



Multidisciplinary studies of Southern Brazil Holocene: Archaeological, palynological and paleontological data



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ABSTRACT

In order to understand the relationship between human occupation and paleoenvironmental scenario in Southern Brazil during Holocene, multidisciplinary studies were carried out in two archaeological sites located at Northeast of Rio Grande do Sul State: Sangão rockshelter (RS-S-327) and Garivaldino rockshelter (RS-TQ-58). Both sites have radiocarbon ages from 9400 to 3730 ¹⁴C BP, revealing a continuous occupation of this area by hunter-gatherer populations related to Umbu Tradition. Palynological studies conducted in areas near the archaeological sites demonstrated an increase in humidity and in arboreal taxa starting at 5400 ¹⁴C BP, providing evidence of a mosaic of grasslands and forests. These findings are corroborated by the analysis of small-sized mammals related to non-human predation associated to these archaeological sites, which present contemporary taxa typical of forests and open areas. They also demonstrated that environmental changes were slow and gradual during the Holocene. Although paleoenvironmental data suggest that the landscape of this region evolve gradually from mosaic of forest and open landscapes to diverse and densest forests, zooarchaeological analysis indicates a pattern of adaptive stability that persists throughout the Holocene, characterized by generalist strategies of subsistence focused mainly in forest resources. Therefore, the favorable weather conditions and the presence of forest environments restricted to river valleys and mountain slopes until Mid-Holocene, played a central role for the initial human settlement of this area, related mainly with riverine routes.

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1. Introduction

Multidisciplinary studies allow a better understanding of ecosystems development in regional micro-scale, through the integration of several paleoenvironmental studies tools, which combined with a consistent chronology form the database for paleovegetational and paleoclimatic interpretations (Quattrocchio et al., 2008).

In order to understand the relationship between human occupation and paleoenvironmental scenario evolution in Southern Brazil during the Holocene, multidisciplinary studies were carried out in two archaeological sites located in the northeast region of Rio Grande do Sul State: Sangão rockshelter (RS-S-327) and Garivaldino rockshelter (RS-TQ-58). Both sites have radiocarbon ages ranging from 9400 to 3730 BP, revealing a continuous occupation of this area by hunter-gatherer populations related to Umbu Tradition (Ribeiro and Ribeiro, 1999; Dias, 2003, 2011).

Both sites are located in the physiographic region of the Lower Northeast Slope (LNS), which has an area of 15,847 km² (Fortes, 1959). The LNS is seated on basalt flows, as well as siltstone and shales, and the landscape is strongly inclined with altitudes ranging from 50 m South to 600 m North. The Sangão site is located on the Coastal Plain of Rio Grande do Sul State, in Santo Antônio da Patrulha, and the Garivaldino site, more inland, is located at the boundary between the Central Depression and the Serra Geral, in Brochier (Fig. 1). The climate is humid subtropical with annual average rainfall between 1500 and 1800 mm, evenly distributed throughout the year. The relative humidity is around 85% and the average temperature is 18 °C, July being the coldest month (average temperature between 13° and 15 °C) and January the warmest (average temperature between 22° and 24 °C) (IBGE, 1986).

The region studied is now covered by a broadleaf forest that varies its composition depending on the landscape. The main forest present in the LNS is the Semi-deciduous Forest, considered as an extension of the Brazilian rainforests. The Semi-deciduous Forest vegetation is the result of the interaction of the Uruguay High

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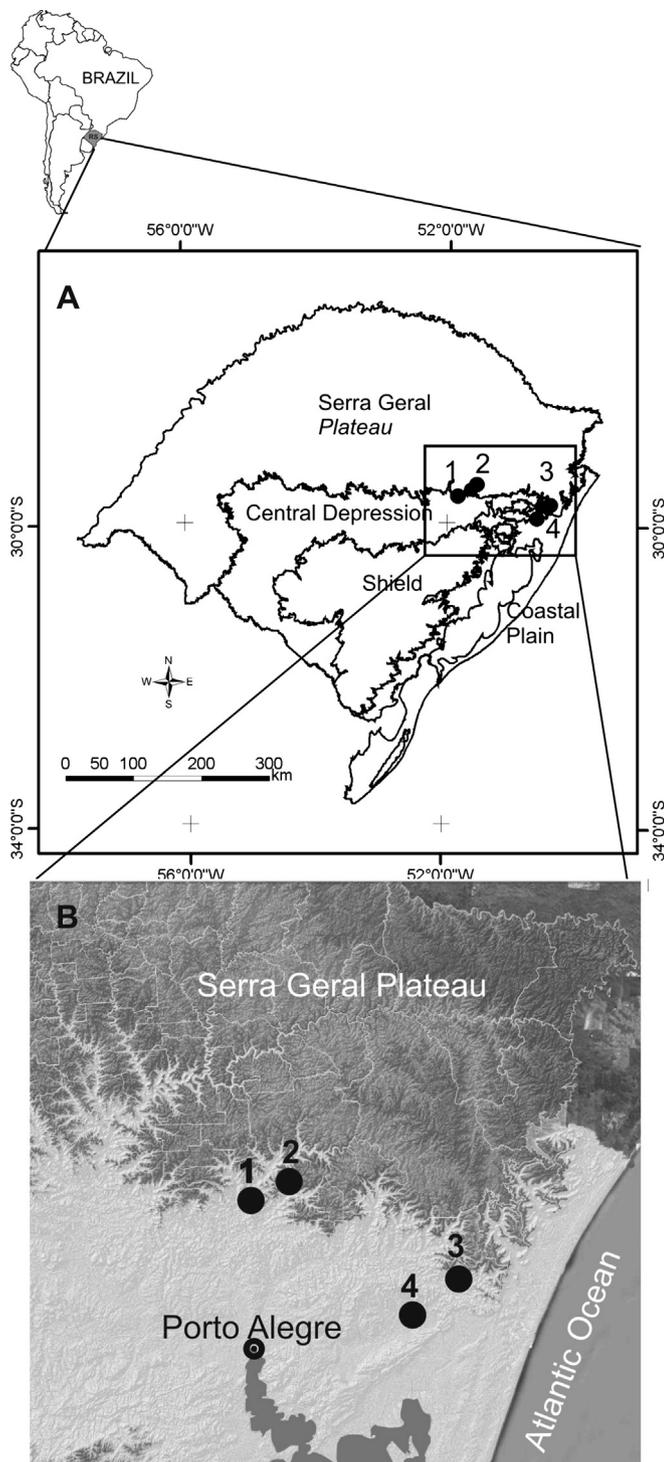


