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Early Holocene Bone Technology at the La Olla 1 Site, Atlantic Coast of the Argentine Pampas

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La Olla 1, in the Pampas of Argentina, is an open-air site located on the Atlantic coast in the Monte Hermoso District, southern Buenos Aires Province. Bones in lacustrine layers outcrop during very low tide exposed by longshore drift. Based on an initial analysis of the faunal assemblage, two species of sea mammal, guanaco, pampean deer, greater rhea, and a fish were represented in the almost 300 bones recovered during the rescue excavation. The lithic assemblage consisted of unifacially flaked tools, rounded cobbles reduced by bipolar technique, flakes, and artifacts with flat abraded surfaces. Radiocarbon determinations of *c.* 7300 and 6600 BP came from sea mammal femora. An informal bone tool recovered from the site is made from the left proximal tibia of an adult otariid. It is identified as a utilitarian bone tool on the basis of use-wear characters that are restricted in distribution, and as a fracture-based bone tool on the basis of technological characters. The element was dynamically impacted in the mid-diaphysis region. Use-wear characters are loss of edge angularity, microflaking, pitting, striae, and polish. Microflaking occurs along the posterior fracture surface and exterior adjacent cortical surface. Pitting of the fracture surface extends along the entire length of the worn edge, but is most concentrated along the posterior fracture surface. A multitude of very fine striae runs parallel to the fracture edge. The area of striations is limited to this edge with a well-demarcated boundary. Covering all of these characters is differential wear-polish. This high gloss polish is strongly reflective and occurs over very worn and rounded areas, providing a very bright, melted appearance. Based on these different use-wear patterns, the La Olla 1 bone tool is interpreted as a dual-purpose implement most likely used for carcass dismemberment and hide processing. The La Olla 1 tool is unusual in that it is made from pinniped bone. Biomechanical analysis of southern fur seal bone indicates, however, a strong suitability for impact-related tasks and, therefore, an appropriate choice for use as butchering tools.

Keywords: BONE TECHNOLOGY, OTARIIDS, BONE TOOL, HOLOCENE COASTAL ADAPTATION, PAMPAS, ARGENTINA.

Introduction

The age and nature of human occupation of the Pampean coast have been a subject of controversy since the beginning of the century. While Ameghino (1908, 1910) postulated a great antiquity for the lithic material found on the surface in littoral sites, a much younger age of only a few centuries was postulated by Hrdlicka (1912). After this initial controversy, the debate moved in three different directions. One position suggested that coastal sites were part of a larger settlement system that included inland sites (Holmes, 1912; Aparicio, 1932; Politis, 1984). These sites were seen as the result of seasonal or periodical exploitation of coastal resources produced by pampean hunter–gatherers during Late Holocene times (Politis, 1984). A second position recognized an independent identity of coastal foragers adapted to the exploitation of marine resources (Menghin, 1957; 1963; Sanguinetti de Bórmida, 1965 Bórmida, 1969; Mesa & Conlazo, 1982). The third position postulated that some of the coastal sites belonged to a "mixed industry", the

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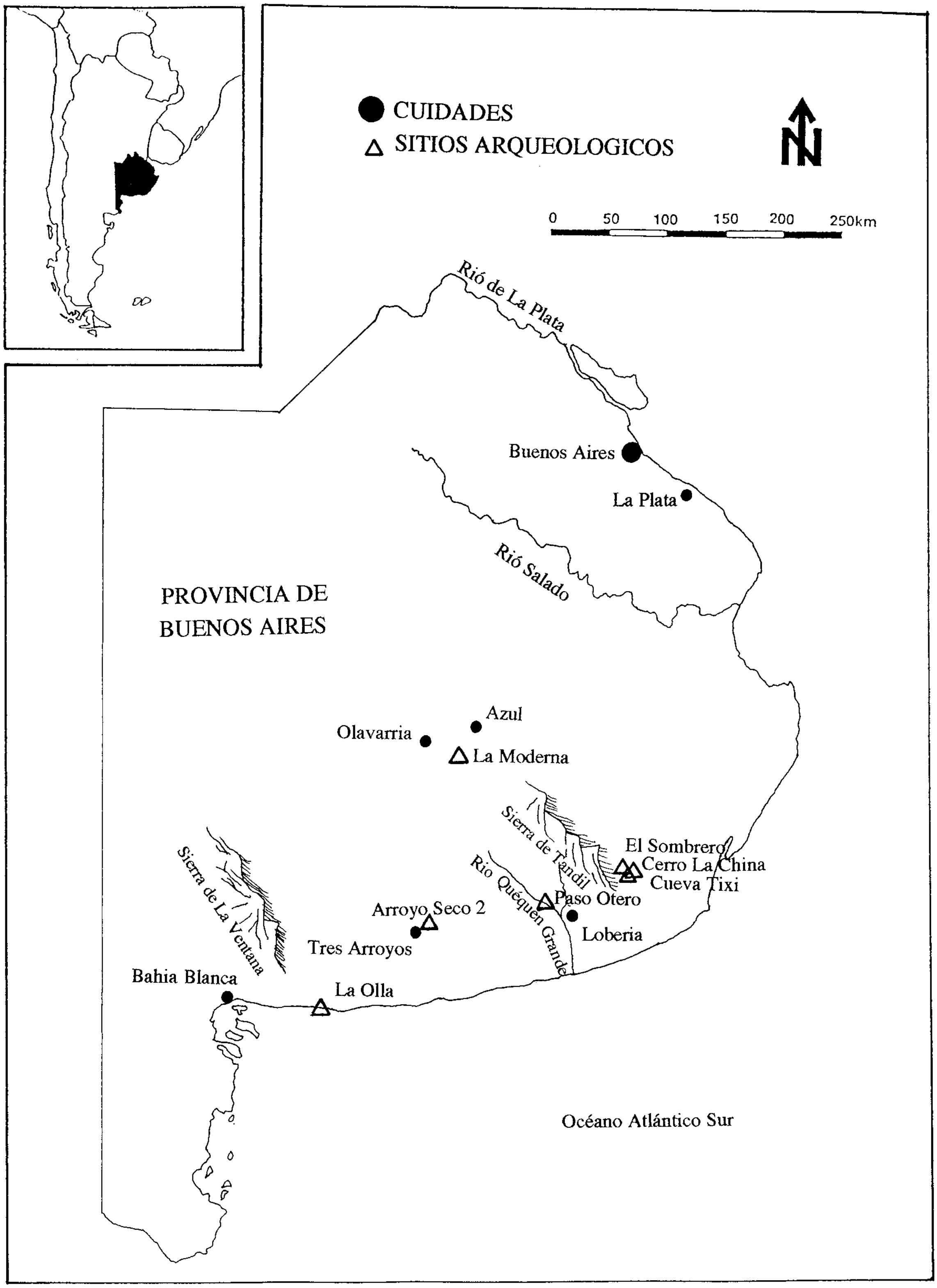

