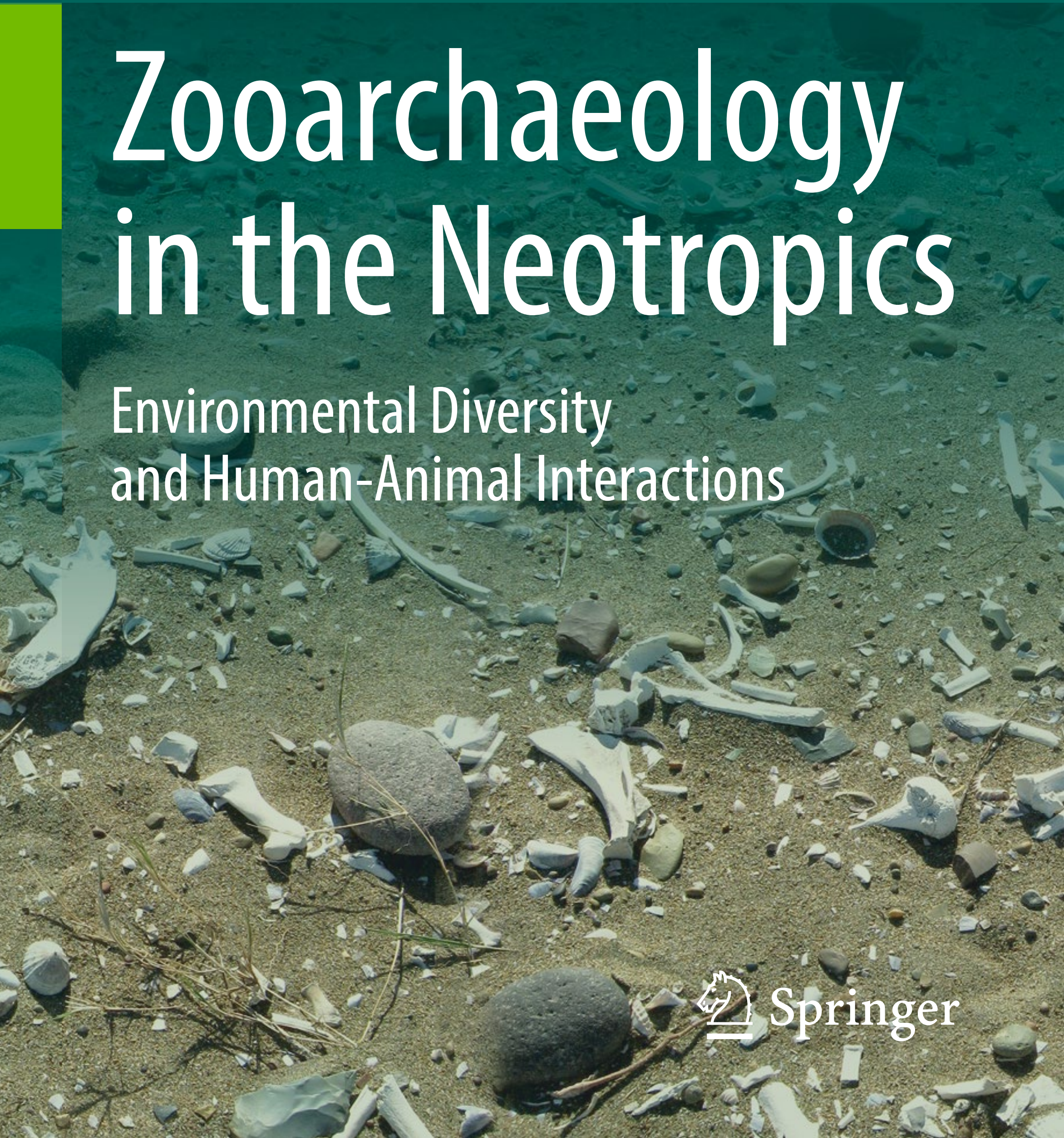
Mariana Mondini
A. Sebastián Muñoz
Pablo M. Fernández
Editors



Zooarchaeology in the Neotropics

Environmental Diversity and Human-Animal Interactions

Springer

Zooarchaeology in the Neotropics

Mariana Mondini • A. Sebastián Muñoz
Pablo M. Fernández
Editors

Zooarchaeology in the Neotropics

Environmental Diversity and Human-Animal Interactions

Springer

Editors

Mariana Mondini
Laboratorio de Zooarqueología y Tafonomía de Zonas Áridas (LaZTA)
IDACOR, CONICET/Universidad Nacional de Córdoba
Córdoba, Argentina

Facultad de Filosofía y Letras
Universidad de Buenos Aires
Ciudad Autónoma de Buenos Aires, Argentina

A. Sebastián Muñoz
Laboratorio de Zooarqueología y Tafonomía de Zonas Áridas (LaZTA)
IDACOR, CONICET/Universidad Nacional de Córdoba
Córdoba, Argentina

Pablo M. Fernández
Instituto Nacional de Antropología y Pensamiento Latinoamericano—CONICET
Ciudad Autónoma de Buenos Aires, Argentina

Facultad de Filosofía y Letras
Universidad de Buenos Aires
Ciudad Autónoma de Buenos Aires, Argentina

ISBN 978-3-319-57326-7 ISBN 978-3-319-57328-1 (eBook)
DOI 10.1007/978-3-319-57328-1

Library of Congress Control Number: 2017944079

© Springer International Publishing AG 2017
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Taphonomy of Surface Archaeological Bone Assemblages in Coastal Patagonia: A Case Study

