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Plant diversity and ecosystem services in Amazonian homegardens of Ecuador

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ABSTRACT

Homegardens (HG) can play a key role in the conservation of plant diversity and at the same time provide ecosystem services that have a direct and positive impact on human welfare. The relationships among plant diversity, ecosystem services, and the factors that influence them formed the subject of study in tropical HG in Sangay, Ecuador. We compiled information from 138 HG in 11 localities and found 484 plant species associated with 20 ecosystem services, the most important of which, according to interviews with the gardeners, provide food, medicine and ornamentation. Influential physical factors on plant diversity in the HG were altitude, precipitation and temperature, while socioeconomic factors, including ethnicity, gender, income and education, were perhaps more important determinants of HG diversity. Three groups of HG were identified by Hierarchical Ascendant Correspondence Analysis: "small HG of recent origin," having the fewest species and ecosystem services, "large, transitional HG," having a wide range of services, and "medium, established HG," mainly supplying food, medicine, ornamentation, shade and fencing. Ethnicity may be a stronger determinant of differences in HG composition: for *Shuar* people, HG were a main source of food, critical to their subsistence in rural areas; in total, *Shuar* gardeners cultivated on the whole more plant species. On the other hand, HG belonging to *mestizos* were more diverse, have more exotic plant species, and provide mainly cultural and regulatory services. HG in more urban settings mainly provided ornamentation, fencing and shade. This information can be applied by policy makers to the design of strategies for biodiversity conservation and food security.

1. Introduction

Homegardens (HG) offer a wide range of ecosystem services (ES; Galluzzi et al., 2010). ES are the benefits generated directly or indirectly from ecosystems (De Groot et al., 2002), associated both with specific functions of an ecosystem and with social drivers (Andersson et al., 2007). As a result of this dual association, biodiversity conservation determines the supply of ES and *vice versa* (Cardinale et al., 2011). In the case of HG, benefits provided by ES are recognized more often by intuition than measured quantitatively; consequently, policy makers have tended not to incorporate HG into land use planning (Kumar and Nair, 2004). Also, although HG are considered biodiversity hotspots (Kumar and Nair, 2004), recently regarded as critical for their role in conservation of biodiversity in tropical areas (Bardhan et al., 2012), most policy is dedicated to natural landscapes and forests, ignoring the importance of agricultural systems in biodiversity conservation (Perfecto and Vandermeer, 2008). Characterizing the diversity

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and composition of HG and the ES they provide is an important first step in recognizing their conservation value (Clarke et al., 2014; Huai and Hamilton, 2009).

Traditionally, HG refer to agroforestry systems located close to family dwellings, providing small-scale production focused especially on food for household consumption; they often occur with a multi-layered, carefully managed structure; they employ family labour; each species within them is chosen to fulfil a function or ES (Fernandes and Nair, 1986; Niñez, 1987). HG are increasingly recognized as reservoirs of plant genetic diversity, especially of traditional crops (Galluzzi et al., 2010; Blanckaert et al., 2004); they serve as a refuge for wildlife (Perfecto and Vandermeer, 2008) and they are important spaces for transmission of cultural heritage (Galluzzi et al., 2010). Thus, HG are crucial to the economic, social and cultural development of a society, generating food, economic resources, medicine and employment, all of which improve the welfare of people who benefit from them (Kumar and Nair, 2004; Wiersum, 2006; Pulido et al., 2008).

The practice of HG is one of the traditional forms of subsistence for Amazonian people, along with hunting, fishing and gathering (Padoch et al., 1985; Wezel and Olh, 2005). Despite the importance of HG to social and environmental sustainability, they have received little scientific attention in Amazonian areas, other than descriptions of the ES they provide (Calvet-Mir et al., 2012). In general, HG characteristics (e.g., high biodiversity, complex structure, sustainability) and the types of ES they supply are influenced by physical, ecological and socioeconomic factors, and the needs and preference of gardeners (Huai and Hamilton, 2009; Van der Wal and Bongers, 2013). For instance, in tropical HG, altitude has been identified as an influencing factor in the selection of garden plants (Abebe et al., 2013; Das and Das, 2015). In the Amazon, several studies have highlighted the role of ethnicity in HG plant diversity and composition (Lamont et al., 1999; Wezel and Ohl, 2005; Perrault-Archambault and Coomes, 2008). Studies in China show that the level of urbanization, including such factors as the availability of domestic services and supplementary incomes, also affects the wealth and services provided by HG (Clarke et al., 2014). Integrated analyses on physical and socioeconomic aspects of HG are fundamental to understanding the functionality and benefits they provide (Das and Das, 2015).

