Acta zoologica cracoviensia, **45**(special issue): 151-165, Kraków, 29 Nov., 2002

Bird management in America's extreme south during the 19th century

Laura MAMELI

Received: 11 Nov., 2001

Accepted for publication: 10 Apr., 2002

MAMELI L. 2002. Bird management in America's extreme south during the 19th century. In: Proceedings of the 4th Meeting of the ICAZ Bird Working Group Kraków, Poland, 11-15 September, 2001. *Acta zoologica cracoviensia*, **45**(special issue): 151-165.

Abstract. In this paper, bird bones from the Túnel VII (Tierra de Fuego, Argentina) archaeological site are presented and analysed. This site was successively occupied by bands of hunter-gatherers during the 19th century. The author has analysed bird bones as material remains of human consumption. Traces and cut marks on bones are used as evidence for human processing and differential consumption. A quantitative study of bone remains is presented, stressing the differential representation of species, body parts, bones with processing evidence, and the location of discarded material. The archaeological analysis intends to show the existence of relevant changes in the way animal preys were selected and processed by human hunters through time in the extreme south of America.

Key words: South America, Tierra del Fuego, hunter-gatherer, archaeozoology, birds, processing marks.

Laura MAMELI, Laboratori de Arqueozoologia, Divisió de Prehistoria. Facultat de Lletres, Universitat Autónoma de Barcelona, 08193 Bellaterra. España.
laura.mameli@campus.uab.es

I. INTRODUCTION

In this paper I present the results of a zooarchaeological analysis of bird remains from an archaeological site in Tierra del Fuego, Argentina. Our intention is to use these data as an example of economic resource social management by the Yámana society. This human group inhabited the southernmost extreme of America.

The Túnel VII archaeological site is on the northern shore of the Beagle Channel (Tierra del Fuego), and is the result of successive occupations by hunter-gatherer groups living there whose subsistence was based on the exploitation of coastal resources. The site has been dated to the end of the 19th century. The Yámana society collapsed between the end of the 19th century and the beginnings of the 20th due to European colonization, as shown by ethnographic, archaeological and historical sources (ORQUERA & PIANA 1995a).

In this region at latitudes south of 50º south, edible vegetables are very scarce, and animal life is not very abundant in the hinterland. However, the sea and coastal areas are rich in food for human groups (sea mammals, birds, mussels, seafood, fish, and even some whales found dying on the beaches) (ORQUERA & PIANA 1995a; ESTÉVEZ et al. 1995, in press).

Birds are one of the most typical resources for human groups living in coastal ecosystems. The archaeozoological analysis of bird remains will provide information, not only about the consumed species, but also about the ways of subsistence (production, social management) of the Yámana groups as a distinct society.

This study includes an analysis of changes through time in the exploitation of bird species selected for subsistence (food or as raw material for instruments), and intends to investigate whether prey processing show relevant changes. Regularity or variability patterns in the archaeological record can be used as evidences for production/consumption changes. We use such evidence to define some general patterns of social action, during a critical period of Yámana society, when the European installation began to produce important transformations in indigenous groups.

It is necessary to understand the role played by birds within the Yámana economic strategies. The complex relationship between human hunting, the behaviour of birds and ecological variability in the area can be analysed through the examination of anatomic and taxonomic frequencies present in the archaeological record. We have quantified the different species and body part exploitation, and we have included bone modifications produced by social action in the analysis (hunting, dismembering, butchering, cooking).

This research attempts to distinguish variation through time from spatial variability. On the one hand we have looked for relevant time differences in the exploitation of birds among the successive occupations evidenced on the site. While on the other hand we have investigated relevant spatial patterns, which define different processing activities inside the residential unit, the immediate open area, and discarded material accumulations.

II. TÚNEL VII. AN ARCHAEOLOGICAL SITE

The archaeological site of Túnel VII is located on the northern shore of the Beagle Channel, at 54º 49’ 15” latitude south and 68º 09’ 20” longitude west, in Isla Grande de Tierra de Fuego, Argentina (Fig. 1). This island and the archipelago all the way to the Cape Horn are the southernmost limit inhabited by human groups.

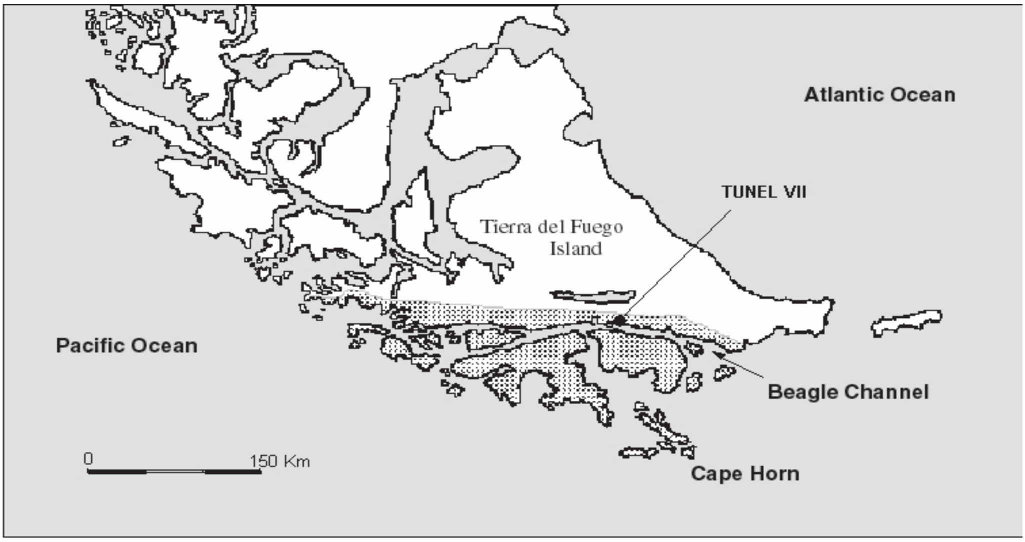

Fig. 1. Map of Tierra del Fuego, with the area occupied by Yámana groups (dotted zone), and location of the Túnel VII site.

Like most archaeological sites in this region, Túnel VII is a "shell midden" associated with the archaeological remains of an old hut.

