

PRE-COLONIAL GROUPS FROM BRAZILIAN COAST AND SHARKS: FIRST GLIMPSE ON A COMPLEX RELATIONSHIP THROUGH THE CASE STUDY OF THE SHALLOW SITE RIO DO MEIO, SANTA CATARINA

GRUPOS PRÉ-COLONIAIS DA COSTA BRASILEIRA E TUBARÕES: PRIMEIRO OLHAR SOBRE UMA RELAÇÃO COMPLEXA ATRAVÉS DO ESTUDO DE CASO DO SÍTIO RASO RIO DO MEIO, SANTA CATARINA

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Como citar este artigo:

GILSON, Simon-Pierre; LESSA, Andrea. *Pre-colonial groups from Brazilian coast and sharks: first glimpse on a complex relationship through the case study of the shallow site Rio do Meio, Santa Catarina*. In: Cadernos do Lepaarq, v. XVI, n.32., p. 156-168, Jul-Dez. 2019.

Recebido em: 31/05/2019

Aprovado em: 22/10/2019

Publicado em: 15/12/2019

ISSN 2316 8412

Pre-colonial groups from Brazilian coast and sharks: first glimpse on a complex relationship through the case study of the shallow site Rio do Meio, Santa Catarina.

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Abstract: The excavation of the coastal shallow site Rio do Meio (500-700 years cal BP, Santa Catarina, Brazil) made available a large faunal collection with a particularly interesting frequency of shark remains. Considering all the identified faunal fragments, the centra and teeth of sharks participate with 15% of the remains, being the third most important element behind the bones of fish and shells. The high frequency of shark remains led to the questioning of the dietary value of this resource for coastal groups, fishing and processing techniques, as well as issues associated with their interaction with the supply territory. In this sense, the high frequency of Whitemouth croaker (*Micropogonias furnieri*) in association with shark remains at the Rio do Meio site suggests fishing strategies with non-aleatory choices, which may be related to geographic and environmental conditions, as well as to the interspecies interactions. These reflections provide new elements for discussions on diet and territory exploration for subsistence activities, and their implications in terms of spacial movement by these fisher-hunter-gatherer groups.

Resumo: A escavação do sítio raso Rio do Meio (500-700 years cal BP, Santa Catarina, Brasil) disponibilizou uma numerosa coleção faunística com uma frequência particularmente interessante de restos de tubarões. Considerando-se todos os remanescentes faunísticos identificados, as vértebras e dentes de tubarões participam com 15% do total da coleção, sendo o terceiro elemento mais importante, atrás dos ossos de peixes e das conchas. A alta frequência de restos de tubarões observada levou ao questionamento sobre o valor dietético desse recurso para os grupos litorâneos, sobre as técnicas de pesca e de processamento, assim como sobre questões associadas a sua interação com o território de abastecimento. Neste sentido, a alta frequência da corvina (*Micropogonias furnieri*) em associação com restos de tubarão no sítio Rio do Meio sugere estratégias de pesca com escolhas não-aleatórias, o que pode ser relacionado com condições geográficas e ambientais, assim como com interações interespecies. Essas reflexões fornecem novos elementos para discussões sobre dieta e exploração do território para atividades de subsistência, e suas implicações em termos de movimentação espacial por parte desses grupos pescadores-caçadores-coletores.

Palavras Chave:

Zooarchaeology, Shark remains, Diet, Fishing strategies, Brazil

Keywords:

Zooarqueologia, Restos de tubarão, Dieta, Técnicas de pesca, Brasil

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INTRODUCTION

The first studies on faunal remains from pre-colonial coastal sites were carried out in the 1990s, in the context of southern and southeastern sambaquis. These studies were fundamental for proposing new paradigms on the lifestyle of these groups, especially on diet and mobility, from discussions on the preponderance of fish and the secondary role of mollusks as a food source. They also indicated the permanent feature of the settlements demonstrating the consumption of species captured throughout the year (BANDEIRA, 1992; FIGUTI, 1993, 1995, 1998; FIGUTI; KLOKLER, 1996). Since then, other studies on food consumption of marine resources have been carried out, even from an extended interpretive perspective, as symbolic behavior has become an element of discussion (PLENS, 2010; KLOKLER, 2008, 2012, 2014, 2016).

