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POLLEN RECORD OF HOLOCENE SEDIMENTS IN THE CENTRAL AMAZON, BRAZIL

Registro polínico de sedimentos del Holoceno en la Amazonía Central, Brasil

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SUMMARY: Phases in seasonal fluctuations in rainfall in late Holocene are already known to the Amazonia, especially in the Central Amazon basin. Periods of lower effective rainfall were recorded in the range of 2700-2100 years BP and identified by pollen analysis of sediments of the basins of the Purus, Negro and Solimões rivers. Pollen analysis of Lago Cabaliana confirmed this interval of reduced precipitation, indicated by the establishment of forest terra firme and late successional varzea forest. Since the variations of the flood pulse of large rivers are a direct result of the actual amount of precipitation, it can be stated that there was a minor flood phase in the Central Amazon basin in the late Holocene.
KEYWORDS: varzea, rainfall, Solimões River, flood pulse.

RESUMEN: Fases en las fluctuaciones estacionales de las precipitaciones en el Holoceno tardío son de sobra conocidas en la Amazonía, especialmente en la cuenca central del Amazonas. Los períodos de precipitación efectiva más baja se registraron en el rango de 2700-2100 años BP y se identificaron mediante análisis polínico de sedimentos de las cuencas de los ríos Purus, Negro y Solimões. El análisis de polen del Lago Cabaliana confirmó este intervalo de disminución de las precipitaciones, indicado por el establecimiento de bosques de tierra firme y bosque sucesional tardío varzea. Dado que las variaciones del pulso de inundación de los grandes ríos son el resultado directo de la cantidad real de la precipitación, se puede afirmar que hubo una fase de inundación menor en la cuenca central del Amazonas en el Holoceno tardío.
PALABRAS CLAVE: varzea, precipitación, río Solimões, pulso de inundación.

INTRODUCTION

Studies of past environmental conditions, based principally on palynological data, have led to a better understanding of fluctuations in water level in central Amazon basin. The sediments samples studied are from the lake of the river delta. The local vegetation around the lake is mainly determined by the water level (the average high-water–level, the difference between high - and - low - water levels, the number of months that a site is inundated every year). This work deals with the study of pollen analyses and ^{14}C datings of Holocene sediments from Lake Cabaliana, Central Amazon basin.

MATERIAL AND METHODS

The sediment samples were collected in Lake Cabaliana, Central Amazon (Figure 1). The drilling was done with a vibracore core sampler. Each sample was taken at 10 cm intervals, from the surface to 160 cm depth. The samples were treated for 10 minutes with a boiling 10 percent aqueous KOH solution (FAEGRI & IVERSEN, 1966), followed by acetolysis method and a gravity separation by means of a bromoform-alcohol mixture s.g. 2.0. After the preparation, the residue was mounted in glycerin jelly. The identification of the pollen grains was made with the aid of the reference pollen collection of the Palynology Laboratory of the Instituto Nacional de Pesquisas da Amazônia (INPA). Three ^{14}C datings were carried out in the Beta Analytic Laboratory (Florida, USA) by using of the Accelerator Mass Spectrometry (AMS). These three samples dated indicate ages of Late Holocene (Figure 2). The pollen diagrams were made by means of the Tilia, TiliaView Programs and CONISS (GRIMM, 1987). The palynomorphs were grouped according to their habitat. The pollen sum corresponds to the total of the pollen belonging to the terrestrial plants (n = 300). For those taxa that occur in both varzea and upland forest (terra firme forest) habitats have been named as environmental indeterminate.

RESULTS

Previous palynological studies in Central Amazon and their relation to the data of Lake Cabaliana. The data described below are in accordance with ABSY (1979). The results of pollen analysis of fluvial sediments from the Central Amazon comprised the study of three hydrographic basins of the region: 1- Rio Negro, 2- Solimões and 3- Purus. Palynological study of Lago do Cajú (Rio Negro River) has shown changes in vegetation during the last 2700 years BP. One phase of lower rainfall was recorded for 2150 years BP based on the increased frequency of pollen of Graminae, *Borreria*, *Polygala* and *Byrsonima* (open vegetation elements). These data of Lago do Caju indicated that there was a flood of lower amplitude in the floodplain of the Rio Negro, which allowed the establishment of open vegetation on sand banks formed by fluvial activity. The record in Lago do Caju was coincident with the interval of lower precipitation found in 2 the Costa da Terra Nova