8

A. Sebastián Muñoz

8.1 Introduction

Surface bone assemblages are a key source of information to gain a better understanding of the regional properties of the archaeological record in Patagonian coastal landscapes. Several natural and anthropogenic factors are involved in the present-day dynamics shown by the coastal archaeological record, which usually implies different degrees of information quality and resolution as well as mixing of materials (Favier Dubois and Borella 2007; Caracotche and Ladrón de Guevara 2008; Manzi et al. 2009; Hammond et al. 2013). Trying to understand this dynamics is key to build up a regional picture of the coastal archaeological record, the range of processes affecting it and their consequences, namely the resulting differential preservation and degradation of particular records as well as their integrity and resolution (*sensu* Binford 1981). Several decades of ranching have resulted in a major and constant impact on the Patagonian grasslands by means of losing soil coverage and increasing soil impermeability (Coppa 2004). As a result, soil dynamics is altered by a higher evaporation, leading to a decrease in soil humidity as derived from temperature and wind acting on exposed soils (Coppa 2004). Once soil cover disappears, sedimentary particles respond differently to erosion: some get compacted through trampling; others move away by the action of wind. Bones are sedimentary particles with an organic component and, hence, are strongly affected by changes/variations in soil humidity and exposure (Behrensmeyer 1991). On the other hand, natural deposition of bones can also affect the integrity of bone assemblage, particularly through the input of fresh bones of different size to anthropogenic deposits (Borrero 1989, 1990; L'Heureux and Borrero 2002). It is necessary, then, to understand the way this regional soil erosion process, already in

A.S. Muñoz (✉)
Laboratorio de Zooarqueología y Tafonomía de Zonas Áridas, IDACOR, CONICET, Universidad Nacional de Córdoba, Av. H. Yrigoyen 174, 5000 Córdoba, Argentina
e-mail: smunoz@conicet.gov.ar

M. Mondini et al. (eds.), *Zooarchaeology in the Neotropics*,
DOI 10.1007/978-3-319-57328-1_8

progress, is affecting the nature of the zooarchaeological record and, particularly, its implication in zooarchaeological data needed to understand human-animal relationships in the past. In order to address this point, we have analyzed a surface bone deposit at the Santa Cruz river mouth which was collected in three different consecutive seasons as it became exposed. Our aim is to trace, in the assemblages recovered, the resulting potential taphonomic features that can be sensitive to understand the already mentioned processes and its consequences on the studied bone materials.

The current situation in the southern Santa Cruz river mouth can be described as one where extended deflated areas concentrate archaeological materials. As previously stated, the area is being threatened by several erosional processes, such as marine action, overgrazing and faunal turbation. The former acting on present and past coastal beach ridges, while the second involves trampling by sheep and horse livestock and wild fauna—penguins—passing to coastline from their seasonal nests (Cruz et al. 2008) (Fig. 8.1). The Aeolian erosion, in particular, results both from low precipitation values and average wind action capable of moving sand-sized particles (Ercolano et al. 2013). Although these conditions have characterized the whole twentieth century, Ercolano et al. highlight that during the last decades water imbalance increased probably due to the rise of mean annual temperature by 1 °C. This, in turn, would have increased water imbalance and vegetation instability and, hence, contributed to accelerating, more recently, the exposure of archaeological material (Ercolano et al. 2013).

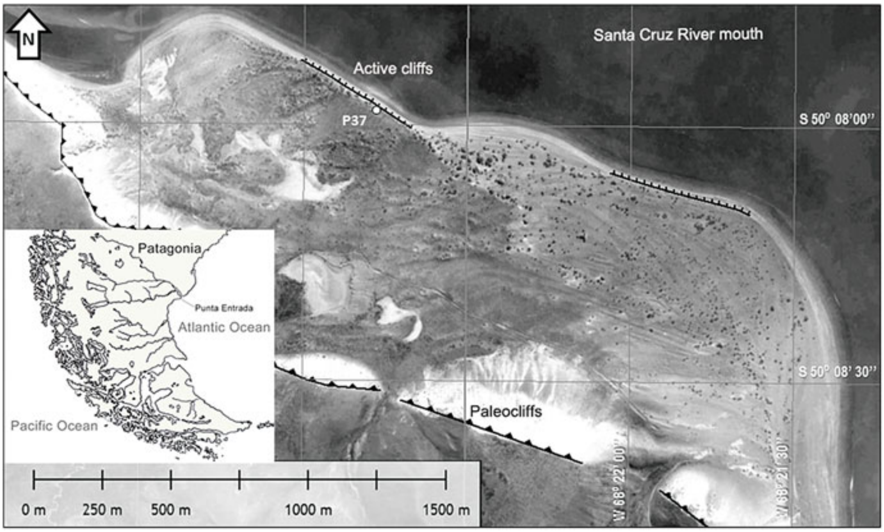


Fig. 8.1 P 37 archaeological site location map

8.2 Objectives, Materials and Methods

In this chapter we analyze zooarchaeological data recovered in three successive collections undertaken at P 37 archaeological site (Fig. 8.2). P 37 is located on the southern bank of Santa Cruz river mouth, in Punta Entrada, a marine accretional landform. This landform is a small territory formed by the sediments that have been transported and deposited by current and by the action of the river during the last 4000 years BP (Fig. 8.1). P 37, in particular, consists of a concentration of archaeological materials that is exposed through erosion. Animal bones are the main materials found in this deposit, followed by lithics and few mollusk shells. The almost complete absence of mollusks makes P 37 an interesting way to explore the reaction of animal bone to exposure conditions, since the matrix is composed of the same sandy particles found on the non archaeological surfaces. Hence, it is expected that archaeological bones do not improve their conservation possibilities by being under more protective conditions such as those provided by shell middens. We discuss the taphonomic signals acquired by bones when they are left exposed and become part of surface assemblages; we consider possible changes in assemblage resolution and taphonomic biases as well as assemblage comparability with other buried material when recovered.