Figure 1. Location of La Olla 1 along the Atlantic coast of the Argentine Pampas.

Figure 2. La Olla 1 exposed at low tide; note lacustrine sediments above the sands.

product of the influence of inland foragers on coastal small-game hunter–gatherers (Austral, 1968). This debate was fueled by differences in interpretation of surface sites, as no stratigraphic contexts were found in the costal strip of the Pampas until the mid 1980s when La Olla 1 was discovered (Guzmán & Di Martino, 1984; Politis & Lozano, 1988).

La Olla 1 (Figure 1) is the first site in stratigraphic context located on the Atlantic seashore of the Argentine Pampas, situated in the tidal zone at Monte Hermoso (Buenos Aires Province, Argentina). It contains significant information about the use of marine resources, primarily sea mammals, in the pampean region during Early Holocene times. The site also provides new information about bone technology during this time period. Although bone tools previously were unknown for the Early Holocene in the Argentine Pampas, bone technology is in evidence for that time. Helically fractured mammal long bones (indicating dynamic impact of fresh bones) come from the Lower Component (dated *c.* 7300 to 11,500 BP) at Arroyo Seco 2 (Politis, 1984; Fidalgo *et al.*, 1986; Politis *et al.*, 1995; Johnson & Gutierrez, in press). At the same site, drilled carnivore canine beads have been found as funerary goods associated with human skeletons dated *c.* 6300 to 7800 BP (Politis, 1989; Barrientos, 1997; Barrientos & Politis, in press). The use of bone for formal implements is known only in the Late Holocene of the Pampas. A few spatula-like artefacts have been found between the two mountain ranges in the Interserrana area of the Pampas (Figure 1) (Politis, 1984; Salemme *et al.*, 1985). In the northeastern Pampas (Cigliano, 1963) and in the Salado River Depression (Figure 1; González de Bonaveri, 1997), a variety of bone implements are common.

Archaeological Background

La Olla 1 is an open-air site located in the beach of the Atlantic seashore at 38° 57′ 47″ S and 61° 22′ 48″ W, in the Monte Hermoso District, on the southern edge of the Pampas (Figure 1). The site is 6 km west of the city of Monte Hermoso. In 1984, sea mammal bones in lacustrine layers outcropped from the sand. These layers (15 to 30 cm thick) had been exposed during very low tide by longshore drift (Figure 2). Test excavations were conducted in a rescue manner because the site was exposed only 3–4 hours a day, and even then, water was percolating through the lacustrine layers. The sand bar began to move north, resulting in the process of burying the site (Guzmán & Di Martino, 1984). The site was covered completely by sand after two weeks of excavation. Since then, it has been

Figure 3. Close-up of lacustrine layers exposed at La Olla 1; note the otariid radius at the top of the exposed sediments.

exposed only three times for brief periods of a few days each. No further excavation has been possible although additional materials were collected during each exposure period.

The excavated material was associated with the lacustrine layers of the stratigraphic sequence and some sea mammal bones were articulated (Figures 3 & 4). Assays on collagen from two different sea mammal femora yielded ages of 7315 ± 55 and 6640 ± 90 BP (Politis & Bayón, 1995; Bayón & Politis, 1996). Based on the initial analysis of the test excavation materials, two species of sea mammal (*Arctocephalus australis* and *Otaria byronia*), guanaco (*Lama guanicoe*), pampean deer (*Ozotoceros bezoarticus*), greater rhea (*Rhea americana*), and a fish were represented (Politis & Lozano, 1988). Almost 300 bones were identified as to element and taxon from the rescue excavation. The lithic assemblage consisted of a few unifacially flaked tools, rounded cobbles reduced by bipolar technique (known as bipolars), and flakes, along with several artefacts with flat abraded surfaces. The raw materials used were rounded cobbles of coarse-grained quartzite, sandstone, and another as yet undetermined material (Politis & Lozano, 1988).

La Olla 2 also is in the inter-tidal zone, about 50 m west of La Olla 1. The site was exposed only once, and a few seal bones and lithic artefacts were recovered (Bayón & Politis, 1996). Along the beach in an upper layer, several outcrops of lacustrine sediments contained several hundred preserved tracks of human footprints with associated dates of 6795 ± 120 BP, 7125 ± 75 BP, and 7400 ± 95 BP (Bayón & Politis, 1996).

The sediments that contain the La Olla 1 remains are lacustrine in origin. They overlay the Pampiano Formation in an erosional unconformity (Fidalgo, 1986, pers. comm.; Zavala *et al.*, 1992). This Formation has a Late Pleistocene age (Fidalgo, 1979). The lacustrine sequence is formed by silt-clay laminae with intercalated sand laminae. The former represents submarine deposition, while the second corresponds to subaerial deposition with sand blowing in from neighboring zones. Due to their thickness, bones usually cross-cut several laminae.

