

POSSIBLE PREHISTORIC ANTHROPOGENIC EFFECT ON *ARAUCARIA ANGUSTIFOLIA* (BERT.) O. KUNTZE EXPANSION DURING THE LATE HOLOCENE

ANA LUISA VIETTI BITENCOURT & PATRÍCIA MARIA KRAUSPENHAR
Instituto Anchieta de Pesquisas, UNISINOS, Av. Brasil, 725, Cx. P. 275, 93001-970, São Leopoldo, RS, Brasil.
vietti@unisinós.br; patriciakrauspenhar@yahoo.com.br

ABSTRACT – This study offers a few thoughts about a possible prehistoric anthropogenic effect on the expansion of *Araucaria angustifolia* during the late Holocene based on overlay and analysis of archeological, geographical, palynological and botanical data. Archeological research reveals that groups of pottery-producing hunter-gatherers belonging to the *Jê* linguistic stock. These are archeologically defined as the Taquara/Itararé Tradition, and occupied the highlands in southern Brazil from 2000 years BP until 200 years BP. Major resource uses regarding forest vegetation were hunting, *Araucaria* nuts seed harvesting (considered an essential component in the diet) and agroforestry management. Their settlements, known as *casas subterrâneas* (pit houses), were distributed according to relief and geography under the domain of *Araucaria* forest. A strong expansion of *Araucaria angustifolia* in the late Holocene is recorded by various palynological studies as occurring after 1,500 years BP in Paraná, 1,000 years BP in Santa Catarina and 1,140 years BP in Rio Grande do Sul over areas near archaeological settlements. These data deserve some attention. Furthermore, botanical sources indicate that *Araucaria angustifolia* need a dispersing factor, including birds, animals and humans. In spite of climate conditions being considered one of the major causes of increase, the possibility of contribution by pottery-producing hunter-gatherers of the Taquara/Itararé Tradition in seed dispersal by harvesting of seeds, and possible management and planting of this species. These sites are considered important elements as indicators of *Araucaria* forest areas in landscape reconstruction studies.

Key words: Prehistoric occupation, pit houses, *Araucaria angustifolia*, southern Brazil.

RESUMO – Este trabalho apresenta algumas reflexões sobre a possível influência antropogênica pré-histórica na expansão da *Araucaria angustifolia* durante o Holoceno tardio, a partir da análise e do cruzamento de dados arqueológicos, geográficos, palinológicos e botânicos. Estudos arqueológicos revelaram que grupos de caçadores e coletores com cerâmica, pertencentes ao tronco cultural *Jê*, definidos arqueologicamente como Tradição Taquara/Itararé ocuparam a região do planalto sul brasileiro desde 2000 anos A.P. até, aproximadamente, 200 anos A.P. A caça de animais, a coleta de pinhão, considerado item básico da dieta vegetal, e o manejo agroflorestal, constituíam os principais recursos utilizados, relacionados à floresta. Seus assentamentos, conhecidos como casas subterrâneas, estão distribuídos altimétrica e geograficamente segundo o domínio da Floresta Ombrófila Mista. A expansão de *Araucaria angustifolia* no Holoceno tardio é fortemente assinalada em vários trabalhos palinológicos, depois de 1500 anos A.P. no Paraná, 1000 anos A.P. em Santa Catarina e 1140 anos A.P. no Rio Grande do Sul, em áreas próximas aos assentamentos arqueológicos. Esses dados chamam a atenção. Além disso, fontes botânicas indicam que *Araucaria angustifolia* necessita de um agente dispersor, citando aves, animais e o próprio homem. Apesar das condições climáticas serem apontadas como a principal causa desse aumento, discute-se, também, a possibilidade de uma contribuição da ação dos grupos de caçadores-coletores com cerâmica da Tradição Taquara/Itararé na dispersão da espécie, pela coleta do pinhão, manejo e o possível plantio da espécie. Estes sítios constituem, ainda, elementos importantes em estudos de reconstituição da paisagem como indicadores de áreas de floresta com araucária.

Palavras-chave: Ocupação pré-histórica, expansão, *Araucaria angustifolia*, planalto sul-brasileiro.

INTRODUCTION

Research on grassland (*campos*) and *Araucaria* forest evolution during the Holocene has been accomplished with

use of palynological analysis of bog sediments from the southern highlands of Brazil. Hence, the sites at Serra Campos Gerais in the state of Paraná (Behling, 1997), Serra do Rio do Rastro, Morro da Igreja and Serra da Boa Vista in

the state of Santa Catarina (Behling, 1995) and Aparados da Serra (Roth & Lorscheitter, 1993), São Francisco de Paula (Behling *et al.*, 2001) and Cambará do Sul (Behling *et al.*, 2004) in Rio Grande do Sul are highlighted. Such studies indicate that grasslands have covered extensive areas of highland during the latest glacial period until the middle Holocene. According to Behling & Lichte (1997), predominance of grassland is due to the effects of a colder, drier climate during the last glacial period and warm and dry climate in the beginning of the Holocene.

Increase of area occupied by *Araucaria angustifolia* began with the migration of gallery forests between 4,000 and 3,000 years BP (Behling *et al.*, 2004) denoting a more humid climate condition. A strong expansion into the grassland is registered as occurring circa 1,500 years BP in Paraná and about 1,000 years BP in Santa Catarina and 1,140 years BP in Rio Grande do Sul.

