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Review

Metrical variability in ethnographic arrows from southernmost Patagonia: Comparing collections from Tierra del Fuego at European museums ☆

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ABSTRACT

Tierra del Fuego indigenous peoples (southernmost Argentinean and Chilean Patagonia) have been frequently accounted for since the 16th century; their weapons, however, were hardly described. Thus, this article aims to evaluate arrow technology variability in late 19th–early 20th century hunter-gatherer's ethnographic samples from Tierra del Fuego. This proposal rests on previous archaeological studies which suggested a pattern of north–south morphometric variation in projectile points for the last 3000 years, which follows a distribution that resembles the indigenous territories at historical times. However, a more limited chronological scale is needed to identify time-specific variations. 68 ethnographic arrows were thus surveyed at the Weltmuseum Wien (Austria), the Ethnologisches Museum (Germany) and the Musée du quai Branly (France) to test the existence of differences at the time. By means of multivariate statistics, the metrical comparison of the whole arrows, as well as the individual points and shafts, from land- and sea-resources specialized hunter-gatherers (Selk'nam/Yámana and Alacaluf, respectively) have revealed size differences. While Selk'nam arrows present longer and wider shafts, with smaller fletching and points, Alacaluf and Yámana arrows show the opposite trend. Results show that morphometric variations previously detected on archaeological projectile points are also present in the time-specific ethnographic arrows analyzed here, at least regarding size.

Contents

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1. Introduction

American indigenous artifacts currently present in different ethnographic collections worldwide can be a highly valuable source of information to study both spatial and chronological cultural variability.

Regarding ethnographic weapons in particular, museum collections raise a peculiar interest for archaeologists as they allow studying technical and functional traits of the complete weapon system, a feature hardly found in excavated materials due to the poor preservation of the organic parts, such as wooden bows and arrow shafts. Hence, the study of indigenous weapons and the way they were used poses a complex situation, since the only part recovered from the archaeological record tends to be just the point, typically of a lithic nature. Thus, the reconstruction of the complete weapon usually rests on the metrical measurement of the points.

Archaeology weapon variability has been mainly studied from four different perspectives: (1) by means of experimental and replication studies in simulated use situations, the most usual methodology (Flenniken and Raymond, 1986; Howard, 1974; Hunzicker, 2008; Martínez and Funes, 2011; Odell, 1988; Odell and Cowan, 1986; Peets, 1960; Raymond, 1986; Shea et al., 2001); (2) by ethnoarchaeological and ethnographic observations – either directly or using previous reports to build models (Bartram, 1997; Elkin, 1948; Ellis, 1997; Griffin, 1997; Hitchcock and Bleed, 1997); (3) by studying design variables based on mechanical physics and optimal engineering (Cotterell and Kamminga, 1990; Hughes, 1994; Knetch, 1997; Ratto, 1994, 2003); and (4) by reviewing museum collections of ethnographic weapons of known functions (Shott, 1997; Thomas, 1978, on projectile points; Bergman and McEwen, 1997; Ratto, 1988, 2003, on bows; Bushnell, 1949, on atlatls, among others). The latter view guides the present discussion, which is framed in a long-term project focused on exploring size and shape variability among different kinds of weapons.

The several works based on the study of ethnographic weapon collections in particular have contributed important information such as:

1. Detailed descriptions of several ancient weapon systems, considering manufacture techniques, functional traits, hafting types and raw materials (e.g. Borrero and Franco, 2001; Bushnell, 1949; Franco et al., 2005; Piqué, 2006; Ratto, 1988, 2003; Scheinsohn, 2010).
2. Metrical models to differentiate arrow-points from spearheads, an useful proposal to classify archaeological materials of unknown function (e.g. Thomas, 1978; Shott, 1997; Ratto, 1991a, 1991b, 1992, 1994, 2003).
3. Identification of organic resources used in the manufacture of bows and shafts, emphasizing the mechanical and physical properties of the species chosen (e.g. Caruso et al., 2011; Ratto, 1988, 2003; Ratto and Marconetto, 2011).
4. Studies of changes in spear crafting and harpoon designs, among other tools, resulting from the exchange with colonialists (e.g. Borrero and Borella, 2010; Crowne and Torrence, 1993; Harrison, 2006; Prieto and Cárdenas, 2002, 2006; Scheinsohn, 1990-1992; Torrence, 1993, 2000, 2002), among many other topics.

In the case of Tierra del Fuego, a large number of ethnographic observations and descriptions by explorers, scientists, priests and ethnologists since the 16th century may be cited (Beauvoir, 2005 [1915]; Bove, 2005 [1883]; Bougainville, 1921 [1771-1772]; Bridges, 1952; Chapman, 1986 [1982]; Chapman, 2002 [1990]; Chapman, 2008 [2002]; Cook, 1921-1922 [1772-1775]; Darwin, 1945 [1839]; De Agostini, 2005 [1956]; Fitz Roy, 2009 [1839]; Gallardo, 1910; Gusinde, 1982 [1931]; Hyades and Deniker, 1891; Lista, 1998 [1887]; Lothrop, 1928; Martial, 2005 [1888]; Nordenskjöld, 2004 [1904]; Sarmiento de Gamboa, 1768; Skottsberg, 2004 [1911], among others. For a review of European expeditions to Tierra del Fuego, see Hyades and Deniker, 1891 and Salerno and Tagliacozzo, 2006). Despite their interest in indigenous weapons, only a few reports describe them in detail (Fitz Roy, 2009 [1839]; Gallardo, 1910; Gusinde, 1982 [1931]; Hyades and Deniker, 1891; Lothrop, 1928. See Ratto (2003) for an analysis of the description of indigenous weapons in these original sources). Furthermore, as European expansionist and colonial policies encouraged ethnographic collection in the new territories, a number of materials are currently curated in European museums, providing the framework for further studies like the one presented here.

Tierra del Fuego is particularly interesting in this issue due to the many different subsistence and settlement strategies developed in a relatively small territory, which represent distinctive adaptation strategies to the environment, also implying variations in technologies and home-ranges. While to the northern and northeastern area of the island the inhabitants (i.e. Selk'nam or Ona) were hunter-gatherers specialized in land resources, mainly guanaco meat (*Lama guanicoe*), their southern counterparts, on the Beagle Channel and southernmost islands (known as Yámana or Yahgan) as well as the ones inhabiting the western regions (Alacaluf or Kaweskar) developed a sea-related strategy, including mollusks, fish, pinnipeds, and whales (Fig. 1). That is why traditional literature usually identifies them as "foot Indians" and "canoe Indians" (Bird, 1946; Chapman, 1986 [1982]; Chapman and Hester, 1973; Fitz Roy, 2009 [1839]; Lothrop, 1928, among others).

The nature of a fourth group who occupied the southeastern area of the island (Mitre Peninsula), known as Haush (also Aush) or Mannekenk, is still unclear, though. Borrero (2001a) points out that they may have been a relatively recent group segregated from a larger organization due to cultural transformations in historical times. At the time of Gusinde's fieldwork (1918-1924) on the island, they were disappearing (Gusinde, 1982 [1931]), although still Chapman (1986 [1982]) located 11 Haush territories previous to 1880, when the modern colonization of the island began. Nowadays, from the pioneering archaeological works by Chapman and Hester (1973), an extensive research project is in progress to understand the history and way of life of this group (Zangrando et al., 2011).

