Pesquisas em Geociências
http://seer.ufrgs.br/PesquisasemGeociencias

Vegetation stability in the Brazilian littoral during the late holocene - anthracological evidence

Rita Scheel-Ybert

Pesquisas em Geociências, 28 (2): 315-323, maio/ago., 2002.

Versão online disponível em:
http://seer.ufrgs.br/PesquisasemGeociencias/article/view/20305

Publicado por
Instituto de Geociências

Data de publicação - maio/ago., 2002.
Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brasil

Pesquisas em Geociências, 28(2): 315-323, 2001
ISSN 1518-2398

Instituto de Geociências, UFRGS
Porto Alegre, RS - Brasil

Vegetation stability in the Brazilian littoral during the late holocene – anthracological evidence

RITA SCHEEL-YBERT[1]

Laboratoire de Paléoenvironnements, Anthracologie et Action de l'Homme (UMR 5059).
Institut de Botanique, 163 – Rue Auguste Broussonnet, 34090 Montpellier, France.
[1] Endereço atual: Museu Nacional, UFRJ. Departamento de Antropologia. Setor de Arqueologia.
Quinta da Boa Vista, São Cristóvão. 20940-040, Rio de Janeiro. Brasil – rita@scheel.com

(Recebido em 10/01. Aceito para publicação em 05/02)

Abstract - Anthracological studies carried out on six sambaquis from Rio de Janeiro State (southeastern Brazilian coast) and one sambaqui from Santa Catarina State (southern Brazil) showed that coastal vegetation presents a marked resilience to climatic changes. Charcoal samples were collected from vertical profiles along the entire sambaqui height and examined under a reflected light microscope. In the southeastern Brazilian coast, the anthracological spectra is essentially the same between 5500 and 1400 yrs BP. Coastal sandy beach ridges were already colonized by the restinga vegetation since at least the Middle Holocene. Depending on the site, the open restinga or the restinga forest are dominant. Forest and mangrove elements are present in all sites. In southern Brazil, no significant variation of the vegetal environment is recorded between 2500 and 1800 yrs BP. The studied site was established in the restinga environment, and the inland Atlantic Forest was probably situated quite far away. Mangrove vegetation was probably already absent from this region, which is presently under subtropical climatic conditions. No major changes of the vegetal ecosystem has taken place during the second part of the Holocene, notwithstanding many centuries of human occupation, pointing out to the fact that the vegetation was not greatly affected either by climatic or by anthropogenic perturbations. However, significant oscillations recorded in the mangrove vegetation from the Cabo Frio region (southeastern Brazil) might be related to climatic oscillations producing lagoon salinity variations. The stability of the mainland coastal vegetation, in spite of the occurrence of climatic variations, is probably due to the edaphic character of coastal environments, particularly the restinga ecosystem, which is related to sandy soils and to the geomorphologic nature of sandy beach ridges.

Keywords - Vegetation stability, coastal Brazil, Holocene.

INTRODUCTION

In spite of the largely spread idea that coastal environments are extremely sensitive to climatic changes, and that coastal vegetation responds quickly to these oscillations, recent anthracological studies carried out on Brazilian sambaquis show this is not true.

The *sambaquis*, shellmounds constructed by fisher-gatherer populations, are the oldest vestiges of human occupation in the Brazilian coast. The most ancient sites are dated from ca. 7000 yrs BP, in Amazonia, and from 6500 yrs BP, in Paraná State, Southern Brazil (Gaspar, 1996). More ancient sites might have existed, but they were probably destructed by the sea level rising in the beginning of the Holocene.

Sambaquis archaeological deposits are composed of mollusk shells and fish bones, frequently alternating with sandy layers. Charcoal fragments, which represent an invaluable but largely ignored source of information, are generally abundant. The sambaquis are usually established on lagoons margins, near the ocean, presenting a set of various ecological habitats in the surroundings (restingas, mangroves, forests...). Sambaquis inhabitants were probably sedentary (Gaspar, 1992) and have occupied the same sites for a very long time. In the studied sites, the period of occupation varies from about 500 to over 3000 years.

Anthracology is the study of charcoal retrieved in soils or in archaeological sites. It provides information concerning palaeoethnological aspects such as wood exploitation by prehistorical populations, but also palaeoenvironmental and palaeoclimatic reconstructions (Scheel *et al.*, 1996a, 1996b; Scheel-Ybert, 2001). This discipline is deeply complementary with palynology. It allows a good reconstitution of the local woody vegetation, and confrontation with phytosociological data is usually quite direct. In addition, taxonomic determination, frequently at genus level, is often more accurate than in palynological studies.

The validity of anthracology for tropical palaeoenvironmental reconstruction is now well established. Charcoal samples present a great taxonomic diversity, anthracological results are similar in neighboring sites, and there is good

Em respeito ao meio ambiente, este número foi impresso em papel branqueado por processo parcialmente isento de cloro (ECF).

correspondence between charcoal assemblages and present-day vegetation. Wood gathering by fisher-gatherer populations, most likely for domestic fires, was not selective. Therefore, analysis of tropical archaeological charcoal supplies reliable information on past environments (Scheel-Ybert, 2000).

The present paper is part of a research program which main objectives are: reconstruction of the palaeoenvironment in which lived Brazilian fisher-gatherer populations; evaluation of the relationship between these populations and their environment; search of palaeoethnological information concerning plant use by these communities (Scheel-Ybert, 1998, 1999, 2000, 2001). It presents original data from the Santa Catarina State. Vegetation stability in the coastal area, as well as the implications of mangrove elements variations in the anthracological spectra for Holocene sea level oscillations hypotheses, were unexpected results that we estimated of interest to the Quaternarists research community.

