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Great White Shark Teeth Used as Pendants and Possible Tools by Early-Middle Holocene Terrestrial Mammal Hunter-Gatherers in the Eastern Pampas (Southern South America)

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ABSTRACT Two great white shark (*Carcharodon carcharias*) teeth recovered in a terrestrial mammal hunter-gatherers context in the Pampas are described. Associated lithic (mainly quarzite) tools, and the predominant exploitation of the *Lama guanicoe* relate the ancient inhabitants of the site with those of the early-middle Holocene sites of the Area Interserrana of the Provincia de Buenos Aires. According to the stratigraphic context and the terrestrial fauna, the age of the deposit seems to be constrained to the early-middle Holocene. The root tips of the shark teeth are marked by an artificial transvers groove fitted to tie a thread. Tooth edge serrations are strongly eroded, suggesting they were used as tools. We favour the hypotheses that the fish could have stranded on the beach or a small estuary in the neighbourhood, or that the teeth were obtained from the body of a pinniped attacked by a shark and sobsequenty found by humans. Copyright © 2003 John Wiley & Sons, Ltd.

Key words: *Carcharodon*; hunter-gatherers; Pampean region; Argentina; Holocene

Introduction

A multidisciplinary research team formed with workers of the Universidad Nacional de La Plata (UNLP) and Universidad Nacional del Centro (UNCPBA) is investigating the Nutria Mansa archaeological locality in Centinela del Mar, on the coast of the Provincia de Buenos Aires, Argentina. This locality includes the Nutria Mansa 1 site (NM1) which contitutes an early-middle Holocene component. During the field work, two great white shark teeth with signs of being modified by humans were found. The great white shark (*Carcharodon carcharias*) is a huge, fearsome, torpedo-shaped, conical snouted species with a normal assortment of dorsal, anal and paired fins (Compagno, 1984; Tricas *et al*., 1997). It is the largest flesh-eating shark and is characterized by large, compressed, nearly symmetrical triangular teeth with coarsely serrated edges.

Archaeological and ethnographic studies demonstrate that sharks have been used as a food resource and raw material in different areas of the Americas (the Atlantic coast of Uruguay, Brazil and the Gulf of Maine in northeastern United States; the Caribbean coast of Mexico and Florida; and the Pacific coast of Peru, Ecuador, Costa Rica, Panama, Mexico, Hawaii and California). There is also abundant information about the use of cartilaginous fish in southeastern Asia

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and Oceania (Australia, New Zealand, Polynesia, Melanesia and Micronesia) (e.g. Akerman, 1995; Hunt, 1981; Kosuch, 1993; Lima, 1999–2000; López Mazz, 1994–1995; MacQuitty, 1993; Tricas *et al.*, 1997). *C. carcharias* teeth were used by the Calusa indians from south Florida (Kosuch, 1993). Different shark products have been utilized by a variety of groups worldwide; mainly teeth, vertebrae, meat, oil and skin. Teeth have been employed for weapons and tools such as knives, scrapers, drills, clubs, projectile points, and implements for trepanations. Teeth and vertebrae have also frequently been employed as ornaments such as rings, pendants and necklaces (e.g. ancient Egypt; Boessneck & von den Driesch, 1992). The skin has been used to polish wooden objects and for the manufacture of drums, where the meat was included in the diet of some groups, and the oil was used as fuel and to make mosquito repellant and paint (Barbosa & Franco, 1991; Lima, 1999–2000; Kosuch, 1993). In the archaeological literature it has not been reported yet that ancient terrestrial mammal hunter-gatherers used shark products. However, in Uruguay & Brazil a few shark teeth were found in a similar context to those described here (López Mazz, 1994–1995; Mentz Ribeiro & Torrano Ribeiro, 2001). None of them included white shark remains and they were not modified in any way. In this paper, the white shark teeth found at NM1 site are described and their origin and use are discussed.

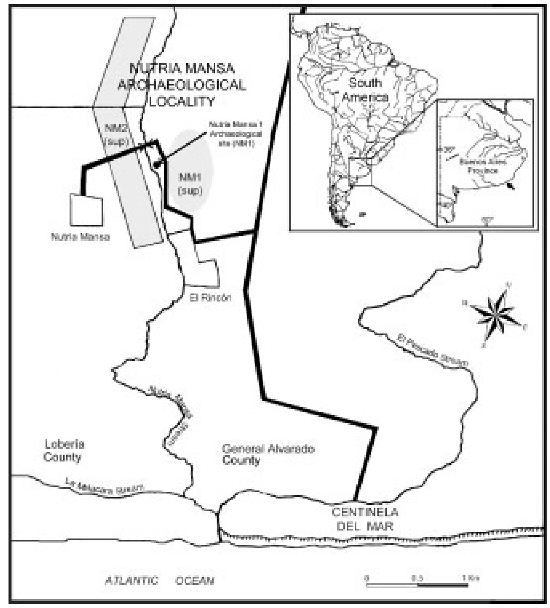

Figure 1. The large map shows the Nutria Mansa archaeological locality. NM1 (sup) and NM2 (sup) indicate material concentration on surface ploughzone. The smaller maps show the province of Buenos Aires and South America; the arrow indicates Centinela del Mar.

Figure 2. General view of NM1 site.