Conversely, archeological research performed by Miller (1971), La Salvia (1983), Kern (1985), Schmitz *et al.* (1988), Schmitz & Basile-Becker (1991), Noelli (2000), Schmitz (2002) in the southern highlands of Brazil reveals that pottery-producing hunter-gatherers, related to the *Jê* linguistic stock, occupied this region from 2,000 years BP to, approximately, 200 years BP. These groups are archeologically included in the Taquara Tradition in Rio Grande do Sul and Itararé Tradition in Santa Catarina, Paraná and São Paulo (Schmitz, 1999), and historically related to Kaingang and Xokleng ethnic groups.

The *Araucaria* nut was one of the fundamental components in the diet of these peoples, who handled its production in order to obtain this subtropical pine nut throughout the year. Jacobus (1991) and Kern (1991) remark on the management of vegetation by these peoples, both for food and/or medicine,

as well as hunting and harvesting of resources in areas adjacent to their settlements. These peoples lived in villages distinguished by typical *casas subterrâneas* (pit houses), which represent a landmark of this occupation throughout the southern highlands of Brazil (Figure 1).

This paper presents a few observations on the possible prehistorical anthropogenic contribution to the expansion of *Araucaria angustifolia* during the late Holocene by relying on the results of comparison of archeological, geographical, palynological and botanical informations.

MATERIAL AND METHODS

The data shown here are the results of bibliographical research of studies in the southern highlands of Brazil. The array of environmental and archeological parameters, both numerical and non-numerical, determined the way data should be compared. Numerical input correspond to altimetric distribution (forest *versus* pit houses) and chronological occurrence (*Araucaria* expansion *versus* period of occupation) from non-calibrated dates. These parameters permitted to plot values into a graph for input comparison. Non-numerical input represent botanical and archeological features including *Araucaria angustifolia* dispersion and highland occupation, respectively. Ethnobiological input and 19th century reports were included in order to supplement discussion. The name of the species cited is indicated in the Appendix.

RESULTS

Casas subterrâneas (pit houses) are man made shelters identified as a symbol of Taquara/Itararé Tradition

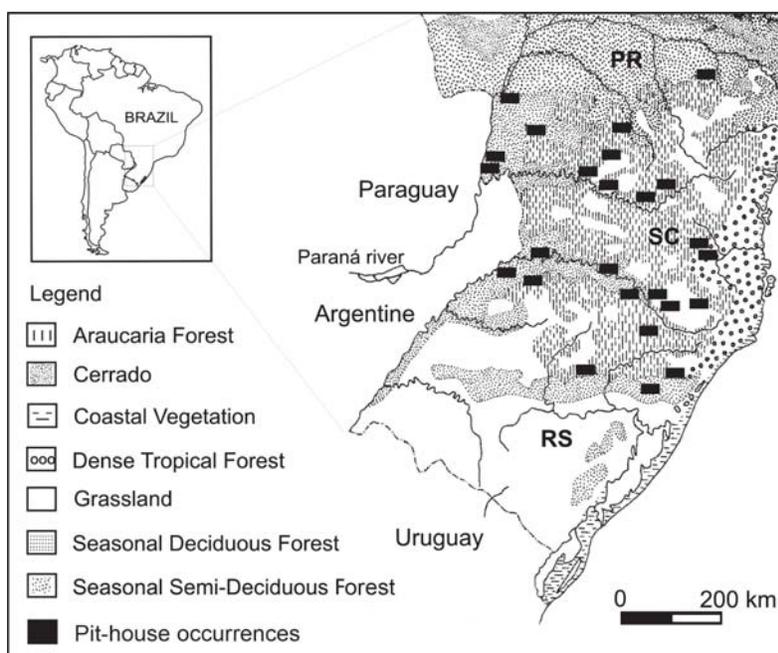


Figure 1. Geographical distribution of pit houses (“*casas subterrâneas*”) in the highlands of southern Brazil (modified from Schmitz, 1969). **Abbreviations:** PR, Paraná State; SC, Santa Catarina State; RS, Rio Grande do Sul State.



Figure 2. Morphological aspects of the archeological sites (pit houses): circle or oval-shaped depressions, artificially produced by removal and lowering of soil (arrow shows one pit house).

settlements throughout the southern highlands of Brazil, from Rio Grande do Sul to São Paulo (Figure 1). These constructions are considered genuine engineering workmanship (La Salvia, 1983; Schmitz & Basile-Becker, 1991; Schmitz, 2002), and are shown in Figures 2 and 3. Their geographical and altimetric limits coincide with the ones presented by the *Araucaria* forest domain.

Several archeological studies point to discussions concerning patterns of settlement, material culture (artefacts, pottery), natural resource use and management by these peoples who occupied the highlands from 2,000 years BP until approximately 200 years BP (Noelli, 2000; Schmitz, 2002).

