Multi-disciplinary evidence of the Holocene history of a cultivated floodplain area in the wetlands of northern Colombia

Juan Carlos Berrio¹, Arnoud Boom², Pedro José Botero³, Luisa Fernanda Herrera⁴, Henry Hooghiemstra¹, Freddy Romero⁵ and Gustavo Sarmiento⁵

¹ Institute of Biodiversity and Ecosystem Dynamics (IBED), Research group Palynology and Paleo/Actuo-ecology *, University of Amsterdam, Kruislaan 318, 1098 SM Amsterdam, The Netherlands. E-mail: berrio@science.uva.nl
* Formerly Hugo de Vries Laboratory; participating in the Centre for Geo-Ecological Research (ICG)
² Department of Marine Biogeochemistry and Toxicology, Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands
³ Fundación Terra Preta, Cra. 67 No. 50-47, Bogotá, Colombia
⁴ Fundación Erigate, P.O. Box: A.A. 89657, Bogotá, Colombia
⁵ Universidad Nacional de Colombia, Dept. de Geociencias, Edificio Manuel Ancizar, Oficina 2072, Bogotá, Colombia

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Abstract. An environmental reconstruction of the last 10,000 ¹⁴C years of a frequently flooded wetland ecosystem in the lower Magdalena valley in northern Colombia is presented, on the basis of a multi-disciplinary study of the sediments of the upper 15 m of the core from Boquillas (74°33'E, 9°7'N; 20 m a.s.l.). We used the following studies: pollen, lithology, organic structures, clay mineralogy, soil and sediment geochemistry, and δ¹³C values. The chronology is based on 13 AMS radiocarbon dates; the humic acid fractions were used in the case of seven samples. Pollen from local origin (swamps, open grass-rich vegetation, and gallery forest) show the development of the wetland area. River-transported pollen from a greater distance (dry forest, montane forest, Alnus) show changes in river activity and reflect large-scale changes of climatic conditions in the Mompoxina basin. From c. 10,101 to 9370 uncal B.P. (zone BQS-Ia) the river system was of high energy, as inferred by the lithological changes. The landscape was dominated by open grass-rich vegetation with gallery forest along the streams. A marked representation of Alnus and montane forest taxa indicate significant water transport and river dynamics. Climatic conditions were dry. From c. 9370-8430 uncal B.P. (zone BQS-Ib) wetlands were isolated from the main river system, and clayey sediments with kaolinite, smectite and illite as the main minerals accumulated in a lower-energy environment. Climatic conditions were dry and changes in the seasonal precipitation favoured the expansion of the gallery forest. From c. 8430 to 8040 uncal B.P. (zone BQS-Ic) low values of river-transported pollen indicate dry climatic conditions and open vegetation became more abundant. The flooding frequency of the Boquillas site diminished. From 8040 to 4900 uncal B.P. (zone BQS-Id) the Boquillas site was dominated by open vegetation with patches of gallery forest along the streams. Supply of river-transported allochthonous pollen (from many sources) was minimal. Clay minerals from the sediments suggest variable temperature and precipitation. From c. 4900 to 1550 uncal B.P. (zone BQS-II) the site was within the reach of the main river system as is the case today. Frequent floodings, coinciding with peaks of river-trans-

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Introduction

The palaeoecological history of the wetland ecosystem in northern Colombia is poorly known. This floodplain area is one of the large wetlands in the world (Van der Hammen 1986). Palaeoecological understanding is based on pollen records from the Ciénaga Morrocoy site, located in the lower Magdalena river valley, providing evidence of a dry period around 720 uncal B.P. (Wijmstra 1967). Van der Hammen and Noldas (1984) studied the pollen profile from Ciénaga Grande de Santa Marta, located at the mouth of Magdalena river near the Caribbean Sea. They showed regression-transgression cycles during the Holocene based on migrations of the belt with mangrove vegetation. Herrera and Berrio (1998) showed in a pollen record from Caño Carate that climatic conditions were dry between 940 and 780 uncal B.P., and wetter around 550 uncal B.P. Van der Hammen (1986) dated 25 peat-rich horizons intercalated with clay from 9 boreholes, recording Holocene fluctuations in the flooding intensity in the basin of the Magdalena-Cauca-San Jorge rivers. The inundation frequency was interpreted as reflecting changes in precipitation in the catchment area of this composite drainage system. An estimated mean sedimentation rate of 3.82 mm/yr was inferred for the last 7500 uncal B.P., based on all boreholes (HIMAT 1977).
Multi-disciplinary analysis of the sedimentary record is important to better understand the dynamics of an ecosystem on a regional scale (Lowe and Walker 1997). Integration of the biotic and abiotic information obtained from sediment cores results in a more complete reconstruction of palaeoenvironmental change (Patience et al. 1996; Huizer and Isarin 1997). Different proxies may be used depending the environment, but mostly geochemical analysis of sediments is a basis (Mackereh 1965). In Latin America few multi-disciplinary studies have been published; we mention the studies in Carajás (Soubies et al. 1991), the central Amazon basin (Rion et al. 1995), in the Venezuelan lake Valencia (Curtis et al. 1999) and the study of Cauxianã in Brasil (Behling and Lima da Costa 2000). From the Colombian Amazon we mention the study by Duivenvoorden and Lips (1995) in which proxies of the biotic and abiotic environment were integrated to show the natural processes in a lowland rainforest ecosystem.