The sediments of La Olla 1 belong to a litoral interdunal lagoon (Zavala *et al.*, 1992). Although some degree of salinity was identified, the lagoon was not in contact with the sea. Its evolution shows periods of expansion and retraction, with a tendency toward reducing the size of the lagoon (Zavala *et al.*, 1992). Seeds of *Ruppia* spp., a cosmopolitan reed that today lives in the Dry Pampa lagoons, were found in abundance in some layers. A wooden piece of "chañar" (*Geoffrea decorticans*), a tree characteristic of the Dry

Figure 4. Articulated otariid bones within the lacustrine layers at La Olla 1.

Pampa, also was recovered (Villamil, 1992, pers. comm.).

Biological Background

Pinnipeds are amphibious mammalian carnivores and share many basic traits with other mammals. However, changes have occurred in their physiology, anatomy, and osteology as a result of their marine adaptation (Harrison, 1972; Ridgeway, 1972; King, 1983). The sequence of postnatal tissue development is fat–bone–muscle rather than the terrestrial sequence of bone–muscle–fat (Bryden, 1972:51). Fat provides the necessary insulation critical to survival in the marine environment. Bones have become shorter and stouter, but the major change is in density (King, 1983; Wall, 1983). Most pinniped bones are far more dense than those of terrestrial mammals, with density related to reduction of buoyancy and diving adaptations (Wall, 1983). This higher density is accomplished through increased bone deposition (both cortical and cancellous) and concomitant reduction of the marrow cavity in long bones. The marrow cavity additionally is filled with solidly constructed cancellous bone that merges with the thickened compact bone. This mechanism allows structural integrity of the bone to be maintained while withstanding compressive and tensile forces (Wall, 1983:203–204). Some pinnipeds [e.g. *Mirounga angustirostris* (elephant seal) and *Odobenus rosmarus* (walrus)] have a lower bone density (similar to terrestrial mammals) that is a secondary adaptation related to deep diving habits (Wall, 1983:200, 203). The elasticity modulus (related to bone tissue stiffness) is lower in pinniped bone compared with terrestrial mammals, providing a high energy-absorption ability and resistance to fracture (Scheinsohn & Ferretti, 1995:716, 1997).

Based on dentition, two otariid penniped genera are represented in the La Olla 1 faunal assemblage, the southern fur seal (*Arctocephalus australis*) and the southern sea lion (*Otaria byronia*). The ranges of these two otariids are sympatric (Redford & Eisenberg, 1992). While fur seals prefer rocky areas and sea lions sandy beaches, they often haul out together (Bonner, 1981; King, 1983). Sea lions are the larger of the two species (males being about twice the weight of male fur seals and females about three times the weight of female fur seals), with some overlap in weight and length between female sea lions and male fur seals. Sexual dimorphism is marked in these otariids, with fur seal males being more than three times heavier than females and up to 1·5 times longer; and sea lion males being more than twice as heavy as females and up to 1·5 times longer (King, 1983; Redford & Eisenberg, 1992). Closely related, *Otaria* diverged from *Arctocephalus* around 3 million years ago (Repenning & Tedford, 1977). The main characteristics that separate the two genera are body size, thick undercoat, and single-rooted cheek teeth in *Otaria* (King, 1983:132). None of these translates into post-cranial differences other than overall size of elements. The lack of distinctive differences and potential overlap of element size has made it difficult to separate these two otariids within an assemblage (Schiavini, 1987). On the size continuum, the smaller end of adult (i.e. fused) elements represent *Arctocephalus* while the larger end represents *Otaria*. The problem with using only size is both the area of potential overlap and taxon identification of the juvenile elements. However, some post-cranial differences exist that can be used as a guide (Blainville, 1840; Murie, 1874; Burmeister, 1879; Mitchell, 1961; King, 1983) and reduce the number of elements identified only to otariid.

Pinniped skulls and dentition have been studied extensively for species identification and adaptive measures (e.g. Sivertsen, 1954; Cave & King, 1964; Orr *et al*., 1970; King, 1971, 1972, 1983; Repenning *et al*., 1971; Repenning, 1972, 1976; Schiavini, 1987). However, very little has been published on pinniped bone itself or its biomechanical properties, with most of the literature oriented towards anatomical and morphological adaptations for life in the sea (e.g. Harrison, 1972; Ridgeway, 1972; King, 1983). Little research on experimental fracturing of pinniped bones has been published, but based on Wall's (1983) and Scheinsohn and Ferretti's (1995, 1997) work, the biomechanical properties of pinniped bone appear to be the same as for mammalian bone in general (Evans, 1973; Currey, 1984). Furthermore, proboscidean bone (although for different reasons than pinniped bone; cf. Currey, 1984) similarly has thickened cortical bone and marrow cavities filled with cancellous bone. This bone generally behaves in the same way, and some experimental evidence indicates that fracture mechanics are similar (Stanford *et al*., 1981; Johnson, 1985; Haynes, 1991). Based on this limited information, then, understanding pinniped bone response to stress is predicated on understanding basic mammalian bone and biomechanical data.

Bone Technology

Human reduction and modification of bone are dynamic processes involving biomechanics and technology (Johnson, 1985:191). People modify bone for a variety of purposes, a major one being for tool production. The tool manufacturing process is documented in the final morphology of the implement and technological traces preserved on the bone. Formal tools have long been recognized as products of cultural manipulation and their manufacturing process can be quite complex (e.g. Campana, 1980, 1987, 1989). Informal bone tools, on the other hand, have undergone much greater scrutiny in attempts to determine if these objects indeed were tools because morphological changes and manufacturing processes are not as recognizable on them. A major set of informal implements undergoing this intense examination is that of fracture-based utilitarian tools (implements created from segments of dynamically impacted bone for functional, practical purposes with little to no modification of the fractured edge).