In the specific case of the Túnel VII site, archaeologists excavated 68 squared meters during five seasons, which allowed the discovery of a complex archaeological sequence (VILA et al. 1995). Each archaeological layer corresponds to successive occupations of a very simple hut, a residential unit for a single family, with different open-air activity areas near the hut, and the associated garbage accumulations (shell middens).

The mobility of the Yámana groups and their local exploitation of available resources in the immediacy of the settlement (seafood, fish, wood, etc.), suggest very short occupations, and repeated visits to the same places. From ethnographic and historical sources (see references in ORQUERA & PIANA 1999a), we know occupations lasted a short period of time, usually by isolated family groups. The main features of the local landscape make the reuse of the remains of abandoned huts a very attractive possibility. This is the reason why the same places are reoccupied time after time (ORQUERA & PIANA 1999a, BARCELÓ et al. 2001). In the Túnel VII case, 8 short occupations have been identified lasting for a maximum temporal span of 150 years.

In this paper, we present the analysis of materials recovered from those layers, which have been seriated from the oldest (lowest in the stratigraphy) to the most modern (highest in the stratigraphy). Their names are: B, C, D, E, F, G, H and J. Radiocarbon dates suggest a chronology of 100±45 years before 1950.

III. METHODS

The taxonomic determinations for this site have not been easy. Bird analysis has an important disadvantage compared to standard archaeozoology: the huge quantity of species and the very little morphological variability between bones of those species makes it detailed taxonomic classification difficult. In Tierra del Fuego 198 living bird species have been identified today (CLARK 1986, see also HUMPHREY et al. 1970).

We have carried out an exhaustive compilation of comparative anatomical and bone textbooks of bird species living in the region. We have also used specific compilations made by N. PROSSER-GOODALL (unpubl.) and J. ESTÉVEZ (unpubl.). We have also considered the general publications of GILBERT et al. (1981), COHEN & SERJEANTSON (1996) and von den DRIESCH (1976). The Digital Photographic File at the Centro Austral de Investigaciones Científicas (Tierra del Fuego, Argentina) has been very useful. Finally, we have consulted other archaezoological works on other sites of the same region (LEFÈVRE 1989a, 1989b, 1992).

We have produced our own reference collection by selecting of archaeological materials and other reference bones with the aim of achieving a complete individual with each skeletal element, side and species, following the species list for the region (VENEGAS 1986, CLARK 1986, OLROG 1984).

One of the main aspects in this research has been testing the quality of the sample. During site excavation, archaeologists recovered systematically all bone materials bigger than 0.5 cm. We have processed more than 13000 fragments from the Túnel VII site. The size of the sample, and the thorough nature of the archaeological recovery guarantees very low statistical errors in diversity calculations (ORTON 1999).

In this paper, we present the analysis of all bone fragments from the central sector of the archaeological site (5054). 45% of them have been classified anatomically and taxonomically (2150 fragments). 43% of the total sample was determined only anatomically, and 12% of the remains are unclassified. Phalanges, ribs and vertebrae have not been classified given their intrinsic classificatory uncertainty.

In all cases, the bone surface has been analysed using magnifying glasses (between 7x and 45x). Our goal was the identification of natural modifications (differential preservation, natural disturbance process, taphonomic fracture, animal gnawing, and human marks (use wear, butchering and cut marks, deliberate fracture, burning, polishing, etc.). We have digitalized in a computer the bone surface images and textures of each individual element, and we have described and measured qualitative features, frequencies, intensities, regularity patterns and distribution of marks. In the case of human marks, we have also tried to relate the mark with the kind of tool which could produce it, according to present evidences. We have also investigated the series of marks according to the sequence of prey processing.

We have quantified the elements, and the body parts they belong for each identified species. We have calculated diversity according to NISP and MNI, and the ratios of NISP/MNI.

In general terms, the dependent variable in our model is taxonomic diversity, while the most relevant independent variables are:

– Anatomical diversity

– Fragmentation (random, post-deposition or consequence of processing)

– Marks (random, post-deposition or consequence of processing)

The goal of our analysis has been the identification of regular patterns in the bone sample to be able to explain social behaviour. We have investigated:

1. Whether different bird species present in the archaeological record were the result of different hunting strategies in different times;

2. Whether different species were processed differently;

3. Whether different body parts of the same bird were processed differently, or whether one specific body part was processed before another,

4. Whether cut marks are more frequent in some species or body parts than in others.

The purpose of this analysis has been to identify whether morphological variability was related with spatial distribution of social actions, and whether this variability was reproduced all along the successive reoccupations of the site.

IV. RESULTS

Taxonomic diversity

Bird remains found in the central sector of the Tunel VII site are represented by the following species (following Narosky & Yzurieta 1993):

	% of Total	NISP
Spheniscidae	27.00 %	581
Eudyptes chrysocome (Forster, 1781) Rockhopper Penguin		
Spheniscus magellanicus (Forster, 1781) Magellanic Penguin		
Diomedeidae and big Procellariidae[1]	18.40%	396
Diomedea chrysostoma Forster, 1785 Grey-head Albatross		
Macronectes giganteus (Gmelin, 1789) Southern Giant Petrel		
Procellariidae (other than *Macronectes*)	6.50%	140
Fulmarus glacialoides (Smith, 1840) Southern Fulmar		
Thalassoica antarctica (Gmelin, 1789) Antarctic Petrel		
Phalacrocoracidae	39.00 %	839
Phalacrocorax olivaceus (Humboldt, 1805) Neotropic Cormorant		
Phalacrocorax magellanicus (Gmelin, 1789) Rock Cormorant		
Phalacrocorax atriceps King, 1828 Blue-eyed Cormorant		

---

[1] We could not distinguish between them, because of the fragmentation of the bone sample, and anatomic similarity between both species

