



Taphonomic evaluation of penguin (Spheniscidae) remains at a shell-midden on the northern coast of Patagonia (San Matías Gulf, Río Negro, Argentina)

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ABSTRACT

Archaeological deposits in continental Patagonia that allow an adequate discussion of the exploitation of seabirds, particularly the Spheniscidae, are scarce. In many cases, characteristics of bone assemblages seem to indicate the natural incorporation of penguin bones into archaeological contexts. This suggests it is not always possible to support the argument that the presence of penguin remains indicates, a priori, consumption by humans. The Bajada de los Pescadores (BP2) site, San Matías Gulf (Río Negro, Patagonia, Argentina), provides a case study that allows the origin of these deposits and their contents to be evaluated in terms of the exploitation of penguins and other marine resources by hunter-gatherers during the Late Holocene. This paper discusses the origin of the archaeological deposit, its context, and the agents involved in its formation. The analysis used criteria formulated previously in the framework of actualistic taphonomic observations, with the aim of assessing the integrity of this sample, and evaluating its contribution towards clarifying the role of penguins in the subsistence of people on the northern Patagonian coast.

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1. Introduction

Penguins (Spheniscidae) are the most frequently recorded seabirds in the southern hemisphere, as they represent almost 80% of the total bird biomass in southern oceans (Williams, 1995). They have properties that make them very suitable for intensive exploitation by human hunters. They breed in colonies that can comprise up to hundreds of thousands of individuals and, though they are pelagic, are land bound for a long period in predictable places during the breeding period. They are flightless and thus easy to hunt and, depending on the species, provide a higher economic yield than other coastal birds (Lefèvre, 1993–1994; Cruz, 1999, 2001).

During the Holocene, penguins were hunted in several places of the southern hemisphere. In South Africa they are common in Later Stone Age sites (e.g. Avery and Underhill, 1986; Avery, 2011) and are one of the most abundant among bird species in some Middle Stone Age deposits (e.g. Klein et al., 2004; Avery et al., 2008). In New Zealand, evidence shows that, since the settlement of the islands, at least one species of penguin (*Megadyptes waitaha*) became extinct due to human over-exploitation (Boessenkool et al., 2008). In South America, in insular Patagonia, penguins have been hunted for 6000 years, and their remains, together with those of cormorants (Phalacrocoracidae), are the most abundant in several archaeological deposits

(Lefèvre, 1989, 1992; Lanata et al., 1992; Savanti, 1994; Mameli, 2002; Tivoli, 2010; Tivoli and Zangrando, 2011). However, the Atlantic coast of continental Patagonia has yielded scant or non-existent evidence for the exploitation of penguin breeding colonies during the Holocene (Cruz, 2001). This is in notable contrast to the current abundance of breeding areas of the Magellanic penguin (*Spheniscus magellanicus*), whose colonies include hundreds of thousands of individuals during the austral spring (Schiavini et al., 2005).

Several causes have been proposed for the low incidence of prehistoric exploitation on the Patagonian coasts. First, changes in their breeding distribution during the Holocene (Cruz, 2001). Penguins are extremely sensitive to climatic and environmental changes (Williams, 1995; Cooper et al., 1997), so that it is necessary to investigate whether the Late Pleistocene and Holocene climatic and environmental changes influenced their distribution. Second, based on 16th–18th century historical accounts, it has been suggested that penguin breeding colonies were on islands and not on the mainland as they are nowadays (Cruz et al., 2004, 2010). Nesting on islands is a well-known defense against predators, used by many birds. Because native populations of continental Patagonia did not use boats, penguin hunting must have been restricted to those few individuals that arrived at the continental Atlantic coast, and not at their breeding colonies. Finally, through systematic observations of modern penguin bones deposits, possible taphonomic biases that might have prevented their preservation in the archaeological deposits of the region have been explored. These

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investigations ruled this possibility out, and brought to light the possibility that present day penguins can “contaminate” the archaeological record (Cruz, 1999, 2004, 2007) by the incorporation of modern bones. This emphasizes the need to intensify zooarchaeological research in order to evaluate whether penguins were available as a food resource for continental Patagonian hunter-gatherers, and to establish their contribution to human subsistence during the Holocene.

