Available online at www.sciencedirect.com
SCIENCE DIRECT®
Palaeogeography, Palaeoclimatology, Palaeoecology 234 (2006) 45–61
PALAEO
www.elsevier.com/locate/palaeo

Holocene space–time succession of the Middle Atrato wetlands, Chocó biogeographic region, Colombia

Ligia Estela Urrego *, Luz Adriana Molina, Dunia Heidi Urrego, Luisa Fernanda Ramírez

Departamento de Ciencias Forestales, Universidad Nacional de Colombia-Sede Medellín, Calle 59A No. 63-20, A.A. 568, Medellín, Colombia

Received 23 August 2004; accepted 20 October 2005

Abstract

Successional sequences from forested wetlands in the Middle Atrato River Basin were reconstructed using characterisation of present vegetation communities and palynological analysis. A 4.8 km transect, drawn across a river meander, and two 6 and 8 m deep sediment cores (San Martín and Villanueva) were collected in the floodplain within two different vegetation assemblages. Based on the floristic and environmental characteristics of the local vegetation communities, ecological changes spanning the last 4 ka (cal years BP) were analysed in San Martín and Villanueva cores. Present vegetation is dominated by four communities determined by flood tolerance and drainage conditions. We found *Euterpe oleraceae*, *Mauritiella macroclada–Campnosperma panamensis* and *Oenocarpus bataua* forests, and mixed forest and open vegetation in a gradient from poor to improved drainage conditions. Vegetation changes in the palynological record suggest that sedimentation and erosion processes on flood basins are due to changes in drainage conditions and to variable flooding levels.

A wet period in the 4 to 2.7 ka interval is postulated, which might be related to sea level rise or local subsidence. Lower flooding levels and improved drainage conditions dominated the 2.7 to ~1.6 ka interval, whereas a flooding event (and a hiatus) occurred between 1.5 and 0.5 ka. This flooding event might be synchronous with analogous events as recorded in the Colombian Amazonia between 1.6 and 1.45 ka. Forest disturbance, probably of anthropogenic origin, is recorded in both sites since 0.5 ka.

Keywords: Plant succession; Forested wetlands; Palynology; Fluvial dynamics; Holocene; Chocó Biogeographic region

1. Introduction

Landscape transformations caused by changes in fluvial dynamics generate a vegetation mosaic that recomposes the primary succession process that begins with the colonization of sandbars and beaches. At these sedimentation sites, biological reproductive sources are absent; hence, colonization begins with either migrating propagules, dispersed by wind or water, or the invasion of species by vegetative means. In addition, the persistence of the initial plant assemblages is controlled by fluvial landforms (Kalliola et al., 1991).

Secondary successions occur when the original vegetation is replaced following an interruption in its development. Subsequent development depends on the pre-existent edaphic structure and seed bank (Glenn-Lewin and Van Der Maarel, 1998). Both succession processes contribute to forest diversity in the tropical lowlands. Beta diversity, or differences between habitats, produces a mosaic of different forest types determined by the succession stage, the hydro-period, the slope and the edaphic conditions, among other factors (Bush et al., 2001).

* Corresponding author. Fax: +57 4 4309079.
E-mail address: leurrego@unalmed.edu.co (L.E. Urrego).

0031-0182/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.palaeo.2005.10.018

Successional processes can be studied by sampling directly the present vegetation along a spatial gradient or by analysing micro- and macrofossil records along a temporal gradient. Simultaneous analysis of both gradients allows a reconstruction of long term successional sequences that otherwise cannot be done by the exclusive analysis of present sequences. In a spatial analysis, environmental factors such as climate, soils and hydrologic conditions are characterised in order to determine their relationship with vegetation changes in composition and structure along the successional process. This approach has been applied to present tropical floodplains in Amazonia (e.g. Kalliola et al., 1987, 1991; Foster, 1990; Urrego, 1997; Ferreira, 2000).