As a rule, however, the studies were carried out in sambaquis. Shallow sites, pre-colonial coastal settlements other than sambaquis, have not received the same attention for systematic zooarchaeological studies, with Bandeira (1992) and Cardoso (2018) being the only two up to now. Indeed, few shallow sites (with or without ceramic) were excavated, probably due to the low visibility in the landscape and location in areas with high real estate speculation, which led to the destruction of many of these sites.

In addition to the scarcity of approaches to shallow sites, specific studies on sharks are rare, although they are often found in the archaeological record. Gonzalez's thesis (2005) on shark remains from sambaquis of São Paulo state is an exception, in which the author discusses some current fishing techniques in Brazil and traditional techniques in several regions of the world, besides the use of faunal elements as instruments or adornments.

Rio do Meio Archaeological Context

The shallow site Rio do Meio was found on Jurerê beach, Santa Catarina Island, Santa Catarina state (Figure 1). It was identified in 1987 by the archaeological team of the MARquE-UFSC (*Museu de Arqueologia e Etnologia da Universidade Federal de Santa Catarina*) and was excavated between 1996 and 1997 by a team of the same museum under the direction of the archaeologist Teresa Fossari. The excavation was part of an archaeological survey project since the preservation of the site was threatened by a real estate business.

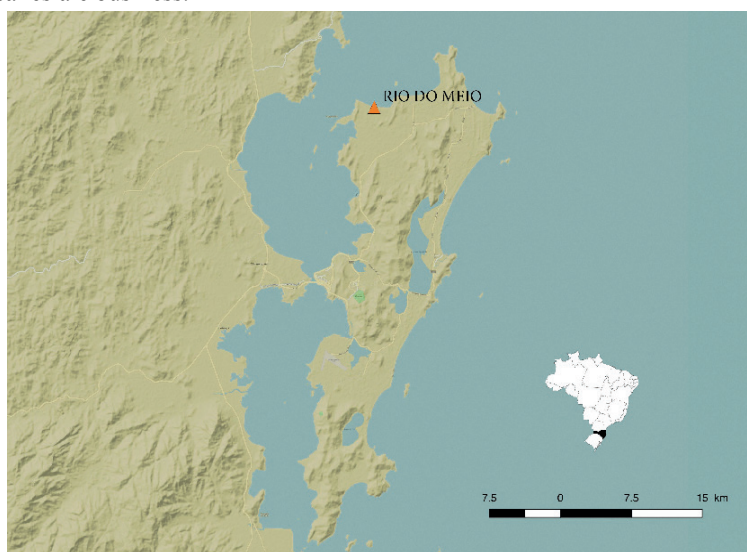


Figure 1: Map showing the shallow site Rio do Meio, Santa Catarina Island, Brazil. QGIS 2.14/ Sources: Apple Iphoto Map and Unidades Federativas shapefile of the Núcleo de Economia Regional e Urbana da USP-NEREUS

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Situated on the waterfront in a dune area with current dense vegetation of *restinga*, the site is on a beach ridge plain which is delimited at the east and west by an elevation of Precambrian rocks, still covered by a Neotropical forest, and by a mangrove at the south (FOSSARI, 2004). From the ecological perspective, its condition is privileged once the site is located in the entrance of a bay and close to an estuary formed by the flowing of the Rio do Meio river. In recent decades, the strong wave action has slowly closed the Rio do Meio river mouth, which certainly had greater affluence in the past (FOSSARI, 2004) (Figure 2).