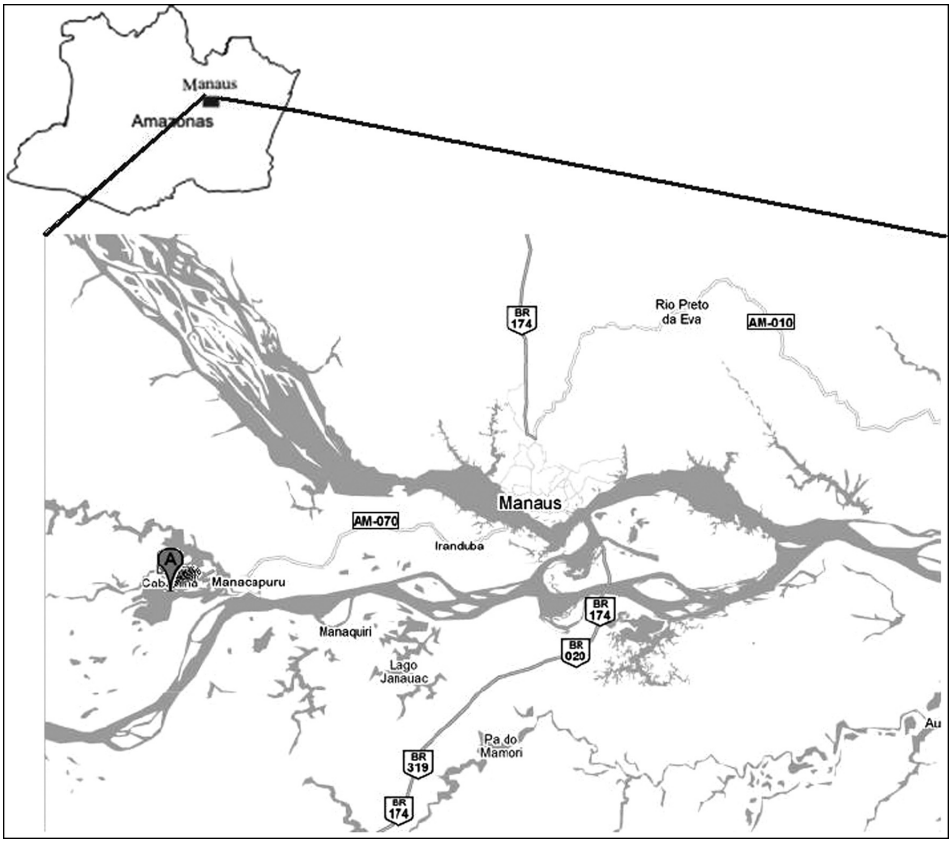

FIGURE 1. Location of Lago Cabaliana in the Central Amazon. Study area identified at point A: 3˚17'35.62"S and 60˚48'18.71"W.

(Solimões River) about 2700-2100 years BP. At this phase, there was a predominance of *Cecropia* (varzea forest) in relation to the pollen of aquatic macrophytes (some Poaceae, Cyperaceae) and increased frequency of *Symmeria* (varzea forest) and *Byrsonima* (swampy areas - AYRES, 1993) suggesting the beginning of varzea vegetational succession on the banks of fluvial course. At Lake Surara (Purus river), the vegetational dynamic responded to phase decrease in precipitation occurred in the interval of 2400-2000 years BP. The increase in grass pollen in this interval was indication of a possible decrease in the flood phase. After 2000 years BP, wetter conditions were detected for the three basins, indicating an increase in effective rainfall in the Central Amazon region.

Results of Lago Cabaliana. The pollen diagram of Lake Cabaliana shows changes in the vegetation during the last 2700 years (Figure 2). In the whole profile, there was a predominance of varzea vegetation, characterized by pollen of *Cecropia*, *Pseudobombax*, *Sapium* and Myrtaceae (SÁ *et al*., 2010). At the beginning of Zone I (2700-2500 ^{14}C yr BP) there was an increase in the percentage of pollen of Sapotaceae, Rutaceae, *Symphonia* and *Protium*, suggesting the advancement of terra firme forest toward the Lake Cabaliana basin. Later, there was a retraction of terra firme forest and varzea forest expansion, which can be interpreted as the continuity of the floristic succession of varzea vegetation. At around 2500 ^{14}C yr BP, pollen of terra firme forest increases slightly and varies little in the upper zone. In the interval of 2500-1500 ^{14}C yr BP (Zone II), the varzea forest shows highest percentages, however, these values are related only for a few taxa*: Cecropia*, Poaceae and *Symmeria* (SÁ *et al*., 2010). In zone III (1500-700 ^{14}C yr BP), taxa of terra firme forest show the highest frequencies (in relation to other zones) never varying less than 15% and reaching peaks of 25% of total pollen sum. The varzea forest declines relatively, probably by the establishment of the later seres of plant succession. At around 700 ^{14}C yr BP, terra firme forest continues to advance toward the basin of Lake Cabaliana, representing about 40% of the surrounding vegetation, however, at about 400 ^{14}C yr BP (Zona IV), the terra firme vegetation is replaced by pioneer vegetation of varzea characterized by low species richness as well as in the interval of 2500-1500 ^{14}C yr BP (Zone II).