In this paper we present the results of the new core from Boquillas. We used a combination of soil geo-chemistry, changes in the content of δ13C of the total organic content (δ13C TOC), pollen analysis and changes in sediment characteristics along the core. The aim of this paper is to reconstruct environmental change of the Lower Magdalena wetland ecosystem in northern Colombia since the Late Glacial. We also try to improve the understanding of how the pre-Hispanic cultures, which existed there according to the archaeological records for over 3000 years, modified the landscape to control their environment and turn it into an extensive agricultural system.

The setting of the area

Geography and climate

The Boquillas core was collected in the town of Boquillas, province of Bolivar, southeast of the village of Magangué, and southwest of the village of Mompóx. The site is located 13 km from the Brazo de Leba, and 2 km from the river Chicaguá, at 74°33'45"E and 9°7'25"N in the centre of the Momposina basin (Fig. 1). This region is known as 'Depresión Momposina' because it includes some 80% of the total number of ciénagas, depressions in the Cretaceous-Tertiary bedrock with stagnant or river-dependent water bodies that accumulate sediments (Forero et al. 1997; Ballesteros 1983).

There is a dry period from the end of November until the end of March. Most precipitation falls from May to July, and from October to November. The total annual precipitation is some 1500 mm in the localities of Magangué and Mompóx; towards the south the annual precipitation increases to 2500 mm (IGAC 1998). The mean annual temperature is 26°C. This region receives water from the rivers Magdalena, Cauca, San Jorge, and César, which transport huge amounts of sediments from the three Colombian Cordilleras into the Caribbean Sea (IGAC 1989). The area is the most frequently flooded part in Colombia. According to Van der Hammen (1986) the uppermost 40 to 50 m of sediment in the Momposina basin is not older than of Late glacial age, that is with a maximum age of 11,000 uncal B.P.

Vegetation

In the vegetation study of IGAC (1977) four main vegetation types were recognised in the study area:

(1) Tropical dry forest (Bosque Seco Tropical; bs-T) with Attalea butyracea, Syagrus sancona, Acrocomia antioquiensis, Amaranthus hybridus, A. spinosus, Anacardium excelsum, Aspisidoperma dugandii, Bursa tomentosa, Capparis indica and C. odorata, Casearia corimbosa as the main taxa. Local vegetation is characterised by Eichornia crassipes, Eliochris interstincta, Hydrocotyle umbellata, Ludwigia pilosa, Pistia stratiotes, Polygonum densiflorum, Salvinia sprucei, and Typha angustifolia.

(2) Premontane wet forest (Bosque Húmedo Premontano; bh-PM) is located in the valley of the river Magdalena. The main taxa are Clidemia pitellata, C. octona, Miconia aeruginosa and M. stenostachya; Clusia sp., Croton sp., Cupania sp., Cordia allidora, Didymopanax morototoni, Erythrina poepigiana, Ficus sp., Inga densiflora, Ladenbergia magnifolia, Nectandra sp., Ochroma lagopus, Myrsine guianensis, Trichanthera gigantea and Trinufetta mollissima.

(3) Tropical wet forest (Bosque Húmedo Tropical; bh-T) mostly present as gallery forest along the rivers with Acalypha macrostachya, Alchornea sp., Cassia reticulata, C. spectabilis, Calcitra sp., Erythrina edulis, Cecropia sp., Vismia sp., Piper aduncum, Tabebuia rosea, Tecoma mollis, Tremo micrantha, Warszewiczia coccinea, Spondias mombin, Ilex sp., Tapirira guianensis and Virola sebifera.

(4) Savanna vegetation, present for climatic (annual precipitation less than 500 mm) as well as for edaphic reasons (subsoil characterised by floodplain soils called Entisols or Aquents). The open herb vegetation is characterised by Poaceae (Bouteloua filiformis, Cynodon dactylon), Cyperaceae (Cyperus ferax), and Asteraceae (Aspilia tenella). Savanna trees are mainly represented by Curatella americana and Byrsonima crassifolia.

Fig. 1. Map of the study area showing the location of the Momposina basin and the coring site of Boquillas, in the lower Magdalena valley, northern Colombia.