Determining the presence of fracture-based utilitarian tools is based on identifying: (1) key characters of dynamic loading of fresh bone (e.g. helical fracture, impact point); (2) contrasting characters of carnivore fracturing; and (3) characters of subsequent cultural use (Johnson, 1985:202). This tool class involves minimal modification of the bone beyond fracture and the fracture surface itself is the tool bit (Johnson, 1985). The most common bone selected is a long bone. However, simply because a bone is fractured does not mean that it is a tool. A primary reason for fracturing bones by both hominids and carnivores is marrow extraction and retrieval of interstitial nutrients. If fresh bone is dynamically impacted for these extractive purposes, the same technological characters can be preserved as when fresh bone is dynamically impacted for expedient tool production (Johnson, 1985, 1989). The designation of "tool" is dependent on use-wear.

Johnson (1985) provides a summary discussion of the issues concerning hominid versus carnivore bone modification and criteria to separate the two agencies based on experimental and actualistic studies. More recent studies (e.g. Blumenschine, 1988; Blumenschine & Selvaggio, 1991; Capaldo & Blumenschine, 1994) strengthen some of these criteria and underscore the fact that differences exist even when similarities in bone damage are very striking. Use-wear characters for bone are analogous to those defined in lithic studies (cf. Hayden, 1979; Odell, 1979, 1980; Yerkes, 1989; Grace, 1989, 1990). Among the diagnostic characters are utilization flaking, polishing, striations, and edge-rounding. These characters are defined on the basis of restricted distribution on an element and their distinction from the locations and kinds of known carnivore or other natural agency damage (Johnson, 1985).

La Olla 1 Bone Tool

The La Olla 1 implement (LO-525) is a fracture-based utilitarian bone tool (Figure 5) made from the left proximal tibia of an adult otariid (i.e., fused epiphysis), referred to the southern fur seal (cf. *Arctocephalus australis*). The main segment of the fracture surface is on the medial side and the fracture edges are referred to as right and left sides in relationship to the working bit. Illustrations are oriented with the working bit of the tool up. The bone is stable with intact cortical surfaces; subaerial weathering features are absent.

The element was dynamically impacted in the mid-diaphysis region, as indicated by the helical fracture surface, intersecting fracture fronts, and negative flake scars along the interior compact bone (Figure 5). Diagnostic characters are lacking to indicate whether a single anvil mode (cantilever loading) or double anvil mode (simple beam loading) was used (Johnson, 1985:207,210). Minimal experimental evidence suggests a link between type of mode used in dynamic fracturing and thickness of fracture surface (Johnson, 1985:210, 212–213). Although this specimen primarily has thin fracture surfaces, a segment along the right side (away from the impact area) is broad. Slightly roughened fracture surfaces (Figure 6) point to the direction of force being towards the proximal end of the bone (i.e. away from the interior flake scars and mid-diaphysis). These fracture fronts (labelled as 2 and 3) intersect near the proximal end of the helical path (referred to as the proximal intersecting fracture front), along the right fracture surface (Figures 5 & 7). The roughened surface appears responsible for the broadening of the right fracture surface rather than the mode of fracturing. Determination of the mode, therefore, is inconclusive.

A second intersecting fracture front occurs at the medial antero-distal (referred to as the distal intersecting fracture front) opposite the area of interior flake scars. The intersection represents the juncture of a third radiating fracture front (labelled as 1) with fracture front 2. The proximal intersecting fracture front represents the juncture of this radiating fracture front 2 with radiating fracture front 3 coming from the impact zone in the vicinity of the interior flake scars. These scars occur on the interior compact bone wall as a

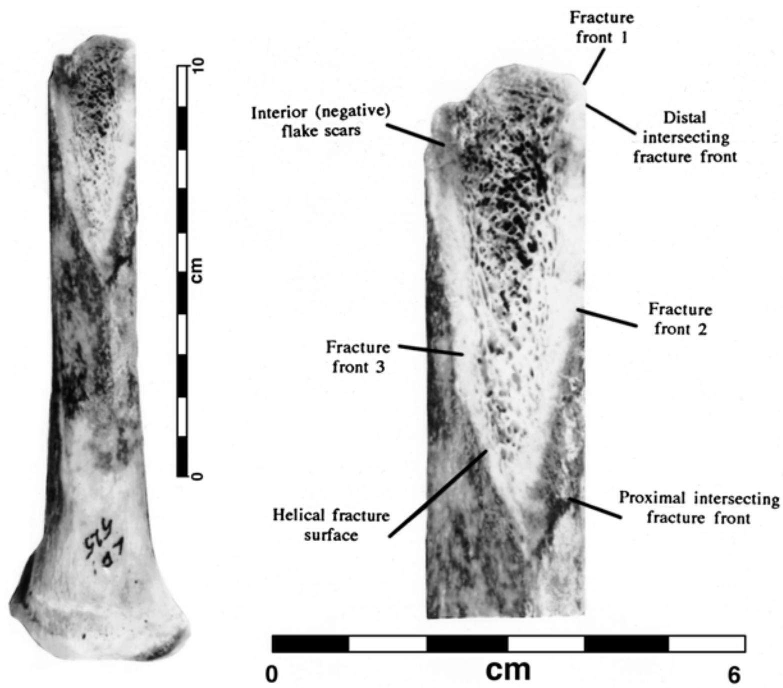

Figure 5. La Olla 1 bone tool with × 16 magnification of helical fracture surfaces, intersecting fracture fronts, and interior flake scars.

Figure 6. Roughened fracture surface along fracture front 2 (× 100 magnification).