Ardeidae	0.10%	2
Nycticorax nycticorax (LINNAEUS, 1758) Black-crowned Night Heron *Ardea cocoi* LINNAEUS, 1766 White-necked Heron		
Anatidae	0.40%	8
Tachyeres pteneres (FORSTER, 1844) Flightless Steamer Duck *Tachyeres patachonicus* (KING, 1931) Flying Steamer Duck		
Accipitridae	0.05%	1
Buteo polyosoma (QUOY et GAIMARDI, 1824) Red-backed Hawk		
Falconidae	1.10%	23
Milvago chimango (VIEILLOT, 1816) Chimango Caracara *Polyborus plancus* (MILLER, 1777) Crested Caracara		
Laridae	2.80%	60
Larus dominicanus LICHTENSTEIN, 1823 Kelp Gull *Leucophaeus scoresbii* (TRAILL, 1823) Dolphin Gull		
Sternidae	0.90%	19
Sterna hirundinacea LESSON, 1831 South American Tern		
Psittacidae	3.30%	71
Enicognathus ferrugineus (MÜLLER, 1776) Austral Parakeet		
Tytonidae	0.05%	1
Tyto alba (SCOPOLI, 1769) Barn Owl		
Strigidae	0.05%	1
Bubo virginianus (GMELIN, 1788) Great Horned Owl		
Furnariidae	0.30%	6
Cinclodes patagonicus (GMELIN, 1789) Cinclodes		
Emberizidae	0.10%	2
Zonotrichia capensis (MÜLLER, 1776) Rufus Collared Sparrow		

To give some archaeological meaning to above results, we have grouped similar sized and anatomically comparable species, which share the same habitat or some behaviour, specially gregarious or individual behaviour. We have used the following groups:

- Cormorants: Phalacrocoracidae
- Penguins: Spheniscidae
- Big Sea Birds: Diomedeidae, and *Macronectes giganteus*
- Little Sea Birds: Laridae, Sternidae, and *Fulmarus glacialoides, Thalassoica antarctica*
- Small Birds: Psittacidae, Furnariidae, Emberizidae
- Predatory Birds: Accipitridae, Falconidae, Tytonidae, Strigidae
- Ducks and Heron: Anatidae, Ardeidae

In the Túnel VII case we have observed a predominance of cormorant bone fragments, followed in decreasing order by penguin remains, big sea birds (albatross, giant petrel), and little sea birds (Southern Fulmar, Antarctic Petrel, gulls, tern), which constitute 94.37% of the taxonomically classified sample. Less relevant groups are: small birds (sparrow, cinclodes, parakeet), predatory birds (chimango, caracara, owl, hawk) and ducks and heron, whose total average is only 5% of the sample.

It is important to remark that parakeets and even predatory birds were consumed by the Yámana population, given that all species present at the site have clear traces of processing.

The fact that a greater abundance of sea birds over terrestrial ones was apparent should be stressed. The lack of bird species characteristic of lagoons, marshes or swamps, or species adapted to large open plains is especially remarkable.

Other archaeozoological studies also reveal the predominance of cormorant and penguin (LEFÈVRE 1989a, 1989b, 1992; SAVANTI 1994; ESTÉVEZ et al. 1995).

Anatomical representation

Body part averages are similar for the more similar species, and seem to be related to size (Table I).

The low frequencies of the pelvic bone elements seem to be related to fragmentation, and therefore, there is some risk in making the wrong taxonomic determinations.

Table I

Frequencies of chosen skeletal parts found in the material belonging to certain groups of birds

Category	Axial skeleton %	Forelimbs %	Posterior limbs %	Scapular waist %	Pelvic waist %
Cormorants	23.99	30.88	26.13	15.32	3.68
Big sea birds	29.22	35.26	18.39	14.11	3.02
Penguins	32.82	20.41	23.64	14.63	8.50
Little sea birds	14.36	31.19	27.23	17.33	9.90

The scarce representation of penguin forelimbs fragments, compared to the abundance of other species forelimbs, suggests a very scarce use of this body part in the case of penguins. However, the very few observed cases present clear traces of processing.

In other categories, we observe that big sea birds have higher frequencies of forelimbs, and lower frequencies of posterior limbs. Little sea birds have lower frequencies of axial skeletal elements, but an overrepresentation of pelvic bones.

From this fact, and the observed pattern of butchering marks, we know that birds were brought to the site as whole individuals. The fact that broken bones may be reconstructed is another evidence in the same sense.

Differential fragmentation

Many factors and processes may be associated with different breakage patterns. Bones may break during hunting, plucking, skinning, processing, butchering, tool manufacturing, cooking, eating, but also because of scavenging, trampling, and even after being integrated in the archaeological deposit, as a result of mechanical, physical or chemical processes. Therefore, this kind of modifications may have a human or natural (animal or physic-chemical) origin. The fact that most of the remains come from a shell-midden, which is a characteristic alkaline context, makes it difficult to identify recent fractures (or “fresh” fractures).

In order to enable the distinction between human or natural fractures, we must evaluate fragmentation evidence in situ, that is, at the place where the bones were recovered. If different fragments belonging to the same bone appear together, it is likely that breakage was produced by taphonomic processes (notably trampling) (DAVIDSON & ESTÉVEZ 1985). Nevertheless, in a geologically stable archaeological site like Túnel VII, where sedimentary deposits have not experienced significant movements or erosion, different fragments have been found at relatively great distances.

The most fragile bones in the birds skeleton (skulls, sternum, and pelvis,) appear broken in situ, which should be explained in terms of taphonomic fragmentation. For the rest of the bones, the most possible hypothesis is that fragments have been included in the sedimentary matrix (archaeological deposit) as fragments. Breakage was a result of human action, deliberate or not, before or after deposit, but always before inclusion in the sedimentary matrix.

Cormorant and Little Sea Birds have similar averages of complete bones (Fig. 2). Penguin bone fragmentation is very different to the pattern for big sea birds. Both are also different to the cormorant/little sea birds pattern. We note the significant average of complete penguin bones (notably forelimbs), and the high level of breakage for big sea birds. Breakage for posterior limbs is similar in all categories.

