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The origins and early development of plant food production and farming in Colombian tropical forests

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ABSTRACT

This paper concentrates on archaeobotanical evidence for the adoption of plant cultivation in the forests in seven regions of Colombia. We present a synthesis and explanation of the evidence we currently have for the process that involved the adoption of plant cultivation and the development of food production in this area. The use of locally available plant foods in these forests is evident by the Pleistocene/Holocene transition. By the Middle Holocene, exogenous plant domesticates were added, including maize, manioc, and possibly common beans. We further explore available data on other proxies to discuss models to explain the transition from hunting and gathering to horticulture.

1. Introduction

The origin of food production is one of the major landmarks in human evolution (Watson, 2001; Winterhalder and Kennett, 2006). Plants were domesticated in multiple regions around the globe, between five and ten, depending on the author (e.g. Harlan, 1971; Vavilov, 1992: 126–128; Piperno and Pearsall, 1998; Piperno, 2011a,b; Smith, 1998; Diamond, 2002; Zeder et al., 2006; Balter, 2007). One of these regions – northwestern South America (Andean Colombia and adjacent Ecuador) – is a belt of tropical forests with dissimilar temperature and precipitation regimes. Piperno (2011a,b) has proposed that this region was a center for plant domestication in South America. Synergisms between socio-cultural, climatic, and environmental processes at the late Pleistocene/early Holocene boundary and subsequently in the early and mid-Holocene, favored situations that enhanced the subsistence value of planting groups of vegetable foods, rather than gathering them off the landscape (Gnecco, 2003; Gnecco and Aceituno, 2004, 2006; Aceituno and Loaiza, 2014, 2015; Loaiza and Aceituno, 2015; Morcote et al., 2014; Piperno, 2011a,b, 2017; Dickau et al., 2015; Loaiza and Aceituno, 2015; Piperno, 1989; Santos et al., 2015).

A growing number of taxonomic and genetic studies in different parts of the lowland and premontane forests in the Neotropics show that important food plants such as manioc (*Manihot esculenta* Crantz), arrowroot (*Maranta arundinacea* L), cocoyam (*Xanthosoma sagittifolium* (L) Schott), leren (*Calathea allouia* Lindl) and sweet potato (*Ipomoea batatas* (L) Lam) were domesticated in different regions (e.g. Brücher, 1989; Piperno and Pearsall, 1998: 4–6; Iriarte, 2007, 2009; Rouiller et al., 2013). Archaeological data recovered over the past three decades have indicated that Colombia is a key region for understanding the origin and dispersal of plant cultivation and domestication, as well as their cultural evolutionary consequences throughout the Neotropics (Cardale et al., 1989; Gnecco and Salgado, 1989; Gnecco and Mora, 1997; Morcote et al., 1998, 2014; Gnecco, 2000, 2003; Aceituno and Loaiza, 2014; Santos et al., 2015). We present, analyze and discuss several lines of information that elucidate the range of adaptive strategies adopted by people living in several regions of Colombian humid forests. We show how they developed strategies during the early Holocene and the middle Holocene, setting the scene for the transition from lifeways combining hunting, fishing, and gathering to others that increasingly relied upon a small number of domesticated vegetable foods.

Human groups present on the Colombian landscape since at least 12,400 ± 160, years BP (Correal, 1986: 117) (all dates are uncalibrated ^{14}C, unless noted otherwise) responded to the strong environmental changes of this long period by developing plant management practices that modified the regional and local vegetation and included the use of cultigens whose initial domestication occurred outside and even well beyond Colombia, such as manioc and maize (Piperno, 2011a,b; 2017). These management strategies are the steppingstones for the origins of food production and signal the beginning of the Archaic, a Holocene cultural period in which the development of

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plant domestication and cultivation as well as the insertion of horticulture as a principal player in the subsistence economy.

We use the expression food production in the sense of low-level food production (Smith, 2001), defined as an economy that is a mixture of practices characteristic of hunting and gathering and agricultural societies (Winterhalder and Kennett, 2006: 4). Horticulture should be understood as a form of low-level food production that entails small-scale planting of species that range from wild to domesticated (Piperno and Pearsall, 1998: 6–7; Winterhalder and Kennett, 2006: 4). Following these authors, domesticates are new varieties or species of plants or animals created through artificial selection (Winterhalder and Kennett, 2006: 3). Domestication then is the process that leads to the evolution by artificial selection of altered organisms that display features advantageous for human environments but that are disadvantageous for surviving in the wild, and this last feature is also known as the domestication syndrome (Allaby, 2014). Cultivation should be understood as the "tending of plants, wild or domesticated" (Winterhalder and Kennett, 2006: 4).

2. Archaeobotanical evidence of plant use during the Archaic period

At the onset of the Holocene, field evidence shows a rise in regional population as new areas were colonized (Aceituno et al., 2013). The evidence to be discussed in this paper is located from south to north of the Andean region of Colombia following the Cauca River Basin in Popayan, Calima River Basin, middle Cauca River Basin (middle Cauca), Medellin/Porce River Basin. Outside the Andes in the Amazon basin the Peña Roja site is located. Finally we will refer to archaeological evidence in the Sabana de Bogota and middle Magdalena River Basin (middle Magdalena) (Fig. 1).