The present study introduces an analysis of the metrical and raw material data of a sample of 68 Fuegian arrows from the late 19th–early 20th century analyzed at the Weltmuseum Wien (Vienna, Austria), the Ethnologisches Museum (Berlin, Germany) and the Musée du quai Branly (Paris, France). The focus is to assess the existence of variability in ethnographic arrow technologies throughout Tierra del Fuego. The interest in evaluating the possibility of such differences among the arrows manufactured by the several ethnographic groups (who are clustered here by economic strategy, see below) rests on the results from previous spatial archaeological analyses. Such studies yielded a long-term pattern of spatially constrained morphometric variation in projectile points following a north–south distribution which seems to

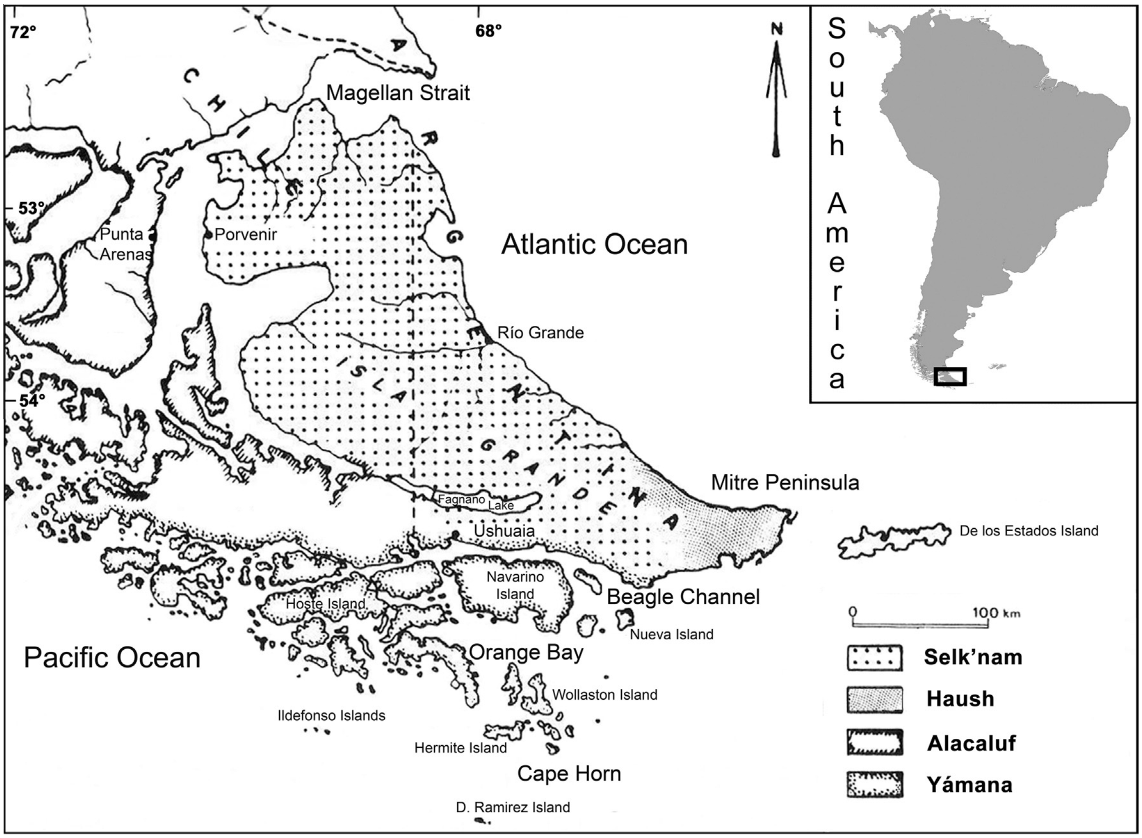

Fig. 1. Ethnic territories settled at historical times, after Chapman (1986 [1982]).

approximately reproduce the location of indigenous populations at historical times (Charlin et al., 2014). Thereby, here we are considering between-group arrow differences as a spatial proxy for arrow variability across space since the home-range of land (Selk'nam or Ona) and sea resources (Alacaluf and Yámana) hunter-gatherer populations is well-known. The sample is composed by Selk'nam, Yámana and Alacaluf arrows collected by scientific expeditions, ethnological research teams and a commercial company (see below).

2. The study of museum collections

The study of museum collections presents a number of drawbacks. Frequently, contextual information of the material or even its origin is far from complete. Furthermore, population variability is usually masked by the use of classical ethnographic tags at museum catalogs (see Borrero, 2001a, 2001b). A typical problem when the first European got in contact with American populations was the frequent misunderstanding regarding indigenous languages, which was reflected in the subsequent use of many different terms to distinguish among groups (e.g. Bougainville, 1921 [1771-1772]). Ethnic groups were generally identified with the place where the explorers first met them. Thus, when studying museum collections, caution should be exerted as some ethnic names may include many different groups and, on the opposite, many different names could refer to the same groups, masking the number of peoples present (Borrero, 2001a).

In the case of the indigenous peoples from Tierra del Fuego, several names have been known for the same groups through time. During the first expeditions (16th–18th century), both Yámana and Alacaluf, who were the groups more frequently found by European ships due to their coastal residence, were called "Fuegians" without any further distinction (Hyades and Deniker, 1891; Orquera and Piana, 1999; Prieto, 1994). In fact, Fitz Roy (2009 [1839]:131) was the first one to postulate the existence of four different tribes among the Fuegians.

Until the end of the 19th century, local groups were frequently referenced with different names depending on the explorers (Bougainville, 1921 [1771-1772]; Cook, 1921-1921 [1772-1775]; Fitz Roy, 2009 [1839], among others. See a summary of different nominations in Gusinde, 1982 [1931]; Hyades and Deniker, 1891; Orquera and Piana, 1999). Later, a tripartite segmentation which was mainly based on linguistic variation was proposed by the Anglican priest T. Bridges, in charge of the religious mission settled in Ushuaia between 1871 and 1886 (Bove, 2005 [1883], Giglioli 1867 in Puccini, 2006; Martial, 2005 [1888]; Hyades and Deniker, 1891, among others. See discussion in Orquera and Piana, 1999). He called the groups who traveled the Beagle Channel and southernmost regions by canoe *Yahgan*, used *Alookooloo* for the ones from the western part, and *Owensmen* to the people from the northern lands, later simplified as *Yahgan*, *Alaculoof*, and *Ona* (Orquera and Piana, 1999).

In 1884, T. Bridges also suggested a linguistic difference between the Ona from the western and eastern corners of the island; consequently, a fourth group was recognized and called *Haush* or *Aush* (Orquera and Piana, 1999). However, Gusinde (1982 [1931]) considered that Selk'nam (Ona) and Haush shared linguistic as well as physical and cultural traits, so it was impossible to settle territorial limits between them at least for the last centuries. It should be mentioned that at the time of Gusinde fieldwork (1918-1924), the Haush were quickly disappearing.

The name Yahgan was coined by T. Bridges from a place called Yahgashaga (Murray Channel) where southern sea hunter-gatherer families frequently met. However, this name had not any meaning whatsoever for the indigenous group (Bridges, 1952: 55), who called themselves Yámana (people) and referred to the northern land groups as Ona, who, in turn, recognized themselves as Selk'nam (Bridges, 1952).

Having in mind this difficulties regarding terminology, the analysis here will follow the name assigned by the different authors/museums for each group. In order to overcome the variability in ethnic classifications, a more comprehensive approach based on local lifeways (Borrero, 2001a) is followed here, to compare the arrow technology of land (Selk'nam) and sea hunter-gatherers (Alacaluf and Yámana), avoiding the traditional culture division frequent in previous literature.

3. Archaeological background

The first evidence of human presence in Tierra del Fuego was dated to 10,500 BP at the Tres Arroyos 1 rockshelter, to the north of the island (Massone et al., 1999). Until 8000 BP Tierra del Fuego island was connected to the continent by a narrow land bridge (McCulloch et al., 1997, 2005). These early Fuego-Patagonian hunter-gatherers shared a common genetic background (González-José et al., 2004), an economic strategy based on guanaco hunting (Borrero, 2003; Massone, 1987, 2004; Mengoni Goñalons, 1987) and a lithic technology for weapons known as Fishtail projectile points (Bird, 1946, 1988; Jackson, 1987; Massone et al., 1993; Nami, 1985-86, Prieto, 1991, among others).

By 8000 BP, the land bridge connecting Tierra del Fuego to the mainland was definitively closed, forming the Magellan Strait and the Isla Grande de Tierra del Fuego island (McCulloch et al., 1997, 2005. See Fig. 1). Land populations previously inhabiting the region were thus divided and isolated, a situation which eventually led to a long-term cultural divergence process (Borrero, 1989-1990).

