

Wood charcoal production and forest dynamics in the Pedra Branca Massif, Rio de Janeiro, RJ, Brazil

Mariana Beauclair^{1,2,4}, Alisson Rangel^{1,3}, Rogério Ribeiro de Oliveira⁴ and Rita Scheel-Ybert¹

- 1 Museu Nacional, Universidade Federal do Rio de Janeiro (MN/UF RJ) – Departamento de Antropologia, Laboratório de Paleoecologia Vegetal, Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, Brazil; scheelybert@mn.ufrj.br
- 2 Instituto Estadual do Ambiente (INEA/RJ), Av. Venezuela 110, 20081-312, Rio de Janeiro, RJ, Brazil; mariana.oliveira@inea.rj.gov.br
- 3 Escola Superior de Agricultura "Luiz de Queiroz", USP. Av. Pádua Dias, 11, 13418-900, Piracicaba, SP, Brazil; alissonrangel@usp.br
- 4 Pontifícia Universidade Católica do Rio de Janeiro, Rua Marquês de São Vicente 225, Gávea, 22453-900, Rio de Janeiro, RJ, Brazil.

Summary: *Vestiges of dozens of historical charcoal kilns are found in the Caçambe River watershed (Southeastern Pedra Branca Massif, Rio de Janeiro, Brazil). They are remains of the charcoal production that took place in the region from late 19th to mid 20th century to supply Rio de Janeiro city. Taxonomic identification and diameter estimates, compared to present day phytosociological data, aimed to understand the Atlantic Forest dynamics under human influence. Almost a thousand fragments were analyzed from a kiln at the valley bottom and another at the top of the drainage basin.*

Key words: *charcoal kilns, anthracology, Atlantic forest, forest dynamics, Brazil.*

INTRODUCTION

Anthracological analysis of charcoal kilns has shown that wood charcoal production can have deep and long lasting effects in the landscape (e.g. Izard, 1992) or no significant change at all (e.g. Ludemann, 2002). No research of this kind has yet been carried out in tropical regions, although phytosociological studies in areas where historical land use is known, have shown that charcoal production may have long lasting effects (e.g. García-Montiel and Scatena, 1994).

The Pedra Branca Massif is located to the west of Rio de Janeiro city. At present, it is covered by Atlantic Forest, and up to now 156 charcoal kilns have been found among the woods. The charcoal production took place in this region at least from the late 19th to the mid 20th century, to supply the federal capital (Magalhães Correa, 1936).

This work aims to understand the forest dynamics under human influence, through the anthracological analysis of charcoal kilns located in the Southeast Massif, in the Caçambe River watershed, and its comparison with the forest that stands now in the same area.

MATERIAL AND METHODS

Two charcoal kilns were sampled: one at the valley bottom and another at the top of the drainage basin. Test pits of 0.04 m² located at the center, periphery and middle (between center and periphery) of the kilns were sampled. Non-stratified soil samples were obtained from 0.05 m layers. Soil was sieved and floted using 4 mm meshes. Charcoal fragments were broken by hand to expose transverse, longitudinal tangential and longitudinal radial sections, observed in a reflected light microscope with bright and dark fields. Taxonomical identification was based on wood anatomy literature and databases, and on a charcoal reference collection.

Minimum diameters were estimated using a diameter stencil. Sample validity was tested through saturation and Gini-Lorenz curves. Multivariate statistical analysis tested differences among samples (SIMPER and ANOSIM) and compared charcoal and phytosociological data (NMDS).

Phytosociological data were obtained by Santos (2009), who surveyed trees around ten kilns in the studied area (four 100 m² parcels around each kiln). Volume and explored area were estimated based on kiln area and historic description (Magalhães Correa, 1936), to render phytosociological and archaeological data comparable.

RESULTS AND DISCUSSION

Taxonomic identification and diameter estimates were performed for 594 charcoal pieces from the valley bottom kiln (MPB IV) and 350 from the top of the drainage basin kiln (MPB IX).

Charcoal types were heterogeneously distributed through the archaeological sites, either horizontally or vertically, but were not statistically significant. Anatomical types or diameter classes could not be associated to charcoal kiln structure. These results, coupled to the absence of stratification in the sites, suggest that charcoal kilns were produced by single events.