REGIONAL SETTING

Six sambaquis were studied in the Rio de Janeiro State, on the southeastern Brazilian coast. The Sambaquis do Forte, Salinas Peroano and Boca da Barra, are situated in the Cabo Frio region (22°53'S, 42°03'W) (Fig. 1). The first site is localized between the Itajuru Channel and the Atlantic Ocean, on the west margin of the channel which connects the Araruama Lagoon to the sea, and on the north side of Praia do Forte; the later ones are situated on low inland crystalline hills on the east side of the Itajuru Channel, no more than 500 m apart from each other. The Sambaqui Ponta da Cabeça is situated at the Arraial do Cabo Peninsula (22°57'S, 42°14'W), upon a crystalline hill near the Massambaba Beach. The Sambaquis da Beirada and da Pontinha are situated at the Saquarema region (22°55'S, 42°33'W), on the back of the Pleistocene beach ridge between the Saquarema Lagoon and the sea, ca. 400 m distant from each other.

In most of the Rio de Janeiro State coastal zone the climate is tropical wet, hot and rainy in summer with a mild dry season in winter (Barbiére, 1984). In the Saquarema region, mean annual temperature is 24-26 °C and mean precipitation is 1000 mm/yr (Sá, 1992). The Cabo Frio and Arraial do Cabo region present a particularly dry climate that is a variant of semi-arid hot climate, due to upwelling of cold waters along the coast, which reduces local precipitation. Mean annual temperature is 25 °C and precipitation rarely exceeds 800 mm/yr (Barbiére, 1984).

Plant associations in this region vary according to physiographic conditions and distance from the ocean. The land-sea interface, especially along the edges of rivers and lagoons, is covered by floristically poor mangrove and by saltwater marshes. The different vegetation types of the restinga ecosystem occupy sandy beach ridges. They vary from sparse open plant communities, such as herbaceous and scrub formations ("open restinga") to dense evergreen forest ("restinga forest").

Rocky outcrops from the Cabo Frio region present particular formations. The xeromorphic forest, which is up to ca. 8 m high, has a well-developed understory (FEEMA, 1988). Farther from the ocean, low mountains support forests similar in composition to those of the Atlantic Rain Forest.

One other site was studied in the Santa Catarina State, southern Brazil (28°36'S, 48°57'W). The Sambaqui Jabuticabeira II is situated on the Jaguaruna region, at ca. 1 km from the southwestern margins of the Garopaba do Sul Lagoon and at ca. 6 km from the sea (Fig. 1). This site is situated on the side of a palaeodune, in the contact with the plane, which is geologically more recent. The plane ground floods during the overflows.

In this region the climate is temperate sub-hot, with winter mean temperatures over 15 °C and no dry season. Mean annual temperature is 20 °C and mean precipitation is 1400 mm/yr (Nimer, 1989).

Although the natural vegetation is almost absent from this region in the present days, the site is situated in the phytosociological domain of the restinga ecosystem. Restinga forest probably dominated the palaeodunes. The Atlantic Forest is situated inland, as well as the subtropical forest, typical of the high plateaus of more than 800 m altitude. Mangrove vegetation is absent from this region, under subtropical climatic conditions. Southern limit of mangrove distribution is presently at the Santa Catarina Island, ca. 150 km northwards.

The Atlantic Forest in the Santa Catarina State is in fact the extra-tropical prolongation of the dense ombrophilous forest extending along the atlantic coast from Rio Grande do Norte (5° S) to Rio Grande do Sul State (29° S). Macro and mesoclimatic influence induce floristic variations in its various facies. In the southern region, the mild winter temperatures along the coast and the abundant rains, well distributed all over the