2.1. Popayan

Popayan is located in the Central Cordillera in the upper Cauca River Basin at about 1600 m above sea level (masl) in a Subandean forest zone (Fig. 1) (Gnecco, 2000: 17). In this setting is located San Isidro, a site dated between 10,050 ± 100 and 9530 ± 100 years BP (Gnecco, 2000: 48, Gnecco, 2003) (Fig. 2) and characterized by thousands of flaked chert and some obsidian artifacts There are retouched and unretouched flakes, lanceolate bifaces and projectile preforms. In addition to the knapped artifacts there are edge ground cobbles (handstones), flat milling stones, cobbles with concave grooves, and a ground stone axe (Gnecco, 2000: 60–62). Thousands of seeds were recovered in association with the artifacts. These included avocado (*Persea* cf. *americana*), basul (*Erythrina* cf. *edulis*), *Caryocar* spp., *Virola* spp., several palm types, highlighting *Acrocomia* (Piperno and Pearsall, 1998: 200; Gnecco, 2000: 67–69). Macrobotanical remains of *Lagenaria* sp. were also recovered at San Isidro (Gnecco, 2003; Gnecco and Aceituno, 2006: 93). Starch grains extracted from an edge ground cobble were identified as cf. *Xanthosoma/Ipomoea* and/or *Manihot* and *Maranta* (cf. *arundinacea*), as well as non-identified grasses and legumes (Piperno and Pearsall, 1998: 200).

According to Gnecco (2000, 2003) San Isidro inhabitants were already practicing cultivation at the Pleistocene/Holocene transition. In the pollen record the identification of colonizing plants (i.e. *Plantago*), grasses and shrubs suggest plot preparation close to the site. Based on the pollen and archaeobotanical records, Gnecco (2003) suggested that San Isidro inhabitants practiced a form of agroecology (Rindos, 1984) based on the selection and cultivation of non-local fruit trees and tubers around 10,000 years BP.

2.2. Calima River Basin

North of Popayan in the Calima River Basin (Western Cordillera) (Fig. 1) in a Subandean moist forest life zone and at 1750 masl, the sites of Sauzalito, El Recreo and El Pital are located. Radiocarbon dates from these sites are between 9670 ± 100 years BP and 4090 ± 90 years BP (Salgado, 1988–1990, Salgado, 1995) (Fig. 2). Stone tools found at them, including milling stones and handstones, and axes/waisted hoes suggest plant processing (Herrera et al., 1988; Salgado, 1988–1990). The last-named is considered a diagnostic tool type for the region and has been related to the removal of soils for plant cultivation, harvesting tubers and roots, and the extraction of starchy hearths from palm trees (Cardale et al., 1989; Gnecco and Salgado, 1989). From these sites archaeologists also recovered charred seeds from palm trees and avocado along with phytoliths identified as palms, bamboos and arrowroot *Maranta* sp. (Piperno, 1985; Piperno and Pearsall, 1998: 202).

It can be argued that the Calima River data revolutionized archaeological interpretations during the 1980s and 1990s) because they suggested a model for early hunter-gatherers that stressed plants, as opposed a heavy reliance on hunting as in the Sabana de Bogotá (Gnecco and Salgado, 1989). This new model also put forward for the first time the possibility of plant cultivation in early Holocene occupations in Colombia.

2.3. Middle Cauca

Following the Cauca River Basin to the north, is found the middle Cauca region (Central Cordillera) (Fig. 1). This region has one of the most complete archaeological records in Colombia (26 sites excavated and dated) and a long occupational sequence that dates back to the Pleistocene/Holocene transition to the middle Holocene (Rojas and Tabares, 2000; Rodríguez, 2002; Cano, 2004, 2008; Tabares, 2004; Aceituno and Loaiza, 2007; Dickau et al., 2015). Most of these sites are located between 1400 and 1700 masl in a premontane wet forest (Espinal, 1985). Archaic occupations in the region are dated between 10,619 ± 66 and 4180 ± 70 years BP (Dickau et al., 2015) (Fig. 2).

The Middle Cauca lithic industry comprises flaked and ground tools. Flaked tools were widely used, and some derived from a quartz quarry site at El Antojo where thousands of flakes were collected, some of them bifacially reduced (INTEGRAL, 1997; Aceituno and Loaiza, 2007: 77–78). Two bifacial projectile points: one at the site of El Mirador, dated 9663 ± 83 years BP, and another at the 39 El Recreo Cancha site dated between ca. 8500 and 8000 years BP (Herrera et al., 2011; Dickau et al., 2015). Frequent handstones, milling stones, and waisted tools probable axes/waisted hoes (Fig. 3: 1–3) were manufactured with local volcanic rocks obtained in streams (Aceituno and Loaiza, 2007; 2014; 2015; Loaiza and Aceituno, 2015).

Macrobotanical remains are scarce in middle Cauca sites, and therefore archaeobotanical studies have been based mainly on pollen and starch grain analysis. Even so, the sheer quantity of data underlines the importance of this region for the understanding the evolution of food production in the northern Andes. Tables 1 and 2 show wild and domesticated taxa identified in archaeological sites dated from the early to the middle Holocene. During the early Holocene, microbotanical data on plant use suggest the earliest stages of a form of low-level food production that entailed the selection, propagation, and protection of some plants in areas close to settlements. On the other hand, the exogenous origin of maize (Fig. 4: d and k), *Manihot* cf. *esculenta* (Fig. 4: a, e, m, and p) and *Phaseolus* cf. *vulgaris* (Fig. 4: l and n) confirms that horticultural practices were well established by the middle Holocene throughout the Neotropics. The remaining taxa identified are carbohydrate rich tuberous plants, such as *Xanthosoma* (Fig. 4: f, h, and j), a widespread genus across northern South America (Piperno and Pearsall, 1998: 165) that is well represented within the pollen record at the El Jazmin site between ca. 9000 and 5000 years BP (Jaramillo and Mejía, 2000a; Aceituno and Loaiza, 2007: 84–86). That suggests these tubers were likely a resource used since the first moments of food production. *Ipomoea* (Fig. 4: g) – the genus to which the domesticated species *I. batatas* (L) belongs – produces tuberous plants and has been identified in the middle Cauca. Two wild possible ancestors of *I. batatas*, *I. trifida*