Figure 7. Intersection of fracture fronts 2 and 3 (× 16 magnification).

result of bone flakes that were produced by the impact and are the remnants of the impact area (Johnson, 1985:194, Figure 5·13). These small, broad flakes have overlapping scar ridges, the distal ends of which formed troughs into the compact and cancellous bone (Figure 8). The shape of these troughs indicates an obtuse end to the flake. These flakes were formed through compression. Analogous to lithic studies (e.g. Cotterell & Kamminga, 1987, 1990), then, bone flake propagation is compression-controlled and the termination is axial. However, unlike lithic fracture mechanics where compression-controlled propagation is related to bipolar flaking (cf. Cotterell & Kamminga, 1990:145), both the one-anvil mode and the two-anvil mode in dynamic fracturing of long bones produce compression-controlled propagation.

Use-wear characteristics noted are loss of edge angularity, microflaking, pitting, striae, and polish. These characters are limited in distribution to only the mid-diaphyseal fractured end that is thin, worn, and rounded. The adjacent trabecular bone is rounded and smoothed (Figure 9) and grades towards the interior of the bone where sharp edges still occur. This highly worn edge occurs from the area of the interior flake scars (at the medial postero-distal) to the apex of the fracture surface to the distal intersecting fracture front (lateral postero-distal). Microflaking occurs along the posterior fracture surface and exterior adjacent cortical

Figure 8. Distal troughs of interior flake scars in compact and trabecular bone, with axial termination (× 40 magnification).

surface. Pitting of the fracture surface extends along the entire length of the worn edge, but is most concentrated along the posterior fracture surface. These pits vary in size and depth but all have highly smoothed edges (Figure 10). A multitude of very fine striae run parallel to the fracture edge. These striae vary in size and under very high magnification (× 25,000) appear as small cuts into the bone exposing multiple layers of bone structure. The area of striations is limited to this edge with a well-demarcated boundary. Covering all of these characters is differential wear-polish (alteration that is localized on a segment of the fracture edge and adjacent cortical and internal surfaces).

Polish covers the entire highly worn distal fracture edge, including the interior flake scars. It is most intense in the areas of the apex and the distal intersecting fracture front. The most concentrated pitting and microflaking occur between these two areas. The apex is the most worn and rounded area, with polishing overlapping onto the exterior cortical surface and extending discontinuously into the worn trabecular bone (Figure 11). The distal intersecting fracture front is highly polished on the fracture surface at the juncture of the two fronts. Under a binocular microscope (from × 16 to × 200 magnification), this high gloss polish is strongly reflective and very bright, occurring in variously sized patches and forming extensive lines along raised areas. This polish occurs over very worn and rounded areas, providing a very bright, melted appearance.

Minor sediment abrasion has left a slightly reflective appearance over the entire bone when viewed through a binocular microscope. Because of this situation, this reflective surface was investigated to determine what, if any, differences exsisted between the sedimentary polish and the polish noted on the mid-diaphyseal fractured edge. The sedimentary polish has a dull appearance and cannot be seen as readily at different magnifications as the polish at the distal end until × 200. Because of these differences, the two polishes are interpreted as having distinct origins (cf. Shipman, 1989; Shipman and Rose, 1988).

Discussion

La Olla 1 is located adjacent to an interdunal paleolagoon, probably a few kilometers north of the seashore during Early Holocene times. The current pampean seashore stabilized in Middle Holocene times, after the last regional marine transgression (Fidalgo & Tonni, 1983). The chronology of the last