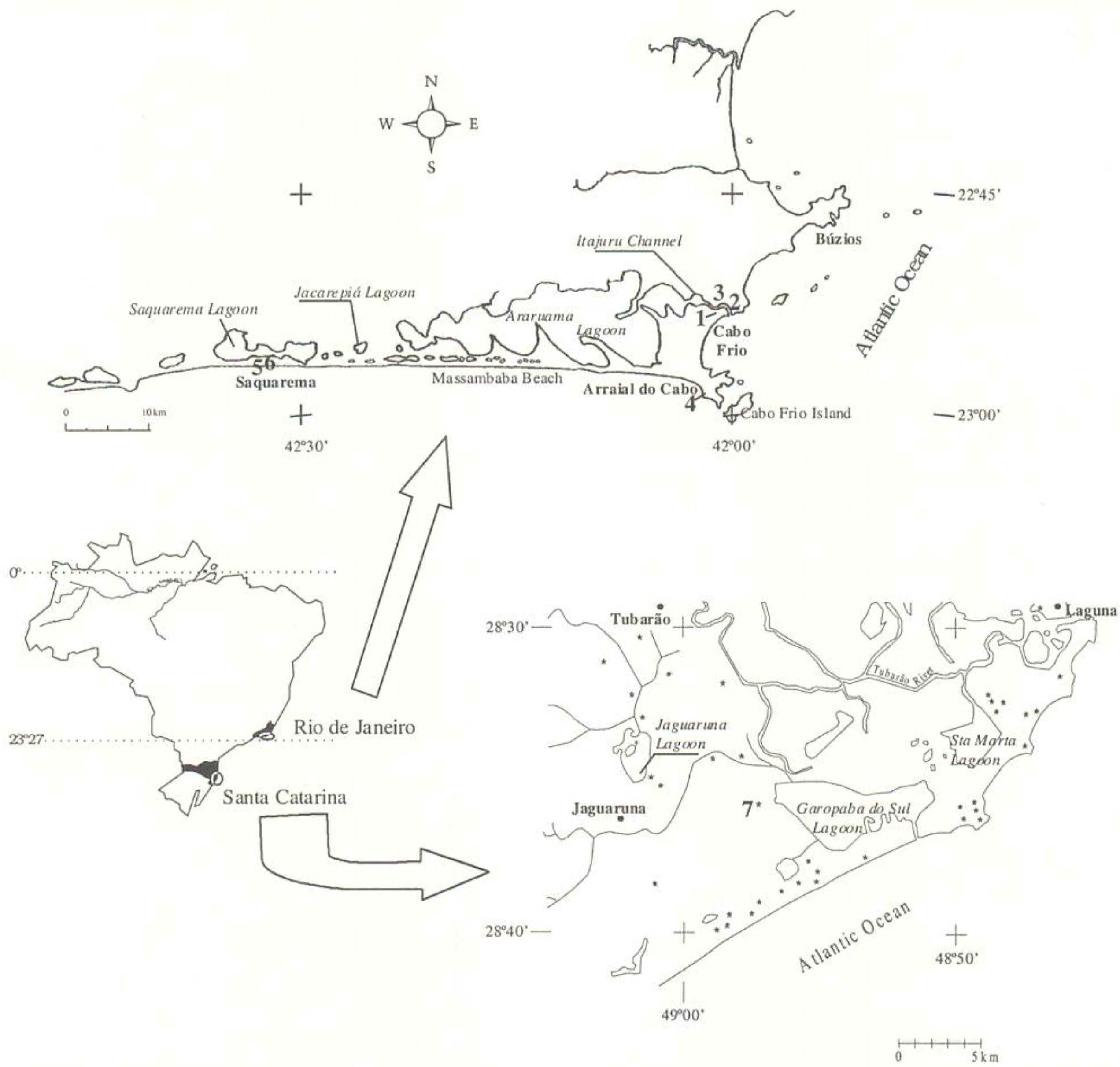

Figure 1 - Geographical situation of the studied sites – 1-6, southeastern Rio de Janeiro State; 7, southern Santa Catarina State. (1) Sambaqui do Forte; (2) Sambaqui Boca da Barra; (3) Sambaqui Salinas Peroano; (4) Sambaqui Ponta da Cabeça; (5) Sambaqui da Beirada; (6) Sambaqui da Pontinha; (7) Sambaqui Jabuticabeira II. In the map of Santa Catarina region, stars indicate sambaquis location.

year, assure the development of an evergreen forest of high biodiversity presenting four strata, rich in epiphytes and lianes and up to 25 to 30-m high (Hering de Queiroz, 1994).

MATERIAL AND METHODS

Charcoal samples were collected from vertical profiles along the entire sambaquis height. Each sample consists of a sediment layer of 2 m width, 50 cm depth and 10 cm thick. Sediment was dry-sieved in the field using a 4-mm mesh. Residual charcoal was later recovered in the laboratory with a flotation machine (Ybert *et al.*, 1997). At Sambaqui Ponta da Cabeça, charcoal fragments were collected during the archaeological excavation and plant remains were sorted by hand.

Charcoal samples were examined under a reflected light brightfield/darkfield microscope. Transversal, tangential longitudinal and tangential radial sections were cut manually. Systematic determination was obtained by comparing the anatomical structure observed with that of extant charred samples and with descriptions and photographs from the literature (Détienne & Jacquet, 1983; Mainieri & Chimelo, 1989; papers on wood anatomy). Wood anatomy of tropical plants is very poorly known, so reference collections of charred wood are indispensable. Over 2000 samples were obtained from wood collections and field sampling. Charcoal identification was facilitated by the elaboration of a program for computer-aided identification specially conceived for anthracology, coupled to a data bank of anatomical features from extant and ancient charcoal (Scheel-Ybert *et al.*, 1998).

All the charcoal fragments over 4 mm were analyzed. Smaller fragments are normally impossible to identify, because in general they do not present enough important characters.

RESULTS AND DISCUSSION

A great floristic diversity characterizes all the charcoal diagrams. Most of the ancient *taxa* identified correspond to the plant associations presently existing in the study region.

In the southeastern Brazilian coast, the anthracological spectra are essentially the same between 5500 and 1400 yrs BP (Scheel-Ybert 2000, 2001). The restinga vegetation already colonized the coastal sandy beach ridges since at least the Middle Holocene. Depending on the site, the open restinga or the restinga forest are dominant. Representation of forest formations and of mangrove *taxa* is also variable in the different sites. All charcoal diagrams show a strong predominance of Myrtaceae species (Fig. 2). This family is abundant in different communities of Brazilian vegetation, but high percentages are typical for restinga formations, particularly in the Rio de Janeiro State.

Charcoal assemblages from Sambaquis do Forte, Salinas Peroano and Boca da Barra show that restinga, xeromorphic forest and mangrove existed in the Cabo Frio region during all the Late Holocene (Fig. 2). Open restinga is better represented in the Sambaqui do Forte, while forest formations are more important in Sambaquis Salinas Peroano and Boca da Barra. This is a consequence of geographical location. The first sambaqui is situated near the beach, in the phytosociological domain of open restinga, while the later ones are situated on the eastern margin of the channel, on crystalline hills dominated by the xeromorphic forest.