Early Holocene human occupations at the Beagle Channel, the southern coast of the island, were identified as hunter-gatherers focused on land resources (Orquera and Piana, 1999, 2009). However, from ca. 6000 BP to historical times, specialized adaptations to the sea were recorded at the Beagle Channel and the western area (Legoupil, 2003; Orquera and Piana, 1999, 2009; Orquera et al., 2011). On the opposite hand, archaeological and ethnographic data show that northern hunter-gatherers had always based their economy on land resources (e.g. Gusinde, 1982 [1931]; Morello et al., 2012).

Regarding lithic technology, the "ethnographic model" played an important role in the pioneering archaeology of Tierra del Fuego and southern continental Patagonia, particularly when classifying projectile points. Although his work was not centered in Tierra del Fuego, Bird (1938, 1943, 1946, 1988) observed a similarity between historical Ona arrows and those recovered at archaeological sites in southern continental Patagonia dated to the Late Holocene. For this reason, he used "Ona points" to refer to the archaeological projectile points of Period V (ca. 700 years BP, see Bird, 1983:Annex IV, Bird, 1988:Table 17) in the cultural sequence proposed for the mainland. He also assumed that the points of Period V were arrow-heads, based on Ona ethnographic analogy and their size, smaller than older archaeological points (see Charlin and González-José, 2012 for a comprehensive review of this topic). The similarities found in the points from the northern and southern coasts of the Magellan Strait led Bird (1946:20) propose that the Onas would have inhabited southern Patagonia in previous times (see Borrero, 1989-1990 and Charlin et al., 2013 for a thorough discussion).

More recent archaeological research in Tierra del Fuego has also noted the similarity between Ona ethnographic arrows and later projectile points (Morello et al., 2012; Huidobro, 2012).

Regarding lithic technology at the Beagle Channel, Bird (1943, 1946) identified a projectile point type called "Yaghan" as typical of the Recent or Yaghan period in his cultural sequence for the southernmost lands. Even though the Yaghan type was thought to be exclusive of the Beagle Channel for a long time (Bird, 1943, 1946), subsequent research proved it was also present throughout the island (Borrero, 1979). However, geometric morphometric analysis showed that projectile point designs from the Beagle Channel area are highly homogeneous, unlike the rest of the island and Patagonia in general (Cardillo et al., 2016; Charlin et al., 2014).

A recent analysis of stemmed projectile points from Late Holocene archaeological contexts at Tierra del Fuego indicated morphometric variation following a north–south distribution (Charlin et al., 2014). Thus, the spread of projectile point's size and shape indicates a spatial pattern closely similar to the distribution of indigenous territories known at historical times (see Fig. 1, Charlin et al., 2014). It basically suggests that a broad chronological scale (i.e. the last 3000 years) should be considered to explain these patterns. The relationship between the spatial distribution of the sample and the morphological similarity of some point designs showed they had a wider distribution throughout the island, whereas the points recovered from the Beagle Channel area presented a more restricted distribution and larger design homogeneity (Charlin et al., 2014). The same pattern was observed in a larger scale study which covered the whole Patagonia with a sample of ca. 1500 projectile points from the Late Holocene, indicating a strong local patterning in the Beagle Channel designs but high point variability in a broader scale (Cardillo et al., 2016).

At the island level, the spatial patterns identified for shape and size variability in projectile points were explained by the different degree of interaction between groups during the Late Holocene. Hence, the role of the Fuegian Andes as a biogeographical barrier was suggested (Charlin et al., 2014). However, socio-cultural and time factors need further research to be properly defined. For instance, a more limited chronological scale is needed to identify time-specific shape and size variations during the Late Holocene. The evaluation of metrical variations of ethnographic projectile point from the late 19th and early 20th century is a first step in this sense. This study is framed in a research program aiming to approach the social boundaries and interaction among Fuego-Patagonian hunter-gatherer populations. Moreover, the analysis of metrical variation on ethnographic arrows could contribute to the identification of parameters so as to postulate an expected function for archaeological projectile points (Shott, 1997; Thomas, 1978).

Regarding the study of function in Tierra del Fuego archaeological projectile points, just a few works followed a model-based approach. Ratto (1988, 1991a, 1991b, 1992, 1994, 2003) carried out the first systematic studies to evaluate the performance of southern Fuego-Patagonia lithic points for the Late Holocene by considering design variables in the frame of mechanical physics and optimal engineering principles.

According to her functional model, Ratto (1991a) identified five technical systems using hafted lithic stemmed points in two sites to the north and southeast areas of the island: arrows, hand-throwing spears, thrusting spears, daggers and hafted-knives. On the other hand, only two systems were observed for stemmed points at the Beagle Channel (arrows and hand-throwing spears, Álvarez, 2009a, 2009b, 2011). This difference in the function of lithic stemmed points across the island should be considered an important element to explain the higher design homogeneity detected at the coast of the Beagle Channel (Cardillo et al., 2016; Charlin et al., 2014).

It should be mentioned that other lines of evidence have also suggested a chronological continuity in ethnohistorically known patterns. Stable isotope analysis on the human bones recovered from burials dated to 1500 years before European presence in the area stressed the link between ethnohistorically recorded economic patterns and prehistoric human diets in the region (Yesner et al., 1991, 2003). Selk'nam's focus on terrestrial resources (guanaco) was in line with the expectations from the ethnographic data; however, a larger dependence of Yámana on this resource was also detected. Data from the area occupied by Haush populations, who were supposed to have a mixed land and sea economy, yielded a greater amount of seafood in the overall diet (Yesner et al., 1991, 2003). Further analyses considering a larger sample found no differences in the importance of sea resources in the diet between the populations inhabiting the Mitre Peninsula (Haush territory) and the Beagle Channel (Yámana territory), indicating a similar intensity in the consumption of sea resources for the whole southern border of the island, regardless social-cultural variations (Panarello et al., 2006).

4. A brief review of Tierra del Fuego collections

The Weltmuseum Wien (WM, Vienna) houses a large ethnographic collection from Tierra del Fuego recovered by the missionary and ethnologist Martin Gusinde, a priest of the Divine Verb congregation (SVD) directed by Wilhelm Schmidt. These artifacts were collected between 1918 and 1921 during his visits to Tierra del Fuego. The assemblage arrived at the museum in 1927 and includes bows, arrows, harpoons, masks, toys and headdresses, among other artifacts, from the Selk'nam, Yámana and Alacaluf peoples. Gusinde was deeply interested in the religious ideas and practices among the Fuegians, which he studied to justify the existence of monotheism among primitive peoples. In Gusinde's opinion (1982 [1931]), the existence of a unique and supreme god previous to Christian influence was confirmed in the case of the Yámana. These data were later used by Schmidt (1931) against the evolutionary theory of E.B. Tylor about "primitive animism" (Cárdenas and Prieto, 1999; Pavez Ojeda, 2012; Prieto and Cárdenas, 2006). This may explain why most of the materials at the Weltmuseum Wien are ritual and ceremonial artifacts. From 1931, Gusinde published three volumes about the indigenous way of life at Tierra del Fuego and a fourth one with anthropometric measurements of the three groups, a real and complete ethnographic masterpiece (Gusinde, 1982 [1931]).

The Museé du quai Branly (QB, Paris) received the materials collected in 1882-1883 by the Cape Horn French scientific expedition (Hyades and Deniker, 1891, translated into Spanish by Legoupil and Prieto, 2007; Martial, 2005 [1888]). They spent a year at Orange Bay (Hoste Island, Tierra del Fuego, Chile) collecting information about local weather, fauna, flora, hydrography, ethnography and the like (Báez and Mason, 2006; Legoupil and Prieto, 2007). This museum also curates the Fuegian artifacts collected by Rousson and Willems (1893) between 1890 and 1891 in the expedition organized by the French Ministry of Public Instruction and Fine Arts. Both collections derive from the former Musée de l'Homme and include a variety of hunting weapons such as arrows, spears, harpoons, hafted knives and bows, belonging to Yámana, Selk'nam and Alacaluf populations.