This paper will present an analysis of an archaeological sample from Bajada de los Pescadores 2 on the north Atlantic coast of Patagonia, in which penguins and a small sea-lion (*Otaridae*) remains predominate. The goal of this paper is to conduct a taphonomic analysis of the penguin remains to evaluate the integrity (*sensu* Binford, 1981:19) of the sample and its context before attempting interpretations of past human behavior.

The deposit and its chronology are characterized, and taphonomic criteria generated by prior actualistic studies on penguin bone accumulations (Cruz, 1999, 2007) are used to describe the taphonomic properties of the archaeological assemblage. The results will be used to assess the possibility that the inhabitants of the site were exploiting predominantly marine resources (the focus being on penguins) as previously established for this region (Favier Dubois et al., 2009). The intent is to link past use of space and littoral resources in this locality with that of other North Patagonian localities during the Late Holocene. Furthermore, given the wide distribution of the *Spheniscidae*, evaluations such as this could also be useful in the analysis of other Southern Hemisphere archaeological samples that includes penguin remains.

2. Bajada de los Pescadores: location and general characteristics

Bajada de los Pescadores (BP) is on the northern Atlantic coast of Patagonia, in the San Matías Gulf (Province of Río Negro, Argentina), where active cliffs alternate with coastal bays and coves (Favier Dubois et al., 2008) (Fig. 1). The study site lies in an area where the cliff has retreated and is covered by eroding dune deposits. Bajada de los Pescadores is 4 km west of the Bajo de la Quinta (BQ) locality, where archaeological research showed that

from 6000 to 460 BP, the area was regularly used by hunter-gatherers (Favier Dubois and Kokot, 2011). Recovery of human remains with different chronologies at BQ allowed palaeodietary studies to be carried out that showed differences in the way marine resources were used over time. Isotopes revealed a predominantly marine diet from 3100 to 2200 BP, which later become mixed terrestrial-marine from 1500 to 420 BP (Favier Dubois et al., 2009). Thus, the evaluation of the integrity of this shell midden will allow discussion of whether or not the penguins at BP2 were a resource consumed by people.

The samples from the BP2 shell midden comprise mainly mussels (*Aulacomya ater*). This cultural accumulation is visible in an exposed section of a partially-vegetated dune 7 m above present sea level that abuts against a palaeo-cliff. Currently, fishermen traverse this slope to access the beach and the top of the vegetated cliff. This activity has damaged the vegetation cover, facilitated erosion of the dunes, and partially exposed discrete lenses of molluscs and charcoals and other archaeological remains.

Surface material was collected from a 3 m² area of the slope adjacent to the exposed midden section and an excavation was carried out over an area of 1.25 m². Three 5 cm spits revealed a 15 cm thick midden. The faunal sample comprised 543 bones, in which birds (mainly *Spheniscus magellanicus*) and a small otariid predominate. Thus, charcoal from the 5–10 cm level was radiocarbon dated to 2197 ± 38 BP (AA81730).

3. Methodology

Guidelines commonly used in the study of zooarchaeological assemblages were followed (e.g. Binford, 1981; Lyman, 1994; Reitz and Wing, 1999). Where possible, the reference collections at the Faculty of Social Sciences in Olavarría (INCUAPA), Archaeology Laboratory were used to determine the family species and gender; the remainder being assigned to broader categories (birds, mammals, otariids, vertebrates). NISP (Number of Identified Specimens) per taxon, MNE (Minimum Number of Elements) and MNI (Minimum Number of Individuals) were calculated. Examination of the modifications observed on cortical bone surfaces was performed macro- and microscopically, according to the following criteria:

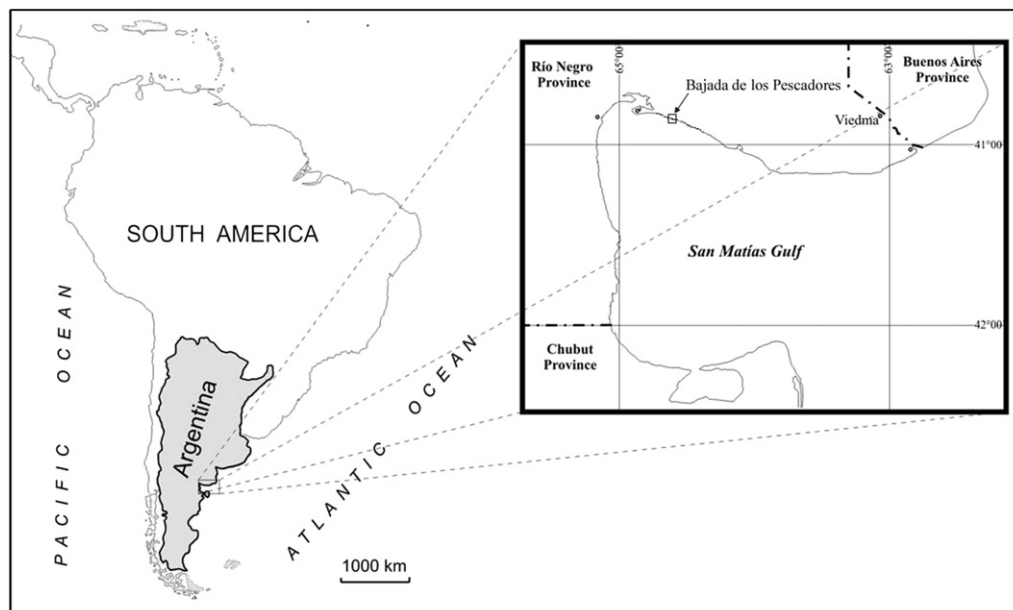


Fig. 1. Location of Bajada de los Pescadores in the North Patagonia Atlantic Coast. Modified from Favier Dubois and Kokot (2011).

weathering (Behrensmeyer, 1978; Behrensmeyer et al., 2003), damage by carnivores, rodents, roots, and cultural processing marks (Binford, 1981; Lyman, 1994). For the penguins, bones were grouped according to their anatomical units: a) forelimbs: humerus, radius, ulna, carpometacarpus, anterior phalanges; b) scapular girdle: scapula, coracoid and furcula; c) hindlimbs: femur; tibiotarsus, fibula, patella, tarsometatarsus, posterior phalanges; d) pelvic girdle: pelvis and sacrum; and e) axial skeleton: cranium, mandible, vertebrae, ribs, and sternum. Furthermore, the taphonomic criteria enunciated below were used, which allowed this information to be included in a discussion on the integrity of the assemblage (*sensu* Binford, 1981).

The starting point for any zooarchaeological analysis, whether artifacts are present or not, must be to determine the role of humans in the deposition and modification of the recovered remains (Binford, 1981; Borrero, 1989; Lyman, 1994). For this purpose it is necessary to have adequate taphonomic criteria, derived from observations designed to understand the recycling of the remains in a specific environment. Taphonomic studies on penguins have been carried out at several locations on the Patagonian coast (e.g. Cruz, 1999, 2004, 2007, 2008) and in Antarctic breeding areas (Emslie, 1995).

Human activity is not the only likely source of bones in archaeological sites. On the Patagonian coast, the probability that bones from natural deaths of penguins and human activity will be mixed is very high (Massone, 1984; Cruz, 2004, 2007, 2008). Penguins can dig burrows directly into archaeological deposits. Therefore, the avifaunal component of the archaeological assemblages must be rigorously examined to determine its chronology and origin. Analysis of the BP2 remains considered three possibilities that might explain the origin of the assemblage, a) completely natural, b) totally cultural, and c) a mixture of both natural and cultural. Three main criteria were used:

- 1) *Taxonomic composition.* Despite their small body size, penguin bones predominate above those of other vertebrates (including birds) in natural deposits at their breeding areas (Cruz, 2007). An attempt was made to establish how this may have affected the composition of the BP2 avifauna.
- 2) *Representation of skeletal parts.* This aspect of bone assemblages is of great importance (e.g. Lyman, 1994). In modern natural assemblages, Spheniscidae elements of both extremities predominate, followed by the scapular girdle, whereas the axial skeleton and pelvic girdle are less commonly preserved (Emslie, 1995; Cruz, 2001, 2007). This profile is clearly different from that for flying birds for which predominance of wings and scapular girdle relative to other skeletal parts are characteristic (Bovy, 2002; Serjeantson, 2009), and is related to the particular anatomy of penguins, which are the most specialized in diving among all birds (Simpson, 1976; Williams, 1995). The pattern derived from deaths during the breeding period should be different from that produced by human action during the hunting, processing, and consumption of these birds.
- 3) *Preservation state of the assemblage.* Weathering profiles and bone modifications (natural and cultural) can elucidate the formation history of a bone accumulation. Taphonomic observations in Patagonia established that one of the main causes of destruction of all bird (including penguin) remains is weathering. The ecological conditions in the south of the continent preclude carnivore impact on bird remains in the coastal sector (Cruz, 2007, 2008). The weathering profile of the penguin remains at BP2 will be a means of evaluating the time of exposure before they were covered by sediments.
- 4) *Comparison of the state of preservation of Spheniscidae and Otariidae remains at BP2.* These comprise the major taxa in the

Table 1

Taxonomic composition recorded at Bajada de los Pescadores 2.