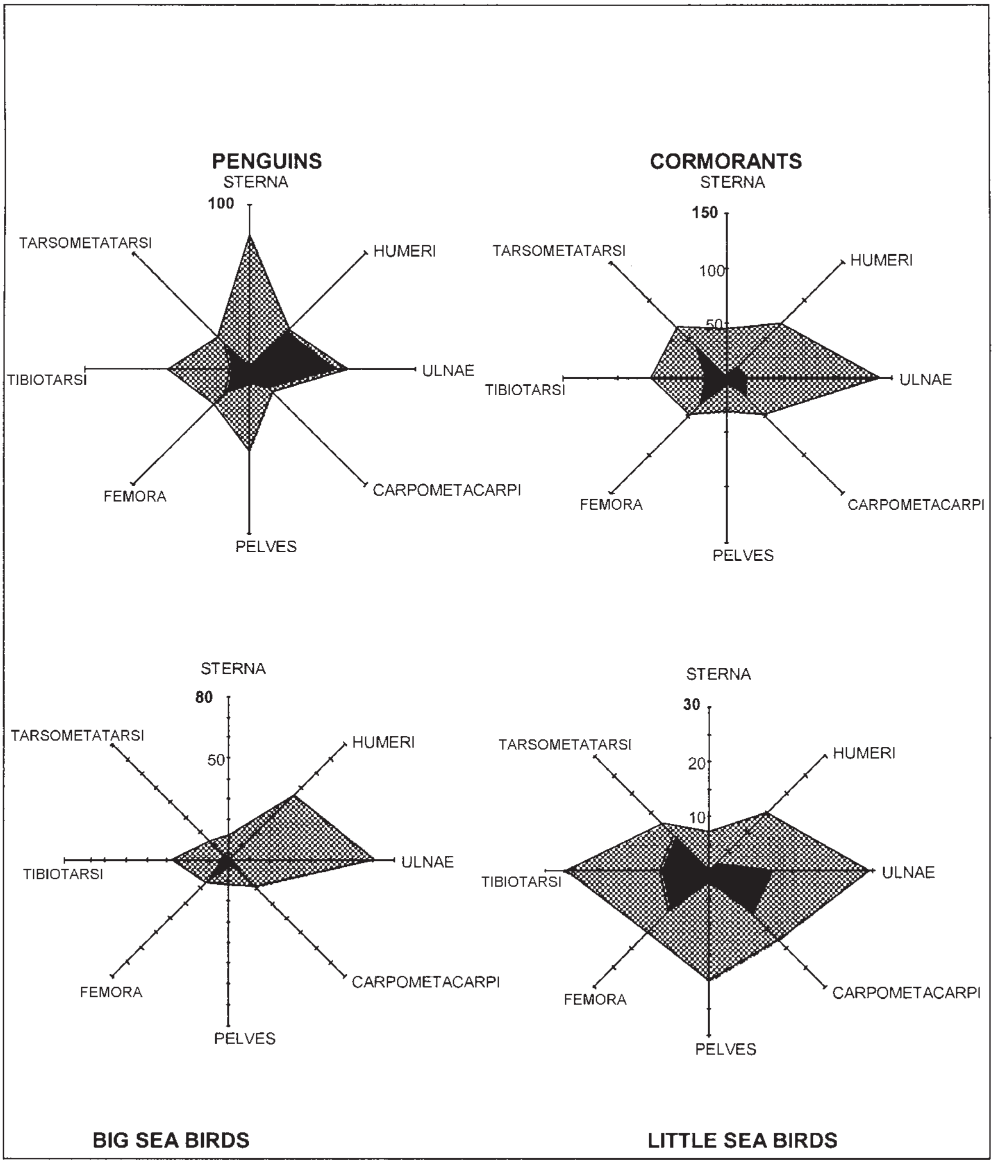

Fig. 2. Quantity of fragments (grey polygon) compared to quantity of whole bones (dark polygon). Results are for the four predominant categories.

Differential processing

Post-mortem modifications can be the consequence of human actions, biotic or non-biotic processes. Human activity is easily recognizable through the repeated observation of specific fracture patterns, the presence of wear (incisions, cut marks, scrapes) or some thermal alteration patterns.

We have recovered 727 fragments with evidence of human processing (from a sample of 5054 bone fragments). In the taxonomically classified sample (2150 fragments), 24.28% (522) have cuts, incisions or scrapes. There are relevant differences in the frequency of traces (Table II).

Table II

Relative frequency of bones with marks left by humans. Percentages indicate the average of marked bones in each species sample

Skeletal element	Penguins %	Cormorants %	Big sea birds %	Little sea birds %
Skull	<10	10-30	10-30	<10
Mandible	10-30	<10	10-30	10-30
Furcula	10-30	>30	10-30	>30
Sternum	10-30	10-30	10-30	10-30
Coracoid	>30	>30	>30	10-30
Scapula	10-30	10-30	>30	10-30
Humerus	>30	>30	>30	>30
Radius	<10	10-30	10-30	10-30
Ulna	<10	10-30	10-30	>30
Carpometacarpus	<10	10-30	10-30	10-30
Pelvis	10-30	10-30	10-30	10-30
Femur	>30	>30	>30	10-30
Tibiatarsus	10-30	10-30	>30	10-30
Fibula	10-30	<10	10-30	<10
Tarsometatrsus	10-30	10-30	>30	<10

Incisions, cuts and scrapes are the consequence of human action. That is, they are the product of separating body parts by dismembering them by hand or with the help of cutting instruments (cuts or incisions). Other marks (sawing, drilling, polishing, etc.) are produced by other actions. These traces constitute deep marks produced by percussion (cut) or linear movement (incision). They appear isolated or clustered (oblique or parallel), and they can be superficial or deep. Depth varies according to the force made with the tool on the bone, the quantity of soft tissue over the bone surface, the presence/absence of tendons in the articulation, or bone strengths.

An incision may end in a scrape. These are linear traces very common in long bones, and related to butchering. They appear as thin parallel lines, produced by the irregularity of the tool edges when moving perpendicularly over the bone surface.

While marks associated with disjointing are usually cuts or incisions oblique to the longitudinal axis, scrape marks and some incisions associated to butchering are parallel to the longitudinal axis.

It is important to remark that bird use does not only imply food consumption. We can think of the exploitation of feathers. The presence of cuts and incisions in posterior phalanges is related with the systematic use of aquatic bird finger membrane as waterproof tissue for manufacturing bags and other equipment. The presence of wear traces on skulls (penguin frontal bones – probably *Eudyptes* – and cormorant) is probably related with the Yámana use of the crests of those birds (ORQUERA & PIANA 1999b).

In 5054 fragments, we have observed 386 cases with thermal alteration (total or partial). When we detect items partially brownish-to-blackish, we have evidences of possible cooking. Instead, when the entire fragment is white, grey or black, we should explain it as an accidentally or deliberately burnt element. Such bones were discarded materials accidentally burnt, or used deliberately as fuel. Microscopically, analysed materials may show a little linear pattern in thermal altered zones, and oblique cracks. We suggest that these alterations are a consequence of the fast dehydration produced when the bone experienced high temperatures.

