



Original Research Article

Understanding the nursery habitat and provision service of a NTFP in a Colombian oak forest: A case of a nomadic vine

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ABSTRACT

The conservation of ecosystems and associated services depends on an understanding of the ecological process. Research has centered on regulation services with little research in support services such as nursery habitat and provisioning of non-timber forest products (NTFP). We evaluate structural characteristics of 210 trees of ten species of ecological importance from a Colombian oak forest and their relation to *Philodendron longirrhizum* (Araceae) and its production of aerial roots to obtain fibers. This species was present in the majority of forest tree species, the structural characteristics of the trees were not distinguished between hosts and non-hosts and the rugosity of the bark and diameter of the trunk of the host species influenced the number of total and harvestable roots. The nursery habitat offered by the oak forest results from the mechanism that *P. longirrhizum* uses to climb over a wide variety of hosts, and the provisioning service is fostered by larger host trees that favor the production of roots. For the management of *P. longirrhizum* we suggest the establishment of individuals over the majority of trees if the aim is the enrichment and the establishment of individuals on larger trees if the aim is to increase the production of fiber.

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1. Introduction

Understanding the mechanisms that result in providing ecosystem services is a basic task for accomplishing the conservation of forest ecosystems, more so if the objective is to take advantage of sustainable resources that are produced from these ecosystems (Dobson et al., 2006). Much of the research on ecosystem services has focused principally on evaluating regulatory and provision services that are easily identifiable and measurable (de Bello et al., 2010; Díaz et al., 2007; Lavorel, 2013; Lavorel and Garnier, 2002). Although there are studies on commensalistic relationships between trees that compose the forests and plants that depend on them for their development (such as those that inhabit the canopy) (Balcázar-Vargas et al., 2012; Bentes-Gama et al., 2013; Callaway et al., 2002; Knab-vispo et al., 2003; Plowden et al., 2003), there are few studies evaluating characteristics of forest ecosystems associated with support services, such as the habitat offered to other plants

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(nursery habitat), and provision services, such as obtaining non-timber forest products (NTFPs), one of the most important ecosystem services for local communities (de Groot et al., 2010; Sakai et al., 2016). Generally, some studies on terrestrial ecosystems highlight the importance of maintaining habitats diversity (either for their nursery or shelter functions) for agricultural production (Cong et al., 2014; Firbank et al., 2008). Others focus on the importance of maintaining habitats and populations for recreational purposes like recreational fisheries, diving or other activities related with ecotourism (Rees et al., 2010) or when species are multipurpose and their harvesting is not appropriate, resulting in a conflict of use (Herrero-Jáuregui et al., 2013) and others studies link the nursery function of certain habitats with the production of food or recreation, either quantifying nurseries independently or as a supporting service (Liquete et al., 2016).

It has been suggested that the characteristics that influence the establishment of plants in the canopy are associated with abiotic factors such as the availability of light, water and nutrients more than being associated with biotic factors (Benzing, 2004; Zotz and Hietz, 2001), although the latter can regulate the former in some ways (Wagner et al., 2015).

In the particular case of structurally dependent plants such as nomadic vines (climbing plants that germinate on the ground and lose the lower parts of their stem later during ontogeny) (Moffett, 2000; Zotz, 2013), host trees and their characteristics are fundamental for their development, since in their absence it is difficult to grow some key structures that fulfill their life cycle such as aerial roots (Balcázar-Vargas et al., 2012; Lopez-Portillo et al., 2000; Turriago, 2013). A number of studies in *Heteropsis* have shown that there is a direct relationship between the diameter of host trees and the abundance of nomadic vines, as well as the number of aerial roots available (Knab-vispo et al., 2003; Plowden et al., 2003).

Bentes-Gama et al. (2013) characterize the forest structure with the vine *H. flexuosa* as a first step in developing sustainable harvest and conservation guidelines for the species. The vine was frequently associated with species of thick bark. The species was less frequent with taller and broader trees and tended to develop in understory light condition, the trunks or branches were the main position for the attaching of the species.

Other studies of vascular epiphyte-host associations have identified a complex array of potential interactive mechanisms that could lead to species-specific interactions. These include variation in canopy effects on light, allelopathic and/or fertilization effects of throughfall, substrate moisture conditions, bark stability, and factors such as bark surface rugosity that might affect epiphyte colonization (Callaway et al., 2002; Knab-vispo et al., 2003; Strong and Ray, 1975).

Many peasant and indigenous communities use the aerial roots of vines to obtain natural fibers, transforming them to sell as artisanal products. In Colombia this type of fiber is mainly obtained from species of nomadic vines of the genus *Heteropsis* that are found in the Amazonian region (Balcázar-Vargas and Van Andel, 2005) and from the species *Philodendron longirrhizum* M. M. Mora & Croat, distributed in the Andean region and of great economic importance for the artisans of the department of Quindío (Colombia). These reached commercial values close to US \$10,500 in 2007, represented by the elaboration of traditional handicrafts that, although they generate a benefit for the inhabitants, degrade the nomadic vine populations and the surrounding forest ecosystem. (García and Galeano, 2009a).

We studied how structural tree traits might affect the development of roots in a species of nomadic vine in a Colombian oak forest (*Quercus humboldtii* Bonpl. Fagaceae) with the purpose of answering the following questions: (1) Are there differences between the structural characteristics of arboreal host individuals and non-host individuals? And (2) Does the host species and its structural characteristics influence the abundance of a nomadic vine and its fiber supply (amount of total and harvestable roots)?

We assumed that the structural characteristics (height, diameter, crown size and bark characteristics) differed between hosts and non-hosts and influenced the abundance of *P. longirrhizum* and its fiber supply independently of the tree taxon. This is because these characteristics regulate access to light and enhance productivity *P. longirrhizum*, which would explain the role of nursery habitat offered by the host tree.

2. Material and methods

2.1. Study area and species studied

This research was carried out in the oak forests of the municipalities of Charalá and Gámbita, located in the south of the department of Santander (Colombia), in the Eastern Cordillera at a range of elevation between 1700 and 2650 m, with a mean precipitation of 2643 mm and mean temperature of 20.5 °C. The forests are dominated by species such as *Quercus humboldtii* Bonpl. (Fagaceae), *Clusia multiflora* Kunth, *Chrysochlamys colombiana* (Cuatrec.) Cuatrec. (Clusiaceae), *Cyathea multiflora* Sm. (Cyatheaceae), *Hieronyma huilensis* Cuatrec. (Phyllanthaceae), *Spirotheca rosea* (Seem.) P.E.Gibbs & W.S.Alverson (Malvaceae) and the palm *Geonoma orbignyana* Mart. (Medina et al., 2009) with the presence of epiphytes. These are all old growth forests, with no evidence of fiber harvesters. The oak forest is important in the Andean region of Colombia, for their high floristic richness and offer ecosystem services for many local communities; currently less than 10% of the original forests extent (Avella and Rangel, 2014).

Philodendron longirrhizum M. Mora & Croat is a nomadic vine defined as climbing plants that germinate on the ground and may lose the older parts of their stem in the process of ascending – in contrast to true vines and lianas (Moffett, 2000; Zotz, 2013). Nomadic vines begin rooted in terrestrial soil, grow up a host tree, disconnect from the soil, and often send aerial roots back down once in their epiphytic stage. This species is distributed in montane forests between 1650 and 2500 m and are present in the three mountain ranges of Colombia as well as in the Mérida mountain range in Venezuela (Mora and Croat, 2007). It is commonly known as *bejuco páramo*, *chusque* or *tripeperro* and its aerial roots (those that are sent down from

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