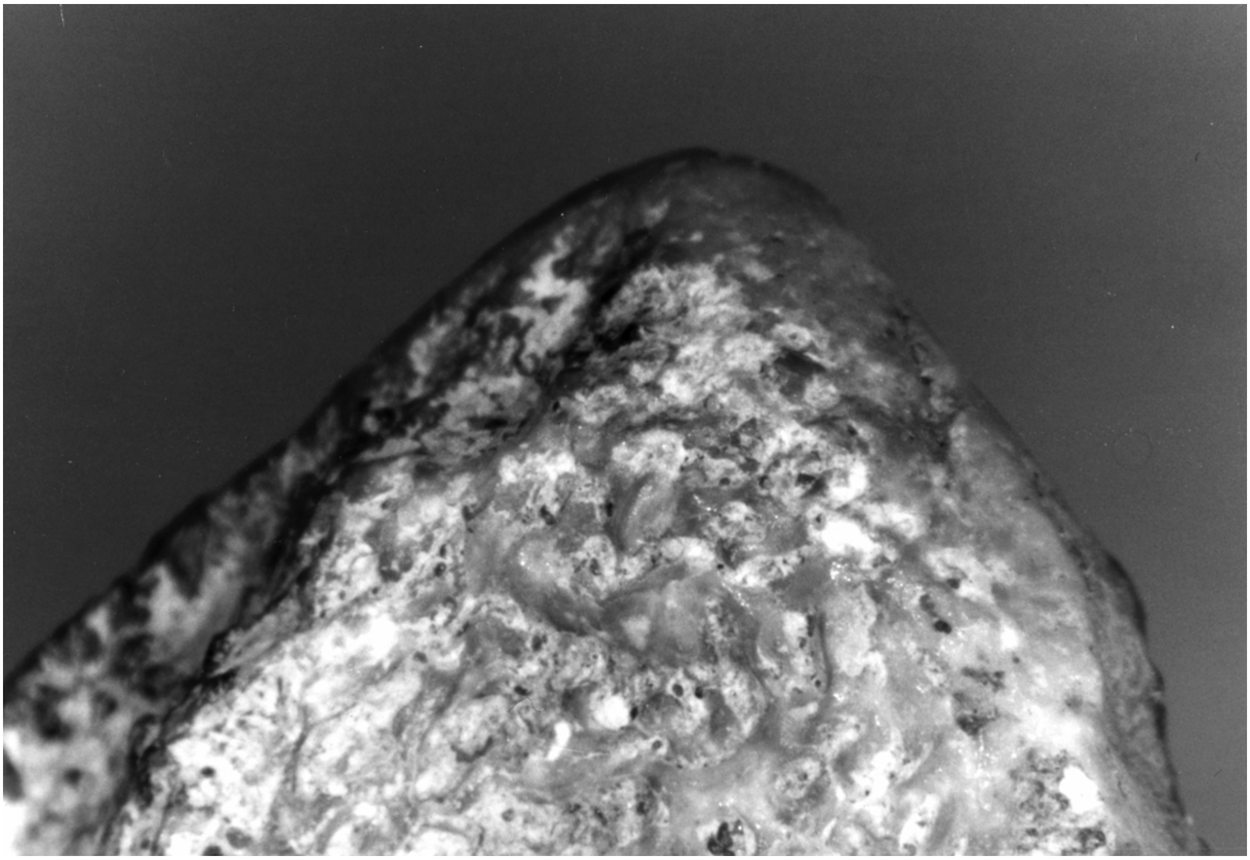

Figure 9. Mid-diaphyseal end exhibiting rounded surfaces and smoothed trabecular bone (× 16 magnification).

marine transgression is a subject of controversy (Fidalgo *et al.*, 1973; Schnack *et al.*, 1982; Isla, 1989; Isla *et al.*, 1986; Fasano *et al.*, 1987; Rutter *et al.*, 1989; Figini, 1992; Aguirre & Whatley, 1995). The Río Quequén inlet transgressive phase reached a maximum height of 2·5 m above moden sea level and dates to 7640 ± 90 BP (Isla *et al.*, 1980) while in the Bahía Blanca estuary, the same transgression is dated to sometime before 6000 BP. (González *et al.*, 1983). La Olla 1 is located between these two coastal outlets. The submergence and recent erosion of the Atlantic coast seem to be related to local geomorphic factors, as tectonism and glacioisostatic effects are minimal along the eastern coast of South America (Rutter *et al.*, 1989). The pampean and Patagonian coast lies on the tectonically stable trailing edge of South America. Global tectonic effects would be expected to be minimal along this coastline. Hence, local subsidence produced by sediment loading in estuarine regions, like the Bahia Blanca estuary, or autocompaction of saturated organic sediment, could act to produce submergence in estuarine coasts (Rutter *et al.*, 1989) like the one where La Olla 1 is located. The dates produced by high quality radiocarbon samples [in-situ seeds and bone collagen subjected to accelerator mass spectroscopy (AMS) dating] indicate the site was occupied by people during or after the maximum high, when the regression phase already had begun to result in the formation of a seashore a few kilometers to the south.

Chañar trees are not found in the local area now and the closest records are several tens of kilometers west (Parodi, 1940). Their presence in La Olla 1 around 7000 years ago indicate an extension of Dry Pampa conditions into this area and the availability of the tree as a resource for prehistoric peoples (Politis, 1984).

The short vertical span of the remains in the upper part of the laminated deposits suggests a brief period of occupation. Processing of sea mammals was the main focus of activity, involving butchery and hide preparation. For these processing activities, people used both lithic and bone tools. Among the former, rounded cobbles were flaked and used expediently. In the same way, pinniped bone was fractured and used. Both the cobble-based flake tools and fracture-based bone tool were discarded when the tasks were completed or they were no longer useful. Little time was spent in their creation or investment made in their refurbishing to keep them useful. However, stones with flat ground surfaces more likely were curated items brought to the site.

The La Olla 1 implement is identified as a utilitarian bone tool on the basis of use-wear characters that are restricted in distribution. It is identified as a fracture-based bone tool on the basis of technological and