Stratigraphic and geographic provenance

NM1 is one of three sites [NM1, NM1 (sup), NM2 (sup)] recorded in the archaeological locality near the small beach resort named Centinela del Mar, General Alvarado County, southeastern Buenos Aires province, Argentina (38° 24′ 54,2″ S 58° 15′ 50,1″ W; Bonomo, 2001; Figures 1–3). The archaeological sites are situated 3.5 km north of the Atlantic seashore. NM1 was excavated in a total surface over an area of 23 m^2, following artificial levels of 0.05 m, taking into account the natural stratigraphy (Bonomo, 2001; Figure 1). The geological context was studied by Cristian Favier Dubois (UNCPBA). Two archaeological

Figure 3. Partial view of NM1 site. Note the great number of mammal bones. Small arrow indicates lithic material.

components separated by sterile sediments were found in the site. The upper component encompasses 25–40 cm of depth from level 0. It contained only scarce lithic artifacts (n = 4) and fragments of mammal bones. The lower component is distributed from 0.75 to 1.50 m from the 0 level and is described in detail below.

The shark teeth, along with most of the archaeological material of the lower component, were found in a developed palaeosoil formed on the top of the Guerrero Member of the Luján Formation (ca. 130 to perhaps 8.5 ky BP; Cione & Tonni, 1999). Above this surface, fluvial and marshy silts were deposited which are correlated with the deposits of the Río Salado Member of the Luján Formation (ca. 8.5 ky BP to XVI century; Cione & Tonni, 1999, 2001; Fidalgo, 1992).

Tonni *et al*. (in press) suggested that four major paedogenetic events occurred in the Pampean region during the latest Pleistocene-Recent: early Holocene (10–8 ky BP; unnamed geosol), middle Holocene (6.5–5 ky BP; Puesto Callejón Viejo Geosol), late Holocene (2.8–2 ky BP; Puesto Berrondo Geosol) and the present soil. Previous authors located the Puesto Callejón Viejo Geosol in the boundary Pleistocene-Holocene. The unnamed geosol and the Puesto Callejón Viejo Geosol overlay in different sections the Guerrero Member (Tonni *et al*., 2001) which indicates that the lower archaeological component is Holocene in age. More than 20,000 faunal remains and 10 different species were recovered, although no extinct South American megafauna were found in the site. In central Argentina, there are almost no Pleistocene archaeological sites without extinct megafauna remains (see Politis *et al*., 1995; Politis & Gutiérrez, 1998; Flegenheimer & Zárate, 1997; Martínez, 2001; Mazzanti & Quintana, 2001). Moreover, several authors found extinct fauna representatives in putative early Holocene archaelogical and palaeontological sites (e.g. Politis & Gutiérrez, 1998).

If the palaeosoil correlates with the Puesto Callejón Viejo Geosol, it also correlates with the Hypsithermal (Iriondo & García, 1993; Carignano, 1999). New evidence from a piston core at 53°S in the South Atlantic indicates that, at about 5 kyr BP, sea surface temperatures cooled, sea ice advanced, and the delivery of ice-rafted detritus to the subantarctic South Atlantic increased abruptly. These changes mark the end of the Hypsithermal and the onset of Neoglacial conditions (Hodell *et al*., 2001; see also Kim *et al*., 2002). They coincide with an early Neoglacial advance of mountain glaciers in South America and New Zealand between 5.4 and 4.9 kyr BP, rapid middle Holocene climate changes inferred from the Taylor Dome Ice Core (Antarctica), cooling and increased ice-rafted detritus in the North Atlantic, and the end of the African humid period. However, we consider that present evidence is insufficient to support an early or middle Holocene age.

Archaeological context of the lower component

In the lower component, 156 lithic materials along with red and yellow pigment remains were found. The most common elements are flakes (62.2%), tools (34.6%) and cores (3.2%). Artifacts are mainly made with fine grain quarzite (75%) coming from the Sierras Bayas Formation which crops out in the Tandilia Mountain range. Some 84.6% of the lithics were manufactured with materials obtained inland and 15.4% with coastal pebbles. The proximity to the coast explains the relatively large percentage of coastal pebble artifacts in comparison with the inland sites (less than 5%; Bonomo, 2001). Most of the lithics are chipped artifacts reduced by direct percussion and bipolar technique. There are also polished stones (boleadoras, millstones), and tool stones used as hammers and anvils.

Mammal bones are abundant (more than 20,000 remains) in NM1. The most abundant species is the camelid *Lama guanicoe* (MNI [minimum number of individuals = 12]). Bones of the fox *Dusicyon gymnocercus* (MNI = 1), the extinct canid *Canis (Dusicyon) avus* (MNI = 1), the cervid *Ozotoceros bezoarticus* (MNI = 1), the rodent *Lagostomus* sp. (NMI = 1), the felid *Panthera onca* (MNI = 1), the sea lion *Otaria flavescens*, some bones of the armadillos *Chaetophractus villosus* and *Zaedyus pichiy*, and the rodents *Ctenomys* sp. and indetermined cricetids were also recorded. As can be seen, most of faunal resources are terrestrial. A few bone tools were found in the site.

In summary, the available evidence suggests that the ancient inhabitants of the NM1 site were primary terrestrial mammal hunter-gatherers. The lithic (mainly quarzite) tools and the predominant exploitation of the *L. guanicoe* relate them with the hunter-gatherers societies that occupied the Area Interserrana of the Buenos Aires province during the early-middle Holocene times.