As previously mentioned, P 37 is a concentration of different kinds of archaeological materials, mostly pinniped bones, which lie on a sandy substrate on a 1.5 m height active cliff. The dune where the materials were embedded in was being deflated and the vegetation cover was progressively undermined. An on surface cut marked *Otaria flavescens* bone was radiocarbon dated at 1540 ± 70 years BP—

Fig. 8.2 P 37 archaeological site

1138 ± 70 BP reservoir correction estimation (Muñoz et al. 2009). This dating was confirmed through a second test, measured on a stratigraphic *Arctocephalus australis* bone (LP-3062) indicating 1650 ± 60 years BP, 1250 ± 60 BP after reservoir correction estimation.

P 37 was first localized in March 2006, when a noticeable amount of vertebrate bones were detected on surface and sampled, through 18 collection squares of 2 × 2 m size over 36 m^2. Sampling of exposed material took place in November 2008, March 2010 and November 2011. At each collection season information on vegetation cover and composition was recorded while all the bone material was picked up for further studies. In order to keep the buried material untouched. The collection was done on bones already exposed, without digging or meshing the sediment. Finally, in November 2011, an additional 1 m^2 stratigraphic sample was taken from C1 square and the fine sediment was screened through a 2 mm mesh. The excavation reached a sterile layer between 18 and 22 cm depth.

In this paper we analyze two 2 m^2 surface collection squares (B2, B3) and the 1 m^2 control stratigraphic sample dug up from C1 square. Thus, a total of four analytical assemblages were isolated. The first assemblage reflects the unknown pre-2008 exposure palimpsest (Assemblage 1: A1). It includes all the material exposed since loss of vegetation cover to the first collection taking place in 2008. Another two assemblages represent bones that were exposed at known time intervals, namely 2008–2010 (A2) and 2010–2011 (A3). Although we cannot be sure that this was the first time they got exposed, we at least know that they were buried at the time of previous collections. Finally, there is a fourth analytical assemblage (A4) which represents the stratigraphic sample from C1 square.

Pinniped bone identification was undertaken with the aid of published osteological guides of *O. flavescens* and *A. australis* (Pérez García 2003, 2008; Sanfelice and Ferigolo 2008). Bone weathering determination follows Behrensmeyer (1978) six-stage sequence for terrestrial vertebrates larger than 5 kg. According to this author, weathering profiles are also presented through three broad categories: fresh (stage 0), slightly weathered (stages 1 and 2) and weathered (stages 3–5). To assess anatomical representation, NISP (number of identified specimens) was calculated and assigned to four anatomical categories of a pinniped skeleton: axial skeleton, front and rear limbs and non determinable limb fragments. Bone modification includes weathering as well as root etching, rodent and carnivore gnawing as well as cut marks (Binford 1981; White 1992). Bone fragmentation considers six size categories as very small (0–1 cm), small (1–2 cm), small-medium (2–4 cm), medium (4–8 cm), large (8–16 cm) and very large (larger than 16 cm).

8.3 Results

We recovered a total of 1028 bones, 875 of which were lying on surface and 153 came from stratigraphy. Most of these remains were identified as pinnipeds, a small part of which could be assigned to species level, namely *A. australis* and *O. flavescens*. These two species, which are osteologically very similar, are well distributed along the Patagonian coast. As shown in Table 8.1, there are also few bird bones and a variable quantity of mammal bones that was not possible to identify at a more specific level.

The assemblage resulting from the first collection (A1) reflects an unknown time of exposure. This is very similar in size to the assemblage recovered later, 16 months ahead, when the site surface was again surveyed to collect a new assemblage (A2). A third assemblage (A3) was recovered in 2011, 20 months after the site surface was cleared away of bones for a second time. Although it represents a longer time interval, it is smaller than the previous ones and similar in size to the stratigraphic assemblage (A4).

Representation of bone fragment size displays a similar trend among these four assemblages, one that is dominated by 2–4 and 4–8 cm bone pieces. Nevertheless some differences are noticeable among them (Table 8.2). The stratigraphic assemblage has a greater proportion of large bone remains (8–16 cm) and a slightly stronger presence of the very small fragments (0–1 cm), something that could be anticipated as the stratigraphic sample included meshing of sediments. In contrast, these categories are underrepresented in A2 and A3, while the 4–8 cm size reaches the higher relative frequency in A1 assemblage as compared to other samples (Table 8.2).

Pinniped anatomical representation is very similar in the four assemblages. Axial bones represent between 45 and 60% of the identifiable bone remains, followed by appendicular bones (rear and front leg) (Fig. 8.3). Undeterminable appendicular bones are more important in A3 and A4 assemblages, something that could be related to the representation of bone size.