Two main areas were excavated by natural layers, RM I and RM II, with a surface of 448 m². There is no direct connection between the two areas but they share a similar material culture and stratigraphic aspect. The RM II area, which presented the bigger extension (350 m²) and received higher attention during the excavation, with all layers carefully screened through a 1 or 2 mm sieve (FOSSARI, 1998; 2004), is the focus of this study. No extensive laboratory work has been done at the time and most of the material remained unprocessed until 2014, when the collection received new attention by a mixed team of the LEIA-UFSC (*Laboratório de Estudos Interdisciplinares em Arqueologia*) and MarquE-UFSC, by the financing obtained with the Program *Elisabete Anderle de Estímulo à Cultura, Prêmio Catarinense de Museus Elisabete Anderle, Modalidade de Pesquisa*, promoted by *Fundação Catarinense de Cultura* (GONDIM; SCHERER; GILSON, 2017).

Figure 2: Aerial photography of the Rio do Meio river in 1957. Sources: Sistema de Informações Geográficas de Santa Catarina (SIGSC)-<http://sigsc.sds.sc.gov.br/>

The site has been characterized in the Brazilian archaeological context as a shallow site (*sítio raso*), which is not the unique term used to call this kind of settlement. The terms *jazidas páleo-etnográficas*, *acampamento litorâneo*, *sambaqui sujo* and *sambaqui tardio* have also been used, creating some confusion in the specialized literature (LESSA, 2005; LESSA; SCHERER, 2008; CARDOSO, 2018). The noun ‘shallow site’ has been preferred as it refers to the physical description of this kind of site, opposite to the sambaquis, and does not involve any cultural or functional interpretation.

Shallow sites are defined based on their own stratigraphic, material, chronological and contextual characteristics, which gives them a great deal of homogeneity. The great quantity of funeral structures, normally exceeding a hundred, is one of those characteristics. The Rio do Meio shallow site, especially, is unique so far in the pre-colonial landscape of the south coast, since no burials have been performed. This particular scenario is certainly due to the small number of sites identified and excavated, which, in turn, is associated with the difficulty in locating and preservation issues. Four dates are available to this site, which a critical review allows to situate between 500 and 700 years cal BP (Table 1). The other shallow sites are situated between 500 and 1300 years cal BP, therefore Rio do Meio site was occupied at a time near the arrival of Europeans

in Brazil (Gilson and Lessa, accepted paper).

In relation to sambaquis, or shellmounds, which dominated the Brazilian coast for at least 7.000 years (GASPAR, 1996, 1998; FISH *et al.*, 2000; LIMA, 2000; DEBLASIS *et al.*, 2007; GASPAR, KLOKLER; DEBLASIS, 2011; FISH *et al.*, 2013), the available dates indicate that shallow sites are more recent, probably having a few hundred years of simultaneous occupation of the coast during the final moments of the shell mound builders.

Table 1: Radiocarbon age of the Rio do Meio site with information about the material used for the datation, the context of the sample used, the conventional data, the calibrated data.

Site	Material	Context	Conventional data (BP)	Calibrated data (cal BP, 2 σ , Oxcal v4.3.1 Bronk Ramsey, 2017)	Curve (Bronk Ramsey, 2017)	References
Rio do Meio Beta451660	Coal	Occupation II	600 \pm 30	519-631	SHCal13	Gilson and Lessa, accepted paper
Rio do Meio Beta451661	Coal	Occupation II	620 \pm 30	527-640	ShCal 13	Gilson and Lessa, accepted paper
Rio do Meio Beta178077	Shell	Unknown	780 \pm 60	473-654	Marina 13, ΔR : -180 (\pm 20; Easteo, et al., 2002)	Fossari 2004; Gilson and Lessa, accepted paper
Rio do Meio Beta451662	Otolith	Occupation I	870 \pm 30	541-675	Marina 13, ΔR : -180 (\pm 20; Easteo, et al., 2002)	Gilson and Lessa, accepted paper

Some zooarchaeological data: sample sorting and representativeness

Three thousand and five hundred shark remains of the Rio do Meio site have already been sorted (10% of the total collection) and 60% of these were identified, part in the work of Mayer (2017), demonstrating the presence of 13 shark species (Occupation I, II and III): *Carcharias taurus*, *Carcharhinus plumbeus*, *Carcharhinus obscurus*, *Carcharhinus leucas*, *Carcharhinus brachyurus*, *Carcharhinus falciformis*, *Negaprion brevirostris*, *Galeocerdo cuvier*, *Carcharodon carcharias*, *Isurus paucus*, *Squatina sp.*, *Sphyrna sp.*, and *Rhizoprionodon sp.*