The shark teeth

Elasmobranchii
Lamniformes
Lamnidae
Carcharodon
Carcharodon carcharias (Linné, 1758)

Material

Two almost complete lower teeth. T1: second right lower tooth: NM1, cuadrícula 5, Western sector, level 105–110 cm, n°53. T2, ?sixth (probably right) lower tooth: NM1, cuadrícula 3, Eastern sector, level 85–90 cm, n°29. Temporarily housed in the División Arqueología, Museo de La Plata, La Plata, Argentina.

Description

Crowns erect, narrow. Both edges concave (T1, slightly concave; T2, markedly concave). Teeth of *C. carcharias* are strongly and coarsely serrated, especially in the medial and basal part of the comisural edge. However, in our material, the serrations are strongly eroded, especially in the distal part of T1. Labial faces are transversely flat. Lingual faces are tranversely strongly convex but apicobasally concave. The tip of T1 is slightly bent lingually. Basally, there are two wide labial sulci that extend to one sixth of crown height.

In both teeth there is a prominent lingual protuberance where several nutrient foramina occur (Figure 4). The branches of T1 are well defined and form an angle of approximately 90°. Branches of T2 are poorly defined and widely separated. The root extremes bear clear intentional transverse grooves fitted to tie a thread.

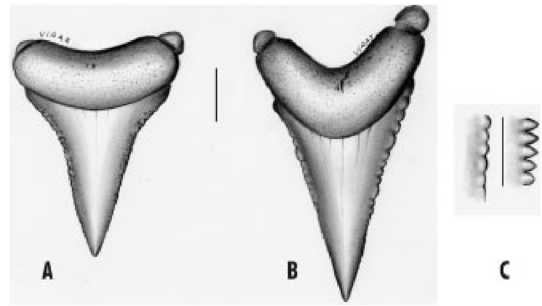

Figure 4. *Carcharodon carcharias*. A: T2, ?sixth lower tooth, lingual view. B: T1, 1°, second lower tooth, lingual view. The line is 10 mm for A and B. C: detail of serrations; right, unworn recent tooth of *C. carcharias*; left, worn edge of T1: the line is 5 mm.

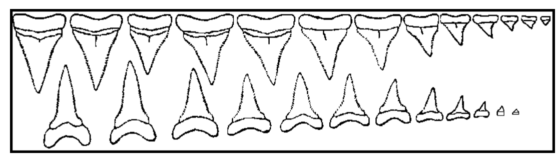

Figure 5. *Carcharodon carcharias*. Tooth series from a specimen of 2.5 m (x 0.7 of original size). Modified from Bigelow & Schroeder (1948).

Comments

The material is assigned to the species because of the size, thickness, triangular crown, absence of lateral denticles in teeth of that size, and the coarse serrations (Figure 5).

Fish size

The total length (TL) of one of the sharks was approximately calculated according to Gottfried *et al.* (1996). These authors gave the formula TL (m) $= a + b$ [UA2H (mm)], where a and b, are -0.22 and 0.096, and UA2H is the total height of the second upper tooth. We calculated this latter measurement on three photographs depicting teeth of *C. carcharias* in Hubbell (1996: figs. 2, 4 and 5) and establishing a medium rate between the second upper and the second lower teeth (total height of T1: 26.5 mm). We then calculated UA2H corresponding to the specimen that gave T1 as measuring 29.68 mm. The TL of the shark was calculated as 2.62 m. This length corresponds to an immature individual of about 200 kg, according to the regression of Gottfried *et al.* (1996).

Tooth morphology varies according to age (see Hubbell, 1996). The morphology of T1 is in agreement with that of an individual of 2.30 m depicted by Bass *et al.* (1975: Pl. 8). If T2 is confirmed as a sixth tooth, it would belong to a different and larger shark.

Habitat and distribution of C. carcharias

C. carcharias primarily is a coastal and offshore inhabitant of the continental and insular shelves worldwide (Compagno, 1984). White sharks occupy a cosmopolitan distribution throughout temperate seas and oceans and will occasionally enter tropical zones (Fergusson, 1996). The great white shark often occurs close inshore to the surfline and even penetrates shallow bays in continental coastal waters, but prefers offshore continental islands (especially those with pinniped colonies; Compagno, 1984). Very few records (five) of *C. carcharias* have been reported from Argentinean coasts (Siccardi *et al.*, 1981; Soto *et al.*, 1998). They correspond to the end of spring and summer from 1952 to 1960 (Siccardi *et al.*, 1981).

Fossil occurrence of white shark in southern South America

Frenguelli (1922) reported (but neither described nor figured) the record of teeth of *C. rondeleti* (= *C. carcharias*) from the 'Entrerriense' (presently Paraná Formation; late Miocene, Entre Ríos). Teeth of *C. carcharias* have been found in the Pliocene of Chile (Long, 1993; Suárez & Brito, 2000; Walsh & Hume, 2001) and on the coast of Rio Grande do Sul, Brazil (Richter, 1987). Ameghino (1898: 143) named (but not figured) a new species, *Carcharias pampeanus*, from the 'Belgranense, Pampeano medio'. The short description agrees in the size and the coarse serrations with that of teeth of *C. carcharias* (see Cione, 1983), but cannot be found in the museums where Ameghino worked. Later, other records of *C. carcharias* in deposits corresponding to Quaternary marine ingressions in the Pampean area were reported (Cione, 1983). An analysis of the fossil record will be published elsewhere (Cione & Barla, submitted).