Finally, both at the Weltmuseum Wien and at the Ethnologishes Museum (EM, Berlin), there are Fuegian artifacts collected by Carl Hagenbeck (1844-1913) for his entertainment company devoted to the trade of exotic wild animals and anthropological-zoological exhibitions or *völkerschau* (Ames, 2008:18). He was a world-famous animal dealer and ethnographic showman who developed an extensive corporate network of travelers, hunters, agents and dealers in the animal business and recruited indigenous performers for park shows. He was also a prolific ethnographic artifact collector well-known by anthropologists and zoo directors (Revol, 1995).

Between 1880 and 1884 the Weltmuseum Wien bought Hagenbeck several harpoons, bows, arrows, daggers and other artifacts from Tierra del Fuego. According to museum archives, some of these artifacts (all of them classified as "Fuegian"[1]) belonged to the indigenous people exhibited in the *Jardin d'Acclimatation*[2] at Paris and in Berlin zoo in 1881. Despite the many documents about these people, their ethnical identity was much discussed due to a wrong reference by Deniker (1882:16) (see Báez and Mason, 2006 and Revol, 1995 for a discussion of this issue). He correctly said that these people were "Alikhoolips", but he added that they came from Hermite Island, a location in Yámana territory. As a consequence, a debate about their ethnic origin was raised (Revol, 1995). Later on, some of these people were observed by the members of the Cape Horn expedition in the Anglican mission at Ushuaia (Tierra del Fuego) and it was clear they spoke a language which was not understood by the Yámana (Hyades and Deniker, 1891; Martial, 2005 [1888]). Martial (2005 [1888]) clarified they were Alacaluf from Clarence Island, located in the Magellan Strait, not far away from the Froward Cape (according to Legoupil and Prieto, 2007: 77, Clarence Island is nowadays Aracena Captain Island). Additionally, Puccini (2006) published four photographs from the Giglioli[3] collection at the National Prehistoric Ethnographic Museum "Luigi Pigorini" (Rome) which depicted the Fuegians exhibited in the *Jardin d'Acclimatation de Paris* in 1881. At the bottom of the photographs the following expressions were written by Giglioli himself: "Alikoolip", "tribù degli Alikoolip or "Alikoulip" (Puccini, 2006: 149 and 151, AFMPE, inv. 5740 and 5737 respectively).

In the Ethnologishes Museum of Berlin, an arrow from the Hagenbeck's collection was correctly recorded as "Yámana" from Hermite Island. Following this reference it could be possible to compare morphometric characteristics of Hagenbeck's arrow collections from both Berlin and Vienna museums to assess similarities. Unfortunately, the lithic points from the Cape Horn scientific settlement classified as "Yahgan" in the Musée du quai Branly are of no use for this analysis as they were collected from shell middens on the coast of Ushuaia, according to the information from museum records. Therefore, they were not acquired through direct exchange with indigenous people, and belong to the archaeological record. Our observations confirmed an archaeological origin for these materials as:

1. They are different in size and shape than the arrow points from the rest of the ethnographic collections and match the "Yaghan type" defined by Bird (1943, 1946).
2. They are probably not arrowheads, like the ethnographic samples studied here, according to the analyses of Ratto (1991a, 1991b, 1992) and Álvarez (2009a, 2009b, 2011) of similar archaeological projectile points from the Late Holocene (see Section 7).

[1] This tag is common in many Tierra del Fuego collections, like the ones at the Museo de La Plata (La Plata, Argentina. See Ratto, 2003; Ratto and Marconetto, 2011) and the Museo del Fin del Mundo (Ushuaia, Argentina. See Caruso et al., 2011).

[2] The *Jardin d'Acclimatation* at Paris, created in 1859 for the study of exotic animals and plants, included from 1877 the exhibition of "savage people", under the direction of Albert Geoffroy Saint-Hilaire (Revol, 1995:27).

[3] Enrico Giglioli was a zoologist –as well as the son of Vincenzo Giglioli, an Italian doctor and anthropologist – who participated in the Magenta's circumnavigation expedition between 1865 and 1868. He developed a deep anthropological interest and became a thorough collector, and scholar of ethnography in the Italian Society of Anthropology and Ethnology of Florence (Puccini, 2006).

Table 1
Frequency of Tierra del Fuego whole arrows, points and shafts surveyed at Vienna, Berlin and Paris ethnographic museums.

Museum	Whole arrows	Arrow points	Arrow shafts	Total
Weltmuseum Wien (WM)	13	4	4	21
Ethnologisches Museum (EM)	29	5	0	34
Museé du quai Branly (QB)	4	5	4	13
Total	46	14	8	68

3. They were manufactured from a grayish metamorphic rock similar to the one used for the archaeological projectile points from the sites on the northern coast of the Beagle Channel for the last 2000 years (Álvarez, 2009a, 2009b, 2011).

Finally, the Ethnologishes Museum also includes Selk'nam arrows from a private collection by Herr Mallman, but devoid of contextual information.

Fig. 2. Some whole arrows and points from Weltmuseum Wien (first line), Museé du quai Branly (second line) and Ethnologisches museum (third line). ID 71.1884.102.12 is the typical archaeological point named Yaghan by Bird (1946) made on stone. ID 253 = lithic point. ID 1979 = bone point.

Table 2
Descriptive statistics of Fuegians (probably Alacaluf and Yámana) arrows collected by Hagenbeck, Weltmuseum Wien (Vienna).

	Whole arrows		Arrow points			Arrow shafts		
	Total length	Weight	Length	Width	Thickness	Length	Width	Fletching length
N	9	9	11	11	11	12	12	10
Min	664	17	26.32	7.81	2.27	620	6.53	35
Max	721	25	40.25	16.93	4.19	690	8	44
Mean	684.89	21.44	32.26	14.10	3.13	653.17	7.36	39.90
Stand. dev	16.86	2.30	4.67	2.82	0.56	17.62	0.46	2.96
Median	687	22	31.78	14.99	3.11	655	7.50	40
25 prcntil	671	20	27.64	12	2.65	638.75	6.85	38.75
75 prcntil	691	23	36.4	16.23	3.55	660	7.725	42.25

5. Sample description

As aforementioned, Selk'nam, Yámana and Alacaluf arrow samples included in the present study were collected during the late 19th–early 20th century by scientific expeditions, ethnological research teams and a private company.

The total frequency of whole arrows, points and shafts surveyed at each museum is presented in Table 1; some of them are also illustrated in Fig. 2.

Hagenbeck's collection at the Weltmuseum Wien comprises 10 whole arrows, three arrow points and two shafts, all of them identified as "Fuegians"; however, some of them probably belonged to the Alacaluf as already mentioned. All the points are made of glass and show a biconvex symmetrical cross-section. The use of glass to make projectile points was quickly adopted by the aboriginal populations; indeed, it was the first cultural change identified with the establishment of colonialism, originated even before the direct contact with Europeans by recycling materials from shipwrecks (Borrero, 2001a:146).

The shafts are of polished wood with circular cross-section. A total of 10 shafts preserve the fletching and three of them have a white substance which covers the proximal end of the shaft. One shaft, on the other hand, does not present any evidence of fletching (such as fresh or non-patinated surface) which suggests it was not finished.

The descriptive statistics for the three classes of complete artifacts identified here are presented in Table 2. All linear dimensions are maximum values measured in millimeters, except weight which is shown in grams. Measurements were performed with a digital caliper and a digital scale respectively. In the whole arrow class, the values correspond to the complete artifact (shaft + point); in the arrow point class, the measurements of the unbroken points without shaft as well as the ones with shafts are included. The same procedure was followed for the shaft class.

Gusinde's collection at the WM includes quite different kinds of arrows in functional terms. There are three whole arrows, all of them from the Selk'nam. Each point was manufactured on a different raw material, probably related to their different functions. For this reason, a description of each element is presented here instead of the descriptive statistics for the sample.