Fig. 1. (A) Geomorphologic map of Rio Grande do Sul State (Brazil), showing the location of the studied sites: (1) Serra Velha, (2) Garivaldino rockshelter, (3) Sangão rockshelter and (4) Barrocadas. (B) Detail of the study area. Maps from Geoprocessing MCN/FZBRS and Google.

Forest (Seasonal Forest), from the west, and the Atlantic Forest, from the east. In the uppermost parts, there is the combination of a Semi-deciduous Forest with *Araucaria* Forest (Kilca and Longhi, 2011). The main characteristic of the Semi-deciduous Forest is that 20–50% of its trees lose their leaves during winter. This process of leaf shedding is associated with physiological drought caused by the intense winter cold, when average temperatures are below 15 °C (Oliveira, 2007). Studies in seasonal forests in Rio Grande do

Sul State showed that these forests are composed mainly of Myrtaceae, Lauraceae, Euphorbiaceae and Fabaceae (Jarenkow and Waechter, 2001; Jurinitz and Jarenkow, 2003; Kilca and Longhi, 2011). Currently, the region has suffered severe changes due to conversion of forested areas to fields for agricultural activities.

In the present work, the paleoenvironmental studies on the formation and expansion of seasonal forest in LNS were made from palynological analysis of sediments collected near the archaeological sites (Bauermann, 2003; Leal and Lorscheitter, 2007; Macedo et al., 2010). For a better understanding of the patterns of climate and environmental change throughout the Holocene in this micro-region, paleontological studies of small mammals associated with the archaeological contexts of Sangão and Garivaldino sites were carried out (Hadler et al., 2008, 2009b, 2010; Rodrigues, 2008). In turn, the interactions between paleoenvironmental changes and human adaptive strategies during the Holocene were evaluated through comparative studies of Sangão and Garivaldino sites' archaeological collections (Dias, 2003; Dias and Jacobus, 2006; Rosa, 2010; Rosa and Jacobus, 2010).

2. Archeological context

The first evidence of hunter-gatherers presence in Rio Grande do Sul State is dated around 10,800 ¹⁴C BP in association with fluvial sediments of the mid-Uruguay River. Related to grassland biomes (Pampa), these archeological sites are associated with lithic industries characterized by the predominance of bifacial technological strategies. Denominated “Umbu Tradition”, these lithic industries are characterized by a “variety of bifacial triangular projectile points, pedunculated and non-pedunculated, some of them with serrated edges, and others with unifacial retouch, usually associated with bolas” (Meggers and Evans, 1977). The technological characteristics of these bifacial industries point to similarities with Argentinean and Uruguayan contemporary contexts, possibly indicating a common cultural matrix. Nonetheless, based on the absence of fishtail projectile points in these assemblages, it is reasonable to propose that the routes that gave origin to the initial colonization of Brazilian Pampa could be more closely related to the occupation of Paraguai and Parana Rivers valley, which are unfortunately still poorly known archaeologically.

The oldest set of evidence of human occupation for Northeast region of Rio Grande do Sul State is associated with the Garivaldino and Sangão rockshelters (Ribeiro and Ribeiro, 1999; Dias, 2003). These sites are associated respectively with Taquari and Sinos Rivers valleys that belong to Guaíba Lake Basin, separated by 200 km. Their location and chronology point to an initial colonization of this area by a riverine route probably initiated in the Uruguay River system and that seems to be strongly associated with the presence of forest environments, restricted since the Pleistocene–Holocene transition to mountain slopes and river valleys.

