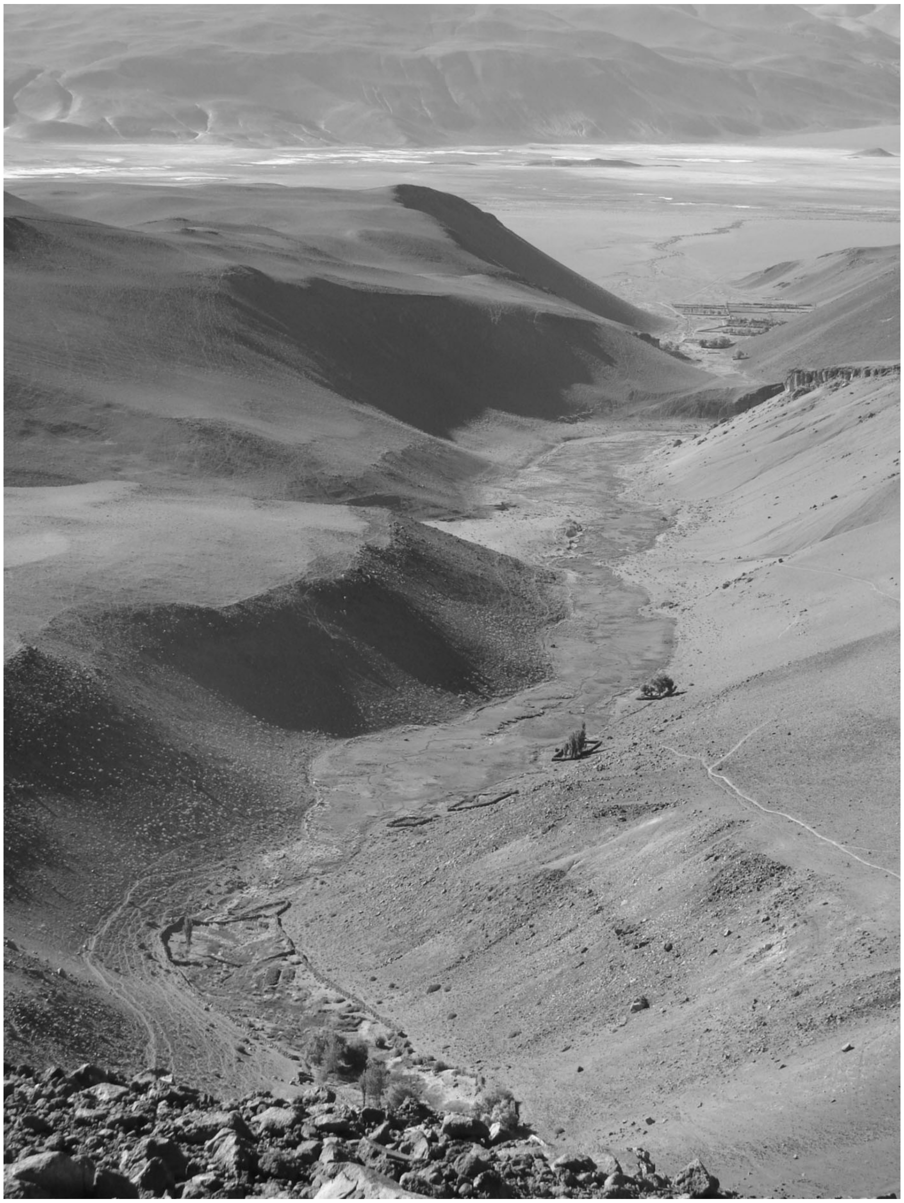

FIGURE 2. General view of Antofalla ravine. Note the characteristic of the slopes and the presence of hydric resource focus in the lower part of the ravine.

nowadays, the only wild camelid present in the area. The social organization of the vicuña is characterized by the existence of family polygynous groups, troops of single males and solo males. In this case we will focus on the family groups, because of the exploitation of animals of both genders and different ages in the archaeofaunal remains (Elkin 1996). The family groups are defined by a dominant male or "relincho," who maintains and controls the territory, a variable number of adult females, young females of more than one year old and offspring of both genders (Bonacic 2005; Franklin 1982; Hoffman *et al.* 1983; Tomka 1992; Wheeler 2006). The dominant adult male is in charge of the protection of the troop, being alert against possible danger and beginning the escape if it is necessary, at a very high speed and through steep and rugged slopes, and that is why hunting by means of persecution would not be a viable option.

The boundaries of the territories are based on the conformation of dung piles (Bonacic 2005; Tomka 1992; Wheeler 2006). This territory includes a sleeping segment, using preferably rocky places, which would give them some protection, and feeding segments placed at lower areas with grazing and water sources. Every day the troops connect each segment, sleeping in the

higher zones, going down during the sunlight hours to graze and drink water, and going back at sunset to the rocky places used as the sleeping segment (Cajal 1998; Franklin 1982; Haber 2003a; Haber and Moreno 2008; Hoffman *et al*. 1983; Koford 1957; Tomka 1992). The physiology of these animals determines the need to drink water every day, so that this movement is indefectibly performed daily.

The ethologic characteristics of the possible preys show the necessity of structuring the landscape to promote encounters between hunters and animals. In this sense, the family groups have a daily movement between segments that is relatively predictable, but they easily perceive predators with their senses (principally smell, sight and hearing) and can very quickly escape, avoiding practically any obstacle which they might encounter. A relevant aspect of these animals is the material marking which they perform by dung piles and the recurrent use of paths (Vila and Cassini 1994), which delimitate territories. In this regard, hunters might use their knowledge of behavior patterns to prepare the landscape where hunting took place.

The hunting landscape

In the Antofalla Valley, the preparation of this landscape was made by the construction of some structures tending to propitiate the hunter's hiding, located in higher positions with good visibility. These structures, named trenches,[3] are simple stone walls, built with blocks of different sizes and no selection describing an arch, although they might also be straight (Figure 3). They consist in a simple wall with an average length of 1.5 m and a maximal average height of 0.7 m. We have recorded trenches of different sizes and construction forms, but the main design is always the same: to provide hunters with a hiding place from the potential preys, locating them in strategic points in relation to the surrounding landscape. We posed the concept of "hunting landscape" in Antofalla Valley, because of the register of 503 of these structures along the valley; in most cases a variable number of trenches were associated in reduced spaces, and in only few cases were they isolated. This landscape supposes the use of an ambush strategy (Churchill 1993) with the possible participation of drivers guiding the preys toward the trenches. In this way, when the animals would be near the trenches hunters could obtain close and relatively fixed targets in order to perform the attack.