Table 8.1 Taxonomical representation at P 37 archaeological site according to the four samples considered in this study

NISP	A1	A2	A3	A4
Pinnipeds	283	311	73	53
A. australis	51	17	5	17
O. flavescens	5	6	1	3
Mammals indet.	31	57	30	79
Avian	2	2	1	1
Total per assemblage	372	393	110	153
Total surface	875			
Total surface + stratigraphy	1028			

Table 8.2 Bone size representation per assemblage from P 37 archaeological site (relative frequencies)

	A1	A2	A3	A4
0–1 cm	3.39	1.16	0.00	5.48
1–2 cm	9.60	19.65	12.35	17.81
2–4 cm	41.53	49.13	46.91	30.14
4–8 cm	35.59	22.83	29.63	17.81
8–16 cm	9.89	6.07	11.11	28.77
> a 16 cm	0	1.16	0	0

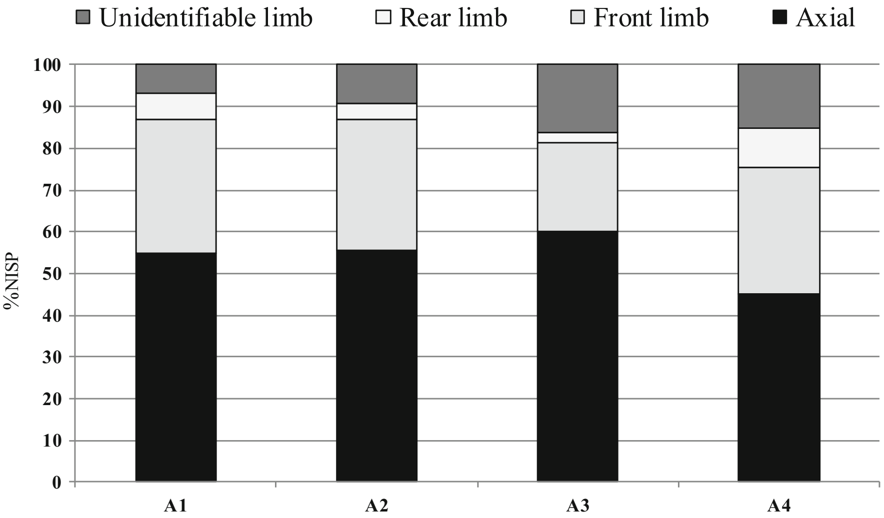


Fig. 8.3 Anatomical pinniped bone representation per assemblage (relative frequencies)

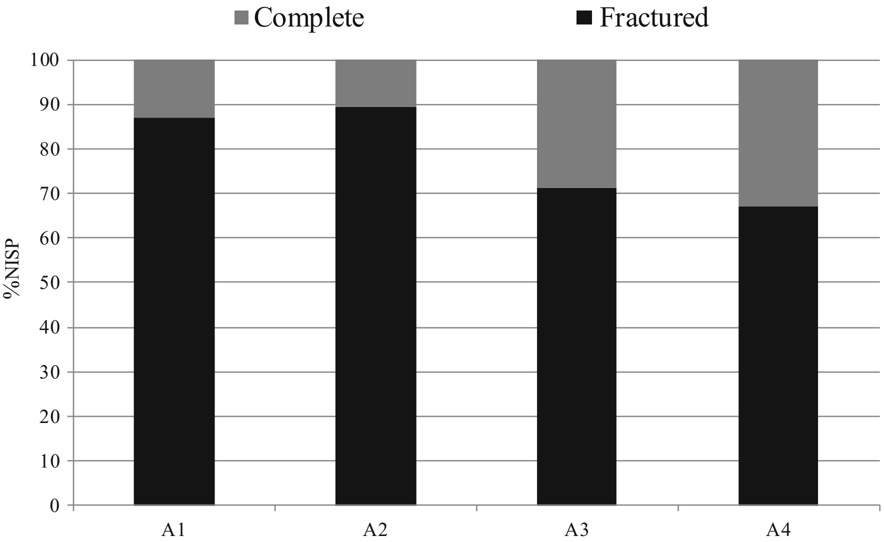


Fig. 8.4 Fragmented bone representation per assemblage (relative frequencies)

Complete bones are better represented in the A4 stratigraphic sample, followed by the A3 surface assemblage, where they represent approximately 30% of the total assemblage in both cases (Fig. 8.4). A1 and A2 assemblages have a higher proportion of broken bones, reaching 90% of the material recovered. Something similar occurs in the representation of unfused bones, consisting of 32–35% of the pinniped specimens recovered in A4 stratigraphic and A3 assemblages and only 15–23% in the first two (A1 and A2 assemblages). Bones which could not be assigned to a fusion state category are, nevertheless, the larger share in the sample exposed (between 41 and 67%) and similar to other categories (27%) in the stratigraphic assemblage.

Two bone modifications differentiate buried from superficial materials, namely bone color and weathering (Fig. 8.5 and Table 8.3). Exposed bones are clearly dominated by a whitish tone that characterizes more than 90% of the material recovered. This color is the result of exposure to solar radiation, a widespread taphonomic signal present on the exposed archaeological bone record of coastal Patagonia (see, for example, Borella et al. 2007; Hammond 2015). A smaller