Various changes related to the expansion of *Araucaria angustifolia* took place on the highland landscape from the beginning of the Holocene. The polinical diagrams show small traces of those changes from 10,000 years BP in Santa Catarina and Rio Grande do Sul, allegedly due to the restricted occurrence of *Araucaria* woods at the bottom of valleys and hillsides (Behling, 1995; Behling *et al.*, 2004). From the late Holocene period, between 3,400 and 2,400 ¹⁴C years BP, an increase in the number of *Araucaria angustifolia* can be seen in various areas of the highlands (Behling *et al.*, 2001, 2004). However, the biggest expansion in the direction of the grasslands can be traced to start in 1,530 ¹⁴C years BP, in Paraná, and 1,000 ¹⁴C years BP (Behling, 1995) in Santa Catarina and 1,140 ¹⁴C years BP in Rio Grande do Sul, (Behling *et al.*, 2001, 2004) (Figure 4). Although better climatic conditions have been pointed out as the main cause for this increase, the peak of this increase was observed as coinciding with the period of occupation of the highlands. In this sense, it is reasonable to suppose that, besides better climate conditions, the action of man might have contributed to the development of *Araucaria angustifolia*. In Rio Grande do Sul, the occupation can be traced to between 1,840 ± 85 ¹⁴C years BP and 950 ± 80 ¹⁴C years BP in Bom Jesus (Noelli, 2000); 1,551 ± 05 ¹⁴C years BP and 970 ± 95 ¹⁴C years BP in São Francisco de Paula (Noelli, 2000); 1,520 ± 90 ¹⁴C years BP and 620 ± 90 ¹⁴C years BP in Caxias do Sul (Schmitz,

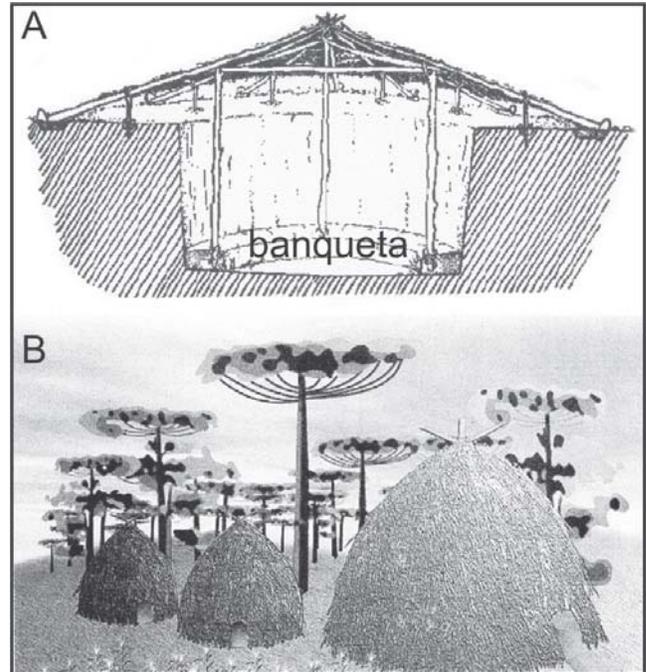


Figure 3. Shelter reconstruction on the highland: **A**, reconstruction according to La Salvia (1983), roof with three straight pillars, propped on a workbench ("banqueta"); **B**, model proposed by Schmitz (2000), roof or canopy, with arched pillars, similar to the circle-shaped houses of the Xavante.

1969) up to between 950 ± 72 ¹⁴C years BP and 166 ± 15 ¹⁴C years BP in Vacaria (Schmitz *et al.*, 2002). In Santa Catarina, starting in 1,920 ± 50 ¹⁴C years BP in São Joaquim (Noelli, 2000) until 3,30 ± 90 ¹⁴C years BP in Ubirici (Schmitz, 1988). In Paraná, the interval of occupation varies between 1,495 ± 65 ¹⁴C years BP in União da Vitória (Noelli, 2000) until 270 ± 70 ¹⁴C years BP in Bairro da Serra (De Blasis, 1996) (Figure 5). If we compare the peaks in number of non-calibrated periods of pit houses with the expansion of *Araucaria angustifolia* during the Holocene, the peak of expansion can be observed as being strongly concentrated after the beginning of the occupation of the highlands, during the late Holocene period (Figure 6). This may suggest that *Araucaria* expansion can also be due to the management strategies achieved by these peoples. This hypothesis is corroborated by botanical data at two main points: competition and dispersal.

Regarding competitiveness, Walter (1986) supports the idea that plant species distribution does not always directly depend on environmental features. However these features play an indirect role as they affect species competitiveness. According to Backes (1999), the discontinuous pattern shown by this species current distribution is typical of dominated species, as dominant species tend toward a more constant distribution. Competitiveness seems to be one of the most remarkable phenomena within *Araucaria* forests from Southern Brazil, which exists in different levels and intensities, basically related to the reproduction and growing of new samples (Backes, 1983). The *Araucaria* forest is a mixed formation

which coexists along with numerous tropical latifoliate species. The interspersed distribution of the *Araucaria* forest in the wide grassland reveals a phytogeographical mosaic feature of the whole Southern Plateau (Backes, 2001). The invasion of the forest towards the grassland (Hueck, 1953) sustained the *Araucaria* pioneering hypothesis, favored mainly by the sun shining. Backes (1983) indicates that the accountability of new *Araucaria angustifolia* specimens contrasted with other species in the inner forest, reveals great disparity, such as the *Podocarpus lambertii*, which shows numerous varieties with several different sizes. The author comments that the results of this observation coincide with the hypothesis that the natural successional process of the latifoliate forest would gradually substitute the *Araucaria*, remaining the *Podocarpus*. The *Araucaria* nut sprouts quickly, producing the main root, starting to evolve in the beginning of spring, together with the increase of temperature and rain. In addition to that, Backes (1983) comments that in the inner forest all the vegetation starts a process of intense development, which quickly shades the inferior stratum. The decrease of luminosity in the inferior stratum of the forest eliminates, in a short time, the early stages of the development of the *Araucaria angustifolia*, causing almost a total absence of mid aged individuals in the heart of the forest.