An example of the linkage between trenches and relief was identified in the middle section of the valley, where we registered a number of structures which correspond to trenches and landmarks located along the break of the higher slope of the hillside. In this case we noted a path, constructed by the removal of rocks, of about 3 m width and about 250 m length, which connects trenches placed there (Figures 4 and 5). Here, hunters in the higher zone would have awaited the ascent of the troops at sunset through a mountain pass. The path would allow hunters to move quickly among the different trenches, without losing sight of preys, as they did not risk tripping on the rocky ground, enabling the attack from the most suitable position.

But besides the trenches, other structures could have been part of this landscape, such as landmarks, used to mark territories; shelters to protect from adverse weather conditions during a hunting expedition, or the presence of lithic workshops associated to structures and eaves would have formed a constructed landscape, reproducing and experimenting with the interaction between hunters and preys over a long historical period.

An important part of this prepared landscape is hunting technology, the focus in this case on projectile points. This aspect is crucial because of two issues: on one side, because of the association they might have with structures and which would allow us to asses modifications in hunting strategies through time; and, on the other, to evaluate the use of these spaces in different historical moments, the design of the projectile points being useful as a relative chronological marker.

Weapons technology in Antofalla

In the Antofalla Valley, we recorded 192 projectile points, of which only 13 were recovered complete. For the manufacture of these projectile points, two raw materials were mainly selected: black basalt-andesite ($n = 125$; 65.5 per cent of the sample) and obsidian ($n = 48$; 25 per cent of the sample). The first raw material presents its quarry in the lower section of the valley, being near and of easy access, and also presenting very good quality for knapping (Moreno 2009, 2010). In the case of the obsidian, 28 projectile points come from the Ona quarry, located about 15 km from the Antofalla Valley which has great importance at the regional level, as studies of neutron activation have allowed us to identify the use of this raw material in different zones of

FIGURE 3. Different types of trenches registered in the intensive survey of the Antofalla Valley.

the Argentinian Northwest at distances that reach 350 km (Yacobaccio *et al.* 2004). Furthermore, in contrast to the obsidian obtained from the Ona quarry, another type was used in the manufacture of other 20 projectile points. This obsidian has the characteristic that it is dull and has a better quality for knapping than the Ona obsidian. Until now, we did not know the source of this raw material. However, in the Archibarca Basin, around 60 km from Antofalla Valley, small disperse nodules of this raw material have been found in the landscape (Haber 2003b). The remaining 10 per cent has been manufactured from other raw materials such as opal, possibly also coming from Archibarca Basin, where a quarry of this material has been identified (Haber 2003b). Finally, five projectile points were manufactured with raw materials which have not yet been identified.

FIGURE 4. Trench placed in association with the path.

The techno-morphological analysis performed on these materials is based on Aschero's (1975, 1983) proposal, with some modifications taken from specialized literature (Aschero and Hocsman 2004; Hocsman 2006; Martínez 2003; Moreno 2005; Ratto 1994, 2003). The assessed variables aim to give a first approximation to the knapping techniques used in the preparation of the piece and the work invested in its manufacture.

The techno-morphological analysis shows the prevalence of micro retouching, it being the technique with which 179 projectile points were manufactured, while only 13 were manufactured by retouching. The extension of the flakes show that 75 projectile points have bifacial thinning, while 65 present bifacial reduction and 52 flakes affect only the bevel. The analysis shows a very homogeneous manufacture which implies the bifacial thinning or reduction of the pieces, but presenting an important variation around the final design.

In regard to this issue we created 10 morphologic types of projectile points and four morphologic specimens (Aschero 1988). These groupings aim at two objectives: on one side, to asses the different types of weapons used in the area, and

FIGURE 5. General view of the path with no rocks, prepared for hunters to run and make the attack.

on the other to construct a relative chronological assignment, through the comparison with specimens obtained in contexts with radiocarbon dating. In Table 1 we present the variables used for the assignment of the pieces to the different types, and in Figure 6 they are exemplified.

To analyze the connection between projectile points and weapon systems, originally the size and form of the projectile points were taken into account, the bigger ones being assigned to atlatl darts and the small ones to bow and arrow (Fenenga 1953; Kidder 1938). Fenenga (1953) proposes weight as a relevant variable for functional assignment. According to this author the projectile points with lower weights, to 4 g, would correspond to bow and arrow, while the ones that exceed this weight would be atlatl darts. This perspective has been criticized starting from studies based on ethnographic cases, because they noticed that taking into account only the weight variable or the size for functional assignment was not enough (Ratto 2003; Shott 1997; Thomas 1978) In a previous work (Moreno 2011), we performed a preliminary analysis of these materials, but we are able to deepen the method here, enlarging the pattern and performing a systematic comparison of both methods, assessing the boundaries and possibilities and which we believe are the best decisions in the studied case.

One of the perspectives used for the functional analysis is the one developed by Thomas (1978), who proposed a model based on the following metric variables: length, width, thickness, neck width and weight. This methodology was later deepened by Shott (1997) who proposed the shoulder width as the most significant variable. This author proposed the following equations in order to differentiate the weapon systems.

For atlatl darts:

$$C = 0.18 \times \text{length} + 0.87 \times \text{shoulder's width} + 0.72 \times \text{thickness} + 0.21 \times \text{peduncle's width} - 18.79$$

For bow and arrow:

$$C = 0.07 \times \text{length} + 0.49 \times \text{shoulder's width} + 1.28 \times \text{thickness} + 0.14\,\text{peduncle's width} - 8.60$$

Applying these equations to each specimen, the one which gives the higher value is assigned as the corresponding weapon type.

Ratto (1994, 2003) has proposed some critiques of this perspective, principally due to its high generalization and the lack of interest in the different raw materials used for the manufacture of projectile points. In order to avoid these difficulties, this author has generated a functional assignment model founded on: (a) the hunting equipment described through ethnographic and experimental papers; (b) the functional mechanics of the weapons based on the laws of the mechanics of the fluids and the projectile's flight trajectory; and (c) the physical-mechanical properties of lithic raw materials.

TABLE 1. DIFFERENT TYPES OF PROJECTILE POINTS REGISTERED IN ANTOFALLA.

