Lianas, to cut or not to cut to conserve forest biodiversity?

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Abstract

Although lianas play an important ecological role in forests, they are considered structural parasites of trees. Both contrasting ideas challenge conservation practitioners. We evaluated the effects of lianas on their host-trees in an old-growth forest in the Chilean Mediterranean Forest to assess the interaction between lianas and the host-tree. Results showed that half of the trees were colonized by lianas (1-6cm DBH) of *Cissus striata* species, with a continuous regeneration. Most lianas hang from lower branches but not tangling the trunk, while most of them did not reach the topmost section of the crown, likely not competing for light with their host-trees. We found no evidence of structural parasitism; therefore, no control of lianas can be recommended in this particular case. Since it is a component of the old-growth Mediterranean forest, lianas could be included into the planning to increase biodiversity and ecological functions. Although we were unable to assess physiological damage or competition, the rapid assessment presented could facilitate the decisions in other forest ecosystems, while gaining information on their ecological function. In forest conservation and sustainable forestry, the structural parasitism should be considering as a hypothesis to test rather than a rule, weighting the socio-ecological trade-offs.

Keywords: Epiphyte, Tree-host colonization, Valdivian Temperate Rainforest, Forest management, structural parasitism, biodiversity conservation

Introduction

Lianas are considered structural parasites of trees. The idea is well-rooted among researchers and practitioners since Stevens (1987) documented structural parasitism caused on *Bursera simaruba*. The main negative effects are trunk constriction, light, water and soil nutrients competition, tree overloading, or regeneration suppression (Stevens 1987; Putz & Mooney 1991). This negative interaction can cause a decreasing host biomass accumulation and productivity (Schnitzer & Bongers 2002; Estrada-Villagas et al. 2020), increasing the lianas frequency (Perring et al. 2020), diminishing the host fruit production (Stevens 1987), or affecting the gross transpiration rate (Schnitzer & Bongers 2002).

Lianas account for 20-50% of the diversity in some tropical forests (Küper et al. 2004) and present in most of the world's forests. But lianas are not well known in many forest ecosystems and they could be considered as key components contributing firstly to increase diversity or support keystone species and ecological functions (e.g., Gentry & Dodson 1987). Lianas can change habitat heterogeneity in the forest by adding more complexity. For instance, they have positive effects on the nutrient and water cycling and carbon sequestration (Putz & Mooney 1991), increase canopy arthropod community, create a complex relationship with frugivorous and insectivorous birds, and bridge the tree crowns that helps prehensile-tailed vertebrates (e.g., Schnitzer & Bongers 2002; Yanoviak & Schnitzer 2013; Yanoviak, 2014; Schnitzer et al. 2020).

Both contrasting ideas on the role of lianas in forest ecosystems challenge managers and stakeholders when implementing conservation projects. They must face the dichotomic resolution whether or not lianas need to be cut, sometimes without enough information. Moreover, the lianas structural parasitism is still used as a recommendation and taught in many forestry schools, using this generalized idea as criteria to cut a tree during intermediate thinning or prescribe cutting the liana and the tree-host when “interfering” in restoration tasks.

We set up a small study case attempting to respond to three questions that might help to describe whether lianas are a problem to forest conservation and to assess the interference degree and damage that lianas might cause to the trunk and crown of the host-tree: i) What is the rate of lianas colonization per host-tree, ii) are lianas damaging the trunk of the host-tree and iii) are the lianas' crowns competing for light resources up in the canopy. We aim to present an easy-to-follow workflow that could be applied by practitioners in a simple but robust method that could be replicated in other forests.

