Available online at http://www.journalijdr.com

International Journal of DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 07, Issue, 06, pp.13166-13173, June, 2017

Full Length Research Article

A CONTRIBUTION TO THE IDENTIFICATION OF CHARCOAL FROM ARCHAEOLOGICAL SITES IN RESTINGA LANDSCAPES OF BRAZIL

Gustavo Borba de Oliveira and *Dr. João Carlos Ferreira de Melo Júnior

Laboratório de Anatomia e Ecologia Vegetal, Programa de Pós-Graduação em Patrimônio Cultural e Sociedade, Universidade da Região de Joinville, Rua Paulo Maschitzki, 10, Joinville, Santa Catarina, Brasil

ARTICLE INFO

Article History:
Received 24th March, 2017
Received in revised form
09th April, 2017
Accepted 27th May, 2017
Published online 20th June, 2017

Key Words:
Archaeological Cultural Heritage,
Archaeobotany,
Antracology, Wood Anatomy,
Coastal Plain Vegetation.

ABSTRACT

Wood charcoal comprises the main vestiges found in archaeological sites and can contribute significantly to understanding the species of plants used by ancient human societies and pale environment reconstruction. The present study aimed to characterize 18 typical woody plant species of the Brazilian resting in order to expand reference collections used in anthracological investigations. The principal diagnostic features of the wood can be easily observed with reflected light and scanning electron microscopy. Given the vast diversity of woody flora in tropical environments, reference collections are vital tools for the identification of species encountered in archaeological remains.

INTRODUCTION

The first archaeo botanical studies, dating from the nineteenth century, were undertaken in archaeological sites in Africa and Europe, whose deposition matrices were favorable for the preservation of archaeological remnants of organic origin, thus permitting the recovery of several vegetal traces (Pearsall, 2000; Rodríguez, 2008). Studies with fruits and seeds found in Egyptian tombs (Kunth, 1826) and with seeds reclaimed in swampy lakes in Switzerland (Heer, 1866) pioneered research with vegetal remnants from archaeological contexts. Subsequent studies have identified a wide variety of plant evidence, such as fibers, fruits, seeds and wood (Heer, 1878). For example, Harshberguer (1896) analyzed vegetable remains in the form of household implements and utensils preserved in canyon shelters in Colorado (USA), and Mills (1901) studied carbonized seeds from an open archaeological site located in Ohio (USA). The need to better interpret plant traces in archaeological contexts, and the use of these resources by pre-literate populations, increased significantly during the 20th century and triggered improvements in protocols and the emergence of new research techniques (Ford, 1979; Silva *et al.*, 2013).

Corresponding author: **Dr. João Carlos Ferreira de Melo Júnior**
Laboratório de Anatomia e Ecologia Vegetal, Programa de Pós-Graduação em Patrimônio Cultural e Sociedade, Universidade da Região de Joinville, Rua Paulo Maschitzki, 10, Joinville, Santa Catarina, Brasil.

Techniques commonly used for the recovery of vegetal traces, such as manual collection and dry or wet sieving, were supplanted by the flotation technique, which functions to fractionate the various traces present in archaeological sediment by its density (Pearsall, 2000). This method involves pouring dry sediment into a container with swirling water, from which soft floating material is removed with the aid of a sieve, while denser material is retained in a sieve located within the container (Scheel-Ybert *et al.*, 2005-2006). The improvement of vestigial recovery techniques enabled research with a multidisciplinary perspective, including the determination of paleo environment organization, the identification of morphological changes that occurred during the process of domestication of species of plants and inferring ethnological hypotheses about different groups of prehistoric populations from their relationships with the environment with which they interacted (Scheel-Ybert *et al.*, 1996; 2005-2006).
The use of flotation and other protocols that increased the chances of recovery of micro- and macroscopic plant traces also boosted archaeo botanical research of archaeological sites in Brazil (Scheel-Ybert *et al.*, 2005-2006). However, archaeological sites located in tropical regions are considered less favorable for the preservation of organic material due to taphonomic processes that accelerate their decomposition in the middle of the highly acidic sedimentary matrix (Hastorf and Popper, 1988). Nonetheless, several Brazilian archaeological sites have undergone archaeobotanical investigation in recent decades, gathering information on the

different typologies of plant traces, including skeins and weaves of vegetable fibers (Ceccantini & Gusella, 2001; Peixe *et al.*, 2007), starch granules and phytoliths (Wesolowski *et al.*, 2007; Pereira, 2010; Corteletti *et al.*, 2016), waterlogged wood stakes (Santos *et al.*, 2013; Melo Júnior *et al.*, 2016), wood in natura (Ceccantini & Fernandez, 2005; Rodrigues & Melo Júnior, 2015) and wood charcoal (Scheel *et al.*, 1996; Figueiral, 1998; Figueiral & Sanches, 1999; Ceccantini, 2001; Scheel-Ybert *et al.*, 2006; Keneip, 2009; Melo Júnior & Ceccantini, 2010; Nakamura *et al.*, 2010; Bechelet *et al.*, 2011; Silva *et al.*, 2013; Melo Júnior & Magalhães, 2015; Bachelet, 2016). With improvements to field and laboratory techniques for the appropriate treatment of traces of plant origin (Scheel-Ybert *et al.*, 2005-2006), the interaction between the natural sciences and archeology narrowed, there by permitting the elaboration of interpretations of a variety of aspects of the way of life of past populations. However, a significant gap in knowledge remains; specifically the taxonomic identification of material of plants species contained in assemblies recovered at archaeological sites. That is to say, archaeobotanical surveys lack reference collections based on the contemporary flora of the natural surroundings of archaeological sites, which would facilitate more reliable typological comparisons and taxonomic identifications.