Garivaldino rockshelter is northeast oriented and is at an altitude of 80 m. Its dimensions are 21.4 m opening, 8.5 m deep and 8.6 m high. An excavation of 12 m² area was conducted in 1989, with the matrix rock identified at 230 cm depth. The site has four radiocarbon ages between 9430 and 7250 BP (Ribeiro and Ribeiro, 1999). Sangão rockshelter is at 50 m and its dimensions are 25 m opening, 10 m deep, and 6 m high, south-oriented. Archaeological excavation of a 13 m² area was conducted between 2000 and 2001, showing homogeneous sediments with fine grain and a dark brown color, with the matrix rock located between 50 and 80 cm deep. Seven radiocarbon ages were conducted, with results between 8790 and 3730 BP (Dias, 2003) (Table 1).

Sangão radiocarbon ages sequence revealed little evidence of post-depositional disturbance, and the physical–chemical and granulometric analyses of the sediments imply that its sedimentary

Table 1
Radiocarbon dates for archaeological sites (Ribeiro and Ribeiro, 1999; Dias, 2003).

Archaeological sites	Coordinates	¹⁴ C BP	Lab code	Stratigraphic level (cm)
RS-TQ-58: Garivaldino	51° 38' 26.4"S 29° 35' 3.8"W	9430 ± 360	Beta 44739	200–210
		8290 ± 130	Beta 32183	170–180
		8020 ± 150	Beta 33458	130–140
		7250 ± 350	Beta 44740	50–60
RS-S-327: Sangão	50° 33' 44.9"S 29° 46' 21.6"W	8790 ± 40	Beta 160845	60–65
		7390 ± 40	Beta 154353	45–50
		4690 ± 40	Beta 154352	35–40
		4610 ± 140	Beta 160847	25–30
		4160 ± 100	Beta 154351	25–30
		3940 ± 40	Beta 160849	20–25
	3730 ± 60	Beta 160846	15–20	

formation is related to anthropic action. The activity areas near the hearths are distinguished by greater concentration of phosphates (P₂O₅) and a decrease in the gravel fraction, indicating primary refuse and intensive trampling. Those analyses also suggest changes in the paleoclimatic conditions, implying a significant increase of humidity between 4000 and 3000 BP (Bitencourt and Dias, 2005).

Comparative studies between Umbu Tradition lithic assemblages of different archaeological sites of this region showed significant recurrences in structural characteristics of settlements and technological organization patterns. The stratigraphic distribution of archaeological material is characterized by patterns of primarily refuse of faunal remains, and bifacial flaking debris associated with the periphery of hearths formed from several episodes of reuse. The lithic assemblages are characterized by technological organization strategies marked by high regularity in synchronic and diachronic terms, related to production and maintenance of bifacial stemmed and unstemmed projectile points (Fig. 2). Formal tools were discarded with low frequency; biface reduction flakes, bipolar flakes and debitage debris are in the majority. The low frequency of cores, cortical flakes and core reduction flakes implies that an initial processing occurred in the raw material gathering places. The informal tools were discarded more frequently around the domestic units, as they are produced over flakes and used in diverse daily activities, such as food processing and consumption, and in the production of other perishable artifacts. There is a tendency towards the intentional deposition of non-processed raw materials around the domestic units in anticipation of future use. The raw material exploitation is focused on local resources, and their selection strategies are related to specific technologies: bifacial reduction is preferably associated with the processing of basalt and silicified sandstone, while the bipolar technique is associated with the treatment of chalcedony and quartz. The typological variations of projectile points follow a variety of technological strategies, but the diachronic analysis of its distribution in the regional archaeological sequences indicates the coexistence and permanence of different techniques over time (Dias, 2003, 2007, 2011; Dias and Neubauer, 2010).

Similarities also exist between Sangão and Garivaldino subsistence patterns throughout the Holocene. Although in the Early Holocene levels of Garivaldino site there are a greater number of individuals associated with open environments, in general terms, throughout the stratigraphic sequences of both sites, the majority of taxa identified are associated with forest habitats. The Late Holocene environmental improvements, in turn, can be detected due to greater vertebrate taxa diversity in the sample of the Garivaldino site, which reflected positively the widening of the hunting range. In all occupational events of Garivaldino and Sangão sites, the NISP and MNI abundance values indicate mammals as more representative in the sample, except for micro-rodents, chiroptera

and small marsupials, related to non-human predation. The mammals hunting choices were characterized by a preference for armadillos (*Dasypus* sp.), red brocket and pampas deer (*Mazama americana* and *Ozotocerus bezoarticus*), collared peccaries (*Pecari tajacu*), and cavies (*Cavia aperea*) with continuity between exploitation strategies and environment resources throughout the Holocene. Reptiles and birds were also a hunting priority in both archaeological contexts, and values of diversity did not show significant differences in statistic terms during different occupational events. The most representative reptile remains are represented by lizards of family Teiidae, with *Tupinambis* a preferential prey. In both sites, fragments of egg shells are frequent, with rhea eggs (*Rhea americana*) the most common elements in this category at Garivaldino site. Also at Garivaldino, the bird remains are more abundant for the Mid-Holocene levels, with many taxa of the Tinamidae family, while at the Sangão site taxa of *Cracidae* and *Raliidae* are predominant. Mollusc gathering also played an important role in subsistence, particularly the gastropod *Megalobulimus* and the bivalve *Diplodon* at Garivaldino and the gastropod *Pomacea* at Sangão. Although they can be found in all occupational periods, the significance of invertebrate fauna in the diet increased from the Mid-Holocene, due to improved weather conditions that favored the natural availability of these resources (Dias and Jacobus, 2006; Rosa, 2010; Rosa and Jacobus, 2010).