The high frequency of shark remains may be associated with the interspecies interaction between sharks and the most represented fish in the faunal collection of the Rio do Meio site, the Whitemouth croaker (*Micropogonias furnieri*). This species, found throughout the year around the Santa Catarina Island, has an annual cycle connected with its reproductive behavior (CARVALHO FILHO, 1999; CATTINI *et al.*, 2016; RIBAS, 2016). The adult fishes, which normally stay on the coastal water around a depth of 60-70 m, enter the bays to spawn. Estuarine environments are also very attractive since whitemouth croakers prefer brackish water to grow. During this time, they will form huge shoals in shallow water at the entrance of bays and estuaries (CARVALHO FILHO, 1999). The current time of reproduction around Santa Catarina Island is from September to November (RIBAS, 2016) when the shoals are in the shallow waters of the bays. Certainly, the human groups that occupied the Rio do Meio settlement have developed fishing techniques to benefit from this quite favorable condition, as demonstrated by the high frequency of this remains (47% of the total bonefish identified fragments; 60% of the total bonefish NMI, 63% of the total bonefish bone weight, 66% of the total bonefish biomass).

Some shark species, like *Carcharhinus plumbeus* and *Carcharias Taurus*, are known to have croakers on their menu (COMPAGNO, 2002; VOIGT; WEBER, 2011; EBERT; FOWLER; COMPAGNO, 2016), so, the huge congregation of these fishes has certainly attracted them closer to shore, making sharks an easier and more abundant prey for human groups. Thus, croakers may have played the role of bait for sharks, which would be caught through the use of specific fishing techniques.

The biomass importance estimation and NMI quantification of these animals is always a hard task (RICK *et al.*, 2002; GONZALEZ, 2005; BORGES, 2015; MAYER, 2017), but the high frequency of remains seems to indicate an intensive exploration of cartilaginous fish, even more if considering the sensitivity of their rests to taphonomic destruction.

The conversion ratio presented by Rick and coauthors (2002) gives, for example, a media of 115:1 for the genus *Carcharhinus* and 132:1 for the genus *Sphyrna*. These ratio conversions are higher than those used for bony fish (e.g. 28:1 for the white croaker). The application of this conversion ratio over the current sample of elasmobranch remains of Rio do Meio suggests participation for at least 10% of the biomass represented by the total of the faunal collection. This preliminary estimation should be confirmed with further studies since it can be influenced by the butchering process applied over sharks (see the section below). The application of the conversion ratio was obtained by multiplying the centra total weight of each species by the mean conversion rate published by Rick and coauthors (2002).

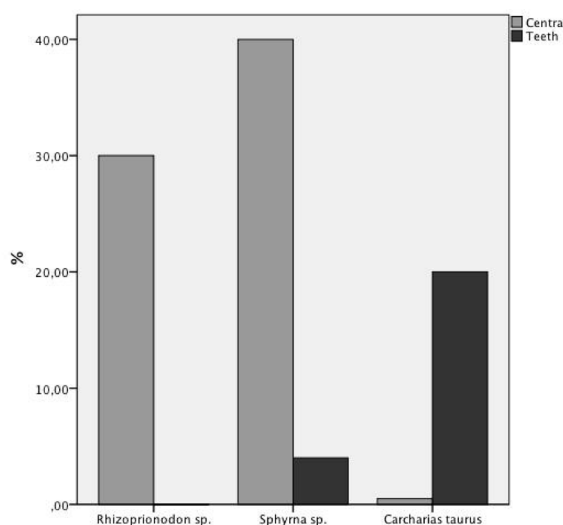


Figure 3: Difference in frequency between species based on the element (teeth or centra) choose for the identification: examples in percent for the genus *Sphyrna sp.*, *Rhizoprionodon sp.* and *Carcharias taurus*.