ID	*N*	Shape	Baseline	Raw material	Length	Width	Thickness	Base Width	Base thickness	Limb Thickness	Limb Width at the Maximal Thickness Point
Af-I	30	Lanceolated	Concave	BB-A (28), Ob Ona (2)	47.9	29.85	11.2	15.95	5	10.2	22.2
Af-II	5	Triangular	Straight	BB-A (3), Ob Ona (1) NI (1)	32.75	24.2	7.05	18.8	2.85	7.1	21.8
Af-III	3	Lanceolated	Convex	BB-A (2) Op (1)	23.5	22.7	9.1				
Af-IV	8	Stemmed lanceolated	Straight	BB-A (5) Ob dull (2) Ob Ona (2)	45.7	21.4	7.4	11.25	3.25	7.4	21
Af-V	4	Lanceolated	Convex	BB-A (2) Ob Ona (2)	46.5	24	9.1	12	3.1	9.1	21.2
Af-VI	6	Stemmed rhomboidal	Convex	BB-A (4) Ob Ona (1) NI (1)	41.6	24.8	9.4	9.2	2.7	9.4	20.5
Af-VII	12	Lanceolated	Convex	BB-A (11) Ob dull (1)	78.65	19.05	11.1	14.8	4.9		
Af-VIII	15	Stemmed lanceolated	Convex	BB-A (9) Ob Ona (2) Ob dull (3) Op (1)	53.8	26.2	10.7	15.3	2.6	10.7	26.2
Af-IX	9	Stemmed triangular	Straight	BB-A (2) Ob Ona (6) Ob dull (1)	26.3	15.9	5.6	5.1	2.9	5.6	15.9
Af-X	3	Stemmed lanceolated	Convex	BB-A	61.35	26.3	10.1				
Af-A	1	Stemmed lanceolated	Concave	BB-A	38.6	30	9.3	20.4	3.8	9.2	24.1
Af-B	1	Stemmed	Convex	BB-A	45.4	29.3	8.8	19.3	6.7		
Af-C	1	Stemmed triangular	Straight	NI	48.3	34	6.8	12.3	3	6.8	19.3
Af-D	1	Lanceolated	Pointed	BB.A	54.2	26.3	9.5	14.8	2.5	9.3	23.3

The raw material references are: B-BA = black basalt-andesite; Ob-Ona = obsidian from Ona; Ob-dull = dull obsidian; Op = opal; NI: not identified. Measurements are expressed in mm.

For the northwestern Argentine area, Ratto (1994, 2003) has generated a functional assignment model, extending the number of weapon systems, as she incorporates spear throwing and hand weapons, based on a series of related aspects of the performance of the technical system (Ratto 2003:87).

- Reinforcement surface: This is the one that supports the impact strength or crash, regarding the type of flight trajectory of the technical system. One next considers the strategies to diminish the possibility of fracture of the piece. This is calculated through the quotient between the maximum limb thickness and the width of the limb at the point of maximal thickness. The index values go from zero to one, constituting ends of a continuum which ranges from very high to very low and with intermediate values.
- Aerodynamic: Considers the instrument's contact with the air, the higher the aerodynamics of the piece being in order to counteract this effect and maximize the weapon's flight control. This is calculated taking into account the transversal section of the piece (sensu Aschero 1975), the contour shape of the limb (symmetrical/asymmetrical), and the contact surface.
- Penetration power: This variable is calculated based on measuring the angle on plain sight of the piece, complemented with the calculation of the area of the apex section. This measure assesses the chances of rebound possibilities of the projectile in the target.
- Stem: Through the measurement of the width of the base or the peduncle, as applicable and taking 10 mm as a limit, it is possible to discriminate atlatl darts and arrows, assigning higher values to the former and lower values to the latter.

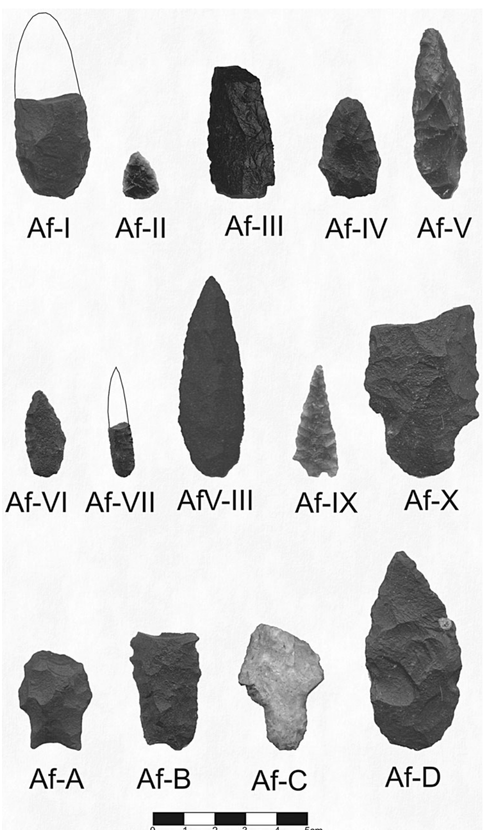

FIGURE 6. Types of projectile points registered at Antofalla.

Through Shott's (1997) proposal, the assignment of 38 specimens was possible, of which nine were assigned to bow and arrow and 29 to atlatl darts. In Table 2 we show the values used and the results of each equation.

The other methodology, posed by Ratto (1994, 2003), includes a signficant number of variables, causing a diminishing number of specimens which present the necessary characteristics to apply the analysis. That is why only 14 projectile points presented all the variables in order to be incorporated to the model. From them, five were assigned to bow and arrow, three to spear throwing, three to hand weapons, and two to atlatl. Finally, one specimen could not be assigned to any weapon system (Table 3).

However, if we compare the results of both models, we notice that there are certain differences in the projectile point's functional assignment. Some of them are based on the possibility that Ratto's (1994, 2003) model grants the possibility of enlarging the type of weapon used, and that is why some specimens, such as AF-CXV and AF-AAO and AF-DTZ, were assigned to atlatl following Shott (1997), while with the other model they would correspond to hand weapons or throwing spears. In these cases, we believe the assignment posed by Ratto (1994, 2003) is more suitable, due to the existence of other systems which were not referred to by Shott (1997), and, therefore, we assigned those specimens following the first proposal.

However, some specimens show inconsistencies between the models. There are two specimens which following Shott (1997) were assigned to atlatl darts, but following Ratto (1994, 2003) were assigned to bow and arrow. At this point we believe it is necessary to take a methodological

Table 2. Projectile point assignments according to the model of Shott (1997).