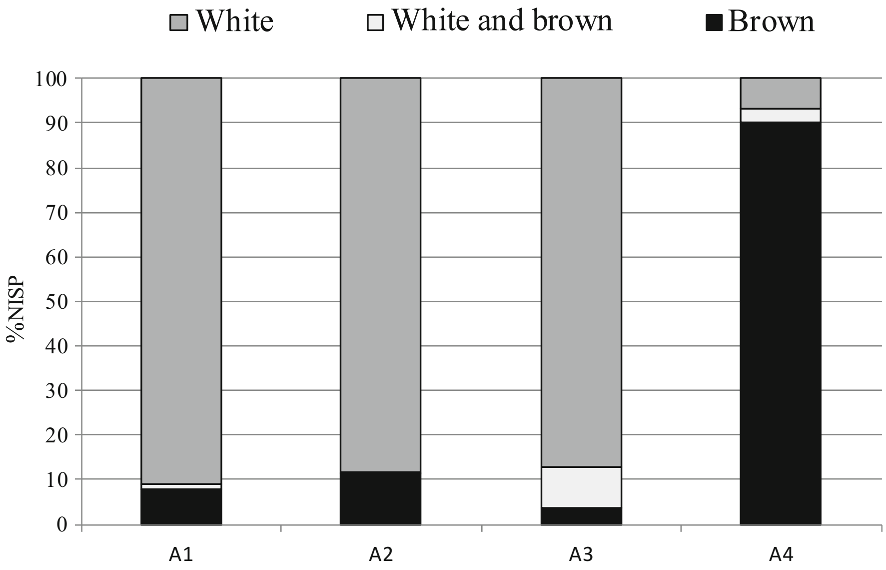


Fig. 8.5 Bone color representation per assemblage (relative frequencies)

Table 8.3 Weathering stage representation per assemblage (relative frequencies)

		A1	A2	A3	A4
Weathering stage representation	0	2.97	1.95	7.79	24.64
	1	34.12	37.01	32.47	63.77
	2	23.74	26.95	29.87	5.80
	3	32.94	31.82	27.27	5.80
	4	6.23	1.95	1.30	0.00
	5	0.00	0.32	1.30	0.00
Bone modifications	Root etching	69.62	54.49	82.28	63.83
	Rodent	1.18	1.80	3.80	5.32
	Cut	7.37	5.99	3.80	11.70

proportion of bones (4–11%) is brown-colored. The opposite happens with buried bones which are 90% brown and only 7% white. Bones displaying a transition between white and brown colors come from A3 assemblage and from stratigraphy (Fig. 8.5).

As a lightly weathered profile dominates all samples, since more than 50% of bone remains can be included in this category (Fig. 8.6). In addition, Fig. 8.6 shows that samples which have been recorded on the surface have a higher proportion of weathered specimens, while fresh bones are more important in A4 sample. The "weathered" category includes 30–40% of bones recovered on surface assemblages but only 6% of those come from stratigraphy. The excavated sample, instead, includes a 25% of fresh bones. This category is underrepresented in the first two surface assemblages, which have less than 3% of bones in fresh condition, while the A3 assemblage rises to 8% of bones with weathering stage 0 (fresh).

Weathering is regularly distributed on bone surface and less than 20% of the specimens display clear indication of contrasting weathering conditions, such as stage 1 and 3 on the same bone and on different surfaces.

When each weathering stage is considered individually it is noticeable that stage 1 dominates exposed and buried bone assemblages. In A4 assemblage, this stage is followed by stage 0, while stage 2 only represents 6% in this assemblage. Instead, surface assemblages have a stage 2 representation between 24 and 30%, similar to that of stage 3. Stage 4 is only present in these assemblages and absent in A4.

Root marks are well represented in the four assemblages, affecting from 54 to 82% of the bone remains, indicating that the deposit had a more stable condition in the past as the result of a grass cover developed on it. Rodent gnawing marks, on the other hand, are scarcely present at P 37 bone materials, although they are relatively

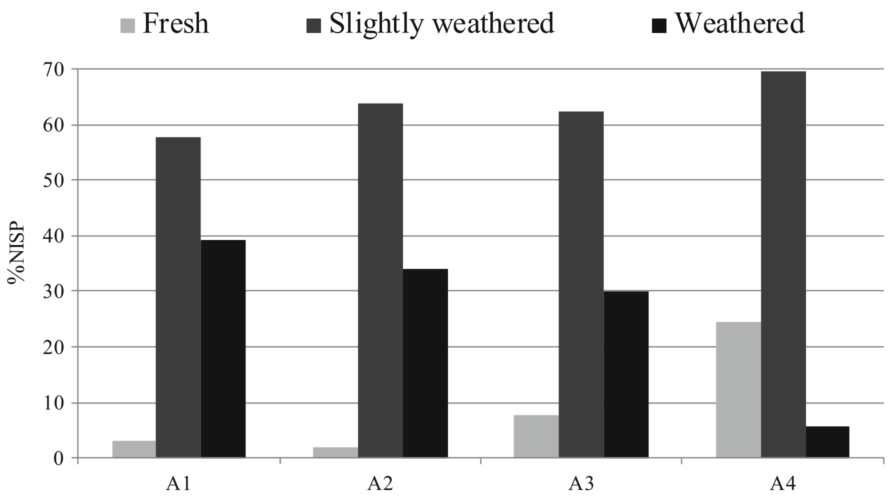


Fig. 8.6 P 37 Bone weathering profiles

more important in A3 and A4 assemblages (Table 8.3). We found no carnivore traces on these bones. Finally, cut marks are better represented among the stratigraphic materials (12%) although they are also important among the A1 materials (Table 8.3).

In sum, taxonomic diversity is similar in all assemblages, although unidentified mammal bone specimens are more important in A4, where very small fragments—usually more difficult to identify—have a better representation. Complete bone specimens are also better represented in this assemblage and also in assemblage A3. In addition, these two assemblages show a higher proportion of bones with fusion state data. A1 and A2, instead, display higher proportions of undetermined fusion state remains.