The first element is an arrow with a wooden point, used to hunt birds according to the illustrations provided by Gusinde (1982 [1931]: Fig. 36). Its total length is 731 mm and weights 31 g. The point is in fact a thin stick 76.33 mm long, with both extremes pointed, and transversely attached to the shaft. In this way, the impact surface is wider, producing a stronger effect (Gusinde, 1982 [1931]: 220–221). Bridges (1952:213) also mentions the use of this kind of wooden arrows to hunt birds among the Aush.

There is also an arrow for training novices, which has a leather ball 7.45 mm in diameter as a point. Its total length is 706 mm and its weight 29 g. It was used for practicing while preserving lithic or glass points, which were highly valuable. According to Gusinde (1982 [1931]: 221), the targets were a leather piece or a trunk. Selk'nam also used to throw to a mobile target made with a grazing wheel descending from the top of a hill to train children (Gallardo, 1910:350). According to Bridges (1952:412), this kind of arrows was also common for competences and sport activities among the Selk'nam, to avoid producing mortal wounds.

Only one arrow in this sample is typical of guanaco hunting, with a glass point 28.35 mm long. The total length is 783 mm and weights 34 g. The main part of the shaft is decorated with zig-zag incised lines on one side, and parallel ones on the other. This may have been a "signature mark" like the ones recorded by Gould (1970) in the spears from Australian Western Desert aboriginals. The shaft proximal end shows the remains of a white substance and a black string of resin (i.e. mastic). According to Gusinde (1982 [1931]: 217-218), the first is gypsum dust mixed with saliva, used to fix the tendon to attach the fletching. Conversely, Bridges (1952:386) mentioned the same function for resin, which was called *teik* by the Selk'nam. Prieto (1994:32) noted that the mastic used by the Selk'nam came from the Bolax gummifera plant, available in the southwestern mountains. The fletching is 40 mm long. This is the only whole arrow from Gusinde's collection at the WM considered in the statistical analysis presented here.

Two shafts without reference to either place or ethnic origin were also available. They may have been novice training arrows since the distal ends does not report any groove to insert the lithic or glass point; it cannot be related to an unfinished state since the proximal ends shows evidence of different patinas generated by fletching. Therefore, they were used for a long time. Both arrows have also the white dust and the resin already described in the proximal end of the shaft.

The last individual of this sample is a lithic point classified as Yámana, in a grayish metamorphic rock that we consider an archaeological specimen for the same reasons presented for the Museé du quai Branly Cape Horn specimens (see Section 7).

The Ethnologisches Museum (EM) owns a large sample of Selk'nam arrows collected by Herr Mallman, amounting for 28 whole arrows, three points and two preforms. All points are made from glass, except for three whole arrows: one of them has a bone head and two are knapped lithics. From them, 23 whole arrows yield resin remains in the proximal part of the shaft. Table 3 presents the descriptive statistics of this sample.

From Hagenbeck's collection, there is one whole arrow (correctly) assigned to the Yámana from Hermite Island. It is 701 mm long and weights 18.1 g. Its lithic point is 26.16 mm long. The proximal part of the shaft has a fletching of 40 mm, with presence of black resin.

Rousson and Willems' collection from the Museé du quai Branly is limited to one whole arrow with a lithic point, three shafts and one point of glass, all by Selk'nam groups. There are three whole arrows with glass points and one shaft as well, but no reference to group affiliation is available (Table 4). Finally, the Cape Horn

Table 3
Descriptive statistics of Selk'nam arrows collected by Herr Mallman from the Ethnologisches Museum (Berlin).

	Whole arrows		Arrow points			Arrow shafts		
	Total length	Weight	Length	Width	Thickness	Length	Width	Fletching length
N	25	25	19	19	19	28	28	27
Min	625	17.7	19.64	8.5	2.07	620	6.93	35
Max	730	24.8	39.03	17.03	3.38	700	8.35	45
Mean	695.32	21.39	26.37	14.22	2.77	673	7.75	38.85
Stand. dev	27.19	2.06	4.65	2.06	0.38	21.13	0.40	2.54
Median	705	21.2	27.89	14.32	2.87	684	7.625	39
25 prcntil	679.5	19.8	21.87	13.31	2.48	660	75.025	37
75 prcntil	714	23.2	29.48	15.89	3.08	687.25	81.375	40

Table 4
Descriptive statistics of Selk'nam arrows from Museé du quai Branly (Rousson and Willems' collection and sample without reference).

	Whole arrows		Arrow points			Arrow shafts		
	Total length	Weight	Length	Width	Thickness	Length	Width	Fletching length
N	4	4	5	5	5	8	8	8
Min	700	21.4	21.67	12.81	2.03	641	7.02	35
Max	746	28.1	40.57	24.43	3.38	720	8.33	40
Mean	725	24.6	30.89	17.51	2.76	683.88	7.65	37.38
Stand. dev	18.99	2.83	6.69	4.29	0.57	24.84	0.46	2.2
Median	727	24.45	30.65	16.84	2.91	685	7.58	36
25 prcntil	706.25	21.95	26.04	14.26	2.17	665	7.31	36
75 prcntil	741.75	27.4	35.86	21.11	3.27	701.5	8.12	40

Table 5
Descriptive statistics of Yahgan lithic points collected by the Cape Horn expedition from Museé du quai Branly.

	Arrow (?) points		
	Length	Width	Thickness
N	4	4	4
Min	62.73	34.81	4.77
Max	82.11	47.68	10.48
Mean	69.57	40.64	7.14
Stand. dev	8.66	5.3	2.81
Median	66.73	40.03	6.66
25 prcntil	63.34	36.06	4.79
75 prcntil	78.66	45.82	9.98

expedition provided the sample already mentioned of four Yahgan lithic points collected in Ushuaia shell middens (Table 5).

6. Methodology

The main trends in arrow metrical variations were explored through Principal Component Analysis (PCA). This method is useful to highlight simple patterns of variation from complex multidimensional data. It reveals most of variations among specimens in a low dimensional space, replacing the original variables with new ones (i.e. principal components, PCs) which are linear combinations of the original variables, every of them being independent (orthogonal) of the rest (Manly, 1994; Zelditch et al., 2004).

PCA was presented for every class of artifact (that is, whole arrow, point, and shaft) considering their different sample size due to incomplete arrows or isolated specimens, particularly points. Another difference among artifact class was triggered by the inclusion of a different number of variables in the analyses to respect the assumptions demanded by the method. Thus, while the analysis of the whole arrows yielded a good synthesis and integration of the general trends regarding point and shaft variations in the ethnographic weapons studied, the analysis of the point dataset was mainly focused on assessing the variability between the five isolated lithic points from QB (from Cape Horn's collection) and WM (from Gusinde's) of a probable archaeological origin, on the one hand, and the clearly defined ethnographic arrowhead samples, on the other.

In the case of shafts, a new variable (i.e. fletching length) was included. It was not considered in the analysis of whole arrows due to bias in the multivariate normality requirement (Manly, 1994). All PCAs were performed on a correlation matrix. Then, the existence of differences between-groups regarding the land (Selk'nam or Ona) or sea (Alacaluf and Yámana) economic strategy followed by these hunter-gatherer populations were evaluated and described by means of a Discriminant Function Analysis (DA).

Whereas PCA is used to describe differences among individuals, DA maximizes the separation between groups according to an *a priori* defined grouping variable, here, the economic strategy (McCune and Grace, 2002; Strauss, 2010). Thus, it maximizes the between-group variation as compared to the within-group variation (McCune and Grace, 2002). This analysis is used to identify the axes ("discriminant functions") from a linear combination of variables which provide the best discrimination among given groups. The discriminant function is the direction in which the group means differs greatly; it finds the metrical variables that best distinguish among them (Zelditch et al., 2004). In this way, metrical data were used to predict the membership to a given group (McCune and Grace, 2002). The statistical significance of the differences between groups was later tested through Hotelling's t^2 test. All these analyses were performed in the PAST 3.01 program (Hammer et al., 2001).