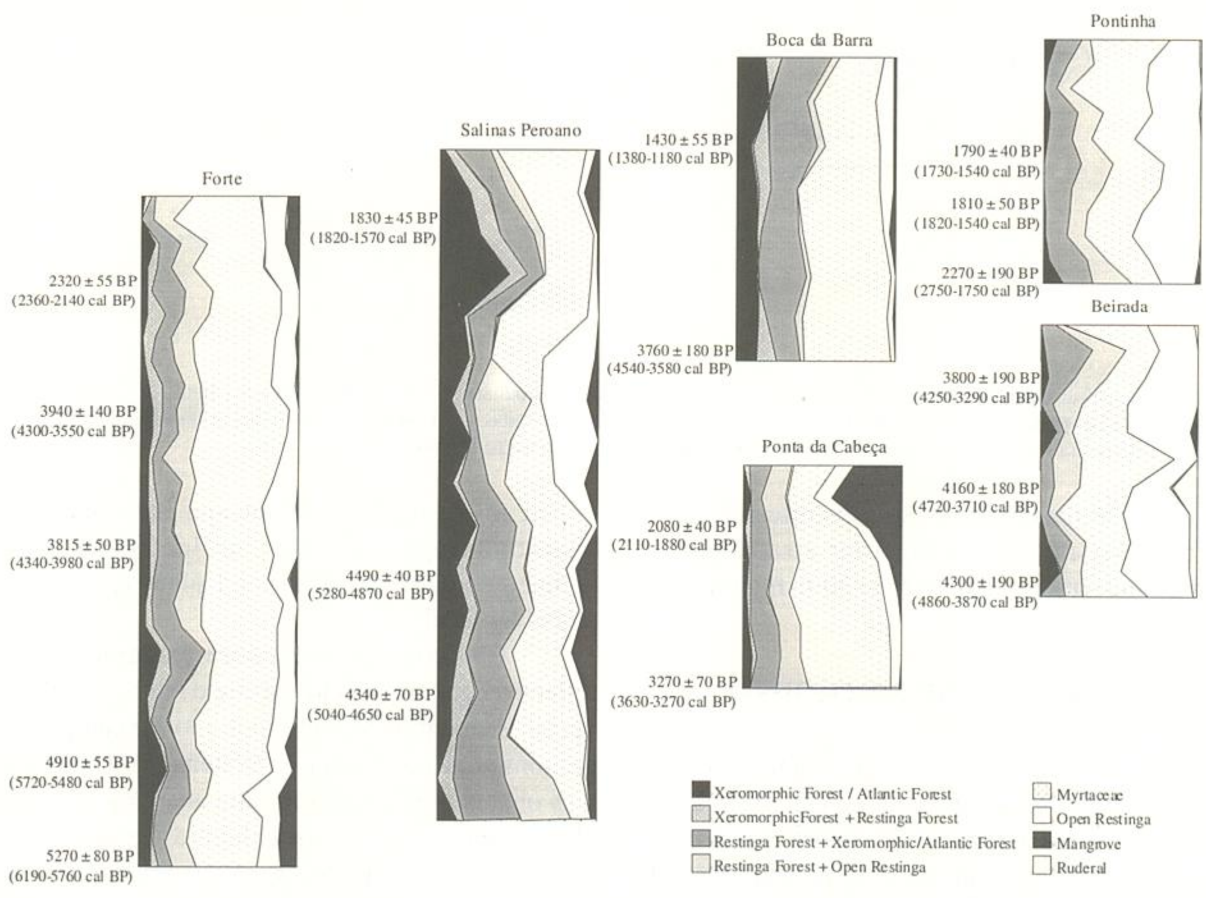

Figure 2 - Summary charcoal diagrams of Sambaquis do Forte, Salinas Peroano, Boca da Barra, Ponta da Cabeça, da Beirada and da Pontinha, Southeastern Rio de Janeiro State (after Scheel-Ybert, 2000).

At the Arraial do Cabo region, Sambaqui Ponta da Cabeça was established on the restinga, but xeromorphic forest and mangrove were also present in the neighborhood (Fig. 2). In spite of the fact that this site is situated upon a crystalline hill, it is located very near the beach, and characterized by an especially dry climate due to upwelling centered in its vicinity. This explains the predominance of restinga elements. Mangrove vegetation, which is presently absent from this region, was probably established on the southeastern margin of the Araruama Lagoon.

Sandy beach ridges from the Saquarema region were occupied by the open restinga (Fig. 2). Low percentages of Atlantic Forest and mangrove *taxa* do not signify these vegetation types were rare during this period. They might have been growing further away from the sambaquis where the wood exploitation was less important. Atlantic Forest vegetation was probably situated on the northern side of the Saquarema Lagoon, and mangrove vegetation on its margins. The slight increase of Atlantic Forest elements at the Sambaqui da Pontinha base level, i.e., around 2300 yrs BP, is not significant and can not be interpreted as a consequence of environmental change.

Also, the oscillations in the relative percentages of the vegetation types in the Sambaqui da Beirada, as well as in some levels of the Sambaquis da Pontinha and Salinas Peroano are not significant, because of the excessively small number of charcoal fragments from these samples.

The only significant variation on the charcoal diagrams concerns mangrove vegetation (Figs. 2-3). In the Sambaqui do Forte, mangrove elements are abundant from the base of the sequence until ca. 4900 yrs BP. After 4900 yrs BP they are rare until ca. 2300 yrs BP and increase again thereafter. In the Sambaqui Salinas Peroano, they are abundant at the base of the diagram (between 100 and 210 cm, ca. 4300/4500 yrs BP), while in the upper 100 cm there is a reduction of the percentages and an irregular presence. Higher percentages of mangrove *taxa* between 50 and 90 cm are probably not significant because of the small number of charcoal fragments analyzed. In the Sambaqui Boca da Barra, mangrove elements are recorded in small percentages between 3700 and 1400 yrs BP.