Although wood, mainly charred, accounts for the largest part of plant remains found in archaeological sites (Scheel-Ybert, 2004), wood collections correspond to only 14.28% of the botanical collections of archaeological interest housed by research institutions in Brazil (Scheel-Ybert, 2016). A recently published survey found that there are only about 28 Brazilian wood collections, most of which are concentrated in the North and Southeast regions of the country (Melo Júnior *et al.*, 2014). Of these, only 4 have archaeobotanical material, and are located in the states of São Paulo (2), Rio de Janeiro (1) (Scheel-Ybert, 2016) and Santa Catarina (1) (Melo Júnior *et al.*, 2014). Therefore, the scarcity of reference collections represents an important void in need of being addressed by the development of projects in support of archaeobotanical research. The present investigation aimed to address this lack of reference collections by studying archaeological sites in areas of contemporary resting a. This work is based on the principle that local floras can facilitate better interpretations of archaeological vestiges by means of providing anatomical characterizations of carbonized wood (chacoal), in the form of an anthracological reference collection.

MATERIALS AND METHODS

Eighteen woody species known to be abundant and widely distributed in Brazilian restingas (Melo Júnior & Boeger, 2015) were analyzed. They are: 1 – *Alchornea triplinervia* (Spreng.) Müll. Arg. (Euphorbiaceae); 2 – *Andira fraxinifolia* Benth. (Fabaceae); 3 - *Calophyllum brasiliense* Cambess. (Calophyllaceae); 4 - *Clusia criuva* Cambess. (Cluseaceae); 5 - *Dalbergia frutescens* (Vell.) Britton (Fabaceae); 6 - *Guapira opposita* (Vell.) Reitz (Nyctaginaceae); 7 – *Ilex theezans* Mart ex Reissek (Aquifoliaceae); 8 - *Myrcia pulchra* (O.Berg) Kiaersk (Myrtaceae); 9 - *Myrsine venosa* A. DC. (Primulaceae); 10 - *Nectandra oppositifolia* Nees & Mart. (Lauraceae); 11 - *Ocotea pulchella* (Nees & Mart.) Mez (Lauraceae); 12 - *Pera glabrata* (Schott) Poepp. ex Baill. (Peraceae); 13 - *Psidium cattleianum* Sabine (Myrtaceae); 14 - *Scaevola plumieri* (L.) Vahl (Goodeniaceae); 15 - *Schinus terebinthifolia* Raddi (Anacardiaceae); 16 - *Schwartzia brasiliensis* Choisy (Marcgraviaceae); 17 - *Symphyopappus casarettoi* B.L. Rob. (Asteraceae); 18 - *Ternstroemia brasiliensis* Cambess. (Pentaphylacaceae). Wood samples were collected from well conserved *restinga* environments of the coastal plain of the state of in Santa Catarina in southern Brazil (Melo Júnior & Boeger, 2015), whose occupation began approximately 7000 years BP (De Blasis *et al*., 2007). Wood samples from trees were taken from main stem branches at 1.3m above the ground, and from the stem base of the largest-diameter tiller when coming from shrubs. All samples are registered in the reference collection of the Xiloteca - JOIw of the Universidade da Região de Joinville, Santa Catarina, Brazil (Melo Júnior *et al*., 2014). Wood samples (3 to 5cm³) were carbonizatized in a muffle furnace (Bravac ®) at the maximum temperature of 400°C for a period of 30 to 50 minutes (Pearsall, 2000). The result ant charcoal was packed in individual plastic bags; labeled with species, botanical family and a number corresponding to the wood sample; and incorporated into the aforementioned anthracological wood collection. Anatomical characterization of charcoal was performed using reflected light microscopy (RLM) (Miskovsky, 1987) by means of manual fragmentation of the charcoal in the three usual planes used for studying wood: transversal, longitudinal tangential and longitudinal radial. The description of the diagnostic characters of the wood of each species and, when possible, of carbonized archaeological remains, employed the terminology recommended by the IAWA committee (1989). Electro micrographs of the charcoal were obtained using a Tescan Vega-3 LMU scanning electron microscope (SEM).

RESULTS

Diagnostic anatomical traits remained well preserved after the carbonization process in all species studied, and could be clearly observed with RLM and in the electro micrographs obtained by SEM. In addition to other characters, growth rings, perforation plates, structural and cellular composition of rays, and axial parenchyma type were particularly useful in describing the wood of the studied species (Table 1). Figures 1-3 shows the electro micrographs in transversal section of the wood charcoal of the 18 species studied, highlighting the main characters of each species. The charcoals micrographs are all of transverse section, because this section has more information about the species.

DISCUSSION

The feasibility of using carbonized vegetal remains obtained from archeological matrices, whether for paleoenvironmental reconstruction or for inferring hypotheses about the use of vegetation by pre-existing populations (Scheel-Ybert, 2004; Scheel-Ybert *et al*., 2005-2006; Scheel-Ybert *et al*., 2006), is no longer under debate. Comparative anatomical study remains today the most common method for identification of plant species (Wheeller & Bass, 1998). Although technological advances have aided anthracological surveys, such as computerized databases, they have not proven to be a substitute for reference collections (Scheel-Ybert *et al*., 2006), particularly in mega diverse tropical regions of the planet. However, in these regions, studies of wood anatomy alone are still insufficient for addressing all of the existing plant species (Scheel-Ybert *et al*., 2006). The great botanical diversity of Brazil, which possesses approximately 49,500 species of plants (Peixoto & Morim, 2003), presents great challenges for species identification compared to temperate regions where

Table 1 - Anatomical description of the 18 woody species from brasilian *restinga*. Legend: GR: growth rings (D): distinct; I: indistinct; Fz: demarcated by fiber zone; Ra: demarcated by enlargement of the rays; Mp: demarcated by marginal parenchyma). Ø: tangential vessel diameter (average). Rays composition (A: body ray cells procumbent with 1-2 row of uprigth and/or square marginal cells; B: body ray cells procumbent with 2-4 rows of uprigth and/or square marginal cells; C: body ray cells procumbent with over 4 rows of uprigth and/or square marginal cells; D: Rays with square and uprigth cells; E: Rays with procumbent, square and uprigth cells mixed throughout the ray).