This process becomes more selective while the angiosperms disperse in the inferior stratum of the aciculifoliate forests. The *Araucaria angustifolia* seems to escape from the forest formations where the lack of

luminosity constitutes an element of constraint for its development. Nevertheless, in the areas of grassland where the luminosity is not a factor of constraint nor is there the competition of the latifoliate species, it evolves much better.

On the other hand, relative to dispersal, Kindel (1996) indicates that *Araucaria angustifolia* needs a dispersal agent, mentioning birds, animals and humans. Backes (1983) comments that the *Araucaria angustifolia* seed are heavy, all vertically and do not show any mechanism that may contribute to its dissemination. The dissemination of the seeds is always dependent on vectors such as the bird 'gralha-azul' (*Cyanocorax caeruleus*) besides many other species of rodent animals. On the other hand, the territorial occupation by the hunter-collector by groups of Taquara/Itararé Tradition having the domain of the *Araucaria* forest, hunting animals and collecting vegetables (Jacobus, 1991), the utilization of the *Araucaria* nuts, and the manipulation of the forest cleaning the understory whether in the excavation of pit houses, or in the plantation of crops, specially corn, reinforce the idea of a possible prehistoric anthropogenic contribution in the dispersal of the *Araucaria angustifolia*.

DISCUSSION

Spatial distribution of 'casas subterrâneas' (pit houses) set a pattern for groups belonging to the Taquara/Itararé Tradition in settlements on the southern highlands of Brazil, which includes the domain of forest with *Araucaria*.

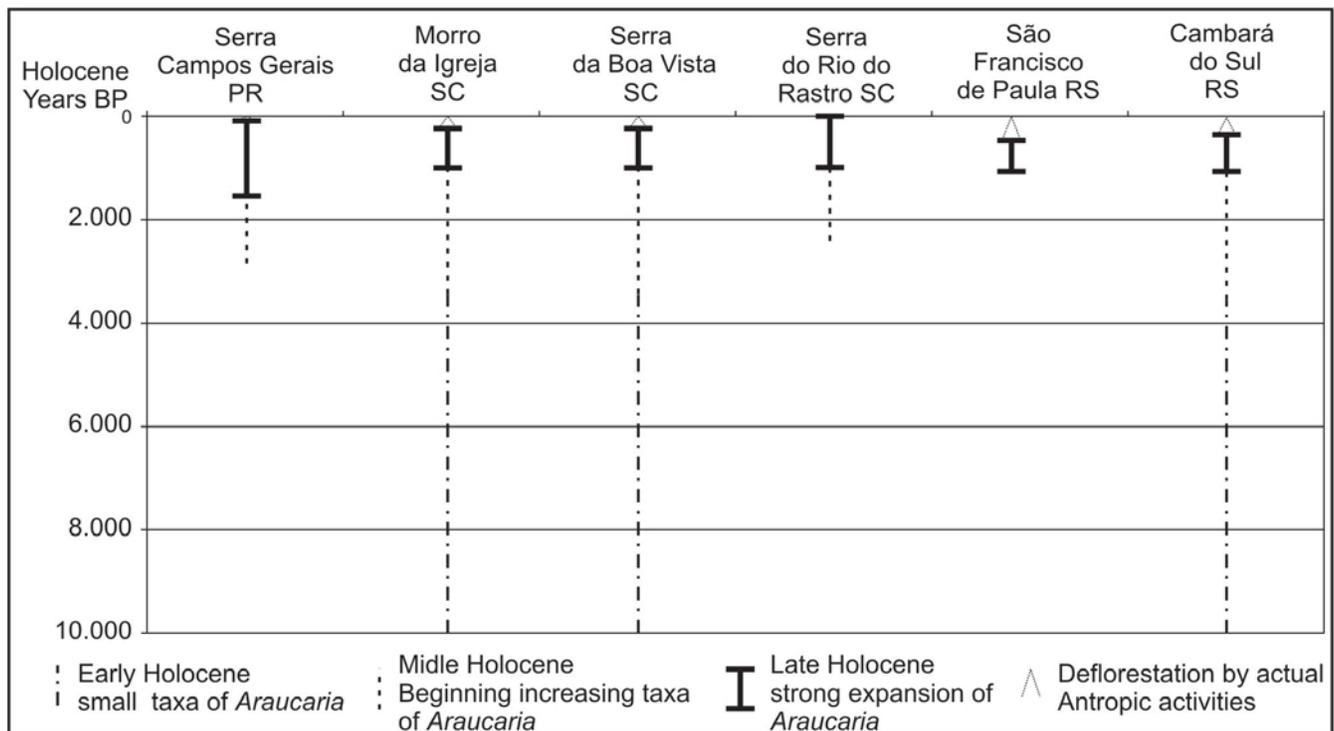


Figure 4. Chronological records of *Araucaria* expansion in the states of Santa Catarina and Rio Grande do Sul, based on Behling (1995) and Behling *et al.* (2001). The broken lined bars indicate periods when only a small number of *Araucaria* was found, in the early and late Holocene, whereas the black bars show a period of great expansion in the late Holocene. **Abbreviations:** PR, Paraná State; SC, Santa Catarina State; RS, Rio Grande do Sul State.

Settlements in this region also consider other aspects concerning mobility, covering an extensive area between states of Rio Grande do Sul, Santa Catarina, Paraná and São Paulo.