Mangrove evolution is different on both sides of the channel. On its western side (Sambaqui do Forte), mangrove vegetation reduces abruptly just after 4900 yrs BP; it remains rare from 4900 to 2300 yrs BP and an important reestablishment is evidenced thereafter. On the eastern side of the channel (Sambaquis Salinas Peroano and Boca da Barra), mangrove is abundant until 4300/4500 yrs BP and reduced thereafter. These chronological differences may be due to geomorphological and/or sedimentological features of the channel related to: different bathymetry; different contours (which can lead to a stronger erosion at one side than another); differences in the sedimentary nature of the subsurface (sandy or clayey); differences of shore nature, which are sandy on the west side and rocky on the east side (favoring rainwater flowing on its east side). It is likely that a precipitation reduction would affect more intensely the west side of the channel, due to the more effective drainage associated to sandy soils.

The changes in mangrove vegetation cannot be attributed to sea level variations. The three regressive and the two transgressive episodes identified for the Brazilian coast during this period (Martin *et al.*, 1979/80, 1997) are not in phase with the mangrove evolution. Therefore, these results might invalidate Martin's hypotheses of sea level fluctuations and corroborate more recent propositions that point out to a continuously declining relative sea level trend during the Holocene (Angulo & Lessa, 1996, 1997; Ybert *et al., this volume*)

Changes in mangrove vegetation may be explained by climatic oscillations. Reduction of mangrove vegetation might be due to a drier climate. Precipitation reduction probably produced a rise of salinity in the Araruama Lagoon. Indeed, modifications of the lagoon sedimentation in several cores from the southeastern Rio de Janeiro State suggest regional climatic variations during the Holocene (Tasayco-Ortega, 1996). This author proposes four dry episodes, attributed to a reinforcement of semi-arid conditions (3600-3500, 3100-3000, 1200-1100 and 600-500 yrs BP), and two rainy episodes (2300-2100 and 700-600 yrs BP).

Our results have been compared to the curve of carbonates isotopic composition variation in sediments of the Araruama Lagoon (Tasayco-Ortega, 1996) (Fig. 3). Low values of dd^{18}O are interpreted to reflect a major influence of rainwater, while high values signify increased salinity. Salinity in the lagoon was low until ca. 5000 yrs BP. This can be correlated to the high percentages of mangrove elements in the base of the charcoal diagrams. After this point, salinity is high until ca. 2300 yrs BP. During this period, mangrove is rare on both sides of the Itajuru Channel. A net reduction of salinity is recorded between 2300 and 2000 yrs BP. It can be correlated to the reestablishment of mangrove elements in the Sambaqui do Forte after 2300 yrs BP. This reestablishment is certainly related to a humid episode. We cannot estimate its duration, but the fact that it is not recorded in the east side of the channel suggests it was brief.

In the Arraial do Cabo region, mangrove elements increase significantly in the top of the diagram (from ca. 2100 yrs BP onward). Either it is due to an actual increase of mangrove vegetation in the environment, possibly explained by climatic reasons, or it is related to the population increase recorded during this period (Tenório *et al.*, 1992), which probably led to an extension of the site catchment area. Of course, these two hypotheses are not mutually exclusive.

The stability of the mainland vegetation seems contradictory with the climatic variations recorded by the mangrove elements. However, it is a consequence of the edaphic character of this vegetation, which renders coastal formations much less sensitive to climatic change. The restinga ecosystem, related to sandy soils and to the geomorphologic nature of sandy beach ridges, is essentially an edaphic formation.

These results were corroborated by the charcoal analysis in Sambaqui Jabuticabeira II. No significant variation of the vegetal environment is recorded in the analyzed profile between 2500 and 1800 yrs BP (Fig. 4). This site was also established in the restinga environment, most probably in the restinga forest. Gathering of firewood was carried out essentially in the restinga forest and in the open restinga area, and very little wood came from the inland Atlantic Forest.

Numerous genera identified in this site can be found either in the restinga or in the Atlantic Forest. However, the very small frequency of wood coming exclusively from the rain forest points out to a negligible exploitation of this environment, at least for domestic fuel. Therefore, we assume that *taxa* labeled "forest/restinga" come most probably from the restinga forest.

Myrtaceae are much less abundant in this site than in the Rio de Janeiro State, while Lauraceae are much more important. It might be a consequence of the climatic differences between these two regions. Myrtaceae is probably, in the present days, the plant family who characterizes the best the Brazilian restingas flora, either in abundance (number of individuals) as in diversity (Araujo & Henriques, 1984; Silva, 1990). However, it is especially important in the Rio de Janeiro State, where it is also, along with Leguminosae, the most important family relative to number of species (Araujo, 2000). Although in the