Methodology

The study was conducted in the Rio Clarillo National Park (RCNP) (33°43’S) in the Chilean Mediterranean climate zone, which is part of a biodiversity hotspot. RCNP is located at ~35 km SE from Santiago de Chile -the capital and most populated (~7 million) region of the country where the land-use has changed intensively along the last century. Within the RCNP, a unique, small patch (~1 ha) of unlogged forest survive past interventions. Within the stand, we established a plot of 1000m^2 (50x20m), at ~900 masl, to capture current structure and composition of the vegetation. We recorded the DBH and species identity of all trees larger than 5cm DBH. In 500m^2, we recorded the lianas identity and DBH of that formed wood, following standard protocol (Gerwing et al. 2006). In absence of previous information for lianas in Chile, in the field we realized species start forming wood above ~0.5cm diameter in some sections, thus adapting to the local traits of the species and considering stems >0.5cm DBH forming wood clearly.

To characterize the habit and assess the threat, we noted if lianas were hanging from the crown (separated from the main trunk), leaning on the tree trunk or it was tangling the trunk

(Fig. 1.a). When tangling, we also noted if the tree was decaying, dead, or if the trunk was deformed. Finally, to test a possible interference and competition for light, we noted the position of the lianas regarding the host-tree crown (Fig. 1.b). Data were further tested with Xi^2 to assess the independence of the variables.

Preliminary results

We counted 57 trees, distributed between 5-110 cm DBH, most individuals having <30 cm DBH. Lianas occurred in 49% of the trees. 26% of trees were colonized by only 1 liana, while only 1 tree (not the biggest within the plot) was colonized by 9 lianas >0.5cm DBH (Fig. 2a). The liana ensemble at the time of the survey was composed uniquely by *Cissus striata* Ruiz et Pav. (Vitaceae). Within the plot, we tallied 61 liana individuals. The mean diameter of the lianas is 2.6±1.4 cm, ranging between 0.95-6.4cm. The diameter distribution also showed an inverted J (Fig. 2b). Individuals between 1-2cm were scarce and individuals smaller than 0.5cm were not tallied because they did not form wood. However, many trees hosted abundant lianas smaller than 1 cm dbh.

In this study, out of 61 lianas, ~70% were hanging from the branches, 20% used the trunk as support, and 10% were tangling the main trunk (Table 1). Of those lianas, ~70% were positioned at the bottom of the crown, 26% at the middle section and a small portion were observed reaching the top section of the crown. Interestingly, statistical analysis indicate the data were not independent (chi-sqr = 14.88; $p < 0.01$), where almost 50% of the lianas were hanging from the lower branches at the bottom of the crown (Table 1). Only half of the tangling lianas were strangling the host, but we observed that none of the trees were dead or clearly decaying at the time of our study. Close to 20% were leaning on the trunk up to the lower part of the crown, while another ~20% were hanging from branches in the middle part of the crown. Most of the lianas tangling the host-tree reached middle and lower parts of the crown, but none individual were tangling and reaching the topmost section of the crown. The single liana that reached the topmost section of the crown was not thickest DBH, while the thickest lianas used the bottom section.

Discussion.

Insights into the Chilean Mediterranean Forest conservation.

Land-use change has affected the vegetation dramatically in many Mediterranean ecosystems whilst nowadays, undisturbed, old-growth reference forests are scarce, overall in the surrounding areas from the capital city, Santiago. Dispersed old-trees can be found nearby Santiago, but so far this patch is unique and perhaps one the best conserved forest in the territory, worth keeping as a reference ecosystem in restoration projects and conserving as it is (Diaz et al., in revision). The same authors show that *C. striata* were scarcely found in the matorral surrounding the studied old-growth patch, suggesting *C. striata* is a conspicuous component of the old-growth Mediterranean forest from Chile. Likewise, since there is a lack of old-growth habitat for *C. striata* in the Mediterranean region, its conservation status might be compromised and the still unknown related species in the region.