As demonstrated by pollen studies - however concentrated on the edges of the highlands - *Araucaria* expansion coincides with the period of occupation. Nonetheless, data comparison indicates that the strong expansion of *Araucaria* during the late Holocene is subsequent to chronological records of human occupation.

On the other hand, botanical research indicate that climate do not always determine species distribution, this also depends on the ability to compete and dispersal (Walter, 1986; Kindel, 1996). Favorable climatic conditions to the development of *Araucaria* notwithstanding, a spreading agent is also necessary.

However, there are still other factors to be considered, which surpass botanical issues, such management and sowing of this species. As Posey & Balée (1989) report, *terra firme forests* are the richest terrestrial ecosystems in the biosphere in respect to species diversity. Such richness is a result of complex nutrient recycling systems, evolution of plants to environmental chemical conditions and to management accomplished by prehistoric peoples. At least 11.8% of mainland forest in the Brazilian Amazon may be considered anthropogenic, indicating intense management and use by Amazonian peoples in the past (Balée, 1989; Posey 1985). Natural resource use reflects not only on adaptation to the environment but also as the efforts to overcome limitations through environmental change (Morán, 1990).

Denevan (1966), Zucchi & Denevan (1979) demonstrate that indigenous peoples have modified the Amazonian environment, promoting biotic diversity by creating “resource islands”, where extremely useful species, such as the *babaçu* (*Orbignyia phalerata*), are predominant. Many of the species observed today are a result of this kind of interference. Among the types of vegetation suggested as having possibly anthropogenic origin are forest with palm, bamboo forest, castanheira forest and liana forests. Palms are excellent indicators of archeological sites and announce human presence. According to Balick (1984) long term anthropogenic influence is indicated by the presence of pupunha (*Bactris gasipaes*), inajá (*Maximiliana maripa*), and buriti (*Mauritia flexuosa*). Boer (1965) arguments that tucumã (*Astrocaryum vulgare*) is never found in uninhabited areas and solely associated in managed areas. Bamboo forests (*Guadua glomerata*) are indicators of past human occupation (Braga 1979), as it was an important source of raw matter for flutes and arrows used for hunting and fishing. The ‘*castanhais*’, forest where the dominant species is *Bertholletia excelsa* (‘*Pará*’ nut tree), may be associated to archeological sites (Simões & Araújo-Costa, 1983). The ‘*caipós grotirés*’ planted ‘*Pará*’ nut trees both for their importance in attracting game and for their nutritional purpose (Posey, 1985).

Amazonian liana forests are not associated to a particular

type of soil, in spite of being frequently found in indigenous areas of black soil (Smith, 1980). These statements are examples for speculation on the possibility of an anthropogenic forest in the southern highlands of Brazil. This may be faced as a strategy to control the territory, since these ethnic groups could have sown this conifer throughout their area.

Significant 19th century reports by Mabilde (1897-99), lead to the idea that *Araucaria* forests were appropriated according to the extension and number of individuals of a tribe. The boundary between two territories was indicated by zigzag lines drawn on an *Araucaria* trunk with a stone axe. The territory was of exclusive use by the tribe established in it. *Araucaria* nut harvesting was one of the reasons of war between tribes, when all the local groups assembled against the invading tribe.

Another interesting fact, is pointed out by Aubreville (1949), who suggests that prehistoric peoples managed the understory of forest with *Araucaria* which promoted this species prevalence in the landscape.

Aside from this information is the fact that the leaves of several cultivated plant species were used as stimulants by these peoples. *Ilex paraguariensis* (“*erva-mate*, *caá guazú*, *Paraguayan tea*”), whose active principle is caffeine, is an example. This species, according to reports of the earliest contacts with European colonists, seems to have been used mostly by the *Guarani* near the rivers Paraná, Paraguay and Uruguay. Later, its use was spread to neighboring tribes: *Charrua*, *Kaingang* and *Xamacoco* (Ribeiro, 1986).

Ethnobiological research point to indigenous peoples

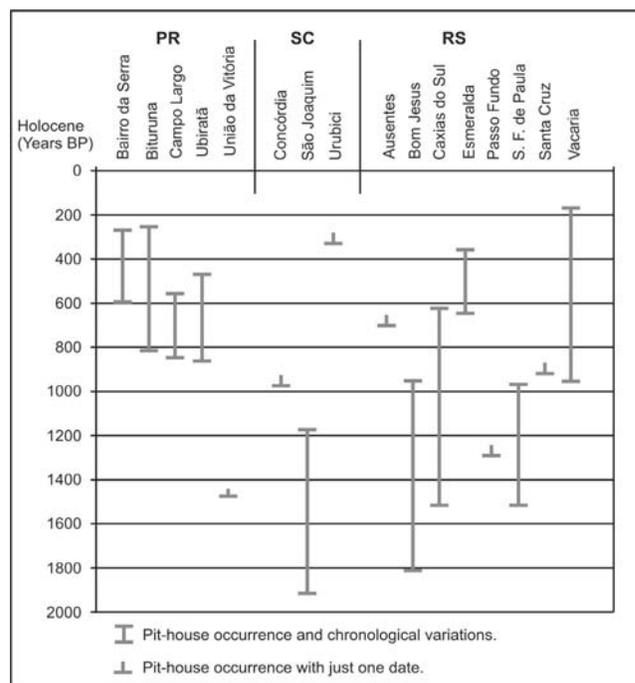


Figure 5. Chronological distribution of highland occupation in the states of Paraná, Santa Catarina and Rio Grande do Sul (based on De Blasis, 1996; Noelli, 2000; Schmitz, 1969, 1988 and Schmitz et al., 2002). **Abbreviations:** PR, Paraná State; SC, Santa Catarina State; RS, Rio Grande do Sul State.

