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A 2000-year reconstruction of forest disturbance from southern Pacific Costa Rica

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Abstract

We reconstruct prehistoric and historic human forest disturbance and vegetation change in southern Pacific Costa Rica, in the vicinity of the Las Cruces Biological Station and the La Amistad International Park and Biosphere Reserve. Pollen and charcoal in sediments from Laguna Santa Elena reveal a nearly continuous record of human alteration of these tropical forests over the past two millennia. The basal portion of the core shows nearly intact premontane forests approximately 1800 cal. year B.P., although there is evidence of human presence on the landscape in the form of maize pollen and charcoal. Clearing for agriculture resulted in the dominance of disturbance taxa in the watershed beginning at least 1400 cal. year B.P. The pollen record reveals a possible, brief hiatus in human occupation of the watershed at approximately 540 cal. year B.P., although secondary succession began to occur in the Laguna Santa Elena watershed prior to that time, beginning about 700 cal. year B.P. Three eruptions of nearby Volcán Barú, which we date to approximately 610, 1080, and 1440 cal. year B.P., apparently had little direct effect on the prehistoric populations in the immediate vicinity of the lake. Historic and modern land clearance has perpetuated a modern vegetation assemblage of disturbance and successional taxa.

Keywords: Costa Rica; Tropical; Pollen analysis; Human impact; Prehistory; Archaeology; Upper Holocene; Rain forest; Charcoal

1. Introduction

The intensive management and alteration of tropical forests in the Americas by indigenous populations prior to the arrival of Europeans is well-established for some regions (Deevey et al., 1979; Binford et al., 1987; Leyden, 1987, 2002; Metcalfe et al., 1989, 1991; Whitmore et al., 1996; Goman and Byrne, 1998). However, the spatial and temporal patterns associated with human modifications of tropical landscapes beyond the regions occupied by

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large, complex civilizations of Mesoamerica and the Andes remain to be resolved, and debate about the timing and magnitude of pre-Columbian forest ecosystem alteration continues (Heckenberger et al., 2003).

Even in less-populated regions outside of the Mesoamerican and Andean empires, pre-Columbian groups in Costa Rica and Panama significantly altered their environments (Bush and Colinvaux, 1994; Northrop and Horn, 1996; Behling, 2000; Clement and Horn, 2001). This includes areas once thought "pristine" or "virgin" (Bush and Colinvaux, 1994; Kennedy and Horn, 1997; Horn and Kennedy, 2001). Human alteration of neotropical ecosystems was surely spatially and temporally complex. Prehistoric cultures throughout the Americas occupied a diverse array of environments, and as such would have been subject to a heterogeneous mix of environmental constraints. In turn, pre-Columbian groups responded to these constraints in different ways. The process of anthropogenic landscape change, therefore, would have followed a different pattern according to the particular environmental constraints of a region and the extent to which humans altered or engineered that environment. Investigations of prehistoric population size, settlement and land use patterns, and resource limitations reveal that cultures throughout the Americas used or engineered their environments differently, with varying levels of success, longevity, and stability (Sheets, 1992, 2001; Dunning, 1996; Fedick, 1996a,b; Beach 1998; Lentz, 2000; Dunning and Beach, 2001).

In southern Pacific Costa Rica and western Panama (Hoopes, 1996; Corrales, 2000), archaeological data suggest cultural differences within and between prehistoric groups, and therefore it should be expected that the timing and magnitude of human impacts on vegetation might likewise be spatially heterogeneous and temporally asynchronous. In this study we present the results of our palaeoecological investigation of Laguna Santa Elena, a mid-elevation lake in the Canton of Coto Brus, at the foot of the Cordillera de Talamanca in southern Pacific Costa Rica. Located within 20 km of both the Organization for Tropical Studies' Las Cruces Biological Station, and the La Amistad International Park (a UNESCO Biosphere Reserve), Laguna Santa Elena presents an opportunity to explore palaeoenvironmental history in an ecologically important region. Our study complements and extends ongoing archaeological research into prehistoric subsistence patterns and landscape modification (Sánchez and Rojas, 2002; Soto and Gómez, 2002). Using palaeoecological indicators in the sediments of Laguna Santa Elena, we address the question of the timing and nature of subsistence patterns prior to the arrival of the Spanish, and how these subsistence activities influenced the forest around Laguna Santa Elena.

2. Environmental and cultural setting

2.1. Environmental setting

Laguna Santa Elena (8°56′ N; 82°56′ W, 1100 m elevation) is a small (~0.25 ha), shallow lake (~4 m) that occupies a landslide-truncated stream channel between east–west trending ridgelines bordering on the Terraba-Coto Brus River Valley (Fig. 1). Old shorelines indicate the lake may have been as large as 1 ha prior to partial draining in recent decades. The ~1 km^2 watershed of the lake and the surrounding region are characterized by undulating to steep terrain dissected by tributaries and associated stream terraces. Average annual rainfall for the region is 3500–4000 mm, with a pronounced but short dry season from January to March, and average annual temperature is 21–23 °C (Herrera, 1985). Laguna Santa Elena is located in the "premontane wet forest transition to rain forest" life zone in the Holdridge bioclimatic classification (Holdridge, 1967; Hartshorn, 1983), which includes potential primary forest vegetation associations with Fagaceae (*Quercus*), Lauraceae, *Hedyosmum*, *Weinmannia*, *Alnus*, and Melastomataceae. Modern vegetation and land-use patterns are coffee cultivation and small-hold farms, with some secondary growth.

2.2. Archaeological setting

Costa Rica is part of an archaeological region known as the Intermediate Area, which includes both Lower Central America and northwestern South America, and encompasses parts of Honduras and El Salvador, and all of Nicaragua, Costa Rica, Panama, northern Ecuador, Colombia, and western Venezuela (Lange, 1992). Archaeologists have proposed desig-