7. Results

7.1. Whole arrow metrical variations

PCA includes all complete specimens ($n = 30$) in order to describe the total variability, even though some individuals – e.g. specimens 22 and 9 – could be considered outliers. From the variables, total length is excluded to avoid redundancy with shaft length and point length. Weight is considered as the total size proxy. Fletching length is not included as it prevents reaching multivariate normality. Almost all arrows points are made from glass

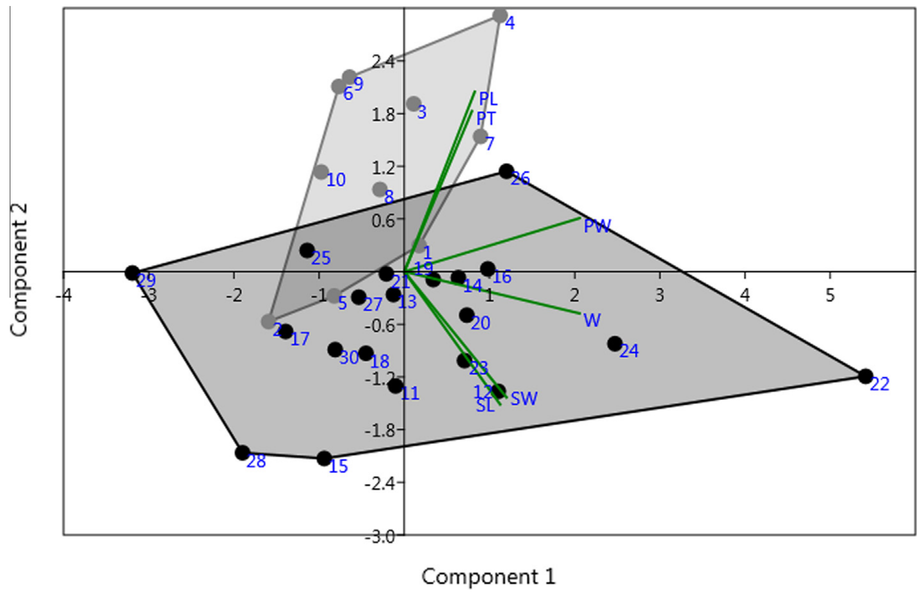

Fig. 3. Principal component analysis of Selk'nam (black dots) and Alacaluf/Yámana (gray dots) whole arrows. Convex hulls mark the scatter area of each group. PL: Point length, PT: Point thickness, PW: Point width, W: Arrow weight, SW: Shaft width, SL: Shaft length.

($n = 27$), two examples are manufactured in stone (ID = 10 and 30) and just one in bone (ID = 29).

The three first axes explain 84.38% of the total variance. Point width and arrow weight show the highest correlations with the first axis (0.5825 and 0.5821 respectively), accounting for 38.6% of arrow variation. Point length and thickness have their maximum correlation with the second axis (0.58 and 0.52 respectively), explaining 26.4% of changes. Shaft length is the variable with the highest correlation with the third axis (0.56) and it explains 19.4% of the variations. Finally, shaft width justifies a small percentage of total variations (8%) and it has the maximum correlation with the PC4 (0.63).

Fig. 3 presents the biplot with the ethnic affiliation of the specimens indicated in different colors. Selk'nam arrows include individuals from the three museums, while Alacaluf or Yámana arrows from the Hagenbeck's collection at the WM are segregated from the only whole arrow from the EM (the weapon from Hermite Island correctly identified as Yámana, ID = 10). This groups differentiation is useful to appreciate the nature of the relationship inside sea hunter-gatherer' assemblages and between them and the group focused on land resources. In Fig. 3 it is clear that most of the Alacaluf or Yámana arrows from WM, as well as the Yámana arrow from EM, grouped together in the upper part of the graphic, whereas most Selk'nam arrows are located at the bottom. Even though PCA is a technique designed to describe variability among individuals rather than to discriminate groups, the distribution of the cases on the Cartesian plane suggests metrical differences between land and sea resource hunter-gatherer's arrows. The two groups of samples considered (i.e. Selk'nam vs. Alacaluf/Yámana arrows) show a limited overlapping.

Selk'nam arrows present a greater variation, probably due to the larger sample available. This variation is mainly related to arrow weight and point width (PC1).

According to the relationship between cases and axes, Selk'nam arrows have wider and longer shafts than Alacaluf/Yámana ones, but the latter have longer and thicker points. In fact, their variation is mainly scattered across PC2.

Thus, while Selk'nam arrows have bigger shafts with smaller points, Alacaluf and Yámana arrows show the opposite pattern. An exception is the Selk'nam arrow with the bone point

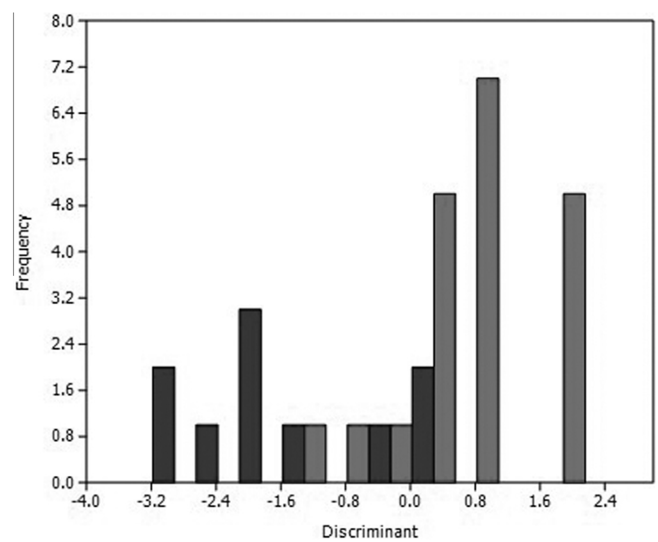

Fig. 4. Discriminant function analysis of Selk'nam (light gray) and Alacaluf/Yámana (dark gray) whole arrows.

(ID = 29), which is the smallest arrow as much as the narrowest point in the sample. The opposite situation can be described for the ID = 22, which is the largest and widest point considered.

7.2. Discriminating between groups

Discriminant function analysis (DA) is concerned with the problem of seeing whether it is possible to separate different groups on the basis of the available measurements (Manly, 1994:13). It also identifies the weight of each variable in the separation. The sample is analyzed using the same matrix developed for the PCA ($n = 30$, excluding fletching length). As the PCA suggests, significant differences between Selk'nam and Alacaluf/Yámana arrows are detected in the multivariate T-square test (Hotellinǵs $t^2 = 32.64$, $p \leqslant 0.001$). The histogram of the discriminant scores is shown in Fig. 4.

In the discriminant function, shaft length (10.52) is by far the variable which explains much of the difference between groups,

Table 6
Classification/misclassification of arrows from discriminant function and the cross-validation procedure.

#	Given group	Classification	Jackknifed
1	Alac/Yám	Selk'nam	Selk'nam
2	Alac/Yám	Selk'nam	Selk'nam
3	Alac/Yám	Alac/Yám	Alac/Yám
4	Alac/Yám	Alac/Yám	Alac/Yám
5	Alac/Yám	Selk'nam	Selk'nam
6	Alac/Yám	Alac/Yám	Alac/Yám
7	Alac/Yám	Alac/Yám	Alac/Yám
8	Alac/Yám	Alac/Yám	Alac/Yám
9	Alac/Yám	Alac/Yám	Alac/Yám
10	Alac/Yám	Alac/Yám	Alac/Yám
11	Selk'nam	Selk'nam	Selk'nam
12	Selk'nam	Selk'nam	Selk'nam
13	Selk'nam	Selk'nam	Selk'nam
14	Selk'nam	Selk'nam	Selk'nam
15	Selk'nam	Selk'nam	Selk'nam
16	Selk'nam	Selk'nam	Selk'nam
17	Selk'nam	Selk'nam	Selk'nam
18	Selk'nam	Selk'nam	Selk'nam
19	Selk'nam	Selk'nam	Selk'nam
20	Selk'nam	Selk'nam	Selk'nam
21	Selk'nam	Selk'nam	Selk'nam
22	Selk'nam	Selk'nam	Selk'nam
23	Selk'nam	Selk'nam	Selk'nam
24	Selk'nam	Selk'nam	Selk'nam
25	Selk'nam	Selk'nam	Alac/Yám
26	Selk'nam	Alac/Yám	Alac/Yám
27	Selk'nam	Selk'nam	Selk'nam
28	Selk'nam	Selk'nam	Selk'nam
29	Selk'nam	Alac/Yám	Alac/Yám
30	Selk'nam	Selk'nam	Selk'nam

followed by point length (−2.18), arrow weight (0.57), shaft width (0.24), point thickness (−0.19) and point width (−0.065). Regarding this linear classifier, 83.33% of arrows are correctly allocated to their original group. Each specimen is assigned to the group with the minimal Mahalanobis distance to the group mean. The Mahalanobis distance is calculated from the pooled within-group covariance matrix. Furthermore, group assignation was cross-validated by a leave-one-out cross-validation (jackknifing) procedure, which resulted in 80% of the arrows being correctly classified. Table 6 lists the given and estimated group affiliations (by the discriminant function and the jackknife procedure) for each specimen.