TAXA	NISP	%NISP
Penguin	139	25
Other birds	63	12
Otariids	133	24
Fishes	65	12
Rodents	37	7
Guanacos	5	1
Crabs	1	0.5
Other vertebrates	100	18.5
Total	543	100

assemblage, and comparison will allow evaluation of whether all of the recovered remains were deposited simultaneously or not.

- 5) *To establish taxon-dates* (*sensu* Borrero, 2009:146). This is particularly important in this case, given the possibility noted above, that mixing of modern and ancient bones can take place (Cruz, 2001). Chronologies obtained on penguin bones provide a more reliable framework for evaluating the evidence.
- 6) *The matrix and geomorphological context of assemblage.* Knowledge of the origin of the deposit (sedimentary matrix) and geoform on which the site is placed are key aspects for a suitable interpretation of its history (Waters, 1992; Borella, 2003; among others). This permits evaluation of whether the environmental conditions required by the penguins to establish their burrows existed at BP2 or any site where these birds nest.

4. Results

A total of 446 of the 543 specimens could be positively identified to skeletal part and taxon (Table 1). Birds comprised 37.19%, otariids 24.49% and fish 11.97%. Other taxa included a few rodent bones 7%, five guanaco (*Lama guanicoe*) bone splinters, an armadillo bone fragment, a fragment of a crab chela, and, on the surface of the slope, a canid bone fragment.

Spheniscus Magellanicus is the most abundant bird taxon in the assemblage, representing 69% of total avifaunal remains (Table 2), with a MNI of five individuals estimated from coracoids and tibiotarsus. Flying birds (11%) represented by very few bones, included cormorants (three bones), gulls (*Larus* sp.), terns (*Sterna* sp.) and ibis (*Theristicus* sp.), each represented by a single bone.

Otariids seal are second in importance, with an MNI of three individuals for *Arctocephalus australis* (based on the right calcaneum), and one for *Otaria flavescens*. Taphonomic observations carried out at a breeding colony of *O. flavescens* on the Rio Negro Atlantic showed that bones of adults had a higher probability of being incorporated naturally into the coastal archaeological record than bones of small individuals or pups (Borella and Borrero, 2010).

Fish, represented by at least five species identified from only a few bones, made up 12% of the total assemblage. Grouper (*Acanthistius brasilianus*) remains are the most numerous (27%), followed by Sea-bass (*Eleginops maclovinus*), and the Sea-catfish (*Genidens barbus*), all species inhabiting shallow coastal waters.

Table 2

Avian representation (NISP and MNE) at BP2 assemblage.

Avian representation	NISP	NISP %	MNE
Penguin	139	69.0	108
Flying birds	22	11.0	6
Avian undetermined	41	20.0	23
Total avian	202	100.0	137

Table 3
Representation of penguin skeletal parts at BP2.

Skeletal parts	Elements	MNE
Forelimb	Humerus	8
	Radius	7
	Ulna	5
	Carpometacarpus	2
	Falange	2
Scapular girdle	Coracoid	9
	Scapula	9
	Furcula	2
Hindlimb	Femur	8
	Tibiotarsus	10
	Fibula	6
	Patella	0
	Tarsometatarsus	5
	Phalange	9
Axial skeleton	Cranium	6
	Mandible	0
	Cervical vertebrae	3
	Thoracic vertebrae	1
	Lumbar vertebrae	2
	Caudal vertebrae	0
	Rib	4
	Sternum	8
Pelvic girdle	Pelvis	1
	Sacrum	2
Total		108

At BP2, bones of almost the whole penguin skeleton are represented (Table 3). Bones from the hindlimbs and scapular girdle, particularly the sternum, predominate. Pelvis and thoracic vertebrae are scantily represented (one specimen of each), whereas mandible, patella and caudal vertebrae were not recorded. Thus, the pattern of skeletal representation from BP2 zooarchaeological assemblage shows differences as well as similarities to that observed in the taphonomic studies (Table 4). In the archaeological assemblage there is a higher proportion of elements belonging to the axial skeleton, and a smaller representation of the forelimbs. On the other hand, scapular girdle and hindlimb representation is similar to that of modern assemblages. It is possible that these differences and similarities are related to the formation of the archaeological deposit and to the particular anatomy of penguins.