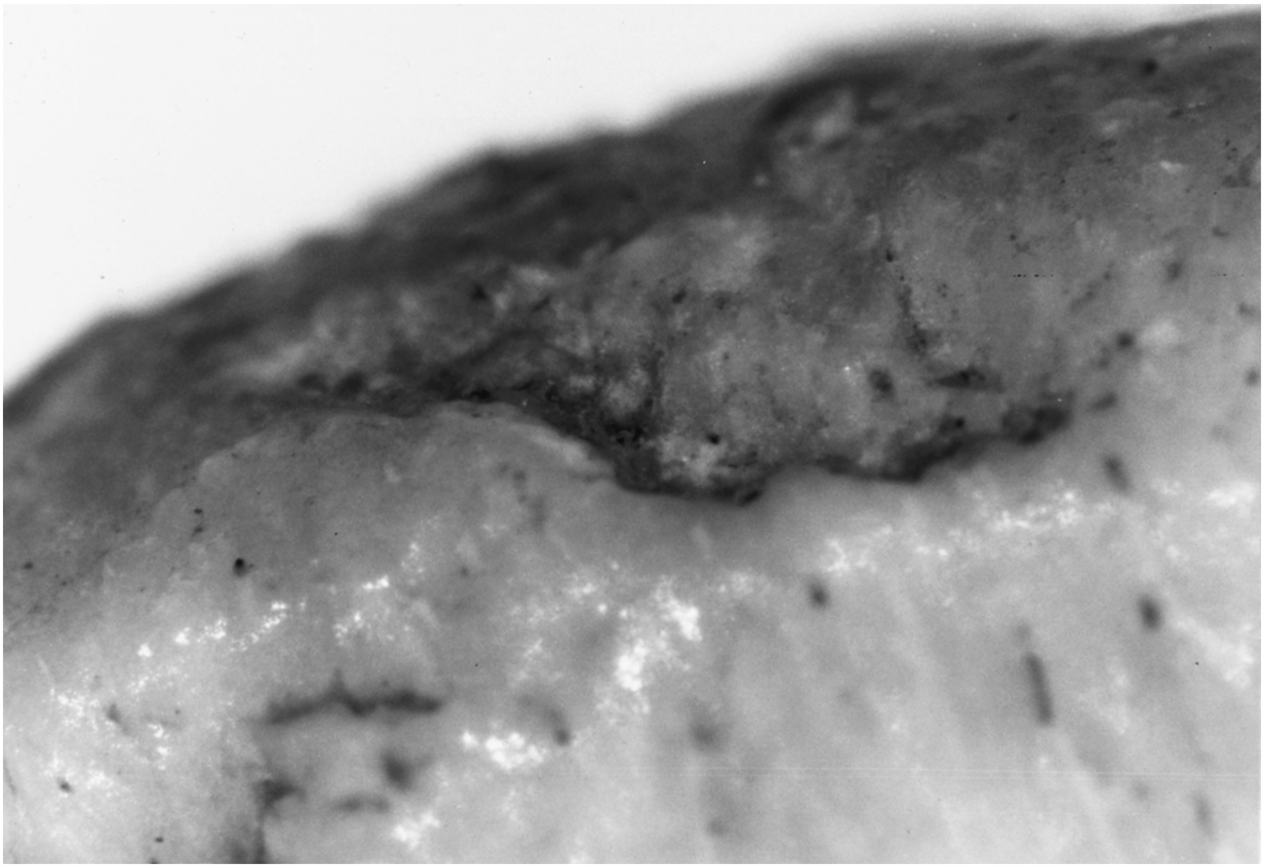

Figure 10. Pit with smoothed and polished edges (× 50 magnification).

use-wear characters. Technologically, the tibia was broken open through dynamic impact that created a helical fracture, impact area and interior flakes through compression, and radiating fracture fronts. The two sets of intersecting fracture fronts represent two similar episodes happening in sequence yet virtually simultaneously during impact. Three fracture fronts are identifiable. The apex and posterior edge of the mid-diaphyseal end of the bone represent a radiating fracture surface emanating from the impact area (fracture front 1). The first episode is the juncture of this radiating fracture surface that has circled around the diaphysis and intersected with another fracture front (fracture front 2), forming the distal intersecting fracture front. The second episode is the juncture of this second fracture front and a third one (fracture front 3), away from the distal end and impact area (proximal intersecting fracture front). It is this second event that forms the extant helical fracture surface. Surface features on the fracture surfaces of these intersecting fracture fronts indicate that the force was moving away from the impact area, thus underscoring the origin of the fracture fronts.

The impact area would have been on the lateral to anterolateral side of the bone. The interior flake scars represent remnants of the outer edge of the impact area (more specifically, the two outermost ring cracks) where compression and crushing of bone were occurring from the force and size of the impact implement (Johnson, 1985: 194–195, Figure 5·13b, 1989: 434, Figure 3).

All of the use-wear characters are restricted to the mid-diaphyseal end along the fractured edge, and this edge is interpreted as the tool bit (i.e. the working end of the tool). The main use-wear characters are the striae, differential high-gloss polish, pitting, and rounded and worn edges. This polish occurs over all other use-damage and presents a smoothed appearance to the fractured and adjacent surfaces. Pitting occurs only along the fracture surface. The pits vary in size but all have rounded and polished edges, indicating that they occurred prior to whatever activity caused the intense polishing. Pitting is the result of small chunks of bone being torn from the surface, caused by resistance. The bone was hitting against material or an obstacle as hard or harder than it was. Polishing, on the other hand, indicates a lack of resistance and use with a soft material.

Experimental work using bison and deer bone in a wide variety of tasks confirms the production of different wear-patterns with different tasks as well as the creation of various kinds of wear-polish reflecting those different tasks (LeMoine, 1991; Griffitts, 1993, 1997: Johnson, 1985:215, Figure 5·27). Pitting is