Occurrence of shark remains in archaeological sites in South America

Very few data about shark use in South America are available in the international archaeological literature, but archaeological evidence of sharks in the South American Atlantic coasts increases from south to north. A shark tooth of the odontaspidid genus *Carcharias* (as *Odontastis*) was reported from the Casa de Piedra 1 site in the hinterland of northern Patagonia, but without any evidence of having been used (Cione in Gradín, 1984). This tooth comes from late Cretaceous or Palaeocene deposits cropping out in the area. On the Buenos Aires coast, some shark remains were found in unclear association with lithic material on a surface site in sand dunes near Monte Hermoso (Conlazo, 1983). In Uruguay, shark teeth have been recovered in the archaeological site CH2D01, located in the San Miguel hill at 30 km from the coast. The shark teeth, along with seal teeth, were found in a ritual context associated with the mound builders of the 'Cerritos' dated from 2.5 kyr BP until historical times. Likewise, in the coastal archaeological site of Punta de La Coronilla Exc. III (2.7 kyr BP), shark teeth were recorded together with other coastal resources such as seal and fish bones. Based on certain similarities in material culture between inland and coastal archaeological sites, some researchers suggested that the people of the site were part of a complex settlement system, which also included coastal sites (López Mazz, 1994–1995; López Mazz & Iriarte, 2000).

In the sambaquis distributed from Rio Grande do Sul State to Espirito Santo State in Brazil, dated between 6 and 2 kyr BP, shark teeth and vertebrae are very common. These shell mounds are associated with hunter-gatherer and fisher groups, with a diet based on the consumption of shellfish, fish, marine and some terrestrial mammals (Barbosa & Franco, 1991; Bryan, 1978; Franco & Barbosa, 1991; Laming-Emperaire, 1968; Lima, 1999–2000; Prous, 1992). These elements are found linked to food waste, and some are also perforated as ornaments. For example, at the archaeological site of Corondó (RJ-JC-64) on the Rio de Janeiro coast (4.2–3 kyr BP), perforated teeth and shark vertebrae have been found repeatedly associated with burials

(Machado, 1984). In the sambaqui of Enmbratel in Guaratiba, Rio de Janeiro, teeth and vertebrae of the sharks *Sphyrna*, *Carcharhinus* and *Isurus* were recovered, and interpreted as consumption remains of coastal groups (Kneip *et al.*, 1984). In the coastal sites Piaçaguera (4.9 kyr BP), Mar Casado (4.4 kyr BP), and Buracão (1.95–1.24 kyr BP) in São Paulo State, human burials associated with funerary goods which include decorated and perforated shark teeth and tools made with shark teeth were reported (Uchôa, 1980). Furthermore, shark teeth of *Carcharhinus* interpreted as pieces of necklaces, have been recovered in the archaeological site Garivaldino RS-TQ-58 (9.4–7.2 kyr BP; near Montenegro District, Rio Grande do Sul State). This site is located in the Caí River valley, more than 100 km from the coast (Mentz Ribeiro & Torrano Ribeiro, 2001). Also, a perforated shark tooth and a decorated marine shell were found in the (RS-S-358) site, in Santo Antônio de Patrulha, (high valley of dos Sinos River, northeast of Rio Grande do Sul State; Adriana Schmidt Dias, personal communication). The two latter sites (Garivaldino and Toca Grande) were asigned to the Umbu preceramic tradition of inland hunter-gatherers. In such sites terrestrial mammals, birds, reptiles and molluscs have been recovered, along with some coastal resources (Mentz Ribeiro & Torrano Ribeiro, 2001; Schmidt Dias, 1994).

Unfortunately, information about the way ancient groups obtained sharks is scarce. In Talara (Guayaquil gulf, Peru), shark remains have been recovered in archaeological sites assigned to the Siches-Estero groups (10–7 kyr BP; Bruhns, 1994, see also Moseley, 1992). It has been suggested that these groups fished sharks in the river estuaries instead of the sea. In Florida, Kosuch (1993) postulated that the Calusa fished in the sea with canoes and hooks. In the coastal site of Costa Purruja midden (Dulce gulf region, Pacific coast of Costa Rica), where the evidence suggested an economy focused on marine resources, teeth of the shark genus *Carcharhinus* were recorded. For this site, Hoopes (1994) proposed that marine fishes would have been caught using tidal currents for netting and trapping, along with line fishing.

In summary, according to both the archaeological and palaeontological records, it appears that the white shark, which is presently very rare in the area, was much more abundant during the late Pleistocene and Holocene in the southwestern Atlantic (Cione, 1983; Cione & Barla, submitted).

How were the shark teeth of NM1 obtained?