Our research considered plant diversity and ecosystem services in tropical HG of the Sangay parish, in Ecuadorian Amazonia. As above, both physical and socioeconomic characteristics were among the factors expected to influence diversity, composition and ES in the HG of our study area. We took the opportunity presented to us by the local parish population to understand, via interviews and garden exploration the differences in HG composition, the ES identified by HG owners, and the related environmental and socioeconomic variables that determine them. We also explored the differences between the HG which belonged to the cultures that coexist in the small parish area; finally we defined the types and characteristics of HG and the ES provided by them. Our intent is to show that cultural context can determine how HG are constructed and how they serve in biodiversity conservation.

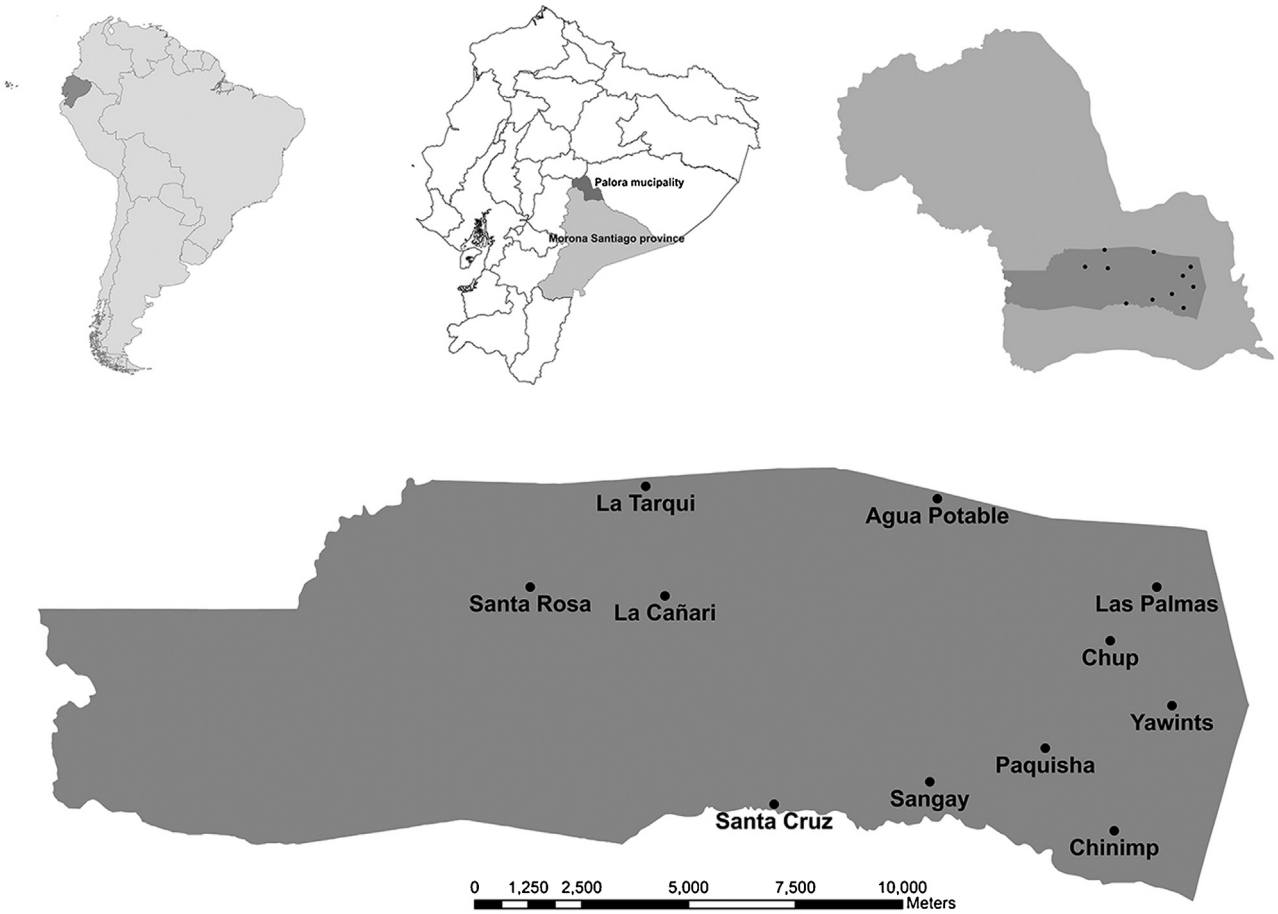

Fig. 1. Map of the sampling points in homegarden survey in Sangay parish, Palora municipality, Morona Santiago province, Ecuador.