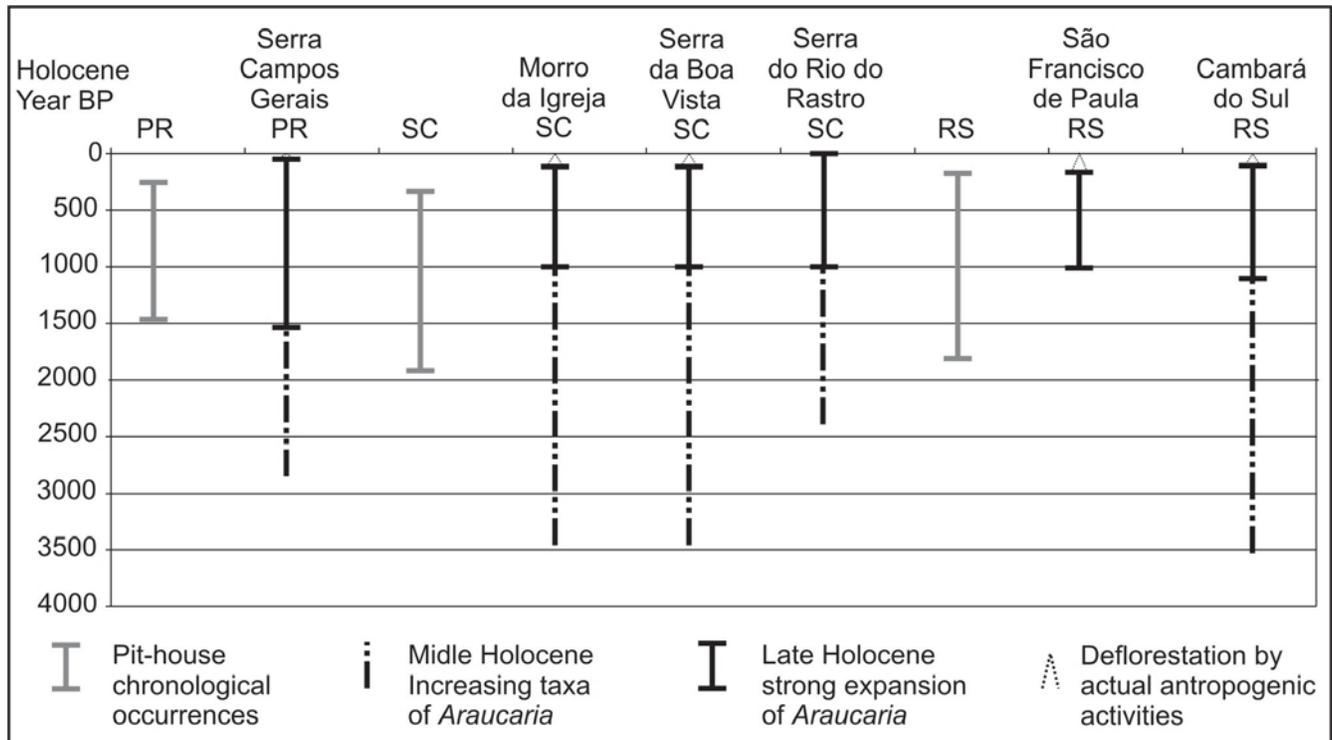


Figure 6. Chronological comparison between the finding of archeological sites and the expansion of *Araucaria angustifolia* throughout the Holocene. The grey bars represent the chronological distribution of archeological sites during the late Holocene. The broken lined bars show the periods when only a small number of *Araucaria* was found, in the early and mid Holocene, whereas the black bars show a period of great expansion during the late Holocene. The period when the number of *Araucaria* greatly increased coincides with the period when the highlands were occupied by man (PR: Paraná State, SC: Santa Catarina State; RS: Rio Grande do Sul State).

ecological adaptation and to their complex use of “resource units”, whether managed or natural. These studies indicate these indigenous populations have intimate knowledge about these units, visiting them frequently to harvest part of its yield. The *Kaiapó* populations are an example of this type of behaviour, transplanting forest species near their settlements, also known as forest fleeds, in order to concentrate resources (Posey, 1983). Abandoned agriculture areas are another kind of resource unit, since these areas attract game.

As demonstrated by Ribeiro (1986), these large scale management strategies result in artificially constructed dense forest reserves, reducing hunting effort and its outcome.

CONCLUSIONS

The expansion of *Araucaria angustifolia*, demonstrated by palinological studies on various areas of the southern highlands of Brazil, may be due to an increase in humidity during mid and late Holocene. The studies clearly demonstrate that the grassland were the dominating vegetation on the highlands since the beginning of Holocene. The low indexes of *Araucaria angustifolia* pollen grains registered during this period suggest the formation of small populations, restricted to the bottom of valleys and damp hillsides. From mid-Holocene an increase in the number of *Araucaria* pollen grains is registered, throughout

the valleys, suggesting an increase in humidity. However, the peak of such expansion can be traced to the late Holocene, from 1,500 years BP in Paraná, 1,000 years BP in Santa Catarina and 1,140 years BP in Rio Grande do Sul. Although climatic conditions are considered the main cause of such expansion, it is necessary to consider the possible contribution of man to this process. The coincidence of geographic and altimetric boundaries of the *Araucaria* woods and pit houses are remarkable evidence of that. The increase in humidity from mid-Holocene stimulates this expansion, but the peak of expansion, recorded to the late Holocene, coincides with the period of occupation by groups of Taquara/Itararé Tradition. This peak might also reflect the influence of human action. Botanically, the spreading of the species could be equally favored by the vector of human action, through the handling and use of the pine nuts seeds as a staple food item in a vegetable-based diet. Moreover, it is important to consider the occupation strategies and domination of the territory through the determination of the boundaries of the *Araucaria* woods. Another interesting aspect is the use of the understory of forest, used in the preparation and lowering of houses and in the cultivation of maize, which might have been favorable to the spreading of *Araucaria angustifolia*.