Specie	GR	Vessel				Fiber	Axial parenchyma	Rays	
		Grouping	Ø	Nº per mm²	Perforation plates	wall thickness	type	Width	Composition
Alchornea triplinervia	D/Fz	multiples 2-6/rarely solitary	128	7.59	simple	thin-walled	apotracheal diffuse-in-aggregates	1	B
Andira fraxinifolia	D/Mp	multiples 2-6/solitary	160	2.73	simple	very thick-walled	bands more than tree cells wide four cells per parenchyma strand	1-4	A
Calophyllum brasiliense	I	clusters common/solitary	163	10	simple	thin-walled	paratracheal confluent in narrow bands or lines	1	A
Clusia criuva	D/Fz	radial and tangential multiples 2-3/solitary/rarely clusters	70	12	simple scalariform	thin- to thick-walled	scanty paratracheal	2-5	A
Dalbergia frutescens	D/Fz	multiples 2-8/clusters/tangential multiples/rarely solitary	45	101	simple	thin-walled	scanty paratracheal	1-3	B
Guapira opposita	D/Fz	multiples 2-(3)-4/rarely solitary	27	17	simple	thin- to thick-walled	scanty paratracheal	1	A
Ilex theezans	D/Fz/Ra	radial multiples 2-10/rclusters common/rarely solitary	55	56	scalariform	thick-walled	apotracheal diffuse and diffuse-in-aggregates, scanty paratracheal	1-5	A
Myrcia pulchra	D/Fz	exclusively solitary	40	70	simple	very thick-walled	scalariform	1-3	C
Myrsine venosa	I	radial multiples 2-7/clusters common/rarely solitary	60	43	simple	very thick-walled	scanty paratracheal	2-11	C
Nectandra oppositifolia	D/Fz	multiples 2-5/solitary	126	10	simple	thin-walled	paratracheal vasicentric	1-5	C
Ocotea pulchella	D/Fz	multiples 2-3/solitary/rarely clusters	112	17	simple	thin-walled	scanty paratracheal, paratracheal vasicentric	2	A
Pera glabrata	D/Fz	multiples 2-8/clusters common/rarely solitary	103	9	simple	thin-walled	scanty paratracheal, scalariform	1	A
Psidium cattleianum	D/Fz	*/multiples 2-5/rarely clusters/solitary	103	34	simple	thin- to thick-walled	scanty paratracheal	4-10	E
Scaevola plumieri	D/Fz	solitary/rarely clusters	67	41	simple	thin-walled	scanty paratracheal	1-4	D
Schinus terebinthifolia	D/Fz	multiples 2-7/solitary/rarely clusters	70	72	simple	thin-walled	scanty paratracheal	1-3	A
Schwartzi abrasiliensis	D/Fz	multiples 2-6/rarely clusters/solitary	78	17	simple	thin- to thick-walled	apotracheal diffuse, scanty paratracheal,	1-3	C
Symphyopappus casarettoi	D/Fz	*/multiples 2-8/clusters common/rarely solitary	31	164	simple	thin- to thick-walled	scanty paratracheal	1-4	D
Ternstroemia brasiliensis	D/Fz	*/radial multiples 2-9/tangential multiples 2-3/rarely clusters/solitary/vasicentric tracheids present	55	97	scalariform	thin- to thick-walled	apotracheal diffuse and diffuse-in-aggregates,scanty paratracheal	1 /5-8	E

there is less floristic diversity. Furthermore, the morphological and anatomical characteristics of plant traces preserved in archaeological matrices in the tropics are poorly known (Scheel-Ybert *et al*., 2006). It is estimated that 8,715 arboreal woody species occur only in Brazil (Beech *et al*., 2017). Therefore, the development of reference collections and research that characterize charcoal anatomy, are becoming increasingly important tools for archeology (Scheel-Ybert *et al*., 2006). More specifically, anthracological analyses of charred vegetal remains are based on taphonomic studies that seek interpretive answers. This bias seeks to understand the "evolution" of these carbonized remains, from their selection from a living organism, to their transportation, burning, even recovery in *situ*, which assist in forming anthrachological interpretations (Théry-Parisot *et al*., 2010). Although quantitative anatomical data of wood obtained from charcoal needs to be used with care since cell size can be altered during the carbonization process, works employing comparative anatomy of wood tend to error less in identifying a botanical genus or family (Wheeller & Bass, 1998).