DISCUSSION AND CONCLUSION

The interval of 2700-2500 ^{14}C yr BP may indicate a phase of lower rainfall in the Lago Cabaliana, once there was the establishment of terra firme vegetation in association with the varzea forest (SÁ *et al*., 2010). This phase has a clayey lithology (Figure 2), characteristic of a lentic environment. Probably, the Lake Cabaliana went through a phase of full, however, the flood was lower in this period (SÁ *et al*., 2010). In the interval of 2500-1500 ^{14}C yr BP, the lithology consisting of sand+mud points to more humid conditions with some intervals of reduced lake water level, *e. g.* in 2200 ^{14}C yr BP, the increase of *Cecropia*, *Byrsonima* and Myrtaceae points for settings the varzea forest in conditions of low water level of the lake. The Lake Cabaliana, in this way, also recorded fluctuations in water level as those found in Lago do Caju, Lago Surara and Costa da Terra Nova in the period of 2700-2100 ^{14}C yr BP (ABSY, 1979). The degree and intensity of flooding is a direct result of the amount of rainfall captured by the basin, either fluvial or lacustrine which was called by JUNK (1989) as flood pulse. In general, the tropical rivers respond rapidly to variations in precipitation and, therefore, the floodpulse vary rapidly in a short time (MARENGO, 1992; IRION *et al*., 1997). Thus, it is evident that there was effective decrease in precipitation in Central Amazon in the period of 2700-2100 ^{14}C yr BP, suggested either by establishment and development of the forest succession periodically flooded (varzea or igapó) and/or the advancement of terra

firme forest. According to the data from this work the Holocene vegetation studied in the lakes of Central Amazon is related to marked changes in the water level: the average high-water-level, the difference between high - and - low - water levels, the number of months that, a site is inundated every year.

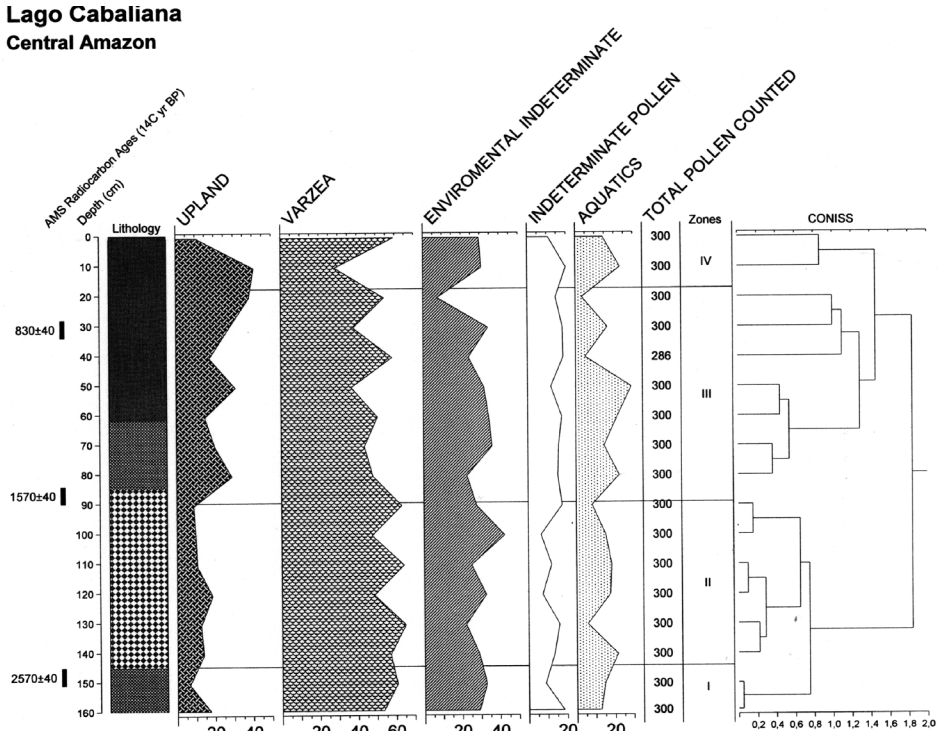

FIGURE 2. Palynological percentage diagram including radiocarbon ages. Lithology, sum, number of counted grains, zones and dendrogram.

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