ID	Length	Shoulder Width	Thickness	Neck Width	Atlatl Equation	Bow and Arrow and Equation	Weapon
Af-1160	26.1	13.5	4.8	5.4	2.243	6.742	Bow and arrow
AF-1489–2000	70	35.8	12.2	25.6	39.116	33.042	Atlatl
Af-1779	31.4	17.7	8	9.2	9.953	13.799	Bow and arrow
Af-1836	51.2	29	12.2	24.4	29.564	28.226	Atlatl
AF-AAO	54.2	26.3	9	14.3	23.33	21.603	Atlatl
AF-AFX	45.4	29.3	8.8	26.5	26.774	23.909	Atlatl
AF-ATF	28.6	12.3	3.3	3.8	0.233	4.185	Bow and arrow
AF-ATV	30.2	27.3	8.6	21.2	21.041	20.867	Atlatl
AF-AUB	28.6	23.2	5.5	11.8	12.98	13.462	Bow and arrow
AF-AVM	42.7	25.8	7	13.6	19.238	17.895	Atlatl
AF-AWH	48.7	23	8.7	18.4	20.114	19.791	Atlatl
AF-BFP	37.6	25.4	10	22.3	21.959	22.4	Bow and arrow
AF-BGI-2001	54	31.1	11.7	23.5	31.346	28.685	Atlatl
AF-BMK	45.7	28.4	6.7	24.5	24.113	20.521	Atlatl
AF-BSZ	74.1	29.2	11.1	24	32.984	28.463	Atlatl
AF-CRB	55.2	24.2	7.7	19	21.734	19.638	Atlatl
AF-CRF	48.3	34	6.4	15.9	27.431	21.859	Atlatl
AF-CWH	25.4	16.2	4.7	6.3	4.583	8.014	Bow and Arrow
AF-CWH-2001	48.4	33.4	11.7	20.7	31.751	29.028	Atlatl
AF-CWV	50.2	24.3	10.4	20.4	23.159	22.989	Atlatl
Af-CXE	52.5	34.8	12.2	26.2	35.222	31.411	Atlatl
AF-CXV	44	20.6	7.7	9.8	14.654	15.802	Bow and arrow
AF-CYB-2000	57.3	32.4	9.9	28.6	32.846	27.963	Atlatl
AF-CYE	46.3	36.3	11	22.3	33.728	29.63	Atlatl
AF-CYG-2001	38.1	25.2	9.3	20.8	21.056	21.231	Bow and arrow
AF-CYJ-2000	59.8	36.2	10.3	15.2	34.076	28.636	Atlatl
AF-CYW	37.3	31.4	9.1	23.5	26.729	24.335	Atlatl
AF-CZB-2000	51.1	32.3	12	19	31.139	28.824	Atlatl
Af-CZB-2001	53.3	33.8	10.4	24.2	32.78	28.393	Atlatl
AF-CZN	24.2	29.6	7.4	21.8	21.224	20.122	Atlatl
Af-CZV	57.7	27.6	9	18.8	26.036	23.115	Atlatl
AF-DAA	42.2	24.4	7.6	17.5	19.181	18.488	Atlatl
AF-DIK	47	22	6	11.7	15.587	14.788	Atlatl
Af-DLD	38	24	7	20.2	18.212	17.608	Atlatl
AF-DLE	40.8	20.8	8.2	18	16.334	17.464	Bow and arrow

Continued

Table 2. Continued.

ID	Length	Shoulder Width	Thickness	Neck Width	Atlatl Equation	Bow and Arrow and Equation	Weapon
AF-DTZ	67.5	24.8	10.2	13.2	25.052	23.181	Atlatl
Af-DUT	33	21	7	9.8	12.518	14.332	Bow and arrow
AF-DUV	38.6	30	9.3	21.6	25.49	23.73	Atlatl

Measurements are expressed in mm.

decision for the specimen's assignment. This is based on assuming Ratto's (1994, 2003) pose, taking into account that it was principally built for materials in the study area, while Shott's (1997) proposal was constructed based on collections obtained in the center of the USA. We also understand that the greater number of aspects considered by Ratto allows a more reliable assignment.

In this way, the projectile point assignment, which is shown in Table 4, gives 38 specimens assigned to different types of weapons, from which 10 correspond to bow and arrow, three to throwing spear, three to hand weapons, and the remaining 22 to atlatl darts.

HUNTING TECHNOLOGY ALONG TIME

The hunting of wild camelids was performed though the use of different kinds of weapons, assuming the replacement of some of the technologies and the change in hunting strategies considering the type of weapon used. The set presented in this paper comes from the surface, and that is why the design comparison with the ones recovered with radiocarbon dates allows the construction of a relative chronology (Aschero 1988; Aschero and Martinez 2001; Aschero *et al.* 2011; De Souza 2004; Escola 1987, 2000; Hocsman 2006, 2010; Hoguin 2014; Martínez 2003; Ratto 2003; Restifo 2013).

For the comparison of the set, we took the obtained dates from the types of projectile points presented above. This comparison, shown in Table 5, allows us to study the presence of projectile points, assigned to different historic moments, from 8600 BP until the first millennium of this era. In the same way we can observe the use of different weapon systems through time, restricting the use of throwing darts and atlatl darts to the early and middle Holocene, while these technologies would be replaced by bow and arrow toward the beginning of the Formative period (type AF-IX) (Aschero 1988; De Souza 2004; Escola 1987, 2000, 2004; Hocsman 2006, 2010; Moreno 2005). When we compare the distribution of projectile points according to their historical depth, the absence of a differential distribution is clear (Figure 7). Instead, this distribution shows a homogeneous pattern, because of which we stand for a reutilization of the hunting landscape through time.

In summary, the Antofalla Valley presents all the characteristics sought by wild camelids, especially vicuñas, to establish their territories, to rely on rocky places to rest and wide spaces to graze and drink water. The daily movements performed by vicuñas between these two spaces, as well as other behaviors, were known by hunters. In this way, when the troops returned to the sleeping segments, hunters, hidden behind trenches, could attack them. Hunter used different types of weapons to kill these animals, which did not permit shots from very long distances, as firearms do. So, they took advantage of the local landscape and, through the construction of structures of simple manufacture, prepared a space which would propitiate the encounter with preys in close positions, increasing the possibility of success. The information on the obtained projectile points on the area allows us to think in terms of a recurrent use in the long historical term of these spaces, reproducing the knowledge of hunters regarding the behavior of these preys. We believe that the ambush strategy (Churchill 1993) would have been reproduced through time, articulating the technical possibilities of the different types of weapons, the ethologic characteristics of the vicuñas and the preparation of a landscape aimed to increase the possibilities of success. In this way the adaptive advantages of preys were diminished, as they have great speed to escape in stress situations, suggesting that hunting by ambush would be practically

TABLE 3. PROJECTILE POINT ASSIGNMENTS ACCORDING TO THE MODEL OF RATTO (1994).