3. Palynological context

Vast landscapes of open vegetation dominated Southern South America during the Pleistocene. This situation was conditioned by some climatic forces such as the displacement of the Intertropical Convergence Zone (ITCZ) which should be located further north, while the polar fronts would be more intense and frequent (Fig. 3). During the Holocene, these conditions were altered, the ITCZ moved to its current position and polar fronts decreased in frequency and intensity.

The predominance of grassland vegetation during the Pleistocene suggests the presence of a cold and dry climate that did not support the development of forests in south and southeastern Brazil. The few pollen grains found in this period are probably from incipient forests along river valleys. In the Holocene, however, a process of change in the monotonous grassland landscape began. Some taxa related to the *Araucaria* Forest showed a slight increase, probably indicating a migration of the forest following the river course (Behling et al., 2004). Pollen records of the Atlantic Forest also showed a slight increase, suggesting that the climate became milder at the beginning of the Holocene (Lorscheitter, 2003).

From the Mid-Holocene, there was a steady increase in forest taxa, in both the *Araucaria* and Atlantic Forest, suggesting warmer climate conditions and higher humidity levels, events that coincide with the Holocene transgression episode. The Late Holocene was a time of expansion and establishment of the *Araucaria* Forest in the highlands of southern Brazil due to the hot and humid climate that remains today. Meanwhile, the Atlantic Forest, originating from the tropical coastal regions of Northern Brazil, has also expanded its inland occurrence, possibly because the marine incursions ceased on the coast of Rio Grande do Sul State.

The results of pollen investigations for the physiographic region of the Lower Northeast Slope (LNS) are related to previous work performed by Bauermann (2003), Leal and Lorscheitter (2007) and Macedo et al. (2010). The modern vegetation of the region is formed by a mosaic of fields and forests, especially elements of the Atlantic Forest and Semi-deciduous Forest. In the studied regions, arboreal elements such as *Alchornea triplinervia* (Sprong.) Mull. Arg., *Allophylus edulis* (St. Hill.) Radlk. ex Warm, *Bactris lindmaniana* Drude,