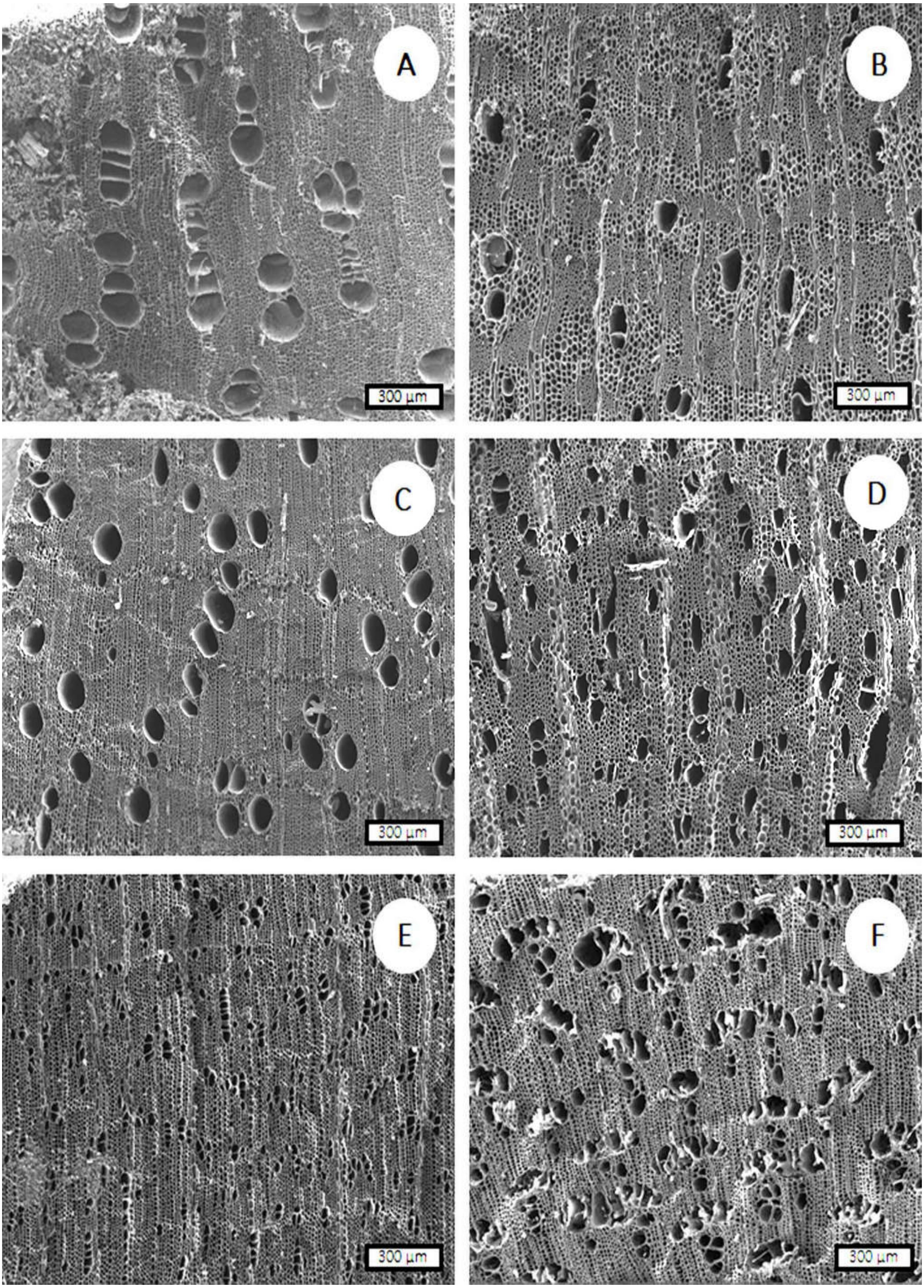

Figure 1. Wood anatomy of the woody species from brasilian *restinga* in cross section. Legend: A - *Alchornea triplinervia* (Spreng.) Müll. Arg. (Euphorbiaceae); B – *Andira fraxinifolia* Benth. (Fabaceae); C - *Calophyllum brasiliense* Cambess. (Calophyllaceae); D - *Clusia criuva* Cambess. (Cluseaceae); E - *Dalbergia frutescens* (Vell.) Britton (Fabaceae); F - *Guapira opposita* (Vell.) Reitz (Nyctaginaceae)