ID	Maximal Limb Thickness	Limb Width at the Maximal Thickness Point	Reinforce Index	Transversal Section	Limb Lenght	Limb Width	Contact Surface	Aerodynamic	Base Width	Angle	Weapon
Af-1160	6.1	11.4	0.535	BA	20.7	15.4	159.390	Normal	3.9	40	Bow and arrow
AF-ATF	3.6	12.7	0.283	BS	26.5	12.7	168.275	Perfect	6.5	25	Bow and arrow
AF-BMK	7.9	16.8	0.470	Pcx	27	29.2	394.200	Imperfect	5.2	35	?
AF-BSZ	10.8	23.6	0.458	BS	54	29.2	788.400	Perfect	14.7	65	Throwing spear
AF-CWH	4.8	13.6	0.353	BS	18.4	15.6	143.520	Perfect	4.5	35	Bow and arrow
AF-CWV	10.6	20.7	0.512	BS	35.2	24.2	425.920	Perfect	14.1	35	Bow and arrow
AF-DAA	8	24.2	0.331	BA	27.9	24.2	337.590	Normal	7.7	35	Bow and arrow
Af-DLD	6.8	17.7	0.384	BA	27.2	24.7	335.920	Normal	17.2	65	Atlatl
Af-DIK	6	21.1	0.284	BA	42.5	21.8	463.250	Normal	21.8	45	Atlatl
AF-AAO	9.3	23.3	0.399	Pcx	54.2	26.8	726.280	Imperfect	14.8	45	Hand weapon
Af-DTZ	10.2	23.6	0.432	Pcx	67.5	26.3	887.625	Imperfect	7.7	45	Throwing spear
AF-AUB	6	19.4	0.309	Pcx	28.7	22.2	318.570	Imperfect	19	65	Hand weapon
AF-CXV	12.9	18.7	0.690	Pcx	42.4	20.8	440.960	Imperfect	13.2	45	Throwing spear
AF-AVM	7.2	25.7	0.280	BA	38.8	27.6	535.440	Normal	14.8	65	Hand weapon

Measurements are expressed in mm.

TABLE 4. ANALYSIS OF PROJECTILE POINT ASSIGNMENT USING THE TWO MODELS.

ID	Weapon by Shott's model	Weapon by Ratto's model	Weapon
Af-1160	Bow and arrow	Bow and arrow	Bow and arrow
AF-1489–2000	Atlatl		Atlatl
Af-1779	Bow and arrow		Bow and arrow
Af-1836	Atlatl		Atlatl
AF-AAO	Atlatl	Hand weapon	Hand weapon
AF-AFX	Atlatl		Atlatl
AF-ATF	Bow and arrow	Bow and arrow	Bow and arrow
AF-ATV	Atlatl		Atlatl
AF-AUB	Bow and arrow	Hand weapon	Hand weapon
AF-AVM	Atlatl	Hand weapon	Hand weapon
AF-AWH	Atlatl		Atlatl
AF-BFP	Bow and arrow		Bow and arrow
AF-BGI-2001	Atlatl		Atlatl
AF-BMK	Atlatl	?	Atlatl
AF-BSZ	Atlatl	Throwing spear	Throwing spear
AF-CRB	Atlatl		Atlatl
AF-CRF	Atlatl		Atlatl
AF-CWH	Bow and arrow	Bow and arrow	bow and arrow
AF-CWH-2001	Atlatl		Atlatl
AF-CWV	Atlatl	Bow and arrow	Bow and arrow
Af-CXE	Atlatl		Atlatl
CXV	Bow and arrow	Throwing spear	Throwing spear
AF-CYB-2000	Atlatl		Atlatl
AF-CYE	Atlatl		Atlatl
AF-CYG-2001	Bow and arrow		Bow and arrow
AF-CYJ-2000	Atlatl		Atlatl
AF-CYW	Atlatl		Atlatl
AF-CZB-2000	Atlatl		Atlatl
Af-CZB-2001	Atlatl		Atlatl
AF-CZN	Atlatl		Atlatl
Af-CZV	Atlatl		Atlatl
AF-DAA	Atlatl	Bow and arrow	Bow and arrow
AF-DIK	Atlatl	Atlatl	Atlatl
Af-DLD	Atlatl	Atlatl	Atlatl
AF-DLE	Bow and arrow		Bow and arrow
AF-DTZ	Atlatl	Throwing spear	Throwing spear
Af-DUT	Bow and arrow		Bow and arrow
AF-DUV	Atlatl		Atlatl

The last column presents the definitive weapon system assignation.

impossible, especially considering the characteristics of weapons such as the throwing spear or the atlatl, which require close targets in order to hurt the prey in an efficient way.

The data obtained from Antofalla Valley give a great deal of relevant information about the construction of hunting landscape and weapon systems. However, we considered it important to

TABLE 5. COMPARATIVE CHART BETWEEN THE PROJECTILE POINT DESIGNS REGISTERED IN ANTOFALLA WITH THOSE CHRONOLOGICALLY ASSIGNED IN SITES FROM ANTOFAGASTA DE LA SIERRA AND NORTHERN CHILE.