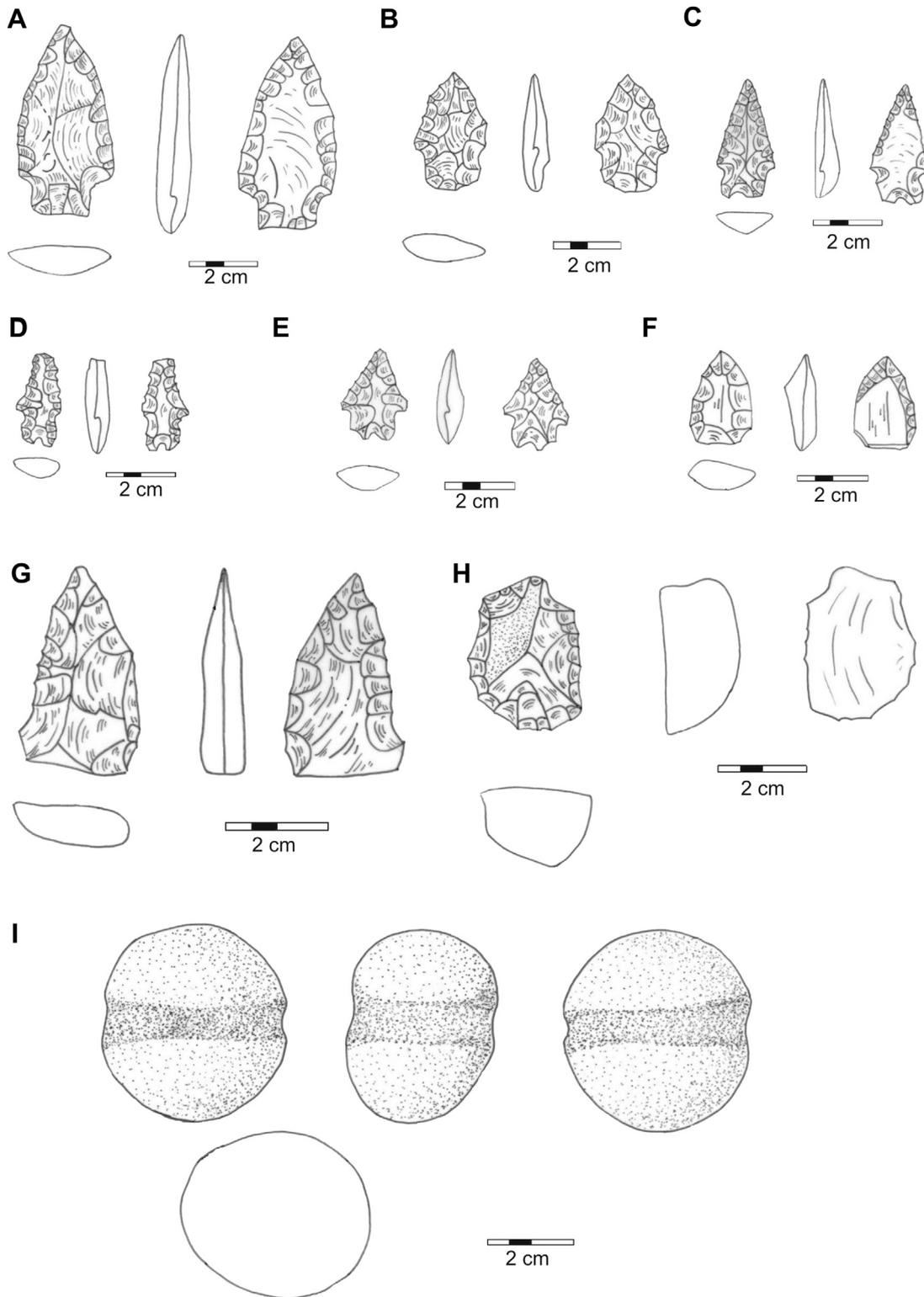


Fig. 2. Sangão site lithic artefacts. (A) projectile point in silicified sandstone; (B–E) projectile points in basalt; (F) projectile point in quartz; (G) preform in silicified sandstone; (H) scraper in silicified sandstone; (I) bola or *Boleadeira* in basalt.

Calliandra tweediei Benth, *Campomanesia xanthocarpa* O. Berg, *Casearia sylvestris* Sw., *Cecropia* Loefl., *Ficus* L., *Cupania vernalis* Cambess., *Daphnopsis racemosa* Griseb., *Erythrina crista-galli* L., *Faramea marginata* Cham., *Geonoma schottiana* Mart., *Gomidesia palustris* (DC.) D. Legrand, *Guapira opposita* (Vell.) Reitz, *Guarea macrophylla* Vahl, *Ilex pseudobuxus* Reissek, *Ilex dumosa* Reissek,

Inga uraguensis Kook. et Arn., *Mimosa bimucronata* Kuntze., *Molli-
nedia elegans* Tul., *Myrsine* L., *Ocotea pulchella* Mart., *Persea venosa*
Nees et Mart., *Piper corcovadense* C. DC., *Salix humboldtiana* Willd.,
Sapium glandulatum (Vell.) Pax, *Sebastiania commersoniana* (Baill.)
L.B.Sm. & R.J.Downs, *Sebastiania brasiliensis* Spreng., *Syagrus
romanzoffiana* (Cham.) Glassman, *Tabernaemontana australis* Müll.

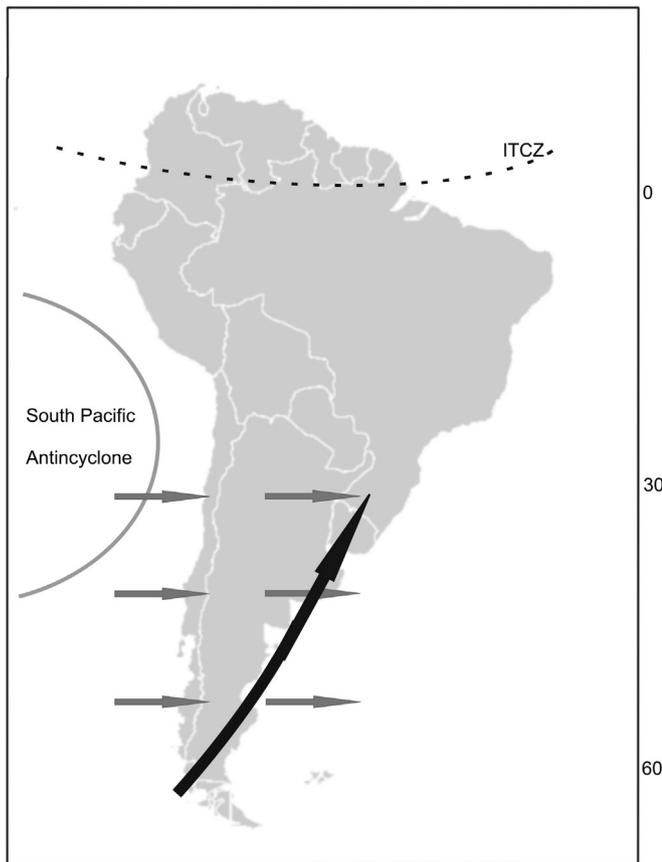


Fig. 3. Main climate forcing acting on the South America during the Pleistocene. The Intertropical Convergence Zone (ITCZ) was possibly displaced to the north while the polar front (diagonal arrow) would be more intense and frequent. The horizontal arrows represent the westerly winds which must have been stronger.