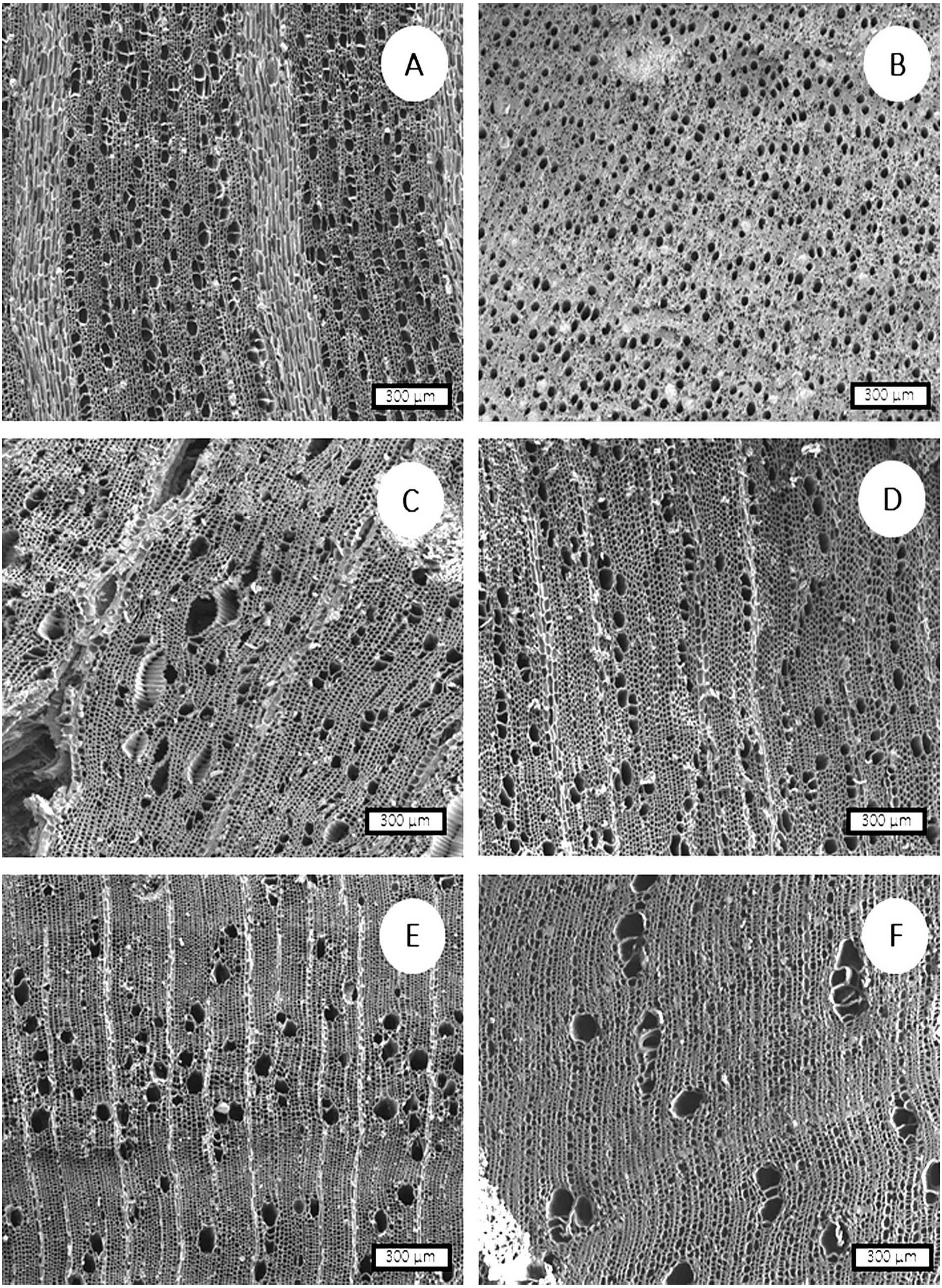

Figure 2. Wood anatomy of the woody species from brasilian *resting* in cross section. Legend: A – *Ilex theezans* Mart ex Reissek (Aquifoliaceae); B - *Myrcia pulchra* (O.Berg) Kiaersk (Myrtaceae); C - *Myrsine venosa* A. DC. (Primulaceae); D - *Nectandra oppositifolia* Nees & Mart. (Lauraceae); E - *Ocotea pulchella* (Nees & Mart.) Mez (Lauraceae); F - *Pera glabrata* (Schott) Poepp. ex Baill. (Peraceae)