The available evidence suggests that the inhabitants of the site were primary terrestrial mammal hunter-gatherers. The occurrence of shark teeth in cultural contexts of inland hunter-gatherers is certainly rare (but see above). In the NM1 site neither continental or marine fish bones nor marine shells were recovered. In this context, we reject the idea that sharks would be fished because the inhabitants a) were not fishermen and b) they did not have the appropriate technology, especially taking into account the capture of such a large and dangerous shark (for an extensive discussion referring to the technology for capture of sharks by the Calusa of Florida and aborigines of other areas see Kosuch, 1993). Fishing gear such as hooks (relatively small, shorter than 70 mm) or supposed net weights were identified from early Pleistocene deposits on the coast at Miramar and Necochea at the beginning of the 20th century (Ameghino, 1919; Vignati, 1939; see also Daino, 1970), but these findings are probably hoaxes (Bonomo, in press; Tonni *et al.*, 2001). Malainey *et al.* (2001) stressed the negative physical effects of eating fish for people accustomed to a diet based on red meat. For instance, a sudden change to consumption of fat-fish may result in fat malabsorption. This observation could be valid for the hunter-gatherers in the study area, who mainly consumed *L. guanicoe*. However, recent stable isotope analyses ($\delta^{13}C$) carried out on human bone remains coming from inland settings in the southeastern Pampas, indicate a continental diet that probably was occasionally complemented with some marine resources (Barrientos, 1997).

Having discarded fishing by the inhabitants of the site themselves, we find four alternative hypotheses:

1. Exchange.
2. Finding isolated shark teeth on the beach.
3. A pinniped or cetacean with a tooth 'nailed' in bone or soft tissue could have been scavenged on the beach or hunted by humans.

4. The fish could have been stranded on the beach or a small estuary in the neighbourhood and scavenged by humans.

We consider exchange unlikely because there are no nearby archaeological sites of groups that might fish sharks. Shark teeth are occasionally found on the beaches of the Buenos Aires province. They do not correspond to recent fishes but to fossil ones, coming from some of the Quaternary formations in the area (Cione, 1983). However, the material of NM1 is not fossil and it has not weathered or naturally eroded. Eroded shark teeth usually present abrasions of softer dental tissue (i.e. the dentine of the roots) while in our material, the only abraded parts are hard enameloid dentations.

The third hypothesis implies two events (attack and stranding) especially taking into account the presence of two teeth. White sharks often attack pinnipeds and cetaceans (Cione & Barla, submitted). Shark teeth are loosely attached and very frequently are found fixed in bone and flesh in carcasses and wounded animals. Sharks species responsible for attacks on humans are usually identified by teeth found on the victims. There is at least one instance of a cetacean killed by a large shark (actually *C. carcharias*) on South American beaches (Soto & Nisa-Castro-Neto, 1993; Klimley & Ainley, 1996). In NM1, several otariid bones were recorded, and pinnipeds were an important resource for some Pampean coast hunter-gatherer groups (La Olla 1, southern Buenos Aires province at 7 ky BP; Bayón & Politis, 1996). However, there are no recorded instances of pinnipeds or cetaceans with attached shark teeth in Argentina.

The fourth hypothesis appears to be more parsimonous than the third one because it implies only one event (stranding). Shark strandings are not common in Buenos Aires province today, but a few have been recorded. Siccardi (1960) cites the landing of a large basking shark (*Cetorhinus maximus*) on the Argentinean coast. Recently, a large shark (about 4 m long) of the squaliform species *Somniosus pacificus* was found on the beach near Monte Hermoso, southern Buenos Aires province (Cione, 1998). Neither of these sharks (or indeed the white shark) is presently common. Stranded white sharks were reported from other regions (Gran Canaria; Bellon & Mateau, 1932; Tenerife; Payne in Fergusson, 1996; Istanbul; Fergusson, 1996; British Columbia; Martin, 1998; South Africa; Martin, 1998; Alaska, R. Collier, personal communication). Scavenging of different large vertebrates is frequently cited in the literature for the purpose of food, or raw material for artifactual use. For example, the G/wi Bushmen hunters of the Central Kalahari occasionally (two or three times a year) scavenge meat by robbing lions kills (Silberbauer, 1981: 479). The Selk'nam hunter-gatherers of Tierra del Fuego exploit the meat and grease of whales that land on the beach (Gusinde 1982: 406–407). The Nukak foragers of the Amazonian rainforest of Colombia also acquire, from dead animal carcasses, deer and jaguar bones to make flutes and jaguar teeth to make necklaces that are sometimes interred in burials (Politis & Saunders, 2002: 124). This last example is closer to the case of the shark teeth of NM1.

Use of the white shark teeth of NM1

Fossil and recent shark remains have been used by different groups as tools, weapons, or ornaments in the Americas and elsewhere (see above). The teeth from NM1 have been transformed into clear artifacts, but no other shark products are known to have been used as artifacts in Argentinean archaeological sites. The teeth of NM1 show clearly artifactual grooves that have been incised in the root tips for attaching a thread and hanging teeth presumably as pendants, they show no evidence of having been hafted (see Kosuch, 1993). Canid teeth and marine shells pieces were used as beads for necklaces, wrist- and anklets found on corpses in human burials in the Arroyo Seco 2 archaeological site (Barrientos, 1997; Politis, 1984), but the edge serrations of the NM1 teeth are strongly eroded indicating that the teeth were used as tools (Figure 4). We do not believe that this erosion could be occasioned by natural processes because the other (even softer) parts of teeth do not show the usual signs of this kind of abrasion. The presence of shark products in contexts of non-fishing groups is certainly rare (e.g. Uruguay, 'Cerritos,' Argentina, Casa de Piedra 1, and Brazil, Toca Grande and Garivaldino sites, see above) and it is likely that the rarity of the original material would have made the teeth special objects. Consequently, the tools could possibly have had a strong symbolic meaning.