Arg., *Trichilia clausenii* C. DC. and epiphytes such as *Tillandsia usneoides* L. and *Peperomia* Ruiz et. Pav. are present.

The sediments of the three depositional sites were collected inside the flooded forest and received the usual acetolytic treatment for recovery of pollen grains and spores (Faegri and Iversen, 1989). The samples were assembled with glycerin gelatin. For quantitative analysis, at least 300 pollen grains in each subsample were counted and the statistical analysis and cluster analysis were performed using the Tilia program. The age of each depositional site was estimated by radiocarbon dating (Table 2).

Table 2

Radiocarbon dates for palynological sites (Bauermann, 2003; Leal and Lorscheitter, 2007; Macedo et al., 2010).

Sample	¹⁴ C BP	Lab code	Depth (cm)
Barrocas	27,775 ± 145	Kia 15909	575
Barrocas	12,948 ± 66	Kia 15908	310
Barrocas	3163 ± 29	Kia 15907	150
Serra Velha	9890 ± 90	Beta 154709	506
Serra Velha	7280 ± 60	Beta 151165	317
Serra Velha	3730 ± 60	Beta 192341	199
SAP	5461 ± 98	Cais 01964	115
SAP	4839 ± 10	Cais 03492	55
SAP	137 ± 102	Cais 0352	13

The drilling for the extraction of the evidence was performed with a peat sampler, in Santo Antônio da Patrulha County, Barrocas site (30° 02' 41"S; 50° 36' 52"W) and Santo Antônio da Patrulha site (SAP) (29°44'45"S; 50°32'56"W) and in Brochier County, Serra Velha site (29°36'22"S; 51°38'55"W).

The oldest radiocarbon age was obtained on the Barrocas site at 27,000 BP, the only place to register Pleistocene events. Serra Velha has a basal age of 9800 BP, allowing the recording of the whole Holocene, and SAP reached 4700 BP, recording events of the Late Holocene (Table 2).

Although Barrocas and Serra Velha sites have reached similar depths (575 cm and 506 cm, respectively), their radiocarbon ages are very different. The rapid sedimentation in Serra Velha is probably due to its location closer to the edge of the plain. The nine radiocarbon ages showed Pleistocene material only in Barrocas, but allowed a chronological correlation of data for two depositional sites throughout the Holocene and the integrated reconstruction of the three sites from the Mid-Holocene of LNS.

The Holocene in LNS begins with an increase in diversity of both herbaceous and arboreal taxa at Barrocas site when compared to Pleistocene conditions. In Serra Velha, this same scenario was observed, with predominance of grassland vegetation next to a water body and sparse trees elements. Among the forest taxa were registered some pioneer elements such as *Celtis*, *Chrysophyllum*, *D. racemosa*, *Ilex*, *Mimosa*, and *Matayba elaeagnoides*. The pollen records indicate an overview with the presence of a water reservoir, abundant grasslands and sparse forest formations, in the presence of a cold climate and drier than today. In Serra Velha site, for the period from 7000 to 5000 BP, there was a record of a hot and dry phase indicated by the general decrease in the pollen records.

From the transgressive event of 5000 BP, the climate gradually became more humid and the vegetation started to diversify gradually. Trees present were *Arecaceae*, *Alchornea*, *Anacardiaceae*, *Celtis*, *Myrtaceae*, *Melastomataceae*, *Urticales* and *Trema micrantha*. At Barrocas and Santo Antônio da Patrulha, a new episode of floristic diversity is registered around 3000 BP, when arboreal taxa never registered before occur, such as *Byrsonima ligustrifolia*, *Clusia criuva*, *Piper*, and *Tripodanthus acutifolius*. From that age on the vegetation and the climate acquire features similar to those of today, including some taxa indicating anthropogenic presence such as *Pinus* and *Zea mays*.

4. Paleontological context (small mammals)

The fossil record of small mammals in Brazil occurs in eleven states, from paleontological studies in karst environments. For most, there is no radiocarbon age, attributed to the Late Pleistocene/Early Holocene based on the associated fauna, particularly mega-mammals (Hadler et al., 2009a). In Central Brazil small mammal samples with better chronological information for this period are associated with archaeological sites in karst rockshelters, such as Lapa do Boquete, Lapa dos Bichos and Santana do Riacho at Minas Gerais State (Kipnis, 2002, 2003) and GO-JA-01 at Goiás State (Schmitz et al., 1989, 2004). For Southern Brazil the best small mammal samples with precise stratigraphic and chronological information is associated with archaeological sites in sandstone rockshelters, such as Sangão and Garivaldino, allowing the study of this data in a systematic and paleoenvironmental perspective.