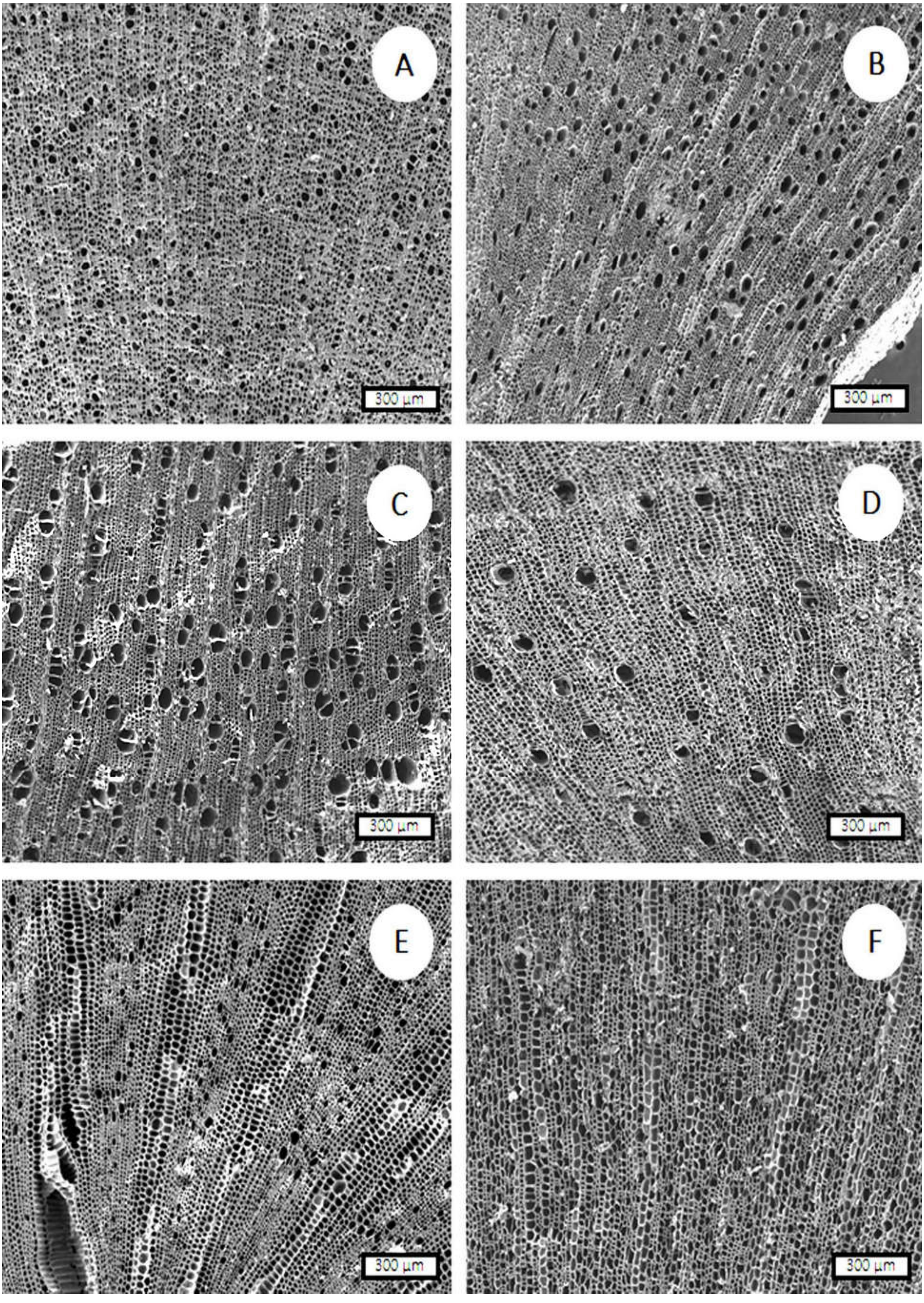

Figure 3. Wood anatomy of the woody species from brasilian *resting* in cross section. Legend: A - *Psidium cattleianum* Sabine (Myrtaceae); B - *Scaevola plumier* (L.) Vahl (Goodeniaceae); C - *Schinus terebinthifolia* Raddi (Anacardiaceae); D - *Schwartzia brasiliensis* Choisy (Marcgraviaceae); E - *Symphyopappus casarettoi* B.L. Rob. (Asteraceae); F - *Ternstroemia brasiliensi* Cambess. (Pentaphylacaceae)

Moreover, the processes of deposition and preservation of remains in archaeological matrices may or may not have a selective influence on the plant species encountered and interpreted to have been used by pre-existing populations, due to their varied uses such wood for cooking (Alves, 2004), lighting, protection, heating, drying and processing of raw materials (Théry-Parisot, 2001); and use in ritual ceremonies (Scheel-Ybert, 2004). Comparing data on the physico-chemical properties of wood with the assemblage of charcoal recovered from a shelter-type archeological site under rockin central Brazil, Melo Júnior and Magalhães (2015) found an important relationship between the calorific content of woody species and the selective collection of timber used in combustion by pre-historic populations that occupied the region between 4140 ± 40 and 8900 ± 40 years BP. These potential "human filters" of selection of species may directly bias antrachological interpretations (Théry-Parisot *et al*., 2010). For some woody species, are duction in wood mass after combustion may also have an unintended influence on anthrachological interpretations, given that certain taxa are not well preserved in charcoal form and rapidly become ash (Scheel-Ybert, 2004, Melo Júnior & Magalhães, 2015). Scheel-Ybert (2004) reports that mass reductions of 4%, 69% and 76% of initial dry weight were observed for combustion temperatures of 250 °C, 400 °C and 600 °C, respectively. These processes not only imply an alteration of remains from their original form, but also their fragmentation (Scheel-Ybert *et al*., 2006). Fragmentation is expressed by the rupture or breaking experienced by charcoal during combustion and/or post-depositional interferences (Scheel-Ybert, 2004). For some authors (Smart & Hoffman, 1988; Popper, 1988; Thompson, 1994), the frequency of charcoal observed at an archaeological site does not directly correspond to the quantity of wood burned, since the proportions among taxa can be altered by preservation, differential fragmentation and mass reduction. Thererfore, when considering the taphonomic aspects involved in the genesis of archaeological charcoals, the comparison of species are likely to be more useful when they experience similar processes of preservaton. For example, woody plant remains that typically have more frequent post-burning preservation, as compared to previously carbonized samples, facilitate species identification (Scheel-Ybert *et al*., 2006). Among the methods and data used for analysis of carbonized remains, wood anatomy has been shown to be one of the more important tools for determining probable botanical identity (Melo Júnior, 2009). Reference collections used in studies of plant anatomy represent the best way of recognizing the different species that were used by pre-historic populations, and thus are provide essential support to the research that pervades archeology.

REFERENCES

Alves, M.A. 2004. Estratigrafia, estruturas arqueológicas e cronologia do sítio Água Limpa, Monte Alto, São Paulo. Revista do Museu de Arqueologia de Xingó. 4: 283-324.

Bachelet C, Vialou AV, Ceccantini G, Vialou D 2011. Um tição de aroeira em contexto arqueológico: contribuição antracológica para a compreensão da relação entre o homem e o ambiente. R. Museu Arq. Etn. São Paulo. 21:115-127.

Bachelet, C. 2016. Use of wood resources during the Holocene by hunter-gatherers of the Cidade de Pedra, Mato Grosso, Brasil.Cadernos do Lepaarc. 13(25): 388-400.

Barros CF, Marcon-Ferreira ML, Callado CH, Lima HRP, Cunha M, Marquete O, Costa CG 2006. Tendências ecológicas na anatomia da madeira de espécies da comunidade arbórea da Reserva Biológica de Poço das Antas, Rio de Janeiro, Brasil. Rodriguésia. 57: 443-460.

Ceccantini GCT 2001. O uso de marcadores florísticos e faunísticos em arqueologia. Cadernos de Pesquisa em Educação PPGE.UFES, 13(1): 47-56.

Ceccantini GCT, Fernandez MH 2005. Anatomia das estacas arqueológicas do abrigo rupestre: considerações tecnológicas e paleoambientais. In: Pré-história do Mato Grosso. Vol.1: Santa Elina[S.l: s.n.].