Important data on the representativeness of the different shark species present in the collection were also obtained. A significant variation in species frequency has been demonstrated according to the element used for identification: the teeth or the centra. Indeed, the quantification of the species is quite different when the identification is based on only one of the two elements. For example, almost no teeth of *Sphyrna sp.* have been identified (4%), but this species is well represented by the centra ($\pm 40\%$). The same phenomenon was noted among the genus *Rhizoprionodon*, from which no tooth was registered, but the centra are common in the collection ($\pm 30\%$). On the contrary, the species *Carcharias taurus*, which is well represented in the identified teeth ($\pm 20\%$), are almost unknown if considered the centra, as less than 20 centra (less than 1%) are known in the all collected and sorted collection (Figure 3).

Three main reasons may explain the difference in the quantification of the same species according to the element used for its identification. Firstly, the differential treatment given to the parts of sharks' bodies during their processing, on which the researchers have no control (see the section below). Secondly, the methodology to select the sample for analysis. The difference is evident when comparing the analysis performed on the material screened in a 2-mm sieve and carefully sorted in the laboratory, and the previous analysis performed by Mayer (2017) only with the teeth collected during the excavation of the

Rio do Meio site. As expected, the sharks with bigger teeth were favored in the work of Mayer, so, the *Carcharias taurus* is the most common species, with a frequency of almost 50%, and the frequency of *Carcharhinus plumbeus* is only 17%. With the data presented here this tendency is reversed since the *Carcharias taurus* fall to only 17% and the *Carcharhinus plumbeus* rise to 35-45%. And thirdly, the lower frequency of one of the elements could be related to its utilization by the various groups that occupied the settlement, which would imply their transportation out of the Rio do Meio.

More zooarchaeological data: Capture and processing of sharks

Of the 1048 identified centra, 80% is of young sharks, which is a high and uncommon frequency. These data suggest that fishing was mostly undertaken in shark nursery areas, as suggested by Lopes and coauthors on their study of several sambaquis of Rio de Janeiro state coast (LOPES *et al.*, 2016). The concept of ‘nursery’ is used as a protected area where female sharks give birth and the young grow on their own (BORNATOWSKI, 2008; VOIGT; WEBER, 2011; EBERT; FOWLER; COMPAGNO, 2016). Indiscriminately used in the literature, this concept has been criticized and reviewed by Heupel and coauthors (2007), mainly in an ecological purpose. The area where the Rio do Meio site is located offers very favorable ecological conditions to be used by sharks as a nursery: a shallow-water bay.

This hypothesis is reinforced by the description of European chroniclers on fishing techniques developed by coastal groups during the XVI century, which could be related to reproduction areas. These interesting ethnohistorical sources of information, presented and discussed by Gilson and Lessa (2019) and Franco (1998), bring some highlights about shark capture in shallow and offshore water, which are favorable places to the birth and development of young individuals.

Although in a lower percentage, adult sharks are also present in the sample (20%). The analyses showed, however, a particular pattern, with the lack of great size centra and especially great size mid trunk centra. This difference could be associated with the meat extraction technique, in which young and small sharks would be processed by cutting off the fillets, and the greater sharks, in its turn, would be cut in the slice manner, that is, in the transverse plane. Once the Rio do Meio site was interpreted as a functional settlement, used for capture and processing of food (GILSON; LESSA, 2018), the vertebrae of small sharks would be discarded *in loco*, whereas the vertebrae of the great ones, still adhered to the slices, would be transported for the consumption of the meat elsewhere. This practice would have as a consequence the lack of great and mid trunk centra at the butchering place.