The small mammals studied in Sangão and Garivaldino contexts are represented by marsupials (Order Didelphimorphia), bats (Order Chiroptera) and caviomorph rodents (Order Rodentia, Suborder Hystricomorpha). These three orders together represent about 60% of known living species of mammals and are important constituents of the mastofauna of different environments (Wilson and Reeder, 2005). Queiroz (2004) examined the taphonomic aspects of microvertebrates remains of Garivaldino and found that they had their origin in non-human predation, thus excluding zooarchaeology.

Some characteristics of small mammals make them good indicators of paleoenvironmental and paleoclimatic conditions, such as

anatomical and physiological characteristics recognizable through skeletons and very specific ecological needs (Mares and Willig, 1994; Pascual et al., 2002). Moreover, most species recorded in Quaternary sites are still living, and many studies have recognized the importance of these groups of mammals as paleoenvironmental indicators (e.g., Goin, 2001; Goin et al., 2010).

Chiroptera, in general, have a sparse fossil record, and among the groups studied for the Holocene in Northeastern Rio Grande do Sul State, it was the one with lower numerical occurrence. Hadler et al. (2010) reported three families: Phyllostomidae (2 species), Molossidae (2 species), and Vespertilionidae (4 species), and emphasized that the small number of individuals, the discontinuous distribution in the stratigraphic column and the generalist character of the recorded species make the group uninformative about the paleoenvironment in the studied area.

On the other hand, marsupials and caviomorph rodents are very well represented in the faunal record of the archaeological sites. Hadler et al. (2009b) recorded 7 taxa of marsupials, including *Gracilinanus microtarsus*, typical of the Atlantic Forest, at both sites since the end of the Early Holocene, and *Thylamys* related to open area environments. Among the caviomorph rodents also occur typical taxa of forested areas, such as *Phyllomys* sp. and taxa of open areas, such as *Ctenomys* sp., *Dicolpomys fossor* and *Euryzgomatomys mordax* (Hadler et al., 2008). The occurrence of these taxa in the same stratigraphic level could represent a non-analogous assemblage (allopatric species registered at the same level). However, considering that the formation of the assemblage was due to the action of non-human predators and that they have a relatively wide area of action, it seems more appropriate to suggest the existence of an environment in mosaic, with coexisting grasslands and forests. The small mammals also indicate that open areas have been prevalent, since animals of this type of environment are the most abundant and varied (see Hadler et al., 2008, 2009b). The animals could have lived in the gallery forest, which would serve as a migration corridor for forested vegetation.

For areas near LNS, such as the Province of Buenos Aires, Argentina, a series of changes in the fauna of mammals throughout the Holocene was attributed to climate changes during this period (Tonni, 1990; Deschamps and Tonni, 1992; Goin, 2001; Quattrocchio et al., 2008). However, in northeast Rio Grande do Sul State, the composition of the fauna of marsupials and caviomorph rodents related to the archaeological sites remains unaltered from about 8000 ¹⁴C BP, indicating that, possibly, climate change was slow and gradual and did not affect small mammals, or climatic pulses did not last long enough for the fauna to respond to this stimulus.

5. Final remarks

The multidisciplinary studies developed in the region of the Lower Northeast Slope in Rio Grande do Sul State in the last ten years have created a structure for paleoclimatic and paleoenvironmental scenario of the area during the Holocene. Hunter-gatherers occupied the area continuously since the Early Holocene, showing uniformity in technology patterns, subsistence strategies and forms of landscape use (Ribeiro and Ribeiro, 1999; Dias, 2003). This combined with the continuous stratigraphic distribution of small mammals and other taxa of zoo-archaeological significance demonstrated climate stability for the area in the Holocene (Rodrigues, 2008; Rosa, 2010).

Araújo et al. (2005), reviewing the archaeological data for Central Brazil, pointed out a moment of absence of human occupation in the area between 6000 and 3000 BP and related this “gap” to a period of severe drought. However, the climate in the LNS seems to have been milder during the Holocene than in Central Brazil. The palynological data showed a drier period between 7000

and 5000 BP for the LNS (Grala and Lorscheitter, 2002). However, this condition does not appear to have been severe enough to affect human populations or the available fauna during the Holocene.

Differences also occur when comparing the data from LNS with Argentina in areas near the southern Brazilian border. Quattrocchio et al. (2008) proposed major climate variability during the Late Holocene in the southwestern part of Buenos Aires Province based