In MPB IV 113 dicot types were identified (107 woody plants, six lianas), mostly pioneer and initial secondary taxa (e.g. *Cecropia* sp., *Guarea* sp., *Tibouchina* sp.). Diameter histograms revealed a coppice type vegetation (Nelle, 2002) (Fig. 1), confirming taxonomic results.

Although in a similar successional stage, present day valley bottom forest is dominated by the species *G.*

Archaeological charcoal: natural or human impact on the vegetation

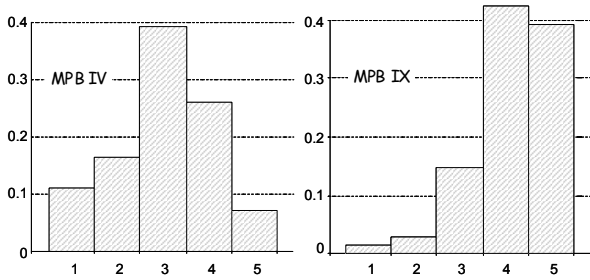


FIGURE 1. Frequency histograms of charcoal fragments according to minimum diameter classes at sites MPB IV ($n=594$) and MPB IX ($n=350$) (1:0-2,9cm; 2:3-4,9cm; 3:5-9,9cm; 4:10-14,9cm; 5:>15cm).

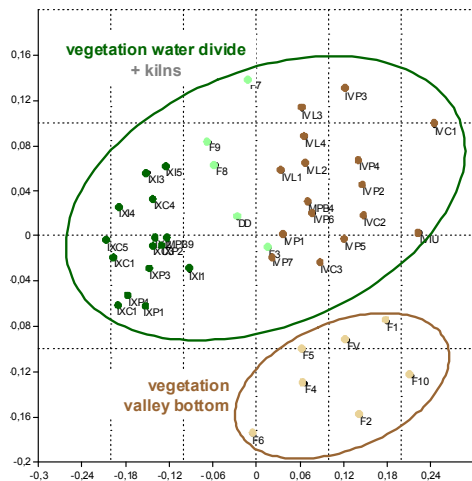


FIGURE 2. NMDS comparing charcoal assemblages to phytosociological data from valley bottom and top of the drainage basin (Santos, 2009).

guidonia (Santos, 2009) and has low species diversity, either by Atlantic forest standards or when compared to the charcoal assemblage.

In MPB IX 66 dicot types were identified (62 woody plants, four liana types), most of them characteristic of mid and late secondary succession (e.g. *Copaifera* sp., *Pouteria* sp., *Lamanonia* sp.). Diameter histograms revealed a profile that can be associated with large wood size type (Nelle, 2002) (Fig. 1), also corroborating taxonomic results, which suggest a forest in a more advanced successional stage.

Present day top of the drainage basin forest, also in a similar successional stage, has a similar diversity and structure pattern (Santos, 2009). The high diversity of both sites, coupled to the presence of many species much valued for other purposes, suggests that species selection was not practiced. Nowadays, species diversity is greater at the top of the drainage basin (Santos, 2009), while the charcoal assemblages suggest greater diversity in the valley bottom. NMDS showed that charcoal assemblages of both kilns and present day top of the drainage basin survey are more similar to each other than to present valley bottom (Fig. 2). SIMPER analysis identified the dominance of *G. guidonia* as the main cause of the separation of present day valley bottom.

G. guidonia is a common species in tropical forests, including the Atlantic Forest, but under few circumstances is the most frequent. It is possible that the

historic management of the valley bottom somehow favored the spread of this species. Due to its allelopathic properties, it is possible that when in higher densities it prevents the establishment of other species. Consequently, it seems that an alternative successional pathway has been triggered, i.e. the successional pathway towards a dynamic equilibrium characterized by high basal area, biomass, and diversity expected in tropical forests (Schnitzer *et al.*, 2000) does not seem to be happening.

CONCLUSION

The forest used to produce charcoal in the valley bottom had higher species diversity than nowadays. *G. guidonia*, the present time dominant species, was probably present in the past, but just as one more species. It is possible that the intense human use of the area triggered an alternative successional pathway in which the allelopathic *G. guidonia* became dominant and challenged the establishment of other species. The top of the drainage basin forest, in which human activities were less intense, does not seem to have had its dynamics significantly altered.

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