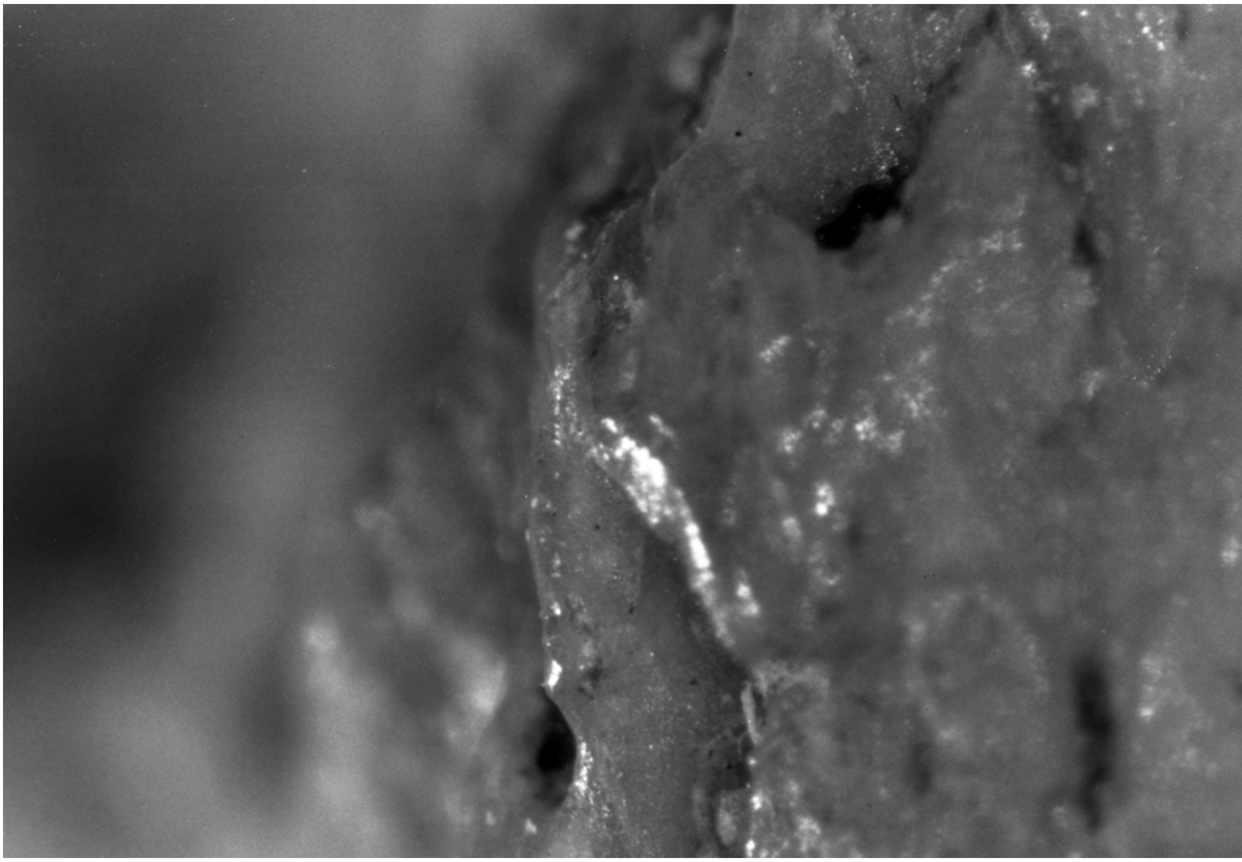

Figure 11. Use-wear polish on trabecular bone (× 50 magnification).

associated with pressure against or impact on a hard substance (see also Campana, 1980, 1987, 1989; Nami & Scheinsohn, 1997). Rounded working edges and adjacent surfaces with a strong, bright polish and striations are characteristic of hide working tools. The wear follows the topography of the bone; striations vary in frequency. Also, wear forms at varying rates using the same type of tool for the same task (Griffitts, 1997:239, 241). What this variation means is that the rate of wear is dependent not only on the individual element selected but also the taxon.

Based on morphological characters, taxonomy, and ethnographic analogy, a number of fractured and splintered bone segments from sites in Tierra del Fuego (some of which were from seal) were identified as bone tools (Scheinsohn, 1990, 1993*a*, 1993*b*). These tools were oriented toward leverage and apparently used in extracting bark needed in canoe and bucket construction. In replicative experiments, tools were used in one direction pushing on the bark to separate it from the tree. Polishing and slight edge rounding were the consistent use-wear characters produced (Scheinsohn, 1997:267; Scheinsohn & Ferretti, 1995:713, Figure 2a, 714–715; 1997). In the experiment, the tool category employing guanaco bone was fracture-based, but the fracture-edge was modified before use through abrasion to produce a beveled edge.

Rounding of edges and creation of polish usually is characteristic of working with soft material providing little resistence. The polish created, however, varies with the task. The differential polish on the La Olla 1 bone tool is associated with hide processing activities. The task causing the pitting along the distal fracture surface is associated with impact against a substance as hard or harder than the bone. This task had to occur prior to intense polishing, as the pit edges are rounded and covered by the polish. Minimal experimental work combined with site context suggest probable use as a chopper in carcass dismemberment. The La Olla 1 bone tool, then, is a dual-purpose implement used for at least two different tasks.

Most of the bone tools found in Argentina are identified as flakers or retouchers; some experimental data add to the validity of that identification (Nami & Scheinsohn, 1997). Expedient fracture-based utilitarian bone tools have not been identified previously in the Pampas. A variety of bone tools from seal and guanaco is known from Tierra del Fuego (Scheinsohn & Ferretti, 1995, 1997). Fracture-based implements are from guanaco long bones, primarily metapodials. In the Tierra del Fuego collection, the bone tools in the pinniped-based category have beveled distal ends that ethnographically were used as wedges in splitting wood. This use appears to have been an exclusive one for pinniped-based tools (Scheinsohn & Ferretti, 1997:73), meaning they were not used for any other tasks.

Pertinent to the use of pinniped-based tools in butchering activities, however, pinniped bone apparently is selected for use as wedges due to its energy-absorbing ability and high resistance to fracture (Scheinsohn & Ferretti, 1995:716). These characteristics also form the foundation for a useful impact-related butchering tool. The activities at La Olla 1, then, would have provided an abundance of bone raw material for the production of expediency butchering tools for use in seal processing.

Conclusions

La Olla 1 is a processing site oriented towards marine resources, with a few terrestrial animals. The majority of bones are from two pinnipeds, the southern fur seal (*Arctocephalus australis*) and the southern sea lion (*Otaria byronia*). A fracture-based utilitarian bone tool has been identified in the assemblage of pinniped bone and represents the first such expediency bone tool recognized for the Pampas. Fracture-based utilitarian tools form a category of implements that are minimally modified prior to use, involving only the fracturing of the element. Dynamic fracturing may be undertaken for different reasons. Therefore, identifying the fractured element as a tool is based on use-wear characteristics and not because of the fracturing.

The La Olla 1 expediency bone tool is the dynamically-fractured proximal end of a tibia. The fractured surface at the mid-diaphysis (distal end) exhibits very worn and rounded edges and surfaces with very fine striae, pitting and microflaking along the fracture surface and adjacent cortical surface, smoothed trabecular bone on the adjacent interior surface, and intensive, bright, highly reflective polish (not exhibited elsewhere on the element). Based on experimental data, this wear pattern indicates that the tool probably was used for two different tasks. These tasks most likely were in the realm of chopping and hide preparation activities.

The rarity of fracture-based expediency tools in the Pampas probably is related to a lack of recognition, as such tools appear to occur elsewhere in Argentina. What is unusual about the La Olla 1 tool is that it is from a pinniped rather than the expected guanaco bone. However, biomechanical analysis of southern fur seal bone (radius and ulna) indicates a strong suitability for impact-related tasks and, therefore, an appropriate choice for use as butchering tools.

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