Vegetation reconstructions based on palynology reflect changes that result from the influence of local (anthropogenic disturbances), regional (geomorphological) and global (climate change) processes. In Amazonia, a number of vegetation and paleoclimate reconstructions have concentrated on late Holocene riverine successional sequences (e.g. Behling et al., 1999; Urrego, 1997; Weng et al., 2002). Whereas, in the Colombian Pacific region, vegetation and paleoclimate reconstructions have concentrated on Holocene lake sediments influenced by fluvio-marine dynamics, e.g. Lake Piusbi (Behling and Hooghiemstra, 1998), Lake Jotaordó (Berrío et al., 2000) and Lake El Caimito (Vélez et al., 2001).

Bush et al. (2001) state that only a few key indicator taxa, identified in pollen spectra, allow statistical separation of specific vegetation communities in tropical lowlands. Moreover, there is still a lack of knowledge on indicator species of hydrarch succession communities in tropical rainforests in the Chocó Biogeographic Region, which is considered one of the most diverse ecosystems in the world (Gentry, 1986). Therefore, research that integrates present and past vegetation should allow more detailed interpretations of palynological data in terms of vegetation communities. This is particularly important in the differentiation between forests that grow under contrasting hydrological but similar climatic regimes (Bush et al., 2001). By using this integrating approach, Phillips et al. (1997) reconstructed changes in the coastline and wetlands in Bocas del Toro in western Panama for the last 4 ka.

Our research characterises the successional process of plant communities in the Atrato River Basin dominated by *Euterpe oleracea*, *Oenocarpus bataua*, *Campnosperma panamensis* and *Mauritiella macroclada*. We intend to characterise the response of these plant communities to fluvial and forest endogenous dynamics by identifying the environmental conditions that favour their growth. Additionally, we reconstruct vegetation changes for the late Holocene, based on environmental characteristics of present wetlands.

1.1. Study site

This research was carried out in the forested wetlands of the Middle Atrato River Basin (6°34′N, 76°34′W, 18 m.a.s.l.), near Vigía del Fuerte (Antioquia) and Bojayá (Chocó) villages, in the Chocó Biogeographic region (Fig. 1). Average annual temperature is 28 °C, whereas annual rainfall varies between 5000 and 7000 mm (Espinal, 1992; Eslava, 1993), with a wet season that lasts 9 months. Average monthly precipitation can exceed 500 mm, as was the case, for example, of April 1998 to December 1999 when it reached 524 mm/month. Conversely, the river level was 2 m higher during the wet season than for the “dry” (low rain) season (unpublished data from Instituto de Hidrología, Metereología y Estudios Ambientales, IDEAM). Alluvial plains, dyke complexes, dyke-depression transition zones and flooded depressions are recognised as landscape units, whereas entisols and histosols are dominant (Cortés, 1993).

1.2. Methods

A 4.8 km long transect was described through an Atrato River meander (Fig. 1). Ten plots of 0.1 ha, i.e. 50 m by 20 m rectangles, were described at 450 m intervals. Two additional 185 and 665.6 m length transects were described in homogeneous *E. oleracea* and *O. bataua* stands, respectively. For each community, one ha plot was also described. Subplots of 25 m^2 (5×5 m) and 1 m^2 were randomly selected within each 0.1 ha plot in order to analyse the understory and seedling composition at each forest type.

Detailed relief measurements were recorded, with the aid of a Kern level, aiming to survey topography and flood changes across the meander. In each plot, some environmental variables were measured, such as texture and percentage of plant roots in the upper soil layer, water table depth, flooding level, and distance and level in relation to the shore of the river. The latter analysis was done in accordance to FAO (1977) guidelines. The relationship between these variables and the floristic composition was established by means of canonical correspondence analysis performed with CANOCO 4.02 (Ter Braak and Smilauer, 1998).

Stems with a diameter at breast height (DBH) greater than 10 cm were recorded in the 12 plots of 0.1 ha as well as the total height using a Vertex digital hypsom-