7.3. The case of points

The sum total of the complete points surveyed (either being part of a whole arrow or isolated pieces) comprises 41 specimens, including those originally classified as Yahgan ($n = 4$) at the QB collected by Cape Horn French expedition, and the only specimen classified as Yámana in Gusinde's collection at the WM (ID 37-40 and 41, respectively). According to QB documents, these four pieces (all of them of lithic raw materials) were collected by the French expedition from shell middens on the Ushuaia coast. It means that they may be archaeological materials, like the specimen number 41 from the WM, which is quite similar in design and raw material. They are purposefully included in this analysis to evaluate the existence of differences with the ethnographic arrow points of known origin, as aforementioned.

Size disparity between the Yámana/Yahgan sample from QB and WM, and the rest of the points is evident (Fig. 5). These five points are the largest specimens in the three variables considered. This pattern is independent of raw material because the largest lithic points are far unlike the ethnographic lithic materials from EM (ID = 12 and 24), which grouped together with the glass points. It should be noted that specimen number 12 is the point correctly assigned to Yámanas from Hermite Island. It yields a negative value in the PC1, quite distant from the positive values of specimens 37–41. The analysis suggests a metrical difference that could be related to at least two factors: a functional difference in the weapon systems represented – it is not possible to know how these isolated lithic points were used – and/or some time variation resulting from the probable archaeological nature of specimens 37-41. Ratto's (1991a, 1991b, 1992) as well as Álvarez's (2009a, 2009b, 2011) studies on Late Holocene projectile points have revealed the existence of functional variation. They noticed the use of hand-thrown spears, thrusting spears, arrows as well as daggers and hafted-knives among the weapon systems in the area. If we compare the metrical values of specimens 37-41 against the

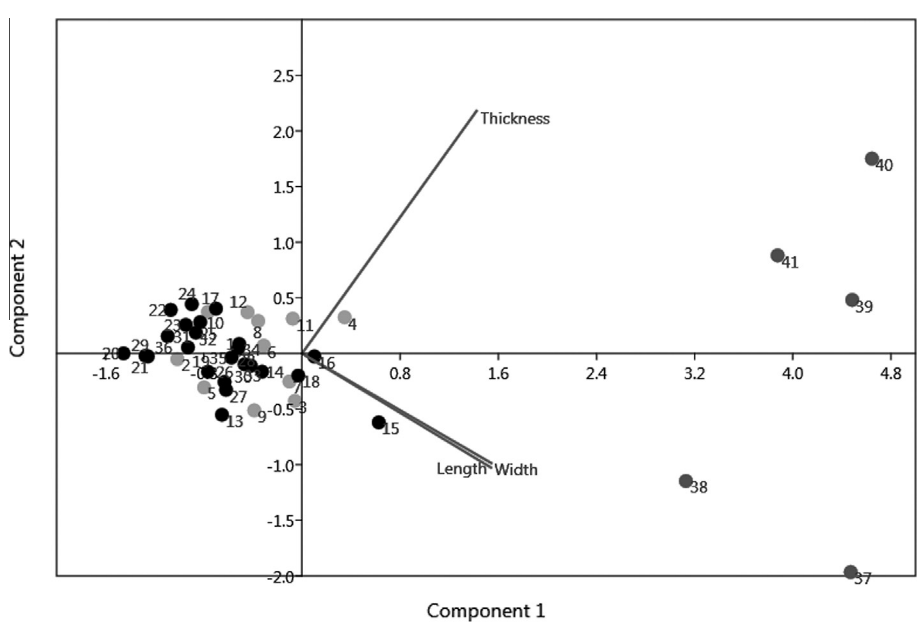

Fig. 5. Principal component analysis of Selk'nam (black dots) and Alacaluf/Yámana (light gray dots) points, including the probable archaeological samples from Museé du quai Branly and Weltmuseum Wien classified as Yámana or Yahgan (dark gray dots, ID 37-41).

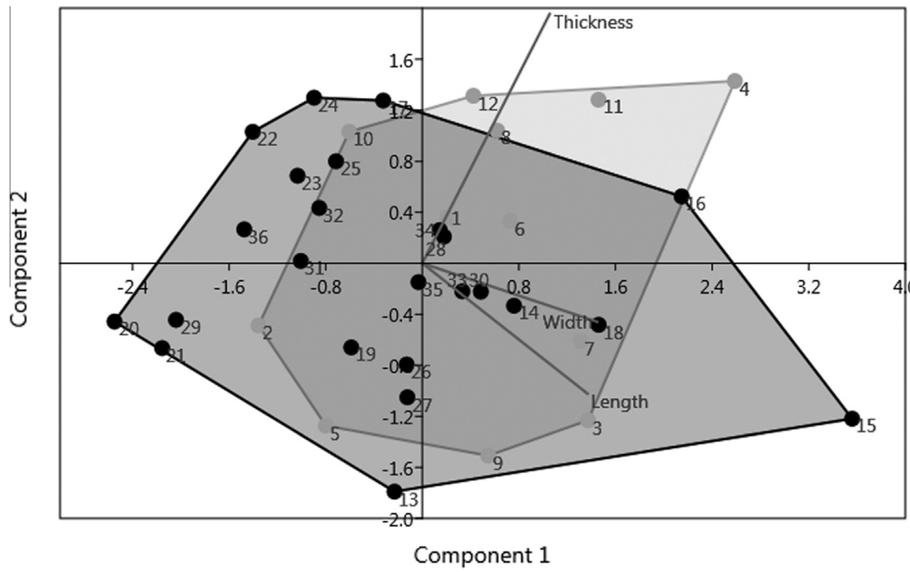

Fig. 6. Principal component analysis on Selk'nam (black dots) and Alacaluf/Yámana points (gray dots). Convex hulls mark the scatter area of each group.