The circulation of groups on the highlands, linked to the handling strategies of the understory of forest, as well as the maintenance and control of the territory by the

Araucaria woods and the handling of the pine nut seed, could also have had a role in the spreading of *Araucaria*. Moreover, it is necessary to consider the examples of strategies in the formation of “resource units”, according to the examples given in the bibliography of Ethnobotanics.

Palinological studies about the sediments in pit houses and adjacent areas are being carried out aiming at a better determining of the boundaries of different kinds of vegetation and the variations during the period of occupation.

Finally, one should keep in mind that Brazilian landscapes have been occupied and huddled by prehistoric peoples since the late Pleistocene. Henceforth, there was constant interaction with the environment, at times causing impacts, such as the possible megafaunal extinction during the late Pleistocene. Variations in climate may have played an unquestionable role in determining quaternary landscapes, although prehistoric occupation have probably led to parallel - and possibly important - effects in Brazilian vegetation.

ACKNOWLEDGEMENTS

The authors wish to thank the Conselho Nacional de Pesquisas (CNPq) and Fundação de Amparo a Pesquisa do Estado do Rio Grande do Sul (FAPERGS), for sponsoring this research. We would like to express our thanks to Hermann Behling and Paulo Eduardo de Oliveira for the corrections and suggestions on the manuscript. The authors are grateful to the editors, Soraia Girardi Bauermann and Paulo Alves de Souza for providing constructive comments.

REFERENCES

- Aubreville, A. 1949. A floresta de pinho do Brasil. *Anais Brasileiro de Economia Florestal*, **2**(2):21-36.
- Backes, A. 1983. A dinâmica do pinheiro brasileiro. *Iheringia, Série Botânica*, **30**:49-84.
- Backes, A. 1999. Condicionamento climático e distribuição geográfica de *Araucaria angustifolia* (Bertol.) Kuntze no Brasil – II. *Pesquisas, Botânica*, **49**:31-51.
- Backes, A. 2001. Determinação da idade de regeneração natural de uma população de *Araucaria angustifolia* (Bertol.) Kuntze em um povoamento florestal localizado no município de Caxias do Sul, RS, Brasil. *Iheringia, Série Botânica*, **56**:115-130.
- Balée, W. 1989. The culture of Amazon Forests. *Advances in Economic Botany*, **7**:129-158.
- Balic, M.J. 1984. Ethnobotany of palms in the Neotropics. *Advances in Economic Botany*, **1**:9-23.
- Behling, H. 1995. A high resolution Holocene pollen record from Lago do Pires, SE Brazil: vegetation, climate and fire history. *Journal of paleolimnology*, **14**:253-268.
- Behling, H. & Lichte, M. 1997. Evidence of dry and cold climate conditions at glacial times in tropical southeastern Brazil. *Quaternary Research*, **48**:348-358.
- Behling, H.; Bauerman, S.G. & Neves, P.C. 2001. Holocene environmental changes from São Francisco de Paula region, southern Brazil. *Journal of South American Earth Sciences*, **14**:631-639.
- Behling, H.; Pillar, V.D.; Orlóci, L. & Bauermann, S.G. 2004. Lata Quaternary *Araucaria* forest, grassland (campos), fire and climate dynamics, studied by high-resolution pollen, charcoal and multivariate analysis of the Cambará do Sul core in southern Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **203**:277-297.
- Boer, J.G.W. 1965. Palmae. *Flora of Suriname*, **5**(1):1-172.
- Braga, P. 1979. Subdivisão fitogeográfica. Tipos de vegetação, conservação e inventário florístico da floresta Amazônica. *Acta Amazonica, Supl.*, **9**(4):53-80.
- De Blasis, P.A. 1996. *Bairro Serra em três tempos. Arqueologia, uso do espaço regional e continuidade cultural no médio vale do Ribeira*. Programa de Pós-graduação em Arqueologia, Universidade de São Paulo, Tese de doutorado, 166 p.
- Denevan, W. 1966. *The aboriginal culture geography of the Llanos de Mojos, Bolívia*. Berkeley, University of California Publications, 185 p. (Series Ibero-Americana, Volume 8).
- Hueck, K. 1953. Distribuição e habitat natural do pinheiro do Paraná (*Araucaria angustifolia*). *Boletins da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo*, **10**:1-24.
- Jacobus, A.L. 1991. A utilização de animais e vegetais na pré-história do Rio Grande do Sul. In: A.A. Kern (org.) 1991. *Arqueologia Pré-Histórica do Rio Grande do Sul*. Mercado Aberto, p. 63-87.
- Kern, A.A. 1985. A interação cultural e meio-ambiente em sítios de habitações subterrâneas no planalto sul-rio-grandense (Município de Vacaria, RS). Taquara, Museu Arqueológico do Rio Grande do Sul, p. 30-33 (Boletim 3).
- Kern, A.A. 1991. Grupos pré-históricos de caçadores-coletores da floresta subtropical. In: A. Kern (org.) *Arqueologia Pré-Histórica do Rio Grande do Sul*, Mercado Aberto, p.135-66.
- Kindel, E.A.I. 1996. *Padrões de dispersão e disposição espacial de Araucaria angustifolia (Bert.) O. Ktze e suas relações com aves e mamíferos na estação ecológica de Aracuri, Esmeralda, RS*. Programa de Pós-graduação em Ecologia, Universidade Federal do Rio Grande do Sul, Dissertação de Mestrado, 66p.
- La Salvia, F. 1983. *A habitação subterrânea, uma adaptação ecológica*. In: G. Weimer (org.) *A arquitetura do Rio Grande do Sul*. Mercado Aberto, p. 7-56.
- Mabilde, A.P.T. 1897-99. Apontamentos sobre os indígenas selvagens na da Nação Coroados dos Matos da Província do Rio Grande do Sul. *Documentos*, **6**:141-172.
- Miller, T. 1971. Pesquisas arqueológicas efetuadas no Planalto Meridional, Rio Grande do Sul (rios Uruguai, Pelotas e Antas). *Publicação Avulsa do Museu Paraense Emílio Goeldi*, **15**:37-70.
- Morán, E. 1990. *A ecologia Humana das populações da Amazônia*. Rio de Janeiro, Editora Vozes, 367 p.
- Noelli, F.S. 2000. A ocupação humana na região sul do Brasil: Arqueologia, debates e perspectivas. *Revista da USP*, **44**:218-169.
- Posey, D. 1983. Indigenous knowledge and development: an ideological bridge to the future. *Ciência e Cultura*, **35**(7):877-894.
- Posey, D. 1985. Indigenous Management of Tropical Forest Ecosystems: The case of Kayapo Indians of the Brazilian Amazon. *Agroforestry Systems*, **3**:139-158.
- Posey, D.A. & Balée, W. 1989. *Managed forest succession in Amazonia: Indigenous and folks strategies*, The New York Botanical Garden, 304 p.
- Ribeiro, D. 1986. *Suma Etnológica Brasileira. Edição atualizada do Handbook of South American Indians*. Rio de Janeiro, Vozes/FINEP, 302 p.
- Roth, L. & Lorscheitter, M.L. 1993. Palynology of a bog in Parque Nacional de Aparados da Serra, East Plateau of Rio Grande do Sul, Brazil. *Quaternary South American Antarctic Peninsula*, **8**:39-69.