All assemblages display a slightly weathered profile, although surface bone assemblages also include an important amount of weathered bones. As expected, A4 stratigraphic assemblage includes a higher proportion of fresh bones. All assemblages are also similar in terms of bone modification and anatomical representation. Root etching marks are present in most of the bones recovered while rodent gnawing and cut marks have a slightly better representation in A3 and A4 assemblages. Axial bone fragments represent around half of the identified specimens followed by bone fragments from the rear leg and the front leg.

8.4 Discussion

The current unstable condition of P 37 derives from wind erosion as well as from the action of sea on coastal beach ridges. The site is located on the estuarine high tide line and is affected by the action of water on coastal beach ridges and dunes. This is noticeable in dissected profiles found along the coast.

When P 37 was first located in 2006, grass cover was already lost and most of the bones were on surface. Bones recovered from A1 assemblage displayed signals of sun burning and a slightly weathered/weathered profile (Fig. 8.6). Naturalistic taphonomic studies that are currently undertaken in the area show that developing such a weathering profile in pinniped assemblages requires a minimum of 7 years of exposure (Cruz and Muñoz 2014). Hence, it can be argued that P 37 bone assemblage has an exposure history which exceeds the observation intervals considered during the recovery procedure (16 and 20 months, respectively). The assemblage could have been exposed before final burial and exposition or, alternatively, exposed several times since first disposal. In any case we can conclude that 16/20 month recovery intervals did not differentiate the general taphonomic picture of the exposed assemblage.

There are at least two taphonomic properties that can be linked to the stability phase referred to: the ubiquitous distribution of root etching marks in the entire assemblage and rodent tooth marks. The latter are present in 5% or less in bone specimens from A3 and A4 assemblages and in a lesser proportion in A1 and A2 (Table 8.3). Even when this is not a high value, it can be considered higher than what is usually found in other coastal assemblages such as shell middens (see, for example, Muñoz 2014). Tucu-tuco (*Ctenomys magellanicus*), the most common Patagonian burial rodent, usually chooses grassy dry sandy soils like those found in coastal Patagonia (Nowak 1991). They usually dig a main tunnel 30 cm below surface (Barlow 1969 and Packard 1967 in Nowak 1991) and, as seen in other fossorial rodents, wear away archaeological materials bigger than 6 cm in size while take smaller particles outside the deposit (Bocek 1986). In P 37 rodent tooth mark data are in agreement with this expectation, since 89% of the specimens displaying rodent marks are larger than 5 cm. It can be said, then, that rodents were involved in P 37 taphonomic history and that probably occurred at the time when the site was a stabilized buried deposit covered with a thicker layer of sediments than that what we can see nowadays. There are no signals of galleries or other spatial data that we could use to evaluate their impact on bone assemblage. At present there is not enough sand substrate to allow tuco-tucos to establish there, nor is this sediment compacted enough as to facilitate these actions. The only taphonomic signals left by this process are the tooth marks above mentioned; yet, we do not know whether differences in rodent tooth mark proportions among P 37 samples are the result of weathering bone conditions displayed by surface and stratigraphic assemblages or of a past stratigraphic position that those bones had at the time when the deposit was part of a thicker and stable soil matrix.

When other bone properties are considered, we have found that buried bones show a better representation of complete bones, bone fragments of a of larger size, and there are a higher proportion of bones displaying weathering stages 0 and 1 as well as a higher proportion of unfused bones. Nevertheless, they also share several diagnostic features, such as taxonomic composition, anatomical part representation and some bone modifications. In other words, the buried sample displays a better preservation condition, although not remarkably better. This may be related to the matrix they are embedded in, a sandy substrate which creates an oxidant environment affecting collagen degradation and, hence, bone resistance to physical and chemical agents (Borella et al. 2007).

It is noticeable that the differences observed in taphonomic data between buried and superficial assemblages did not prevent the identification of cut and processing marks (Table 8.3), allowing the study of carcass processing decisions (see Cañete Mastrángelo and Muñoz 2015). This implies that even when bone assemblages display a slightly weathered/weathered profile, such kind of analysis can be approached. In this way, behavioral data coming from deposits other than shell middens can be gathered and studied and a broader spectrum of animal processing decisions can be addressed.

Finally, P 37 can be interpreted as a single depositional unit. We were not able to find clear evidences of different accumulation events such as those informed for other non-shell midden surface bone assemblages located in Punta Entrada (Cruz et al. 2015). For instance, Cruz et al. informed that P 96 surface assemblage, dated between 900 and 1750 years BP, can be interpreted as a palimpsest composed of different taxa and different temporal resolutions in terms of bone deposition and preservation. P 96 palimpsest displays an alternation of exposure and burial episodes which would have affected taxonomical representation. As previously mentioned, P 37 surface and buried assemblages are quite similar and radiocarbon dating standard deviation overlaps each other. The comparative, more homogeneous picture offered by P 37 represents a different part of the range of variability displayed by surface non-shell middens, archaeological assemblages in this sector of coastal Patagonia. Hence, P 37 and P 96 display complementary pictures derived from the incremental erosional activity referred to by Ercolano et al. (2013), nowadays affecting most of the archaeological coastal record of Patagonia (see Cruz and Caracotche 2008).