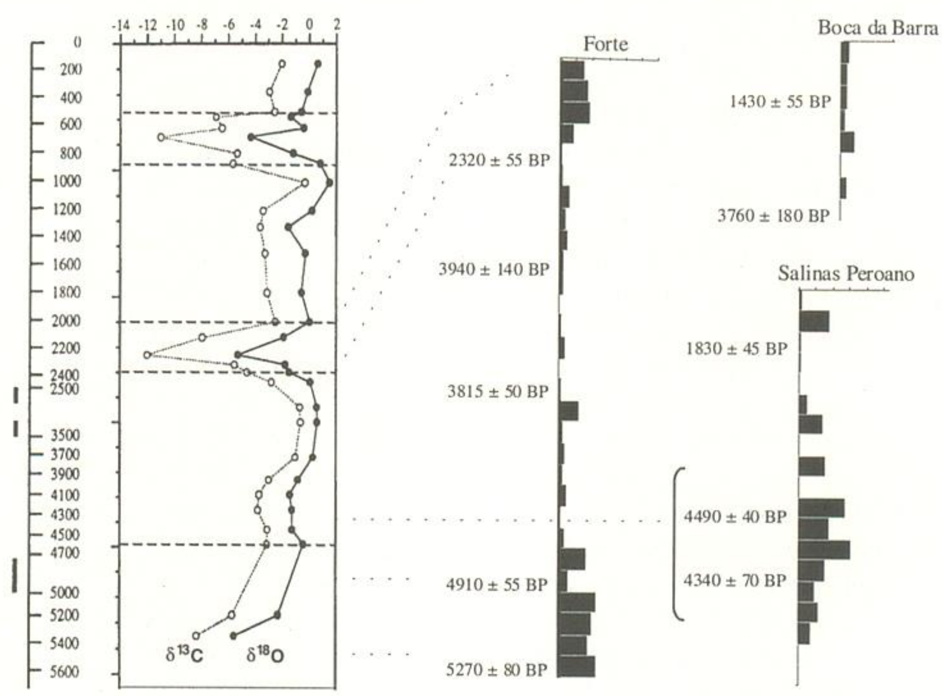

Figure 3 - Comparison of mangrove records and the stable carbonates isotopes curves (dd^{18}O and dd^{13}C) of core B-2 from Araruama Lagoon (after Tasayco-Ortega, 1996). Isotopic values are given in ‰ PDB. Core ages are interpolated from ^{14}C dates obtained from samples signaled by vertical lines (after Scheel-Ybert, 2000).

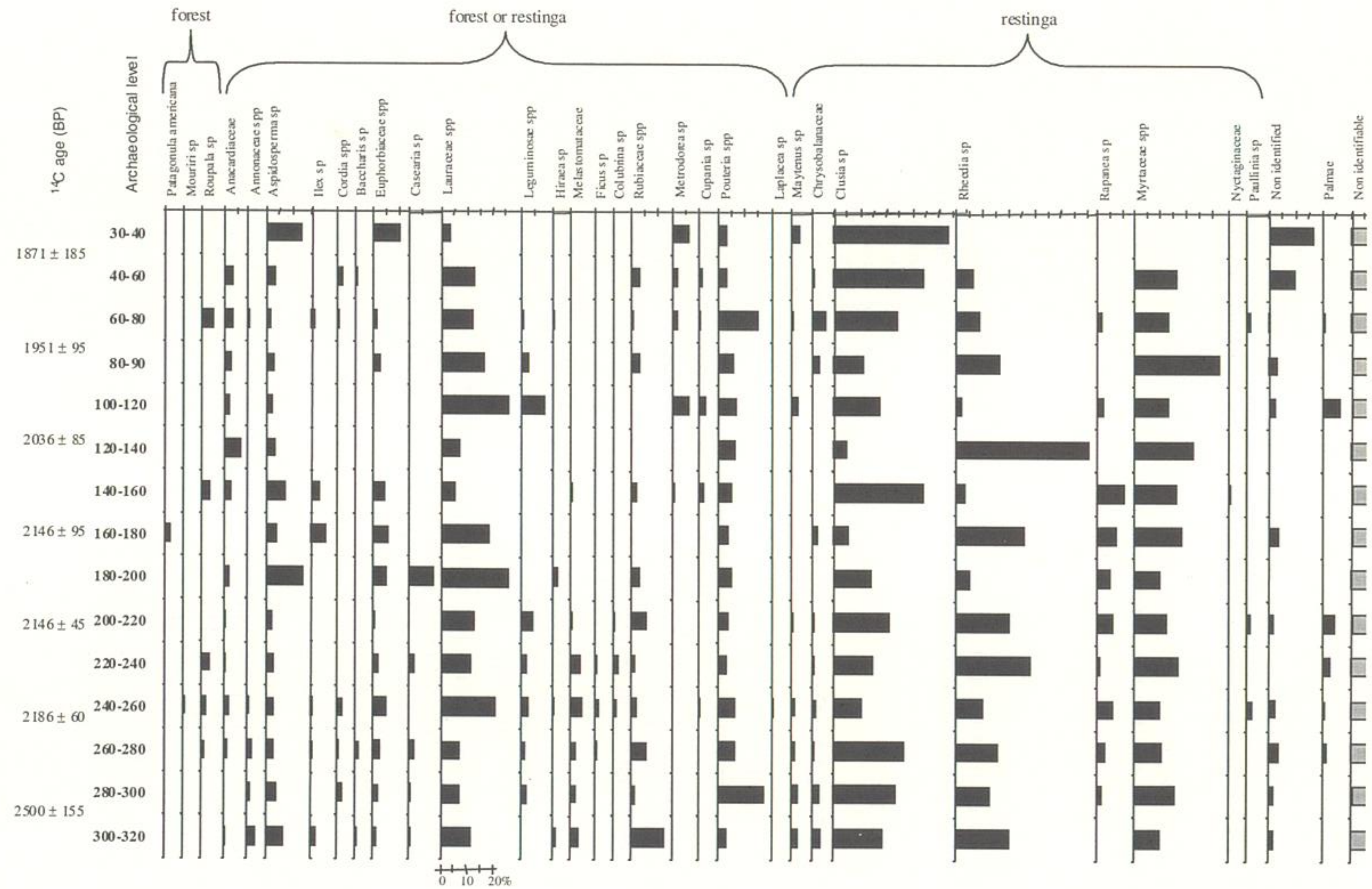

Figure 4 - Charcoal percentage diagram of the Sambaqui Jabuticabeira II, Southern Santa Catarina State. Ni: number of analyzed charcoal pieces; Nsp: number of taxa.

Southern Brazil Lauraceae is not particularly remarkable in number of species, it is always a predominant family relative to number of individuals (Silva, 1990; Sugiyama, 1993).