No bones modified by carnivores were recorded and only 1% of the specimens show signs of abrasion. Most of penguin bones show no sign of weathering (63%) or are slightly weathered (20%), which might imply a rapid burial (Table 5). Advanced weathering was only observed in specimens collected from the slope of the midden, exposed as a result of recent erosive action. The predominance of fractured bones (73%) seems to relate to the erosion and recent human trampling in the area. Root marks affected 60% of the assemblage. As in other archaeological assemblages with penguin bones (Cruz, 2006), the incidence of cut marks is very low (2%). This low representation of human modifications is not linked to masking of cortical surfaces due to natural modifications (such as roots, fractures, etc.).

Table 4
Comparison of penguin anatomical representation at BP2 and modern assemblages.

Skeletal parts	BP2	Modern assemblages ^a
Forelimb	22%	32.2%
Scapular girdle	18%	17%
Hindlimb	35%	35%
Axial skeleton	22%	9.3%
Pelvic girdle	3%	6.5%

^a Data from Cruz, 2007.

Table 5
Natural and cultural modifications in penguin and otariid remains at BP2.

Modifications		Penguin % NISP	Otariid % NISP
Weathering	Stage 0	63	54
	Stage 1	20	22
	Stage 2	14	18
	Stage 3	–	5
	Undetermined ^a	3	1
Breakage	Presence	73	38
	Absence	27	62
Rodents marks	Presence	3	1
	Absence	97	99
Root etching	Presence	60	65
	Absence	40	35
Abrasion	Presence	1	–
	Absence	99	100
Burning	Presence	4	8
	Absence	96	92
Cut marks	Presence	2	6
	Absence	98	94

^a Weathering was not determined in the case of specimens burned or teeth, because is not applicable.

As an indicator of human activity, burning is also underrepresented (4%). However burning can be associated with a circle of thermo-altered pebbles, and the occurrence of charcoal throughout the midden.

5. Discussion and conclusions

Previous studies (Cruz, 2001, 2004, 2007) stressed that the presence of penguin remains in several archaeological deposits on the Atlantic coast of Patagonia could be the result of natural incorporation into archaeological contexts by natural means. Therefore, it is necessary to evaluate the integrity of each deposit before accepting the bird remains as evidence of human exploitation (e.g. Cruz, 2001).

The taxonomic composition at BP2 is different from that observed at modern deposits of Spheniscidae remains in breeding areas. In natural accumulations, penguin remains are the largest taxonomic component (Cruz, 1999, 2004, 2007). In the BP2 archaeological assemblage, on the other hand, otariid remains are found in almost the same proportion (25% of the whole sample NISP). In addition, taxa such as fish, which also would not be expected in aeolian sediments, appear and comprise the most frequent remains in the archaeological assemblages in this sector (Scartascini, 2010).

The representation of skeletal parts at BP2 shows differences and similarities with natural assemblages. Most axial elements in the assemblage are securely related to the human history of the deposit: the archaeofaunal remains were recovered in a shelly lens of valves, which favoured the preservation of bone (Favier Dubois and Borella, 2007). Concomitantly, small fragile elements such as bird vertebrae and cranial and sternal fragments, which are normally poorly represented in modern surface assemblages (Cruz, 2007), are present.

The low representation of forelimb elements in the archaeological assemblage might be interpreted as an argument that people were processing the penguins. Flipper elements have lower economic yield and it is possible that they were discarded elsewhere or destroyed during consumption. For instance, use of bones from the extremities as raw material for the manufacture of tools, (which has been recorded both archaeologically and

ethnographically in other sectors of Patagonia), would explain their absence in the assemblage.