The average number of burnt bones among the different bird categories is relatively similar. This suggests a cooking process not differentiated by species. The results by category are: cormorant (96 burnt fragments), penguin (50), big sea birds (34), little sea birds (16), small birds (2), and unclassified (188). The average of burnt/not burnt bones varies between 11.4% of burnt fragments in cormorant to 1.8% in small birds. 7.9% of little sea birds bone fragments are burnt, 8.5% of big sea birds, and 8.5% of penguins. It may be relevant that littoral and predatory birds have no evidences of thermal alteration, and those frequencies are extremely low in the case of small birds. We have not measured any relevant variation in the thermal alteration of different body parts. The intermediate, proximal and distal parts of bones have similar patterns.

To sum up, we have observed that the humerus is one of the key bones in butchering, and processing, because it concentrates a greater quantity of cuts, incisions, scrapes, and thermal alterations (49.46%). In the big sea birds, however, the higher frequency appears in femur (62.50%), while in the case of little sea birds, it is the furculae that most usually present marks (83.33%). In all species, wing phalanges have no evidence of processing or thermal alteration. We can imagine then that they were discarded without consumption. Feet phalanges, instead, have clear evidences of processing. They were butchered for consumption, or the Yámana extracted the membrane over feet digits to be used in manufacturing.

The high quantity of marks observed on neck vertebrae (26.67%), compared to the frequency of marks in other kinds of vertebrae (3.12%), suggests a different processing mode for the neck of birds. On the other side, thorax vertebrae have higher averages of thermal alteration that neck vertebrae.

Cormorant, penguin and big sea bird jaws have clear evidences of human processing marks. They appear on both the medial and lateral parts of the bone. If we relate this observation with the high frequency of marked neck vertebrae, we have a partial proof of a deliberate use of the birds oesophagus and trachea.

In almost all cases, forelimbs have evidences of processing, with the notable exception of penguins. In the cormorant, wings are disjointed at the distal end of humeri, affecting sometimes the ulna. In some cases, we have observed ulnae marked with heavy punches. Those traces are the result of the deliberate cut of tensor and extensor muscles.

In big sea birds, we have observed a recurrent pattern of humeri butchering, and proximal end thermal alteration. Radii and ulnae also show a regular pattern of marks (most frequent on ulnae), and in some cases, we have registered polish and saw traces in bone diaphises. Such marks may have been produced during tool manufacturing. Wing discard affected the distal end of this body part, hence the carpometacarpi have no evidence of processing.

In the case of the thorax and sternum, we have observed significant differences between cormorant, penguins and big sea birds and the other birds. In the three predominant categories, we can easily follow the activities of butchering and cooking from the general pattern of marks and thermal alterations. Cuts, incisions and scrapes in this body part, are related to the processing of pectoral muscle. Penguins tend to have marks on the dorsal side of the sternum, while cormorant and albatross have the ventral marks. This difference suggests a more systematic use of penguin skins, than skins of other species.

We have also observed some regular patterns of processing at the level of the pelvis waist. In the case of penguins, there is clear evidence of separating pelvic bones from the femur. The same butchering pattern has been observed in the case of cormorants. In both cases, cuts and incisions appear in the distal end of the femur. In the cormorant, marks have also been registered in the proximal end of tibiotarsi.

Scrape butchering marks are easily observable in the case of big sea birds. For penguins, radii and ulnae have no butchering mark, suggesting their systematic discard. Instead, penguin tibiotarsi present evidence of scraping. The distal part of penguin posterior limbs seem also to be discarded (at the level of tarsometatarsus). In the case of cormorants, tarsometatarsi were fractured, what seems related to a partial discard pattern.

In the case of big sea birds, posterior limb processing seems to have been like cormorant processing.

Post-depositional alterations

Gnaw marks on bones are shown by punctures, that is, circular marks on the bone surfaces, which coincide with the general shape of carnivores teeth. The presence of these marks in our sample is the consequence of scavenging activity by dogs or other carnivores. There are also some other bone modifications related with the action of teeth, but in those cases, it is very difficult to distinguish human from animal bites.

If we only take into account punctures, we will probably under-represent the activity of carnivores in the site. The opposite is also true, that it would be a clear mistake to consider all puncture marks as only the consequence of human nibbling.

We have detected 41 cases of gnawing (34 with punctures). There is not any general pattern anatomically or taxonomically.

In Túnel VII plant root activity is present in the archaeological layers. This fact suggests a fast process of deposit formation over the shell layers. The fast accumulation of discarded shells, buried food and bone remains, which were never exposed to the open air for a long time. Tinny circular or semi-circular holes have been observed in some cases. They are different to the classical dendrite patterns with edges characteristic of plant root activity on buried bones (BONNISCHEN & WILL 1990).

Spatial variability

Cormorant bones are the most abundant in the centre and the periphery of the excavated area, which corresponds to the residential unit and neighbouring activity areas. Out of the limits of the hut, cormorant and penguin bones are also the most abundant bird remains. We think this is a consequence of the higher level of cormorants and penguin prey present in the sample, and not to a distinct spatial pattern.

Big sea birds fragments appear concentrated in the central area of the settlement because those kinds of bones were the most used in tool manufacture, given their size, shape and characteristics. We can infer then that working activities were carried out inside the hut. In Túnel VII burins were manufactured using bird bones. Humeri are the most frequent, and also, but in less quantity, radii and tibiotarsi (PIANA & ESTÉVEZ 1995). Radii and ulnae were used for cylindrical beads. However, bone industry recovered in Túnel VII was quantitatively very poor, compared to the abundance in ethnographic collections, and other archaeological sites (PIANA & ESTÉVEZ 1995). These results are important for understanding the use of bird bones as raw material for instruments.

Cormorants, penguins, fulmar, Antarctic petrels, gulls and terns appear both in the centre and in the neighbouring periphery of the archaeological area.

Among the less well-represented bird species, Barn Owl and Rock Hopper Penguin appear mostly in central locations, while Sparrow and Great Horned Owl appear in the periphery. Remains of cinclodes and hawks were observed mainly out of the limits of the hut. The few remains of ducks and heron are usually found out of the hut central area.