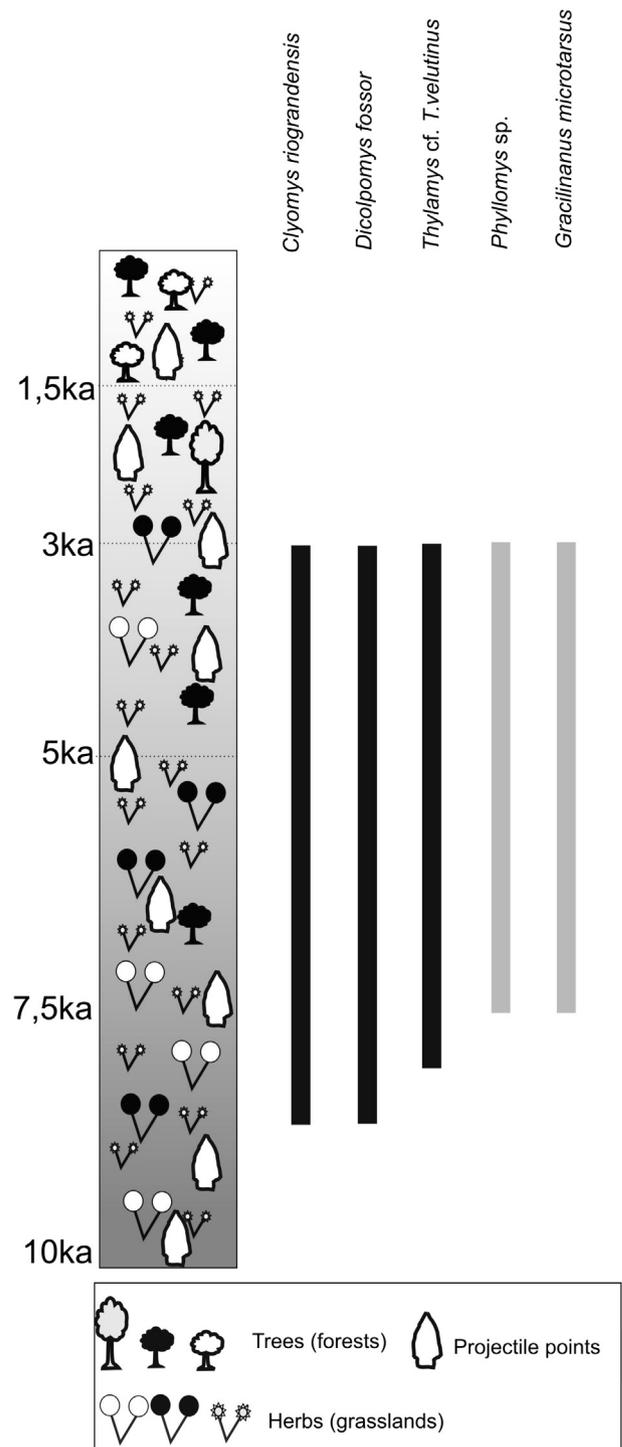


Fig. 4. Elements of the Holocene paleoenvironmental landscape of Northeastern Rio Grande do Sul State. In the left column, the qualitative and numeric increase of arboreal taxa throughout the Holocene and the reduction of herbaceous taxa; in the right columns, the record of small mammals/taxa in the two shelters. In grey, taxa of forested area and in black, of open area.

on palynological, geological and paleontological evidence. Also, paleontological data for the Holocene of Buenos Aires Province has shown changes in the composition of mammal fauna (especially rodents) related to climate changes (e.g., Tonni, 1990; Deschamps and Tonni, 1992). Human occupation in Pampean and Patagonian regions also showed a pattern with modifications, at least in the aspect of resource use (generalist vs. specialist) (Miotti and Salemme, 1999).

Considering the palynological context, the paleoenvironmental scenario proposed for the LNS during the Holocene is represented by the transformation of grassland landscape to a forested landscape (Fig. 4). Archaeological and paleontological data also point in this direction. However, the taxa recorded by zooarchaeology are predominately those of forested areas (Rosa, 2010), while small mammals are predominately those of open areas (Rodrigues, 2008). It is possible that this difference could be related to taphonomic questions of the origins of the assemblages (human predation vs. non-human predation). Among small mammals, the taxa recorded in the older levels are those from open areas such as *D. fossor* and *Clyomys riograndensis*, and from 7500 BP taxa of forested areas begin to appear, such as *G. microtarsus* and *Phyllomys* sp. (Fig. 4). The palynological data show that at this time (around 7000 BP), arboreal taxa that could be associated with areas of high humidity, such as riverbanks, forming gallery forests, are found. Thus, a scenario of grassland predominance associated with gallery forests, responsible for sustaining the fauna connected to forested areas, is proposed for the LNS during the Holocene.

Although paleoenvironmental data suggest that the landscape of this region evolve gradually from mosaic of forest and open landscapes to diverse and densest forests, zooarchaeological analysis indicates a pattern of adaptive stability that persists throughout the Holocene, characterized by generalist strategies of subsistence focused mainly in forest resources. Although in the Early Holocene levels of Garivaldino site there are a greater number of individuals associated with open environments, in general terms, throughout the stratigraphic sequences of both sites, the majority of taxa identified are associated with forest habitats. The Late Holocene environmental improvements, in turn, can be detected due to greater vertebrate taxa diversity in the sample of Garivaldino, which reflected positively the widening of the hunting range. Mollusc gathering increased from the Mid-Holocene, due to improved weather conditions that favored the natural availability of these resources. Therefore, the favorable weather conditions during the Holocene and the presence of a mosaic of open and forest environments restricted to river valleys until the Mid-Holocene, played a central role for the initial human settlement of this area related mainly with riverine routes.

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