Mangrove vegetation was probably already absent from this region, which is presently under subtropical climatic conditions.

Palaeoenvironmental studies in the coastal area are still rare. In the Rio Grande do Sul State, palynological studies on the coastal area have shown climatic oscillations, but they were essentially inferred from the alternation between marine, marshland and continental elements in the lagoon cores, and no significant variations of the continental vegetation was recorded in the Late Holocene (Neves & Lorscheitter, 1991, 1997; Cordeiro & Lorscheitter, 1994). In the São Paulo State, the palynological study of a peat core from a flooded forest showed no variations in the coastal vegetation which could be attributed to climatic changes between ca. 4300 and 1000 yrs BP (Bissa *et al.*, 2000; Ybert *et al.*, *this volume*).

CONCLUSIONS

Taxonomic assemblage identified in all sites is essentially the same during many centuries of human occupation, showing that vegetation was not affected either by climatic or by anthropogenic perturbations.

The only significant variations recorded by the anthracological analysis in seven sites from the Brazilian littoral concerns mangrove vegetation in the Cabo Frio region (southeastern Brazil). They might be related to climatic oscillations provoking lagoon salinity variations. This interpretation is corroborated by the analysis of the curve of isotopic variation on carbonates in the Araruama Lagoon, which confirms the existence in this region of at least two dry episodes, separated by a brief humid episode.

It is expected that climatic changes produce vegetation change. This study showed that this is not the case with regard to the coastal mainland vegetation, particularly the restinga ecosystem. This seems to confirm that coastal formations, strongly depending on edaphic conditioning, are much more resistant to climatic variations.

Environmental stability has important consequences to prehistorical populations, and probably was a decisive factor in the maintenance of the sociocultural system of the fisher-gatherers that have lived on the Brazilian coast for more than 6000 years (Scheel-Ybert, 2000, 2001). However, the coastal vegetation constitutes, in consequence, a very poor palaeoclimatic indicator.

ACKNOWLEDGEMENTS

Thanks are due to Maria Dulce Gaspar, Lina Kneip (*in memorian*) and Maria Cristina Tenório, archaeologists responsible for the studied sites. Part of this work was accomplished while holding a doctoral scholarship from the CAPES, Brazil.

REFERENCES

Angulo, J.R. & Lessa, G. 1996. The brazilian sea level curves: a critical review with emphasis on the curves from Paranaguá and Cananéia regions. In: CONGRESSO BRASILEIRO DE GEOLOGIA, 39, 1996, Salvador. **Anais...** Salvador, SBG. v. 5, p. 285-288.

Angulo, J.R. & Lessa, G. 1997. The brazilian sea level curves: a critical review with emphasis on the curves from the Paranaguá and Cananéia regions. **Marine Geology, 140**: 141-166.

Araujo, D.S.D. 2000. **Análise florística e fitogeográfica das restingas do Estado do Rio de Janeiro**. Rio de Janeiro. 176 p. Tese de Doutorado em Ecologia. Instituto de Biologia, Departamento de Ecologia, Universidade Federal do Rio de Janeiro.

Araujo, D.S.D. & Henriques, R.P.B. 1984. Análise florística das restingas do Estado do Rio de Janeiro. In: Lacerda, L.D.; Araujo, D.S.D.; Cerqueira, R. & Turcq, B. (eds.). **Restingas, Origem, Estrutura, Processos**. Niterói, CEUFF. pp. 159-193.

Barbiére, E.B. 1984. Cabo Frio e Iguaba Grande, dois microclimas distintos a um curto intervalo espacial. In: Lacerda, L.D.; Araujo, D.S.D.; Cerqueira, R. & Turcq, B. (eds.). **Restingas, Origem, Estrutura, Processos**. Niterói, CEUFF. pp. 3-14.

Bissa, W.M.; Ybert, J.-P.; Catharino, E.L.M. & Kutner M. 2000. Evolução ambiental na planicie costeira do Baixo Ribeira durante a ocupação sambaquieira. **Revista do Museu de Arqueologia e Etnologia, São Paulo, 10**: 89-102.

Cordeiro, S.H. & Lorscheitter, M.L. 1994. Palynology of Lagoa dos Patos sediments, Rio Grande do Sul, Brazil. **Journal of Paleolimnology, 10**: 35-42.

Détienne, P. & Jacquet, P. 1983. **Atlas d'identification des bois de l'Amazonie et des régions voisines**. Centre Technique Forestier Tropical, France, 640 p.

FEEMA, 1988. **Importância da biota da região de Cabo Frio**. Rio de Janeiro, 50 p. Relatório técnico. FEEMA

Gaspar, M.D. 1992. Aspectos da organização social de um grupo de pescadores, coletores e caçadores que ocupou o litoral do Estado do Rio de Janeiro. In: Araújo, A.J.G. & Ferreira, L.F. (eds.). **Paleontologia e Paleoepidemiologia: Estudos Multidisciplinares**. Rio de Janeiro, Ensp, Fundação Oswaldo Cruz. pp. 95-109.

Gaspar, M.D. 1996. Análises das datações radiocarbônicas dos sítios de pescadores, coletores e caçadores. **Boletim do Museu Paranaense Emilio Goeldi, Série Ciência Terra, 8**: 81-91.

Hering de Queiroz, M. 1994. **Approche phytoécologique et dynamique des formations végétales secondaires développées après abandon des activités agricoles, dans le domaine de la forêt ombrophile dense de versant (Forêt Atlantique) à Santa Catarina – Brésil**. Nancy, France. 251 p + planches. Tese de doutorado. École Nationale du Génie Rural des Eaux et forêts.