Another possibility is that this difference is associated with the cooking process. Due to a large amount of meat, the central part of the body would need to be exposed to a greater intensity of heat, influencing the poor conservation of centra. The heat, as demonstrated by Gilson and Lessa (submitted), was probably used for processing shark body and may have had a direct consequence over the conservation of the different parts of the carcass. On the other hand, chemical analyses made on ceramic artifacts of Rio do Meio demonstrate the presence of lipids from marine animals, especially elasmobranch (HANSEL; SCHMITZ, 2006), suggesting a cooking process inside clay pots, which influenced the differential conservation of the small centra. Also, the current use of shark centra to produce fish glue (KUANG, 1999) and the results of chemical analyses in ceramic artifacts (HANSEL; SCHMITZ, 2006) open the possibility that shark centra were boiled and processed to produce a strong and useful glue (MURDINAH; NINOEK; NURUL, 1996).

Isotope data

During the last two decades, few carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope analyses have been undertaken to understand some elements of diet from pre-colonial coastal groups (e.g. DEMASI, 2001, 2009; KLOKLER, 2008; BASTOS *et al.*, 2014, 2015). These studies show the high proportion of marine resources in the diet of these groups and, in particular, the analyses made by Bastos and coauthors at the Forte Marechal Luz and Tapera sites (2014, 2015) display isotopic values compatible with high marine trophic level in many individuals, which indicates a frequent consumption of marine top chain animals.

The data obtained with the Rio do Meio faunal collection support these results, since it shows a high frequency of shark remains, which indicates an intentional and well-organized fishing practice, as well as the importance of this resource in the protein intake.

Final Remarks

The occupation of Rio do Meio as a functional settlement focused on specific activities of capture and processing of marine resources, especially sharks, would have involved a complex and dynamic relationship between several elements: ecological conditions, interspecies interactions, specialized techniques, population movements and territory domain.

The zooarchaeological analyses demonstrate that sharks were valuable and frequent resources in the diet of shallow site groups. These results may certainly be correlated with carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope analyses on pre-colonial coastal human remains (e.g. DEMASI, 2001, 2009; KLOKLER, 2008; BASTOS *et al.*, 2014, 2015), which indicate the importance of marine resources in protein intake. The study at the Forte Marechal Luz and Tapera shallow sites, in particular (BASTOS *et al.*, 2014, 2015), demonstrates a frequent consumption of marine top chain animals. Until then, discussions about the relationship between man and sharks converged on the presence of teeth, which, of course, lead the issue to aspects other than diet.

To date, three hypotheses have been considered for the presence of shark teeth in the site: they were collected on the beach after stranding or after the outcropping of Pleistocene material, or the sharks were fished. Specifically regarding the most aggressive species, such as the *Carcharodon carcharias*, the first hypothesis has been the most accepted (GONZALEZ; AMENOMORI, 2003). So, the present analysis also provides new and important data on how human groups obtain this resource.

Further studies are underway by the authors to better understand this complex human-shark relationship suggested by the faunal analyses of the Rio do Meio collection. A more general picture of this relationship should be available only when the Rio do Meio site ceases to be unique in its socio-cultural context, enabling more detailed discussions about the interaction between places, people and their ways of life on the southern coast of Brazil.

With the obtained data, however, it is possible to infer that the predation of sharks was an intentional task, an important aspect of the group's lifestyle. In other words, the catching, processing, and ingestion of sharks of different sizes and species were cultural choices which should be the expression of a subsistence strategy developed for a long time. This fishing activity, as reported by some ethnohistoric reports (GILSON; LESSA, 2019), was dangerous and required cooperation and coordination between the group's members.

Finally, due to the difficulty and the risk of catching sharks, it is interesting to put in perspective this cultural choice. Obviously, it will never be possible to understand it in a holistic form, but the favorable proportion between the used and discarded parts, the pleasure of the palate and symbolic aspects were possibly elements that acted in the configuration of this intense and important relationship between sharks and humans.

ACKNOWLEDGMENTS

The authors would like to thank: the Museum MARQUE-UFSC and the Laboratório de Biologia de Teleósteos e Elasmobrânquios (LABITEL-UFSC) for the welcome and assistance during the research development; the Coordination of Improvement of Higher Level Personnel-Brazil (CAPES) and The National Council for Scientific and Technological Development-Brazil (CNPq) for the financial support.

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