V. TEMPORAL DYNAMICS

We have made some biomass calculations for exploratory purposes only. Quantities do not describe specific exploitation patterns for each species, but they have been used for comparison. We have used the following reference table for the most relevant categories:

CORMORANT, Biomass index: 1150 gr.; PENGUIN, Biomass index: 1450 gr.; BIG SEA BIRDS, Biomass index: 1396 gr. (body mass of one individual, given in grams. We have followed here the values for *Diomedea*, because this species contributes to the category in more than 90%); and LITTLE SEA BIRDS, Biomass index: 326 gr.. We have used an approximate biomass mean index for DUCKS of 3500 gr. Biomass index for SMALL BIRDS is very variable. We have used as a mean value: 150 gr. Based on our own experimental work.

For a proper understanding of this site's temporal dynamics, we should take into account the ethnographic sources that fix the duration of each occupation span in a few weeks. A hut like this one would be occupied by a single family. Duration and human group size are important considerations for understanding the consumption value of hunted birds. The results are the following ones (Figs 3 and 4).

Phase B:

This is the oldest in the sequence. We have a count of 131 bone fragments. 67 were classified taxonomically; 9 of them have cut marks, 4 have thermal alteration and 2 traces of gnawing by carnivores. During this occupation a minimum of 13 individual birds of different species were consumed (MNI). More small birds than any other species were hunted, cormorants come in second place. Prey for other categories appear in even lower frequencies. Although the number of prey individuals is low, the highest biomass corresponds to big sea birds (2792 gr.), followed by cormorants (2300 gr.).

Phase C:

We have 103 bone fragments from this phase. 45 were classified taxonomically. 9 of them have cut marks or incisions, and only 2 have evidence of thermal alteration. There is no evidence of animal scavenging. 12 or 13 birds were probably hunted (MNI). In terms of NISP, there is the same quantity of cormorant, penguins, little sea birds, and small birds. Big sea birds appear in less quantity, and even less is the frequency of predatory birds. There is not any evidence for ducks and heron. In terms of MNI, more parakeets were hunted and consumed than any other species. The higher bio-

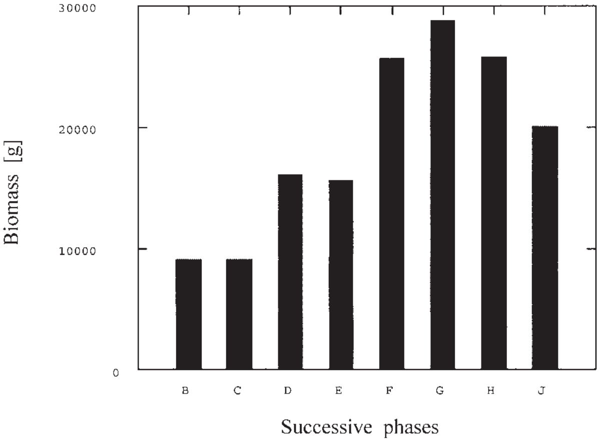

Fig. 3. Biomass variation by phase.

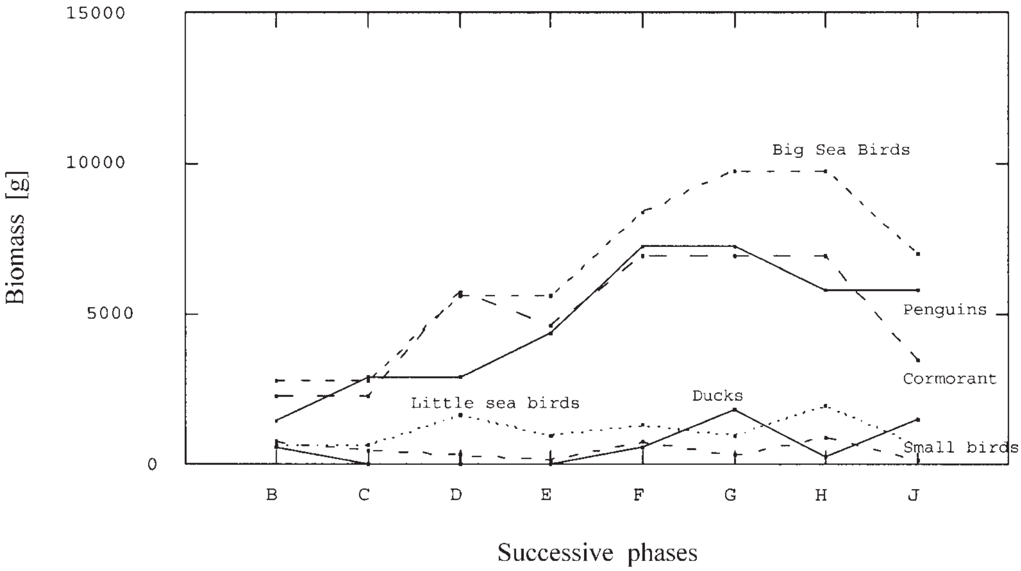

Fig. 4. Biomass variation by phase and by category.

mass, however, corresponds to penguins (2900 gr.), big sea birds (2792 gr.) and cormorant (2300 gr.). All species have evidence of processing and consumption, even little small birds and predatory birds.

Phase D:

There is a sample of 373 bone fragments, and a calculated MNI of 17 individuals. 133 fragments were classified taxonomically, 28 of them have processing marks, 30 are burnt (21 of them belong to cormorant) and 5 show evidences of animal scavenging. In terms of MNI and NISP there is a clear predominance of cormorant. Quantitative differences are very clear with the presence of other species. In decreasing order, we can count penguins, little sea birds and big sea birds, and very few remains of terrestrial and predatory birds. There is no evidence for ducks or heron. Biomass index for cormorant is very high: 5750 gr., and of big sea birds (5584 gr.). Biomass index for penguins is much lower: 2900 gr. All species show evidences of processing. Even owl bones have marks.