ID	Correlation	Chronology
Af-I	Peñas Chicas E	4150–3430 cal yr BP
Af-II	Quebrada Seca A - Tambillo-1	8600 cal yr BP
Af-III	X	X
Af-IV	Peñas Chicas C	4150–3430 cal yr BP
Af-V	X	X
Af-VI	Quebrada Seca F	4150–3430 cal yr BP
Af-VII	Peña de la Cruz A	7270 cal yr BP
Af-VIII	Peñas Chicas A	4150–3430 cal yr BP
Af-IX	Similar designs at TC1, Casa Chavez Montículos, Chaschuil, Real Grande I, Tulan-54	200–1200 aC
Af-X	X	X
Af-A	Quebrada Seca B	7350–3500 cal yr BP
Af-B	X	X
Af-C	X	X
Af-D	Peñas Chicas 4	4150–3430 cal yr BP

test them in other spaces, and also to particularly assess the information we were able to obtain regarding weapon technology. To achieve that, an intensive survey was conducted at Quebrada Seca, also located in the Antofagasta de la Sierra Department, but about 90 km southeast from Antofalla Valley. Specifically, Quebrada Seca is located approximately 15 km east from the Villa de Antofagasta de la Sierra, at 4100 m above sea level. It is a 7-km-long valley which presents located water resources and meadows the rest of the landscape being dry. The valley presents steep slopes (Figure 8) formed by high headlands of gray tabular ignimbrite deposits and detritus slopes (Elkin 1996). This aspect played an important role at the time the characteristic of human occupations is interpreted. This valley is especially known for the eave Quebrada Seca 3 (QS3), which allowed the construction of a long-term sequence of human occupation in the zone, where one of the principal economic activities was camelid hunting, especially vicuñas (Aschero *et al.* 1991, 1993–94; Elkin 1992, 1996; Hocsman 2006; Martínez 2003; Rodríguez 1999).

The information obtained from this survey was presented in another article (Moreno 2013), so here we will focus on the structures associated with hunting and the projectile points obtained in the survey.

The survey at Quebrada Seca included an area of 5 km^2, where 122 units were registered (Figure 9) (Moreno 2013). Among these units we identified 67 structures of which 24 (35.8%) were interpreted as trenches. However, of these structures, 20 are associated in a reduced space (Figure 10), a characteristic which would repeat that observed at Antofalla and which would allow the application of the concept of "hunting landscape" to this space. However, it is the only place we registered which repeats this logic, the other trenches being isolated and located in high zones in relation to the direct surroundings, but not associated.

Nevertheless, we believe that in Quebrada Seca another landscape for performing hunting could have been used. In this sense we have observed a significant difference from Antofalla Valley related to the connection between feeding and sleeping segments. The rugged and steep slopes, and the presence of granitic and ignimbrite blocks, inhibit the linkage between the lower zones of the valley, used by troops to graze, and the high areas where animals sleep at night (Figure 11). This connection, however, could have been performed through long canyons, where large collapsed blocks are located, and could have been used as natural trenches by hunters. Even in these spaces, some projectile points were identified.

PROJECTILE POINTS IN QUEBRADA SECA

During the survey in Quebrada Seca, 16 projectile points were registered. In this set the use of a great

FIGURE 7. Location of projectile points in Antofalla Valley according to their chronological assignment.

diversity of lithic raw material is highlighted, where vulcanites 2, 5, 6, and 7 are present, whose sources are located in places near Quebrada Seca, and obsidian from Ona, about 90 km distant. The manufacturing techniques of these artifacts show similar characteristics to the ones described in Antofalla—that is, a manufacture tending to bifacial reduction and micro touches and touches as final formatting techniques of the piece. A remarkable aspect of the set is the absence of reactivation.

Only five specimens are complete, allowing their measurement in order to be incorporated into the assignment model for the weapon system and the comparison with chronologically situated designs and the ones registered in Antofalla.

From these pieces a variability regarding functional assignment is highlighted, because following Ratto (1994, 2003) three pieces are assigned to atlatl, one to bow and arrow and one to throwing spear (Table 6). If we follow Shott (1997), three points are assigned to atlatl and two to bow and arrow (Table 7). However the equation's calculations in these cases are very close, and that is why we decided to consider Ratto's proposal for the functional assignment of the pieces, maintaining what was proposed for the Antofalla Valley set. Regarding the chronological assignment of these pieces, all of them correspond to the transition period (5500–3000 AP), except for one, which can be compared to the type PCZA and would be located in earlier moments around

TABLE 6. PROJECTILE POINT ASSIGNMENTS ACCORDING TO THE MODEL OF RATTO (1994).

ID	Maximal Limb Thickness	Limb Width at the Maximal Thickness Point	Reinforce Index	Transversal Section	Limb Lenght	Limb Width	Contact Surface	Aerodynamic	Base Width	Angle	Weapon
QSUR0033	7.2	23.5	0.306	BA	42.3	23.2	490.68	Normal	18.7	65	Atlatl
QSUR0046	7.7	21.7	0.354	BA	36.9	20.7	381.91	Normal	-	60	Atlatl
QSUR0047	7	16.2	0.432	BA	35.3	27.6	487.14	Normal	16.2	55	Atlatl
QSUR0057	8.18	17.7	0.461	BA	32.7	21.6	353.16	Perfect	7.8	40	Bow and arrow
QSUR0088	8.87	23.2	0.382	PC	48.3	24.3	586.84	Imperfect	14.8	45	Hand weapon

7270 ± 40 BP (Figure 12). This type of projectile point was identified also at Antofalla Valley (Martínez 2003; Moreno 2010).

Analyzing the distribution of projectile points, we observe a major presence associated with the grouping of trenches described above. The other specimens are located in different sectors of the valley, continuing a similar pattern to that recorded in the case of the trenches, it being impossible to distinguish the differential use of some particular spaces for this type of practice (Figure 13).

Hence, the information obtained at Quebrada Seca shows some similarities with the Antofalla case, regarding the presence of spaces used for hunting, the construction of trenches in some case related to reduced spaces and the association of projectile points with certain historical depth. However, there are some differences. On one side, the valleys present distinct relief characteristics which indicate that the spaces used for hunting also vary. In Antofalla, the linkage between the feeding segments with water resources and the higher zones used as sleeping segments were practically continuous along the valley, while in Quebrada Seca these were very reduced, due to the presence of large ignimbrite blocks which made this relation impossible, leaving just a few spaces in which this travel could be performed. The other difference is based on the quantity of trenches identified in each case, particularly their association in both spaces. While in Antofalla 503 trenches were registered, most of them associated in variable numbers, in Quebrada Seca we observed just one case where the same structure of the landscape could be noted, but in the rest of the studied spaces, these examples reduced themselves, practically obviating the trenches' presence. However, this does not mean that the spaces used to perform hunting activities would have been just the ones where trenches were constructed. In this case, along the valleys which link the low zones with sleeping segments, huge collapsed blocks from the higher places are located and might have been used as natural trenches, allowing hunters to hide in these spaces, used by vicuñas to connect sleeping and feeding segments. Some projectile points were registered in association with these spaces.

Thus, comparing the information on both spaces, we believe they share many aspects related with the hunting strategy, tending to ambush troops for hunting performance, harnessing the local landscape's characteristics and the

TABLE 7. PROJECTILE POINT ASSIGNMENTS ACCORDING TO THE MODEL OF SHOTT (1997).

