



Late Quaternary grassland (Campos), gallery forest, fire and climate dynamics, studied by pollen, charcoal and multivariate analysis of the São Francisco de Assis core in western Rio Grande do Sul (southern Brazil)

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Abstract

We present a detailed pollen and charcoal record of a 368-cm-long sediment core from the lowland Campos (grassland) region near the city of São Francisco de Assis in the western Rio Grande do Sul State in southern Brazil. Based on four AMS radiocarbon dates, the record represents the last about 22,000 cal yr BP. The region was naturally covered by Campos throughout the recorded glacial and Holocene period under cold and relatively dry and warm and dry condition, respectively. Initial expansion of gallery forest after 5170 cal yr BP indicates a change to wetter climatic conditions. Maximum extent of gallery forest after 1550 cal yr BP reflects the wettest recorded period. There is some evidence of plant migration from the eastern Atlantic coastal lowland reaching the western lowland, first after mid Holocene times by *Cecropia* and, possibly, species of *Myrsine* and *Moraceae* and later, after about 1000 cal yr BP, by species of *Alchornea* and *Acalypha*. Multivariate analysis revealed that the long-term pollen composition dynamics is a two-phase process, with random, chaotic changes characterizing some periods when climate conditions were likely more stable, and directional compositional changes (phase transitions) in periods coincide with major climate and/or anthropogenic changes. Natural fires were rare during full- and lateglacial periods, but became frequent at the beginning of the Holocene, suggesting the beginning of human occupation of the western lowland at that time. Highest fire frequency is found during the wet late Holocene period, suggesting an increase of indigenous populations in the São Francisco de Assis region.

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1. Introduction

Several palaeoecological studies from the Campos and *Araucaria* forest regions of the southern Brazilian highlands have been carried out in the last decade. Data from the states of Paraná (Serra Campos Gerais: Behling, 1997), Santa Catarina (Serra do Rio Rastro, Morro da Igreja, Serra da Boa Vista: Behling, 1993, 1995) and Rio Grande do Sul (Aparados da Serra: Roth and Lorscheitter, 1993; São Francisco de Paula: Behling et al., 2001; Cambará do Sul: Behling et al., 2004) have proven that extensive areas of Campos vegetation existed on the highlands through glacial, early and mid Holocene times. The dominance of Campos vegetation was attributed to cold and dry glacial, and warm and dry early Holocene climates. A dry season lasting probably about 3 months per year was characteristic for the early and mid Holocene period (Behling, 1997, 2002). Initial expansion of *Araucaria* forests started by migration from the gallery forests along the rivers about 3210 cal yr BP, which indicates a turn to somewhat wetter climates. A marked expansion of *Araucaria* forests started on the highlands, replacing Campos vegetation in Santa Catarina State about 930 cal yr BP ago, and in Paraná State (Serra Campos Gerais) about 1400 cal yr BP ago, reflecting a very humid climate without a marked seasonal dry period. New data from the 42,000 ¹⁴C years BP old Cambará do Sul record indicate that the initial expansion of *Araucaria* forests started by 4320 cal yr BP, and the marked expansion by 1100 cal yr BP (Behling et al., 2004).

So far, nothing was known about the vegetation and climate history of the Campos region in the lowlands of Rio Grande do Sul State west and south of the highland plateau. Our main questions are: Is the Campos formation the natural vegetation of the southern lowland? Do we have similar climate changes in the southern lowlands, compared to the southern highlands? What would be the effect of climate change on the southern lowland vegetation? What was the fire history in the lowland? How and when began the pre-Columbian occupation in the lowland?

To investigate the late Quaternary vegetation, climate and fire dynamics, we cored a peat bog in the São Francisco de Assis region of western Rio Grande do Sul state. The site is interesting for at

present it is surrounded by grassland characteristic for the western part of Rio Grande do Sul State, close to gallery forest and not far from the edge of the forest on the westernmost escarpments of the southern Brazilian highlands.

2. Environmental setting

2.1. Geographical setting

The lowlands of Rio Grande do Sul (Fig. 1) lie at elevations between 40 and 200 m south and west of the South Brazilian highlands and north of the crystalline shield. The lowland is a soft rolling landscape, and includes some higher elevated hills. Major rivers are the Ibibuí, draining westward to the Uruguay River, and the Jacuí River, draining eastward to the Patos Lagoon and the Atlantic Ocean. More information on the geography of the region can be found in Rambo (1956) and in satellite images at <http://cdbrasil.cnpm.embrapa.br/rs>.

The studied peat bog (29°35'12" S, 55°13'02" W, 100 m elevation) is situated on the Itajuru farm, about 5 km north from the Ibicuí River, 8 km southwest of the city of São Francisco de Assis, in the western region of Rio Grande do Sul state (Fig. 1). The site is about 15 km SW from the westernmost escarpments of the southern Brazilian plateau, which raises here only to elevations of ca. 300 m. The Atlantic Ocean is ca. 480 km to the east. The ca. 50×150 m large peat bog is found in a shallow basin near the southern margin of the Inhacundá River valley, ca. 600 m distant and about 10 m above the river, to which it is not connected.

2.2. Modern vegetation

General information on the flora and ecology of the lowland Campos can be found in Boldrini (1997) among others. The grassland Campos in the study region develops on sandy substrate is highly diverse and dominated by species of the genera *Andropogon*, *Aristida*, *Paspalum*, *Axonopus*, *Elyonurus* in the Poaceae family, of the genera *Baccharis*, *Vernonia* and *Senecio* in the Asteraceae family, several Myrtaceae shrubs of the genera *Eugenia*, *Psidium* and *Campomanesia*, and the palm *Butia paraguayensis*

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