8.5 Conclusion

Coastal areas have drawn the attention of human populations for a long time, resulting in a variety of coastal archaeological sites and landscape transformations (Anderson 1988; Bailey 1975; Beaton 1985; Erlandson and Moss 2001). The range of variability displayed by geological environments and energy flow is also important, hence, it can be said that change is what is to be expected in this kind of settings (Rapp and Hill 1998; Golberg and Macphail 2006). Coastal Patagonia is not an exception to this general picture, as different research from North to Southern Patagonian coasts clearly shows (Borella et al. 2007; Orquera and Piana 1999). As in other regions of the world, shell middens are one of the most conspicuous anthropogenetic deposits in Patagonian coastal settings (Orquera and Piana 2000; Wells 2001) and, hence, the best known archaeological sites (Favier Dubois and Borella 2007).

Coastal archaeological deposits not embedded in a shell matrix are less known from a taphonomical point of view. It can be asked, then, what assemblage properties and taphonomic signals can be informative of the way buried assemblages, such as P 37, become part of surface archaeological distributions; and how this kind of deposits may inform about the dynamics of the coastal archaeological record in Patagonia.

As we could see, even when it was not possible to discriminate at P 37 changes in most taphonomic variables in time scales shorter than the referred 7-year interval estimation based on actualistic observations, we could identify some taphonomic properties which could be indicative of the transition between burial and exposure conditions in shorter time intervals than those displayed by the general weathering picture of the assemblage (bone color, size and fragmentation). Some other bone modifications, such as rodent and cut marks, are better represented in the stratigraphic assemblage; yet, they are also clearly present in the more weathered assemblages, implying that such lines of evidence could be analyzed even when the general condition of the assemblage is not good. This has already been suggested, recognizing the worth of surface assemblages towards better discussion of human animal interaction in the past (see Muñoz et al. 2013; Muñoz 2015; Borella 2016).

Acknowledgements Carolina Mosconi did the language revision of the manuscript. Figure 8.1 credits correspond to Betina Ercolano. Franca Muñoz helped with final edition of Fig. 8.1. Puerto Santa Cruz Town Council offered logistic support during fieldwork. We thank Víctor López from Estancia Monte Entrance. Carolina Moreno, Patricia Lobbia, Adriana Pretto, Daniela Cañete Mastrángelo and Rubén for field work assistance. Mariela Arriagada, Aldana Calderón and Belén Cippitelli assisted in laboratory analysis. This research has been designed and developed in collaboration with Isabel Cruz and Soledad Caracotche, and was funded by CONICET-PIP-112 201201 00359 CO, SeCyT-UNC PID Res. 313/16 and UNPA 29A/364.

References

Anderson AJ (1988) Coastal subsistence economies in prehistoric southern New Zealand. In: Bailey G, Parkington J (eds) The archaeology of prehistoric coastlines. Cambridge University Press, Cambridge, pp 93–101

Bailey GN (1975) The role of shellfish in coastal economies: the results of midden studies in Australia. J Arch Sci 2:45–62

Beaton JM (1985) Evidence for a coastal occupation time-lag at Princess Charolotte Bay (North Queensland) and implications for coastal colonisation and population growth theories for Aboriginal Australia. Arch Oceania 20(1):1–20

Behrensmeyer AK (1978) Taphonomic and ecologic information from bone weathering. Paleobiology 4:130–162

Behrensmeyer AK (1991) Terrestrial vertebrate accumulations. In: Allison PA, Briggs DEG (eds) Taphonomy: releasing the data locked in the Fossil Record. Plenum Press, New York, pp 291–335

Binford LR (1981) Bones. Ancient men and modern myths. Academic Press, New York

Bocek B (1986) Rodent ecology and burrowing behavior: predicted effects on archaeological site formation. Am Antiq 51(3):589–602

Borella F (2016) Antes del Faro. La explotación de mamíferos marinos en la localidad de arqueológica Faro San Matías durante el Holoceno tardío (Nordpatagonia, Argentina). In: Mena F (ed) Arqueología de Patagonia: De Mar a Mar. Ediciones CIEP/Ñire Negro Ediciones, Coyhaique, pp 295–304

Borella F, Mariano MS, Favier-Dubois CM (2007) Procesos tafonómicos en restos humanos de superficie en la localidad arqueológica de Bajo de la Quinta, Golfo San Matías (Río Negro, Argentina). In: Morello F, Martinic M, Prieto A et al (eds) Arqueología de Fuego-Patagonia. Levantando piedras, desenterrando huesos... y develando arcanos. Ediciones CEQUA, Punta Arenas, pp 403–410

Borrero LA (1989) Sites in action: the meaning of guanaco bones in Fueguian archaeological sites. Archaeozoologia 3(1, 2):9–24

Borrero LA (1990) Taphonomy of guanaco bones in Tierra del Fuego. Quat Res 34:361–371

Cañete Mastrángelo DS, Muñoz AS (2015) El procesamiento de pinnípedos en P37, desembocadura del río Santa Cruz, Patagonia Meridional. Cuad INAPL 24(1):134–152

Caracotche MS, Ladrón de Guevara B (2008) El registro arqueológico costero de Patagonia: diagnóstico del estado actual y herramientas para la conservación. In: Cruz I, Caracotche MS (eds) Arqueología de la costa patagónica. Perspectivas para la conservación. Universidad Nacional de la Patagonia Austral - Subsecretaría de Cultura de la Provincia de Santa Cruz, Río Gallegos, pp 17–45

Coppa RA (2004) El deterioro del pastizal patagónico. Medio Ambiente 4:19–22

Cruz I, Caracotche MS (eds) (2008) Arqueología de la costa patagónica. Perspectivas para la conservación. Universidad Nacional de la Patagonia Austral - Subsecretaría de Cultura de la Provincia de Santa Cruz, Río Gallegos