Phase E

365 bone remains have been quantified. 137 of them were classified taxonomically. 51 of the taxonomically determined fragments have processing marks, 42 have evidence of thermal action, and 7 have evidences of carnivore scavenging. Hunted prey (MNI) total 13 individuals. There is a predominance of cormorant, followed by penguins, big sea birds, and little sea birds. The presence of this latter category seems to be much more relevant than in any other phase. In a much lesser average, small birds are also represented, but littoral and predatory birds are absent. Big sea birds have the higher biomass index (5584 gr.), with similar values for cormorant (4600 gr.) and penguin (4350 gr.). All identified species have evidence of processing.

Phase F

The total sample is 670 bone fragments. 222 were taxonomically classified, 71 of them have processing marks, 43 have evidence of thermal modification, and there is only 1 fragment with scavenging marks. 28 birds were hunted in this phase, according to the calculated MNI. Cormorant is the predominant category, with much lower frequencies of penguins and big sea birds (equally represented). Little sea birds and predatory birds appear in even lower quantities. There are very few remains of littoral and small birds. The highest biomass is for big sea birds (8376 gr.), followed by penguin (7250 gr.) and cormorant (6900 gr.). All species have evidence of having been processed, even a Crested Caracara.

Phase G

There are 428 bone remains in this sample. 170 fragments have been classified taxonomically, 25 of them have processing marks, 35 are burnt and 4 have some marks related with animal scavenging. 25 individuals were hunted (MNI). In the sample there is an equal representation of cormorant, penguin and big sea birds, followed by the rest of the categories with much lower frequencies: little sea birds, terrestrial and ducks and heron. Big sea birds is the category bringing the most part of the total biomass, with an index of 9772 gr. Penguins have a biomass index of 7250 gr., and cormorant of 6900 gr. During this phase, littoral and small bird bones have no evidence for processing marks, which is an important difference compared to other occupation periods.

Phase H

757 bone remains constitute the sample. 453 remains were classified taxonomically. 117 of them have processing marks, 51 have thermal alteration, and there are no remains with scavenging marks, among the taxonomically classified birds. MNI is 30. Cormorant and penguin are the most typical categories, followed by big sea birds and little sea birds with much lower frequencies. There are few remains of terrestrial, predatory and ducks and heron. The higher biomass index is for the big sea bird category (6980 gr.), followed by cormorant (5800 gr.) and penguin (3450gr.). All species have processing marks.

Phase J

This is the last occupation phase of the hut, and consequently, the most modern. There are 565 bird bone fragments. 261 of them were classified taxonomically, 59 of them have processing marks, 28 have some thermal alteration or burning, and there is no evidence of scavenging. 16 birds were hunted according to the calculated MNI. The most abundant categories are cormorant, penguins and big sea birds. The three categories have the same frequencies (according MNI and NISP). Little sea birds are much less represented, and there are only very few remains of terrestrial birds, ducks and heron. Higher biomass corresponds to big sea birds (9772 gr.). Cormorants have a biomass index of 6900 gr. Moreover, for penguin, it is 5800 gr. All species have evidences for processing.

A comparison of the relative frequencies allows us a description of successive changes in hunted bird samples along the occupation span of this Yámana camp. We have used multivariate statistics to present the global trend.

A correspondence analysis in two dimensions (Fig. 5) shows a classic seriation pattern, by ordering chronologically the observed quantitative differences. Temporal variation stresses the relevance of small birds at the beginning of the sequence and its under-representation at the end. There is a higher relevance of big sea birds and penguins over cormorants at the end of the period. Oldest phases (B and C, but specially the first one) are characteristically different to the last years of occupation, and the difference involves important changes in the predominance of the cormorant-penguin pair.

However, bird exploitation in the Túnel VII occupation span does not follow a linear gradient. Although the initial phases are different to the last ones, it is not possible to determine abrupt changes in hunted or exploited bird species, although some important change may be present between phases C and D.

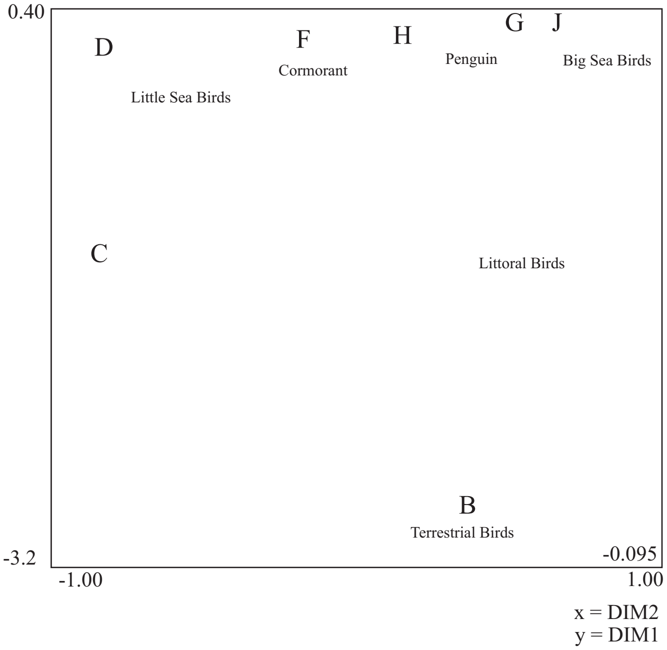

Fig. 5. Correspondence Analysis results. Plotting of the two First Components, for phases and categories. Littoral Birds corresponds to "Ducks" in the text. Terrestrial Birds corresponds to "Small Birds" in the text.

VI. CONCLUDING REMARKS

From the statistical results, we can conclude organized hunting strategies dominated. At each hunting event, various individuals of the same species were captured. Consequently, gregarious species (penguin and cormorant) were much more appreciated, and are better represented in the different bone samples. An opportunistic hunting strategy could never produce a statistical pattern like the one we have analysed. The greater the number of birds hunted was, the higher the predominance of a few species (cormorant and penguin) over the rest. Furthermore, the most appreciated species are also the species having higher averages of processing marks.

The number of available birds in this region was very large, however, Yámana hunters made a clear selection of species hunted which were transported to the camp. Given the assumption that hunting strategies are determined by the behaviour and habitat of each species, we follow the hypothesis of a higher representation of the most gregarious birds, with annual presence in the region nesting locally.

In this way, when the exploitation of birds increased, the consequence was a specialization in the most profitable species. As expected, it has been observed that a higher presence of the most common and easily exploitable resources existed, and a consistently lower presence of occasional resources, or those that were more difficult to exploit.