Ceccantini GCT, Gussella LW 2001. Os novelos de fibras do Abrigo Rupestre Santa Elina (Jangada, MT, Brasil): anatomia vegetal e paleoetnobotânica. Revista do Museu de Arqueologia e Etnologia, São Paulo, 12(11): 189-200.

Corteletti R, Dickal R, Deblasis P, Iriarte J 2016. Análises de Grãos de Amido e Fitólitos nas Terras Altas do Sul do Brasil: Repensando a Economia e Mobilidade dos Grupos Proto-jê Meridionais. Cadernos do *LEPAARQ* – Textos de Antropologia, Arqueologia e Patrimônio*,* 12 (25): 164 - 196.

DeBlasis P, Kneip A, Scheel-Ybert R, Giannini P, Gaspar, MD 2007. Sambaquis e paisagem: Dinâmica Natural e Arqueológia Regional no Litoral Sul do Brasil. Arqueologia Sudamericana/ Arqueologia Sulamericana. 3: 29-61.

Figueiral I 1998. O abrigo Pena d'Água (Torres Novas): a contribuição da antracologia. Revista Portuguesa de Arqueologia. 1(2): 73-79.

Figueiral I, Sanches MJ 1989-1999. A Contribuição da Antracologia no Estudo de Recursos Florestais de Trás-os-montes e Alto Douro Durante a Pré-história Recente. PORTVGALIA. Nova série, Vol. XIX-XX.

Food and Agriculture Organization of the United Nations – FAO 2005. Global Forest Resources Assessment Country Reports, Brazil. Rome: FAO, pp. 104.

Ford RI 1978. Ethnobotany: Historical diversity and synthesis. In: R.I. Ford (ed) The nature and status of ethnobotany. Anthropological Papers, University of Michigan Museum of Anthropology. 67: 33-50.

Harshberger, J.W. 1896. Purposes of ethnobotany. Botanical Gazette, 21: 146-154.

Heer O 1866. Treatise on the plants of the lake dwellings. In: The Lake Dwellings of Switzerland and Other Parts of Europe, edited by Ferdinand Keller, translated by John E. Lee. Longmans, Green, London.

Heer O 1878. Abstract of the treatise on the "Plants of the lake Dwellings." In: The Lake Dwellings of Switzerland and Other Parts of Europe, (Vol. 1), edited by Ferdinand Keller, translated by John E. Lee. Longmans, Green, London.

Hubbell S, Fangliang H, Richard C, Borda-de-Água L, Kellner J, Steege H 2008. How many tree species are there in the amazon and how many of them will go extinct? Proceedings of the National Academy of Sciences USA. 105:11498-11504.

IAWA COMMITTEE, 1989. IAWA list of microscopic features for hardwood identification. In: Wheeler EA, Baas P, Gasson PE (Eds.) IAWA Bulletin.10(3):219-332.

Keneip, LM 2009. A utilização de plantas pelos pescadores, coletores e caçadores pré-históricos da restinga de saquarema, Rio de Janeiro, Brasil. Rodriguésia. 60(1): 203-210.

Kunth, C 1826. Examen botanique. In: Passalacqua, J. (Ed.). Catalogue raisonné et historique de antiquités découvertes emEgypte. Paris: Galerie d'Antiquités Égyptiennes, pp 227-229.

Melo Júnior JCF 2009. Aplicações de macrorrestos vegetais em estudos arqueológicos: aspectos metodológicos e interpretativos. Revista UNIVILLE. 14: 31-44.

Melo Júnior JCF 2015. Plasticidade morfológica e diversidade funcional de comunidades florísticas em gradiente edáfico na restinga do parque estadual do acaraí, São Francisco Do Sul/Sc. 11 de Fevereiro de 2015. 168 pg. Tese (Ecologia e Conservação) – Curso de Pós-Graduação em Ecologia e Conservação da Universidade Federal do Paraná (UFPR). Curitiba, 2015.

Melo Júnior JCF, Amorim MW, Silveira ER 2014. A xiloteca (coleção Joinvillea – JOIw) da Universidade da Região de Joinville. Rodriguésia, 65 (4): 1057-1060.

Melo Júnior JCF, Ceccantini G (2010). Análise antracológica preliminar. Em *Lapa das Boleiras: um sítio peleoíndio do carste de Lagoa Santa, MG, Brasil*, Org. Araújo AGM, Neves WA, São Paulo, Annablume, pp. 159- 187.

Melo Júnior JCF, Magalhães WLE 2015. Antracologia de fogueiras paleoíndias do Brasil central: considerações tecnológicas e paleoetnobotânicas sobre o uso de recursos florestais no Abrigo Rupestre Lapa Do Santo, Minas Gerais, Brasil. Antípoda Rev. Antropol. Arqueol. 22: 137-161.

Melo Júnior JCF, Silveira ER, Bandeira DR 2016. Arqueobotânica de um sambaqui sul-brasileiro: integrando indícios sobre o paleoambiente e o uso de recursos florestais. Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas. 11(3): 727-744.

Mills WC 1901. Plant remains from the Baum Village site. *Ohio Naturalist.* 1(5): 70-71.

Miskovsky, Jean-Claude 1987. *Géologie de la préhistoire: méthodes, techniques, applications*. Paris: Association pour l´Étude de l´Environnement Géologique de la Préhistoire.

Montpellier II, USTL. 1999. Paleoambiente e paleoetnologia de populações sambaquieiras do sudeste do Estado do Rio de Janeiro. Revista do Museu de Arqueologia e Etnologia, São Paulo, 3(9): 43-59.