The weathering profile of the bones (non- or slightly weathered bones 83%) is similar to that of the otariid remains at BP2 (76%). This supports the simultaneous deposition and direct association of the bones with the molluscs and charcoal. Fast burial is implied for the preservation of the assemblage. Root marks on the penguin and otariid bones (60%) suggest that the assemblage was in a stable context protected by plant cover during at least part of its depositional history. This would have stabilized the aeolian mantle (dunes) until recent deflation exposed the midden as commonly observed in localities on the north coast of the San Matías Gulf (Favier Dubois and Borella, 2007). The scarcity of human modifications (2%) is consistent with observations at other archaeological deposits in Patagonia (Cruz, 2006). The location of cut marks on one sternum and one coracoid suggest that they were connected with portions with the highest meat yield. On the other hand, given the anatomy and morphology of penguin bodies, it may have been feasible to process them with minimal use of stone tools. What is important here is that the small quantity of modifications is not an exceptional case, and therefore cannot be used to exclude the human origin of the assemblage. The small number of human modifications on the otariid remains at BP2 (6%) is similar (Table 5).

Another important aspect highlighted by the actualistic studies is the need to consider the possibility of mixing with modern bones, given the presence of active penguin nests and the characteristics of the spaces as potential nesting places in the past. Currently there are no nesting penguin colonies in this sector of the northern Patagonian coast. Even though in previous decades the breeding distribution of these birds has extended northwards (Schiavini et al., 2005) the nearest present breeding area is on Islote Lobos, over 100 km south of BP. Therefore, in this case, situations of mixtures with modern bones can not be expected. On the other hand, the characteristics of the sedimentary and geomorphologic matrix on which the midden lies are not suitable for the placement of penguin burrows after the formation of the shell midden, as these birds do not usually dig their nests in sectors of loose sediments (Stokes and Boersma, 1991) as those that characterize the dunes that would later formed on BP.

To establish contemporaneity of the shell midden and the penguin remains, a coracoid with cut marks (Fig. 2) that was recovered from the slope was dated at 2601 ± 51 BP (AA88056). Considering the average marine reservoir effect incorporated by the calibration programs (400 years; Stuiver and Braziunas, 1993), this age becomes equivalent to that obtained for the charcoal. The coincidence between both dates supports the contention that the deposition of penguin bones was simultaneous with that of the midden (charcoals, otariid remains, molluscs) On the other hand, it also confirms the nearby availability of penguins at the time. Availability may have been the result of the presence of local breeding

sites in the past or birds beached or resting during their dispersal, as nowadays, to tropical waters during the austral autumn–winter period.

On the present shore at Bajada de los Pescadores there are small islets close to the beach, visible at low tide, that emerge in this sector (sediments corresponding to the Patagonia Formation, see Gelós et al., 1988). One of these islets, some 30 m² in area, is around 200 m in front of BP. In accordance with these littoral dynamics, it is possible to imagine that in the past similar projections or rocky islets also existed, suitable for the establishment of seabirds and/or sea-lions. The sea level has not changed significantly since the last sea – level fall about 2600 BP (Schellmann and Radtke, 2010). Nevertheless, the archaeological evidence presented here only establishes the presence of available birds close to the location.

In summary, the taphonomic approach indicates the penguin assemblage at BP2 as a whole formed as a result of human activity. The possible contribution through the admixture of bones from natural deaths can be discounted. Observations on the species composition, modifications and anatomical representation indicate human activity. The dating of the taxon confirms the contemporaneity of penguin remains with the remainder of the deposit, and indicates its existence during the period of human occupation in this coastal sector of Patagonia. The consumption of birds recorded here is consistent with the results from stable isotopes on human remains obtained for this period in the region. These results indicate predominantly marine diets during the first part of the late Holocene (Favier Dubois et al., 2009). BP2 confirms that people were exploiting penguins on the northern Patagonian coast by at least 2200 BP. At this small locality the main resources exploited were penguins, sea-lions, fish, and molluscs, providing a valuable window through which the exploitation strategies and mobility of people at times when human subsistence was firmly linked to the sea.

The archaeological record is the parameter by which the relevance of explanations of the human past are determined (Binford, 1981). On this account, a large part of the archaeologists' task consists in establishing the history of the formation of the deposits. Once this is known, or at least the part of it that is accessible, the evaluation of the way the record in question allows holding or discarding hypotheses on human behavior. This paper has shown the relevance of these statements in one particular case: that of the taphonomic dynamics of penguin remains in the archaeological deposits and their importance in discussing the subsistence of the Patagonian hunter-gatherers.

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Fig. 2. Penguin coracoid with cut marks.

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