Mainieri, C. & Chimelo, J.P. 1989. **Fichas de características das madeiras brasileiras**. 2nd ed. São Paulo, Instituto de Pesquisas Tecnológicas. 418 p.

Martin, L.; Suguio, K.; Flexor, J.-M.; Bittencourt, A. & Villas-Boas, G.

1979/80. Le quaternaire marin brésilien (littoral pauliste, sud fluminense et bahianais). **Cahiers ORSTOM, Série Géologo, 11**, 95-124.

Martin, L.; Suguio, K.; Dominguez, J.M.L. & Flexor, J.-M. 1997. **Geologia do Quaternário costeiro do litoral norte do Rio de Janeiro e do Espírito Santo**. Belo Horizonte, CPRM/FAPESP. 104 p.

Neves, P.C.P. & Lorscheitter, M.L. 1991. Upper Quaternary palaeoenvironments in the Northern Coastal Plain of Rio Grande do Sul, Brazil. **Quaternary of South America and Antartic Peninsula, 9**: 39-67.

Neves, P.C.P. & Lorscheitter, M.L. 1997. Palinologia de sedimentos de uma mata tropical paludosa na Planície Costeira Sul do Rio Grande do Sul, Brasil. In: CONGRESSO DA ASSOCIAÇÃO BRASILEIRA DE ESTUDOS DO QUATERNÁRIO E REUNIÃO SOBRE O QUATERNÁRIO DA AMÉRICA DO SUL, 1997, Curitiba, Paraná. **Resumo expandido...** Curitiba, p. 341-344.

Nimer, E. 1989. **Climatologia do Brasil**. 2ª ed. Rio de Janeiro, IBGE. 421 p.

Sá, C.F.C. 1992. A vegetação da restinga de Ipitangas, Reserva Ecológica Estadual de Jacarepiá, Saquarema (RJ): fisionomia e listagem de Angiospermas. **Arquivos do Jardim Botânico do Rio de Janeiro, 31**: 87-102.

Scheel, R.; Gaspar, M.D. & Ybert, J.P. 1996a. A anatomia dos carvões pré-históricos. Arqueologia encontra respostas em restos de fogueiras e incêndios florestais. **Ciência Hoje, 21** (122): 66-69.

Scheel, R.; Gaspar, M.D. & Ybert, J.P. 1996b. Antracologia, uma nova fonte de informações para a arqueologia brasileira. **Revista do Museu de Arqueologia e Etnologia**, São Paulo, **6**: 3-9.

Scheel-Ybert, R. 1998. **Stabilité de l'Écosystème sur le Littoral Sud-Est du Brésil à l'Holocène Supérieur (5500-1400 ans BP). Les Pêcheurs-Cueilleurs-Chasseurs et le Milieu Végétal : Apports de l'Anthracologie**. Montpellier, France. 3 volumes. Texte, 245 p.; Atlas anthracologique, 114 p. + 1 cdrom; Annexes, 161 p. Tese de Doutorado em Ecologia. Dept. Biologie des Populations et Ecologie, Université Montpellier II.

Scheel-Ybert, R. 1999. Paleoambiente e paleoetnologia de populações sambaquieiras do sudeste do Estado do Rio de Janeiro. **Revista do Museu de Arqueologia e Etnologia, 9**: 43-59.

Scheel-Ybert, R. 2000. Vegetation Stability in the Southeastern Brazilian coastal area from 5500 to 1400 yr BP deduced from charcoal analysis. **Review of Palaeobotany and Palynology, 110**: 111-138.

Scheel-Ybert, R. 2001. Man and vegetation in the Southeastern Brazil during the Upper Holocene. **Journal of Archaeological Science, 28** (5): 471-480.

Scheel-Ybert, R.; Scheel, M. & Ybert, J.-P. 1998. **Atlas Brasil – Databank for charcoal analysis and computerized key to charcoal determination** (In: Portuguese, English and French). Version 1.8. CD-ROM. 1500 entries.

Silva, S.M. 1990. **Composição florística e fitossociologia de um trecho de floresta de restinga na Ilha do Mel, município de Paranaguá, PR**. Campinas. 146 p. Dissertação de Mestrado. Instituto de Biologia, Universidade de Campinas.

Sugiyama, M. 1993. **Estudo de florestas na restinga da Ilha do Cardoso, Cananéia, SP**. São Paulo. 115 p. Dissertação de Mestrado em Ecologia. Instituto de Biociências, Universidade de São Paulo.

Tasayco-Ortega, L.A. 1996. **Variations paléohydrologiques et paléoclimatiques d'une région d'upwelling au cours de l'Holocène: enregistrement dans les lagunes côtières de Cabo Frio (État de Rio de Janeiro, Brésil)**. Paris. 321 p. Tese de Doutorado. Université Paris VI.

Tenório, M.C.; Barbosa, M. & Portela, T. 1992. Pesquisas arqueológicas no sítio Ponta da Cabeça, Arraial do Cabo, Rio de Janeiro. In: REUNIÃO DA SOCIEDADE DE ARQUEOLOGIA BRASILEIRA, 4., 1992, Rio de Janeiro. **Anais...** Rio de Janeiro, SAB. v. 2. p. 279-291.

Ybert, J.P.; Scheel, R. & Gaspar, M.D. 1997. Descrição de alguns instrumentos simples utilizados para a coleta e concentração de elementos fósseis de pequenas dimensões de origem arqueológica ou pedológica. **Revista do Museu de Arqueologia e Etnologia, São Paulo, 7**: 181-189.

Ybert, J.P.; Bissa, W.M. & Kutner, M. 2001. Relative sea-level variations and climatic evolution in Southeastern and Southern Brazil during the Late Holocene. **Pesquisas em Geociências, 28**(2): 75-83