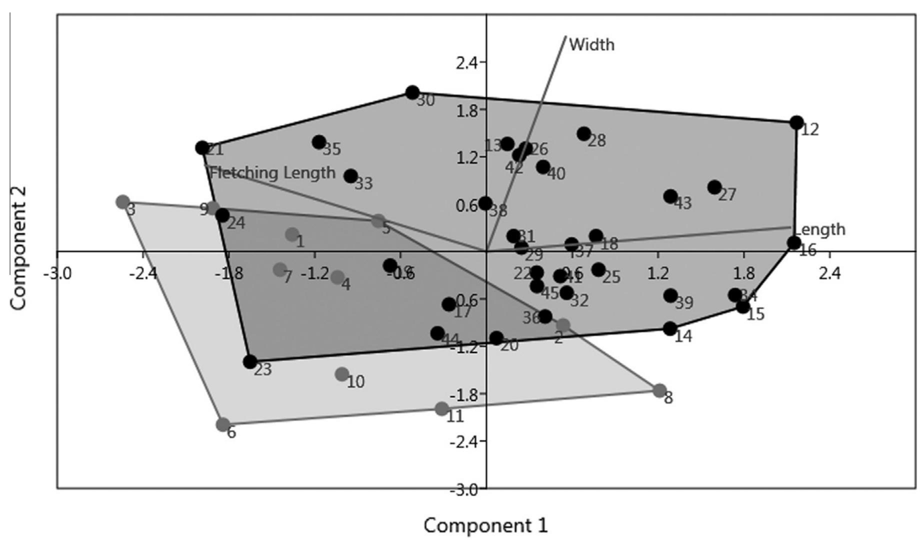

Fig. 7. Principal component analysis on Selk'nam (black dots) and Alacaluf/Yámana (gray dots) shafts. Convex hulls mark the scatter area of each group.

ones for the 14 points from the archaeological sites of Rancho Donata and Punta María 2 classified as arrows by Ratto's performance model (1991a, 1991b), significant mean differences in length (Welch's t test for unequal variance: 4.7315, $p < 0.001$) and width (Welch's t test for unequal variance: 4.5298, $p < 0.001$) – the only two variables that can be compared – are noted. Unfortunately, there are still no information available for the projectile points from the Beagle Channel considered as arrows (Álvarez, 2009a, 2009b, 2011), which impair more thorough comparisons. For the time being, these results show the existence of some metrical differences regarding of archaeological arrow-points which, together with the size difference with respect to the ethnographic specimens, suggests a functional disparity of specimens 37-41 other than chronological variations.

In Fig. 6 specimens 37-41 are excluded, and the pattern remains similar to the one already discussed: Selk'nam arrow points are generally shorter, narrower and thinner than Alacaluf/Yámana ones, with some exceptions in Selk'nam points reaching larger sizes like specimens 15, 16 and 18. It is in line with the maximum variation recorded by the PC1, which explains 86.47% of the variability detected. The three variables (point length, width and thickness) have a similar representation in this axis (0.6, 0.59 and 0.54 respectively). When only the points are considered, the metrical variation between sea and land hunter-gatherer's arrows shows more overlapping. It suggests that the overall weapon system defines a clearer differentiation between the arrow technologies of both groups, since the point:shaft ratio presents a contrasting pattern (smaller points + larger shaft in the former vs. larger points + smaller shafts in the latter).

7.4. Shaft variation

The PCA is performed for a sample of 45 shafts from whole arrows and isolated pieces, including the fletching length among the variables.

The first two PCs explain 81.5% of the variations (Fig. 7). Shaft and fletching lengths show the highest correlation with PC1 accounting for 46.7% of the variability. While shaft length presents a positive correlation (0.72) with this axis, fletching length depicts an inverse relationship (−0.66). Shaft width has the maximum correlation with the second axis (0.92), explaining 34.7% of the variation.

The distribution of cases indicates that Selk'nam arrows have longer and wider shafts, and shorter fletching than Alacaluf/Yámana weapons.

Ethnographic, experimental and optimal engineering studies usually remark the importance of shaft size (mass), straightness and fletching, among other variables, conditioning the performance of throwing weapons (Ahler and Geib, 2000; Bleed, 1986; Cotterell and Kamminga, 1990; Flenniken and Raymond, 1986; Hughes, 1994; Hunzicker, 2008; Knetch, 1997; Odell and Cowan, 1986; Ratto, 1992, 2003; Shea et al., 2001, among others. See discussion about the use of atlatl weights in Peets, 1960 and Raymond, 1986). The arrow intended to cover long distances must incorporate some design improvements in order to guarantee minimum values of aerodynamics, penetration, weight, hafting attachment, etc. Ratto's study (2003) of the mechanical and physical properties of the woods used to make arrow shafts by Fuegian groups threw light on their influence on the stability of flight trajectory and impact effectiveness. Having this information in mind, variations in shaft length and width, as well as fletching length, has to be framed in the overall technical system, that is, the data about point dimensions, and its opposite relationship with shaft dimensions should be considered. The distinct combinations of these variables (shaft and point dimensions) are directly related to the control of the whole arrow mass, which needs to be accurate to achieve an optimal performance. In this interplay, weight as much as other properties of wood species, play an important role. Even though ethnographic information revealed Selk'nam and Yámana used several local wood species to build arrow shafts (in contrast to the uniformity found in the wood used to make bows), taxonomic and morphological studies of "Fuegian" shafts from the collections at the Museo del Fin del Mundo (Ushuaia, Argentina) and Museo de La Plata (La Plata, Argentina) only reported the use of *Berberis sp.* and *Ribes magallanica* (Caruso et al., 2011; Ratto and Marconetto, 2011). The former is the most usual material and refers to the genus of several local species of shrubs. According to ethnographic data, they were used both by Selk'nam and Yámana (Bridges, 1952; Chapman, 1986; Gusinde, 1982 [1931]; Prieto, 1994). On the other hand, *Ribes magallanica* was only recorded for three shafts out of 15 from the Museo del Fin del Mundo (the others were *Berberis sp*., Caruso et al., 2011). Ethnographic data indicate the Selk'nam used it to hunt sea birds due to its capacity to float, which would have made the recovery of shafts easier (Chapman, 1986). Unfortunately, both collections are classified as "Fuegian", impairing any possibility to differentiate ethnic groups on the basis of the wood species used. Nevertheless, the performance of the overall technical system, i.e. the equilibrium between point and shaft dimensions (which includes the weight of the wooden part), must be considered a crucial aspect to interpret these results.

8. Concluding remarks

The metrical comparisons of Tierra del Fuego ethnographic arrow collections from European museums presented here have been fruitful in many ways. First and foremost, multivariate analysis revealed the existence of metrical variations in late 19th–early 20th century hunter-gatherer's arrow technologies throughout Tierra del Fuego. A size difference between the individual parts (point and shaft) of the arrow, as well as a contrasting pattern in the point:shaft ratio was identified between historical arrows of hunter-gatherers specialized on either land or sea resources: while Selk'nam arrows have longer and wider shafts with smaller fletching and points, Alacaluf and Yámana arrows show the opposite trend. Unfortunately, the pattern identified for the point:shaft ratio cannot be easily determined in archaeological arrows due to the limited preservation of organic materials. On the other hand, size disparity in projectile points can be more easily recorded due to the general preservation of the point. Thus, the north–south morphometric variations previously detected on archaeological projectile points for the last 3000 years are also present in the ethnographic samples analyzed here (at least regarding size), following the distribution of land and sea hunter-gatherers' home ranges. Studies of stable isotopes in human bones dated to 1500 years before European contact indicated a clear continuity in subsistence patterns as well (Yesner et al., 1991, 2003). Therefore, both lines of archaeological evidence support the ethnohistorically identified patterns, at least for the Late Holocene.

Nevertheless, further analysis is needed to address the direct comparison between archaeological and ethnographic arrow points controlling functional variations.

The present study also contributed to identify the similarity between the arrows from the Hagenbeck's collection at the WM classified as "Fuegians" from Hermite Island and the correctly assigned Yámana arrow from this island at the EM. Multivariate comparisons proved that both sets of arrows from sea resources hunter-gatherers always grouped together, presenting more similarities among them than with Selk'nam arrows.

A third item to mention is that the statistical analyses proposed offered elements to support the hypothesis of a functional difference between a subsample of five points from QB and WM collections of a probable archaeological origin and the ethnographic arrow-points of well-known makers and functionality studied here. For instance, they showed the first pieces are much larger than ethnographic arrow-points regardless the raw material used. This size dissimilarity could be related with their use in a different technical weapon system (i.e. thrown like spears) as previous archaeological studies suggested. Indeed, this subsample also showed some size difference when compared to the archaeological points classified as arrows in Ratto's model. However, a larger and thoroughly controlled archaeological sample is needed to test this hypothesis in a broader scale.

As these analyses were focused on arrow size, morphological point variations still remain to be explored. It is expected that in the near future geometric morphometric analyses will be applied, as it proved a successfully technique to study projectile point shape variations. An increase in sample size, including new sets of museum collections, will contribute to extend our knowledge about Tierra del Fuego arrow technologies.

Acknowledgments

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