In summary, the great white shark (*C. carcharias*) teeth were modified and used as pendants and probably also tools. We believe that the two teeth found at NM1 were recovered from a stranded specimen collected on the beachs (or from a pinniped attacked by a shark) by guanaco mammal hunter-gatherers. Associated lithic (mainly quarzite) tools and the predominant explotation of the *L. guanicoe* links these ancient inhabitants with inland groups from the Area Interserrana of the Buenos Aires province. According to the stratigraphic context and the terrestrial fauna associated, the age of the deposit seems to be constrained to the early-middle Holocene.

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References

Akerman K. 1995. The use of bone, shell, and teeth by Aboriginal Australians. In *Ancient Peoples and Landscapes*, Johnson E (ed.). Museum of Texas Tech University: Lubbock, TX; 173–183.

Ameghino C. 1919. Nuevos objetos del hombre pampeano: los anzuelos fósiles de Miramar y Necochea. *Physis* **4**: 562–563.

Ameghino F. 1898. Sinopsis geológico-paleontológica. In 2[do] *Censo de la República Argentina, Territorio* 1. Buenos Aires; 115–228.

Barbosa DR, Franco TCB. 1991. Análise e interpretação dos dentes de seláquios. *Reunião Científica da Sociedade de Arqueologia Brasileira* **6**: 36.

Barrientos G. 1997. *Nutrición y dieta de las poblaciones aborígenes prehispánicas del sudeste de la región pampeana*. Ph.D. dissertation. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata: La Plata.

Bass AJ, D'Aubrey J, Kistnasamy N. 1975. Sharks of the east coast of southern Africa. IV. The families Odontoaspididae, Scapanorhynchidae, Isuridae, Cetorhinidae, Alopiidae, Orectolobidae and Rhiniodontidae. *Oceanographic Research Institute. Investigational Report* **39**: 1–102.

Bayón C, Politis G. 1996. Estado actual de las investigaciones en el sitio Monte Hermoso I (Prov. de Buenos Aires). *Arqueología* **6**: 83–116.

Bellon G, Mateau L. 1932. Carcharodon carcharias. *Notas del Instituto Español de Oceanografía* **2**: 11.

Bigelow HB, Schroeder WC. 1948. Fishes of the Western North Atlantic. Sharks. *Memoirs of the Sears Foundation for Marine Reseach* **1**: 59–579.

Boessneck J, von den Driesch A. 1992. Tell El-Dab'A VII. Tiere und historische unwelt im nordost-delta. IM 2. Jahrtausend v. chr. anhand der knochenfunde der ausgrabungen 1975–1986. Fische. *Untersuchungen der Zweigstelle Kairo des Österreichischen Archäologischen Institutes* **10**: 42–48.

Bonomo M. 2001. Análisis preliminar de los materiales arqueológicos recuperados en la Localidad Nutria Mansa (Pdos. de Gral. Alvarado y Lobería). Paper presented at the *XIV Congreso Nacional de Arqueología Argentina*, Rosario.

Bonomo M. In press. El Hombre Fósil de Miramar. *Intersecciones en Antropología* **3**.

Bruhns KO. 1994. *Ancient South America*. Cambridge University Press: Cambridge.

Bryan AL. 1978. Resumo do arqueologia do sambaqui de Forte Marechal Luz. *Arquivos do Museu de História Natural* **2**: 9–30.

Carignano C. 1999. Late Pleistocene to recent climate change in Córdoba Province, Argentina: geomorphological evidence. *Quaternary International* **57/58**: 117–134.

Cione AL. 1983. Registros fósiles de *Carcharodon carcharias* (Linné, 1758) (Elasmobranchii, Lamniformes) en Argentina. *Ameghiniana* **20**: 261–264.

Cione AL. 1998. Record of a slepper shark (Squaliformes, *Somniosus*) in the Argentinean coast. *Neotrópica* **44**: 125–127.

Cione AL, Tonni EP. 1999. Biostratigraphy and chronological scale of the uppermost Cenozoic of the Pampean area, Argentina. In *Quaternary Vertebrates of South America*, Tonni EP, Cione AL (eds). *Quaternary of South America and Antarctic Peninsula* **12**: 23–51.

Cione AL, Tonni EP. 2001. Correlation of Pliocene to Holocene southern South American and European mammal-bearing units. *Bolettino della Societá Paleontologica Italiana* **40**: 167–174.

Compagno LJV. 1984. Sharks of the world. An annotated and illustrated catalogue of shark species in date. *FAO Species Catalogue* **4**(1): 1–249.

Conlazo D. 1983. Resultados de una prospección en la zona medanosa de la costa sur de la provincia de Buenos Aires. *Adeha* **2**: 32–51.

Daino L. 1970. Nuevos datos sobre los anzuelos de Necochea. *Etnía* **12**: 28–33.

Fergusson IK. 1996. Distribution and autoecology of the white shark in the Eastern North Atlantic Ocean and the Mediterranean Sea. In *Great White Sharks. The Biology of Carcharodon Carcharias*, Ainley DG, Klimley AP (eds). Academic Press: San Diego; 321–345.