There are many ethnographic and historic sources about the Yámana use of ducks, gooses and other birds (ORQUERA & PIANA 1999b). Nevertheless, the investigation at the Túnel VII site shows only a sporadic use of those species. Ethnographic sources also show that the Yámana were repulsed by terrestrial and predatory birds. We have tested archaeologically, that those birds were captured, transported to the camp, processed and probably also used. However, although caracara, sparrow, parakeet and owl bones have human produced processing marks, it does not mean that those birds were "eaten". Other uses are probable, although we cannot deny the possibility of their being used as food.

There are no relevant differences in cooking practice seen in the burnt parts of bones. Our results are different from those obtained by LEFÈVRE, for other sites in the same island of Tierra de Fuego. She suggests that the articular part of a bone or its fracture surface will have more evidences of thermal alteration (LEFÈVRE & PASQUET 1994). In our sample, bones show burnt or thermally altered areas in the middle part, in the proximal and distal epiphyses.

Scavenged bones should be studied with much more detail to be able to distinguish the incidence of non-human factors, and the general pattern of post-deposition alteration, both morphologically and spatially.

REFERENCES

BARCELÓ J. A., PIANA E., MARTINIONI D. 2002. Archaeological Spatial Modelling. A case study from the World's End. [In:] G. BURENHULT, J. ARVISSON (eds) – Archaeology at the Interface. ArcheoPress (British Archaeological Reports), Oxford.

BONNICHSEN R., WILL W. 1990. Cultural modification of bone: The experimental approach in faunal analysis. [In:] B. M. GILBERT (ed.) – Mamalian Osteology. Misouri Archaelogical Society. Columbia.

CLARK R. 1986. Las aves de Tierra del Fuego y Cabo de Hornos, guía de campo L.O.L.A. Argentina. 294 pp.

COHEN A., SERJEANTSON D. 1996. A Manual for the Identification of Bird Bones from Archaeological Sites. Archetype Publications Ltd, London. 115 pp.

DAVIDSON I., ESTEVEZ J. 1985. Problemas de Arqueotafonomía. Formación de yacimientos con fauna. *Quaderns,* **2**: 67-83. Barcelona.

DRIESCH A. VON DEN. 1976. A guide to the measurement of animal bones from archaeological sites. Part three: Measurement the bird skeleton (103-129). Peabody Museum Bullekin 1, Harvard, IX ed. 137 pp.

ESTÉVEZ J., JUAN-MUNS N., MARTÍNEZ J., PIQUÉ R., SCHIAVINI A. 1995. Zooarqueología y Antracología: Estrategias de Aprovechamiento de los recursos animales y vegetales en Túnel VII. *Traballs d'Etnoarqueologia*, **1**: 143-163.

ESTÉVEZ J., PIANA E., SCHIAVINI A., JUANS-MUNS N. In press. Marine resources at the Beagle channel region prior to the industrial explotation: an archeological evaluation. ICAZ. Canada.

GILBERT M., MARTIN L., SAVAGE H. 1981. Avian osteology. B. M. GILBERT (ed.) – Wyoming, 252 pp.

HUMPHREY P. S., BRIDGE D., REYNOLDS P. W., PETERSON R. T. 1970. Birds of Isla Grande (Tierra del Fuego). Smithsonian Institution, Washington, DC., 411 pp.

LEFÈVRE C. 1989a. L'avifaune de Patagonie australe et ses relations avec l'homme au cours des six dernieres millenaires. PhD. Dissertation. Université de Paris. 411 pp.

LEFÈVRE C. 1989b. Chapitre 5: Les oiseaux. [In:] D. LEGOUPIL (ed.) – Ethno-archéologie dans les archipiels de Patagonie: les nomades marins de Punta Baja. Editions Recherches sur les Civilisations. Mémoire No. **84**. Paris, 99-113.

LEFÈVRE C. 1992. Punta María 2. Los restos de aves. *Palimsesto. Revista de Arqueología*, º **2**: 71-98.

LEFÈVRE C., PASQUET E. 1994. Les modifications post-mortem chez les oiseaux: l' exemple de l' avifaune holocène de Patagonie australe. *Artefacts, 9. Outillage peu élaboré en os et en bois de Cervidés IV*. Editions du centre d' études et de documentation archéologiques. Belgique.

NAROSKY T., YZURIETA D. 1993. Guía para la identificación de las Aves de Argentina y Uruguay. Editorial Vazquez Mazzini Eds. 345 pp.

OLROG C. 1984. Las aves argentinas: Una nueva guía de campo. Administración de Parques Nacionales. Argentina. INCAFO, España. 352 pp.

ORQUERA L., PIANA E. 1995ª. Túnel VII en la secuencia arqueológica del canal Beagle: hipótesis y expectativas de los investigadores argentinos. *Treballs d'Etnoarqueologia*, **1**: 25-45.

ORQUERA L., PIANA E. 1995b. Túnel VII: La Excavación. *Treballs d'Etnoarqueologia*, 1,. 47-83.

ORQUERA L., PIANA E. 1999a. El extremo autral del continente. Nueva historia de la Nación Argentina, Tomo I, Academia Nacional de la Historia. Ed Planeta. Pp: 233-257.

ORQUERA L., PIANA E. 1999b. La vida material y social de los *Yámana.* Ed. Eudeba. 567 pp.

ORTON C. 1999. Sampling in Archaeology. Cambridge University Press.

PIANA E., ESTÉVEZ J. 1995. Confección y significación de las industrias ósea y malacológica en Túnel VII. *Treballs d'Etnoarqueologia,* **1**: 239-259.

SAVANTI F. 1994. Las aves en la dieta de los cazadores recolectores terrestres de la costa fueguina**.** Temas de Arqueología. Consejo Nacional de Investigaciones Científicas y Técnicas. Argentina. 130 pp.

VENEGAS C. 1986. Aves de Patagonia y Tierra del Fuego Chileno-Argentina. Ediciones. de la Universidad de Magallanes. Punta Arenas, Chile. 79 pp.

VILA A., PIANA E., ESTÉVEZ J., ORQUERA L. 1995. Encuentros en los conchales fueguinos. *Traballs d'Etnoarqueologia*, **1**: 5-16.