ID	Length	Shoulder Width	Thickness	Neck Width	Atlatl Equation	Bow and Arrow Equation	Weapon
QSUR0033	53.7	28.5	13.3	18.3	29.09	28.7	Atlatl
QSUR0046	48.9	26.7	13.1	16.4	26.11	26.97	Bow and arrow
QSUR0047	52.6	27.3	11.7	19.4	26.92	26.15	Atlatl
QSUR0057	43.5	21.6	8.18	9.3	15.67	16.8	Bow and arrow
QSUR0088	54.7	26.3	9.1	14.3	23.49	21.77	Atlatl

knowledge hunters had over their preys, particularly referring to their movements and danger identification.

Hunting strategies and lithic technology

Now, in what way does this model differ from the ones proposed by other authors regarding hunting strategies? Aschero and Martinez (2001) and Ratto (2003) propose hunting strategies which would have varied considering the weapon system used and possible environmental changes throughout the human occupation of this area. In this sense, for the earlier moments, a disadvantage would have been the hunting strategy, using open spaces guiding troops to mudflats to perform hunting. We think this technique would have been hardly executable due to the fact that the potential preys, wild camelids, possess great speed, and perceive danger at a long distance, through smell and hearing, and it would have been very difficult to obtain near targets, considering overall the weapons used in these early moments. Later on, hunting techniques would have focused on the use of parapets in conjunction with relief features.

Based on the obtained dates in Antofalla and then in Quebrada Seca, we believe that the strategy used would have been to ambush prey that moved through recurrent spaces over time, developing a daily movement between the sleeping and feeding segments. These movements propitiate the preparation of a space equipped with hiding places, and obtaining close targets to perform hunting.

FIGURE 8. General view of Quebrada Seca. Note the presence of ignimbritic blocks and steep slopes.

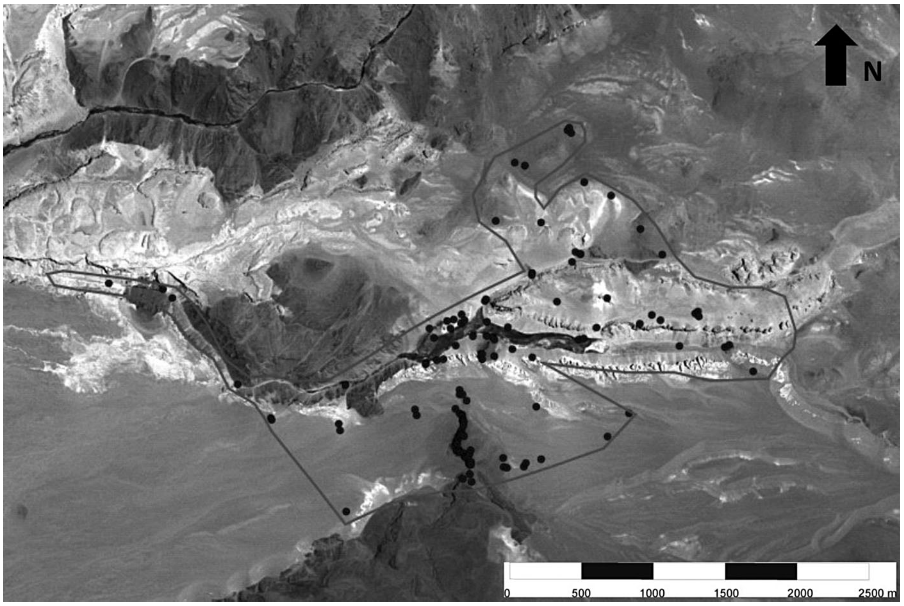

FIGURE 9. Survey limits and registration units at Quebrada Seca.

We think that this strategy would have reproduced through time, not always in the same way, because the addition of hunters and the use of other weapon systems could have generated certain modifications. However, it is possible that hunters might have reproduced this technique over time, reusing the same spaces and the same structures or other similar ones. As we said, sunset would have been the moment selected for the encounter, because shadows are longer and winds stronger so that smell and sounds would have been more difficult to perceive by preys (Haber and Moreno 2008).

All of this knowledge about landscape and prey behavior which propitiates the encounter between hunters and prey was conceived by Haber (2003b, 2007, 2009; Haber and Moreno 2008) as a trap, understood as the conjunction of mutual knowledge between hunters and preys. This conception assume the idea that preys, organized in troops led by the dominant male, possessed certain knowledge of the jeopardy which threatened them and would generate an escape strategy, using their advantages, which are early danger perception and the possibility of escaping any area at great speed, precluding persecution (Vilá

FIGURE 10. General view of trenches' location at Quebrada Seca. The arrow shows the location of trenches.

FIGURE 11. Example of small valley connecting lower and upper zones of Quebrada Seca, potentially used for hunters to perform hunting.

1999). Faced with this situation, hunters develop a hunting strategy which propitiates the encounter with these possible preys. In order to achieve that, the principal strategy would be anticipation —that is to say, the preparation of encounter sceneries in such way as to anticipate the reactions and attitudes of possible preys in order to obtain near targets. These devices imply the basic preparation of the landscape, tending to anticipate the troop's movements. In this sense, the encounter scenery is constructed and appropriated in such a way as to anticipate the movements of animals and diminish their advantages (Haber 2003b, 2007, 2009; Haber and Moreno 2008).

In relation to this landscape preparation, the projectile points associated to it contribute relevant information regarding the different weapon systems, a long-term chronology and the use of these spaces.

The recovered projectile points have given information about manufacturing techniques which are reproduced over time, through mainly bifacial reduction, including in some cases thinning (sensu Aschero and Hocsman 2004). In relation to the use of raw material, the use of predominantly local raw material (principally basalt and vulcanite), followed in importance by obsidian from distant quarries (between 15 and 90 km distance), is observed. If we assess the use of raw material in chronological terms, there is a diminishing of the former, in relation to obsidian, toward the last few millennia of the era. This has already been advanced by other authors (Escola 2000, 2004; Hocsman 2006, 2010; Hocsman and Escola 2007) who have shown the importance of obsidian in contexts corresponding to groups with agropastoral economies, for projectile point manufacturing. Figure 14 presents the raw materials used to manufacture the different types of projectile points in the Antofalla case, where we point out the tendency previously noted, of the groups AF-IX and AF-V being the ones that show the use of obsidian over black basalt-andesite. The AF-IX group has been assigned to the first millennium of the era, where the selection of raw material clearly changes for projectile point manufacturing. A similar situation can be observed at Quebrada Seca where the single specimen manufactured in obsidian presents a similar design to those identified during the first millennium of the era, but with bigger dimensions, so it might be a later sample of the set, marking again the use of obsidian as raw material for projectile point manufacturing in later moments.