Fidalgo F. 1992. Provincia de Buenos Aires. Continental. In *El Holoceno de Argentina*, Iriondo M (ed.). Cadinqua: Buenos Aires; 23–38.

Flegenheimer N, Zárate M. 1997. Considerations on radiocarbon and calibrated dates from Cerro La China and Cerro El Sombrero, Argentina. *Current Research in the Pleistocene* **14**: 27–28.

Franco TCB, Barbosa DR. 1991. Ocorrencia de dentes de *Carcharodon carcharias* (Linneus 1758) no contexto das populacoes pré-históricas. *Anais do XVIII Congreso Brasileiro de Zoología* **18**: 554.

Frenguelli G. 1922. Sulla contemporanea presenza del Carcharodon megalodon Ag. e del Carcharodon rondeleti M.et H. nel Paranense superiore de Entre Ríos (Rep. Argentina). *Bollettino della Società Geologica Italiana* **41**: 50–52.

Gottfried MD, Compagno LJ, Bowman SC. 1996. Size and skeletal anatomy of the giant 'megatooth' shark *Carcharodon megalodon*. In *Great White Sharks. The Biology of Carcharodon Carcharias*, Ainley DG, Klimley AP (eds). Academic Press: San Diego; 55–66.

Gradín CJ. 1984. *Investigaciones arqueológicas en Casa de Piedra*. Dirección General de Cultura y Ente Ejecutivo Casa de Piedra: Pcia. de La Pampa.

Gusinde M. 1982. *Los Indios de Tierra del Fuego*. T. I, v. I. CAEA: Buenos Aires.

Hodell DA, Kanfoush SL, Shemesh A, Costa X, Charles CD, Guilderson TP. 2001. Abrupt Cooling of Antarctic Surface Waters and Sea Ice Expansion in the South Atlantic Sector of the Southern Ocean at 5000 cal yr B.P. *Quaternary Research* **56**: 191–198.

Hoopes JW. 1994. Contributions of Non-Agricultural Subsistence Strategies to the Formation of Complex Society in Coastal Zones of Southern Costa Rica. Paper presented at the *59th Annual Meeting of the Society for American Achaeology*. Anaheim: California.

Hubbell G. 1996. Using tooth structure to determine the evolutionary history of the white shark. In *Great White Sharks. The Biology of Carcharodon Carcharias*, Ainley DG, Klimley AP (eds). Academic Press: San Diego; 9–18.

Hunt C. 1981. *Shark tooth and stone blade, Pacific island art from the University of Aberdeen*. University of Aberdeen: Aberdeen.

Iriondo MH, García NR. 1993. Climatic variations in the Argentine plains during the last 18,000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology* **101**: 209–220.

Kim JH, Schneider RR, Müller PJ, Wefer G. 2002. Interhemispheric comparison of deglacial sea-surface temperature patterns in Atlantic eastern boundary currents. *Earth and Planetary Science Letters* **194**: 383–393.

Klimley AP, Ainley DG (eds). 1996. *Great White Sharks. The Biology of Carcharodon Carcharias*. Academic Press: San Diego.

Kneip LM, Ferrerira AM, Vogel MAC, de Mello EMB. 1984. Contribução ao estudo da arqueologia e do paleoambiente da planicie de maré de Guaratiba, RJ- O Sambaqui da Embratel. *Revista de Pré-História* **6**: 334–360.

Kosuch L. 1993. Sharks and shark products in Prehistoric South Florida. *Monographs of the Institute of Archaeology and Paleoenvironmental Studies* **2**: 1–52. IAPS, University of Florida: Gainesville.

Laming-Emperaire A. 1968. Missions archéologiques françaises au Chili austral et au Brésil méridional—quelques datations de sites par le radiocarbone. *Journal de la Société des Américanistes* **57**: 77–99.

Lima TA. 1999–2000. Em busca dos frutos do mar: os pescadores-coletores do litoral centro-sul do Brasil. *Revista USP* **44**: 270–327.

Long DJ. 1993. Late Miocene and Early Pliocene fish assemblages from the north coast of Chile. *Tertiary Research* **14**: 117–126.

López Mazz JM. 1994–1995. Cabo Polonio: sitio arqueológico del litoral atlántico uruguayo. *Anais da VII Reunião Científica da SAB, Revista de Arqueología* **8**(2): 239–265.

López Mazz JM, Iriarte J. 2000. Relaciones entre el Litoral Atlántico y las Tierras Bajas. In *Arqueología de las Tierras Bajas*, Durán Coirolo A, Bracco Boksar R (eds). Ministerio de Educación y Cultura, Comisión Nacional de Arqueología: Montevideo; 39–47.

Machado LMC. 1984. *Análise de remanescentes ósseos humanos do sítio arqueológico Corondó, RJ. Aspectos biológicos e culturais*. IAB, Série Monografías 1: Río de Janeiro.

MacQuitty M. 1993. *Tiburones*. Altea: Madrid.

Malainey ME, Przybylsky R, Sherriff BL. 2001. One person's food: how and why fish avoidance may affect the settlement and subsistence patterns of hunter-gatherers. *American Antiquity* **66**(1): 141–161.

Martin R. 1998 active 2/2002. *Shark Strandings—A Discussion Piece* [online]. Available: http://www. elasmo.com/martin/strand.html [2002].