- Schmitz, P.I. 1969. Algumas datas de carbono 14 de casas subterrâneas no planalto do Rio Grande do Sul, *Pesquisas, Antropologia*, **20**:163-167.
- Schmitz, P.I. 1988. As tradições ceramistas do planalto sul-brasileiro. *Arqueologia do Rio Grande do Sul, Documentos*, **2**:74-130.
- Schmitz, P.I. 1999 Arqueologia do Planalto Sul-Brasileiro. *Revista de Arqueologia Americana*, **17-19**:51-74.
- Schmitz, P.I. 2002. As "casas subterrâneas". Fragmentos da história dos Índios Kaingang. *Ciência Hoje*, **181**:22-29.
- Schmitz, P.I.; Rogge, J.H.; Rosa, A.O.; Beber, M.V. & Arnt, F.V. 2002. O projeto Vacaria: Casas subterrâneas no Planalto Rio-Grandense. *Pesquisas*, **58**:11-105.
- Schmitz, P.I. & Basile-Becker, I.I. 1991. Os primitivos engenheiros do planalto e suas estruturas subterrâneas: a Tradição Taquara. In: A.A. Kern (org.) *Arqueologia Pré-Histórica do Rio Grande do Sul*. Mercado Aberto, p. 251-289.
- Schmitz, P.I.; Basile-Becker, I.I.; La Salvia, F.; Lazzarotto, D. & Ribeiro, M. 1988. Pesquisas sobre a Tradição Taquara no nordeste do Rio Grande do Sul. *Arqueologia do Rio Grande do Sul, Brasil. Documentos*, **2**:5-74.
- Simões, M & Araújo-Costa, F. 1983. Pesquisas arqueológicas no baixo rio Tocantins. *Revista de Arqueologia*, **4**(1):11-28.
- Smith, N. 1980. Antrosols and human carrying capacity in Amazônia. *Annals Association of American Geographers*, **70**:553-566.
- Walter, H. 1986. *Vegetação e zonas climáticas*. São Paulo, Editora Epu, 325 p.
- Zucchi, A. & Denevan, W. 1979. *Campos Elevados e História Cultural Pré-Hispânica em los Llanos Occidentales de Venezuela*. Caracas, Universidad Católica Andrés Bello, 176 p.

Received in January, 2006; accepted in March, 2006

Appendix. Species list mentioned in the text.

Araucaria angustifolia (Bert.) O. Kuntze
Astrocaryum vulgare Mart.
Bactris gasipaes Kunth
Bertholletia excelsa Bonpl.
Cyanocorax caeruleus Vieillot
Guadua glomerata Munro
Ilex paraguariensis A. St.-Hil.
Mauritia flexuosa L.f.
Maximiliana maripa (Aubl.) Drude
Orbigyia phalerata Mart.
Podocarpus lambertii Klotzsch ex Endl.