The characteristics of projectile points show differences in their design, which have allowed the characterization of the weapon systems used. In this sense, through the use of two methodological proposals (Ratto (1994, 2003) and Shott (1997)), the assignment of projectile points to the

FIGURE 12. Example of projectile points recovered at Quebrada Seca.

different weapon systems was made. The use of both systems is useful to broaden the quantity of specimens which can be assigned, because of the advantage Shott's (1997) model possesses in the use of metric variables against the multiple aspects proposed by Ratto (1994), which makes it necessary to have sets in very good conservation status in order to assess their assignment. But this model enlarges the quantity of weapon systems which can be discriminated, and also has a local background which gives more concrete factual support to the case treated here.

But the use of different type of weapons does not imply the modification of the hunting strategy. In this sense we think that there would have been a reproduction over time of the same hunting strategy, which would have been effective regardless of the type of weapon used. The modifications, we believe, would have been given through the addition of hunters and the participation of drivers. With the information obtained before now, it has not been possible to identify these changes over time, but it was possible to assess areas in which this hunting would have been performed by one hunter or reduced groups, or in other cases by several hunters. To do this, we have proposed different hunting devices in accordance with the total number of trenches from which hunters could have attacked one troop at the same time (Moreno 2010, 2012a). This allows us to consider a different use of space according to hunter organization, but which would in principle maintain the same hunting strategies.

Summarizing, the information on weapons technology in the study area clearly shows a concern for the preparation of projectile points whose purpose was to kill potential preys, noticing relevant changes over time in the design of these instruments

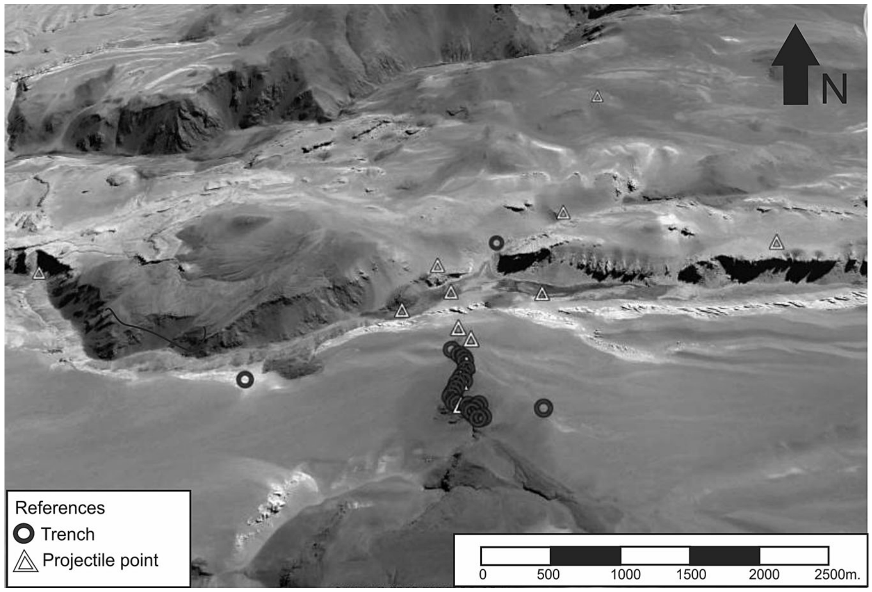

FIGURE 13. Distribution of projectile points and trenches at Quebrada Seca.

as well as the weapon systems of which they were a part. However, we understand that the disadvantaged hunters faced with these preys had to be supplied not only with these weapons, but with an articulation of different aspects, one of the most important being the space in which encounters could take place, due to the fact that its preparation, added to the knowledge of the prey's ethology, increased the possibility of success.

Here we have advanced the characterization of this relevant practice in the history of human occupations in the central-south Andes. We think there are many working lines which could advance from here, such as more detailed work regarding hunting structures, prey ethology, established chronologies in other sites and the addition of other artifactual sets of the area.

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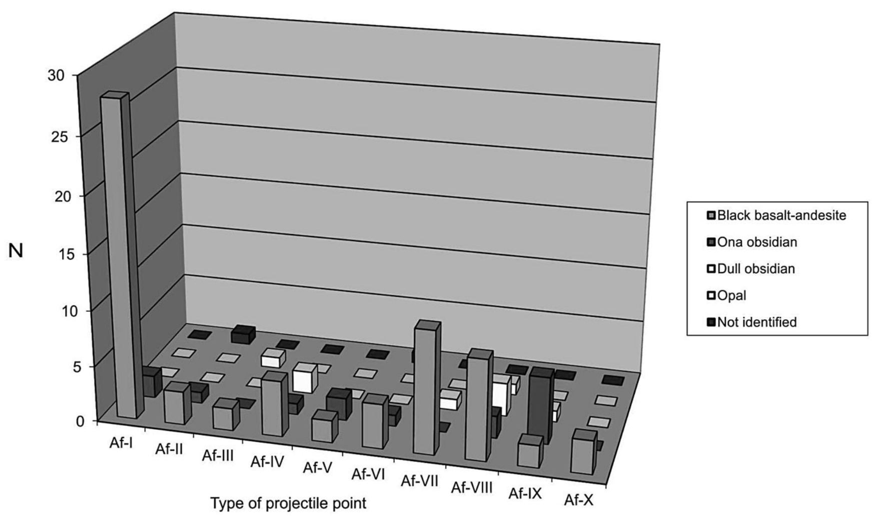

FIGURE 14. Representation of projectile points according to the raw material.

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Notes

1. During the earlier occupations, characterized by hunting-gathering societies, the hunting relevance would have been related to the obtainment of resources tending to social reproduction, while in later contexts, the obtaining of wild camelids, particularly vicuñas, would have been related to the collection of leather and wool, very appreciated goods in the regional exchange (Moreno 2010).
2. The drivers are the ones in charge of intentionally guiding the prey toward the places where the hunters are.
3. The name 'trench' corresponds to the denomination given by the now-existing people to this type of structure, build to hide hunters from their potential preys.

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