Cruz I, Muñoz AS (2014) Mammal bone weathering in a temperate coastal steppe (southern Patagonia, Argentina). A comparison among taxa. In: Abstracts 12th conference of the International Council for Archaeozoology (ICAZ), Universidad Nacional de Córdoba, p 43

Cruz I, Muñoz AS, Caracotche MS (2008) Investigaciones arqueológicas y bioantropológicas en la costa atlántica de Patagonia Meridional. In: Libro de Resúmenes, Séptimas Jornadas de Arqueología de la Patagonia. CADIC, Ushuaia, p 48

Cruz I, Ercolano B, Cañete Mastrángelo DS, Caracotche MS, Lemaire CR (2015) Tafonomía y procesos de formación en Punto 96 (Punta Entrada, Santa Cruz, Argentina). Cuad INAPL 24 (1):95–114

Ercolano B, Cruz I, Marderwald G (2013) Registro arqueológico y procesos de formación en Punta Entrada (Santa Cruz, Patagonia Argentina). In: Bárcena JR, Martín SE (eds) Arqueología Argentina, en el Bicentenario de la Asamblea General Constituyente del año 1813. Universidad Nacional de La Rioja, La Rioja, p 527

Erlandson JM, Moss ML (2001) Shellfish feeders, carrion eaters, and the archaeology of aquatic adaptations. Am Antiq 66:413–432

Favier Dubois CM, Borella F (2007) Consideraciones acerca de los procesos de formación de concheros en la costa Norte del golfo San Matías (Río Negro, Argentina). Caz Rec Cono Sur 2:151–165

Golberg P, Macphail RI (2006) Practical and theoretical geoarchaeology. Blackwell, Malden

Hammond H (2015) Sitios concheros en la costa norte de Santa Cruz: su estructura arqueológica y variabilidad espacial en cazadores recolectores patagónicos Tesis para optar al título de Doctora en Ciencias Naturales. UNLP

Hammond H, Zubimendi MA, Zilio L (2013) Composición de concheros y uso del espacio: aproximaciones al paisaje arqueológico costero en Punta Medanosa. An Arqueo Rosario 5:67–84

L'Heureux GL, Borrero LA (2002) Pautas para el reconocimiento de conjuntos óseos antrópicos y no antrópicos de guanaco en Patagonia. Intersec Antropol 3:29–40

Manzi L, Favier Dubois CM, Borella F (2009) Identificación de agentes perturbadores y estrategias tendientes a la conservación del patrimonio arqueológico en la costa del Golfo de San Matías, Provincia de Río Negro. Intersec Antropol 10:3–16

Muñoz AS (2014) La explotación de lobos marinos por cazadores recolectores terrestres de Tierra del Fuego. In: Oría J, Tívoli AM (eds) Cazadores de Mar y Tierra. Estudios Recientes en Arqueología Fueguina. Editora Cultural Tierra del Fuego y Museo del Fin del Mundo, Ushuaia, pp 197–217

Muñoz AS (2015) El registro zooarqueológico del Parque Nacional Monte León (Santa Cruz, Argentina): una perspectiva desde el sitio Cabeza de León 1. Arqueología 21:261–276

Muñoz AS, Caracotche MS, Cruz I (2009) Cronología de la costa al sur del río Santa Cruz: nuevas dataciones radiocarbónicas en Punta Entrada y Parque Nacional Monte León (Provincia de Santa Cruz). Magallania 37(1):39–43

Muñoz AS, Cruz I, Lemaire CR et al (2013) Los restos arqueológicos de pinnípedos de la desembocadura Del río Santa Cruz (Punta Entrada, costa atlántica de Patagonia) en perspectiva regional. In: Zangrando AF, Barberena R, Gil A et al (Comps) Tendencias Teórico Metodológicas y Casos de Estudio en La Arqueología Patagónica. Museo de Historia Natural de San Rafael, Sociedad Argentina de Antropología e Instituto Nacional de Antropología y Pensamiento Latinoamericano, Buenos Aires, pp 459–467

Nowak RM (1991) Walker's mammals of the world, vol 2, 5th edn. John Hopkins University Press, Baltimore

Orquera LA, Piana EL (1999) Arqueología de la Región del Canal Beagle (Tierra del Fuego, República Argentina). Sociedad Argentina de Antropología, Buenos Aires

Orquera LA, Piana EL (2000) Composición de conchales de la costa del Canal Beagle (Tierra del Fuego, República Argentina). Primera parte. Rel Soc Arg Ant 25:249–274

Pérez García MI (2003) Osteología comparada del esqueleto poscráneo de dos géneros de Otariidae del Uruguay. Bol Soc Zool Uruguay, 2ª Época 14:1–16

Pérez García MI (2008) Ontogenia del postcráneo de *Arctocephalus australis* (MAMMALIA, Otaridae). Bol Soc Zool Uruguay, 2ª Época 17:1–19

Rapp G, Hill CL (1998) Geoarchaeology: the earth-science approach to archaeological interpretation. Yale University Press, New Haven and London

Sanfelice D, Ferigolo J (2008) Estudo comparativo entre os sincrânios de Otariabyronia e Arctocephalusaustralis (Pinnipedia, Otariidae). Iheringia, Sér Zool 98:5–16

Wells LE (2001) Archaeological sediments in coastal environments. In: Stein JK, Farrand WR (eds) Sediments in archaeological context. University of Utah Press, Salt Lake City, pp 149–182

White TD (1992) Prehistoric cannibalism at Mancos 5MTUMR-2346. Princeton University Press, Princeton