Nakamura C, Melo Júnior JCF, Ceccantini G 2010. Macro-restos vegetais: uma abordagem paleoetnobotânica e paleoambiental. In: *Lapa das Boleiras - um sítio Paleoíndio do Carste de Lagoa Santa, MG, Brasil*, Org. Araújo AGM, Neves WA, São Paulo, Annablume, pp. 159- 187.

Pearsall DM 2000. Paleoethnobotany: a handbook of procedures. 2. ed. San Diego: Academic Press.

Peixe SP, Melo Junior JCF, BANDEIRA DR 2007. Paleoetnobotânica dos macrorrestos vegetais do tipo trançados de fibras encontrados no sambaqui Cubatão I, Joinville – SC. *Revista do Museu de Arqueologia e Etnologia*, São Paulo. 17: 211-222.

Peixoto AL, Morim MP 2003. Coleções Botânicas: documentação da biodiversidade brasileira. Cienc. Cult. São Paulo. 55(3).

Pereira, GL 2010. Identificação de fitólitos a partir de fragmentos de carvão. Cadernos do *LEPAARQ* – Textos de Antropologia, Arqueologia e Patrimônio. 7(13/14).

Popper VS 1988. Selecting quantitative measurementsin paleoethnobotany. In: Hastorf CA, Popper VS. Current Paleoethnobotany: Analytical methods and cultural interpretation of archaeological plant remains. Chicago, London: The University of Chicago Press, pp 53-71.

Rodríguez MF 2008. Analizando el registro arqueológico: arqueobotánica vs. paleoetnobotánica. In: Archila MS, Giovannetti M, Lema V (2008). Arqueobotánica y teoriaarqueológica: discusiones desde Sudamérica. Bogotá: Universidad de Los Andes/Ediciones Uniandes, pp 51-62.

Santos AMP, Bianchini GF, Bandeira DR, Melo Júnior JCF 2013. Macrovestígios arqueológicos vegetais encharcados: Subsídios para resgate e conservação. In: Abordagens Estratégicas em Sambaquis, Org. Gaspar MD e Souza SM. Erechim/RS, Habilis, pp. 237 – 250

Scheel R., Gaspar MD, Ybert JP 1996. Antracologia, uma nova fonte de informações para a arqueologia brasileira. Revista doMuseu de Arqueologia e Etnologia, São Paulo. 6: 3-9.

Scheel, R, Gaspar MD, Ybert, JP 1996. Antracologia, uma nova fonte de informações para a Arqueologia Brasileira. *Rev. do Museu de Arqueologia eEtnologia, São* Paulo, 6: 3-9.

Scheel-Ybert R 2004. Teoria e Métodos em Antracologia. 1 – Considerações Teóricas e Perspectivas. Arquivos de Museu Nacional, Rio de Janeiro. 62(1):3-14.

Scheel-Ybert R 2016. Charcoal collections of the word. *IAWA Journal*. 37 (3): 489-505.

Scheel-Ybert R, Carvalho MA, Moura POR, Gonçalves TAP, SCHEEL M, Ybert JP (2006). Coleções de referência e Bancos de Dados de Estruturas Vegetais: Subsídios Para Estudos Paleoecológicos e Paleoetnobotânicos. Arquivos do Museu Nacional, Rio de Janeiro. 64(3): 255-266.

Scheel-Ybert R, Klökler D, Gaspar MD, Figuti L 2005-2006. Proposta de amostragem padronizada para macrovestígios bioarqueológicos: antracologia, arqueobotânica, zooarqueologia. Rev. do Museu de Arqueologia e Etnologia, São Paulo. 15-16: 139-163.

Scheel-Ybert, R 2003. Relações dos habitantes de sambaquis com o meio ambiente: evidências de manejo de vegetais na costa sul-sudeste do Brasil durante o Holoceno Superior. *Atas do IXCongresso da Associação Brasileira deEstudos do Quaternário e II Congresso doQuaternário de Países de Línguas Ibéricas*. Cd-rom. Recife, Video Congress, pp 5.

Silva FM, Shock M, Neves EG, Lima HP, Scheel-Ybert R 2013. Recuperação de macrovestígios em sítios arqueológicos na Amazônia: nova proposta metodológica para estudos arqueobotânicos. Boletim do MuseuParaense Emílio Goeldi. Ciências Humanas. 8(3): 759-769.

Smart TL, Hoffman ES 1988. Environmental interpretation of archaeological charcoal. In: Hastorf CA, Popper VS. Current Paleoethnobotany: Analytical methods and cultural interpretation of archaeological plant remains. Chicago, London: The University of Chicago Press, pp 167-205.

Théry-Parisot I, Chabal L,Chrzavzez J 2010. Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal assemblages, in archaeological contexts. ELSEVIER, Palaeogeography, Palaeoclimatology, Palaeoecology. 291: 142–153.

Théry-Parisot, I 2001. Économie des combustibles au Paléolitique. Paris, CNRS.

Thompson GB 1994. Wood charcoals for tropical sites: a contribution to methodology and interpretation. In: Hather JG (Ed.) Tropical Archaeobotany. Applications and new developments. London, New York: Routledge, pp 9-33.

Weeller EA, Bass P 1998. Wood Identification – A Review. IAWA Journal, 19(3):241-264.

Wesolowski V, Souza SMFM, Karl RK, Ceccantini G 2007. Grânulos de amido e fitólitos em cálculos dentários humanos: contribuição ao estudo do modo de vida e subsistência de grupos sambaquianos do litoral sul do Brasil. Revista do Museu de Arqueologia e Etnologia, São Paulo. 17: 191-210.

****