Martínez GA. 2001. 'Fish-tail' projectile points and megamammals: new evidence from Paso Otero 5 (Argentina). *Antiquity* **75**: 523–528.

Mazzanti D, Quintana C. 2001. *Cueva Tixi: cazadores y recolectores de las sierras de Tandilia Oriental. 1 Geología, Paleontología y Zooarqueología*, Mazzanti D, Quintana C (eds). Laboratorio de Arqueología, UNMdP, Publicación Especial 1: Mar del Plata.

Mentz Ribeiro PA, Torrano Ribeiro C. 2001. Excavaçes arqueológicas no sítio RS-TQ-58, Montenegro, RS, Brasil. *Libro de Resúmenes del XIV Congreso Nacional de Arqueología Argentina*: Rosario; 361.

Moseley ME. 1992. *The Incas and Their Ancestors: The Archaeology of Peru*. Thames and Hudson: New York.

Politis G. 1984. *Arqueología del área Interserrana Bonaerense.* Ph.D. dissertation. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata: La Plata.

Politis G, Gutiérrez M. 1998. Gliptodontes y cazadores-recolectores de la Región Pampeana (Argentina). *Latin American Antiquity* **9**(3): 111–134.

Politis G, Saunders N. 2002. Archaeological Correlates of ideological activity: food taboos and spirit-animals in an Amazonian hunter-gatherer society. In *Consuming Passions and Patterns of Consumption*, Miracle P, Milner N (eds). McDonald Institute Monographs: Cambridge; 113–130.

Politis G, Prado JL, Beukens R. 1995. The human impact in Pleistocene-Holocene extinctions in South America. In *Ancient Peoples and Landscapes*, Johnson E (ed.). Museum of Texas Tech University: Lubbock, TX; 187–206.

Prous A. 1992. *Arqueología Brasileira*. Editorial Universitaria: Brasilia.

Richter M. 1987. Osteichthyes e Elasmobranchii (Pisces) da Bacia de Pelotas, Quaternário de Rio Grande do Sul, Brasil. *Paula-Coutiana* **1**: 17–38.

Schmidt Dias A. 1994. *Representando a Tradição Umbu a partir de um estudo de caso.* Master thesis. Pontífica Universidade Católica do Río Grande do Sul. Instituto de Filosofia e Ciências Humanas: Río Grande do Sul.

Siccardi E. 1960. *'Cetorhinus'* en el Atlántico Sur (Elasmobranchii: Cetorhinidae). *Revista del Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia' Zoología* **6**: 60–102.

Siccardi E, Gosztonyi A, Menni R. 1981. La presencia de *Carcharodon carcharias* e *Isurus oxyrhynchus* en el Mar Argentino (Chondrichthyes, Lamniformes). *Physis* **39**: 55–62.

Silberbauer G. 1981. Hunter/Gatherers of the Central Kalahari. In *Omnivorous Primates. Gathering and Hunting in Human Evolution*, Harding R, Peleki G (eds). Columbia University Press: New York; 455–498.

Soto J, Nisa-Castro-Neto W. 1993. Evidência de ataque de tubarão-branco, *Carcharodon carcharias* (Lamniformes, Lamnidae) em toninha, *Pontoporia blainvillei* (Cetacea, Pontoporiidae). *Resumos da VI Reunião do grupo de trabalho sobre pesca e pesquisa de tubares e raias no Brasil*: Santos; 323–325.

Soto J, Nisa-Castro-Neto W, Mincarone M. 1998. Sobre a presença do tubarão branco, *Carcharodon carcharias* (Linnaeus, 1758) (Lamniformes, Lamnidae), no Atlântico sul ocidental. *Resumos expandidos de a XI Semana Nacional de Oceanografía*: Rio Grande; 323–325.

Suárez M, Brito JM. 2000. Una nueva localidad fosilífera con vertebrados marinos del Terciario de Bahia Salado (III Región), norte de Chile. *Resúmenes de las XVI Jornadas Argentinas de Paleontología de Vertebrados*: San Luis; 57.

Tonni E, Cione AL, Figini A. 2001. Chronology of Holocene pedogenetic events in the Pampean area of Argentina. *Current Research in the Pleistocene* **18**: 124–127.

Tonni E, Pasquali R, Bond M. 2001. Ciencia y fraude: el hombre de Miramar. *Ciencia Hoy* **20**: 58–62.

Tonni E, Cione AL, Figini A. In press. El Piso Aymará del área pampeana de Argentina. Cronología radiocarbónica y paleontología. *Ameghiniana*.

Tricas TC, Deacon K, Last P, McCosker JE, Walker T, Taylor L. 1997. *Sharks and Rays*. Harper Collins Publishers: London.

Uchôa DP. 1980. Sinópse do 'Arcaico' do litoral de São Paulo. *Anuário de Divulgação Científica* **7**: 15–32.

Vignati M. 1939. Los restos humanos y los restos industriales. In *Historia de la Nación Argentina (Desde los orígenes hasta la organización definitiva en 1862)*, Levene R (ed.). Buenos Aires; **1**(2): 163–200.

Walsh SA, Hume JP. 2001. A new Neogene marine avian assemblage from North-Central Chile. *Journal of Vertebrate Paleontology* **21**: 484–491.