This brief communication is an ongoing investigation on the lianas ecology in the Valdivian Temperate Rainforest. Also, we are aware the dataset is small and lack of replicability in the study area, while negative interactions, such as nutrient or water competition, cannot be assessed with the presented categorization. However, the outcomes of a simple method allow a rapid field assessment to know whether a specific liana in a certain forest could affect the host-tree by tangling the main trunk or competing for light resources. Interestingly, we found no evidence that lianas were killing their host trees and apparently nor competing for light resources at crown level since *C. striata* was occupying mostly the lower part of the host crown. This results coincide with a study conducted in an evergreen forest in southern Chile (Lobos-Catalán & Jiménez-Castillo 2014). It seems that *C. striata* in this forest is benefited by the support of the trees, and because not affecting negatively the host tree, we hypothesized that the *C. striata* interaction might be commensalism rather than a structural parasitism. Moreover, stems >5cm DBH of *C. striata* have not been found, suggesting a scarce load that could affect physiologically the tree-host

Although still little is known about the *C. striata* ecological functions, likely, it contributes to increasing biodiversity by supporting several interactions as it has a fleshy edible fruit (Marticorena et al. 2010) and flowers are visited by insects. Recently Diaz (unpublished data) found the Yaca (*Thylamis elegans*) in our study site, a rare and endangered marsupial, climbing at 17 m up in the tree-crown with abundant lianas. Previous records of the Yaca indicates that the species use to eat, mate and nest on shrubs and small trees. Likely, this habit is only because of the absence of this kind of forest in the Mediterranean zone in Chile. Perhaps lianas play a key role in sustaining a Yaca population and other marsupial species, creating structures that facilitate reaching the crown and move between crowns; thanks to its small prehensile hand allowing them to develop an entire life in the canopy save from predator. In the sense, the lack of old-growth forest, with a healthy population of lianas, is the main reason of the Yuca conservation status. Perhaps, lianas propagation helps to recover or maintain ecological structure and functions enhancing ecological outcomes by giving old-growth attributes to forest stands.

Sustainable forestry and restoration ecology, accounting for biodiversity conservation

Sustainable forest management and ecological restoration projects at the beginning of the plan should be clearly stated if the trees are to produce timber products as fast as possible or to restore multiple functions and services. The explicit statement should avoid confusion in the process before making a wrong decision harming biodiversity conservation

(Sutherland & Wordley, 2017), especially when there is no information confirming that the lianas species interact negatively with the host-tree.

Decision should be case-specific. Although with the method presented here we do not know precise physiological damage (sign) that lianas could cause to host, our preliminary results also show a low rate of trunk damaged (symptom) probably because of the climbing mechanism of the single species recorded in this forest. Unlike Stevens (1987), we consider that not all lianas should be considered as structural parasites regardless if the project is focused on restoration, conservation or wood production. Indeed, not all the forests evidence a reduction in biomass accumulation (i.e., Estrada-Villegas et al., 2021). Alternatively, sustainable forestry might include lianas to keep forest functions and maximize biodiversity conservation (Franklin et al., 2018), and search for new, less harmful management method to control lianas when necessary (Sfair et al., 2015).

Lianas in productive forestry could save money during the early stages -when no significant products can be obtained- by eventually thinning selectively less vigorous trees. Same might happen in forest restoration where practitioners could just wait until lianas accelerate succession (Sfair et al., 2015), or can be used to recover soils and reducing cost of successive treatments while increasing biodiversity.

Looking for lianas interaction from the ground can provide limited conclusions about the canopy interference or competition, as for many other epiphytes and ecological processes (e.g., Lowman & Rinker, 2004). Further analyses in those forests can shed lights whether lianas are decreasing the growth of the host. However, researcher and practitioners should acknowledge that the climate change could be the primary driver of decreasing growth trends and not necessarily the competition effects of lianas, instead they might be the result of several interacting factors (e.g., Anderegg et al., 2019; Parmesan & Hanley, 2015).

Ecosystems and species therein have their own peculiarities, and there are many southern hemisphere forests without enough information, especially in the Valdivian Temperate Rainforest. Further studies are required, but it seems that tropical trends and finding cannot be fully homologate to the Valdivian Temperate Rainforests, dismissing the structural parasitism as a rule-of-thumb. Practitioners will need to increase the knowledge about the natural history of target liana before cutting prescriptions, embracing the complexity to improve biodiversity conservation outcomes (e.g., Evans et al., 2017).

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Table, figures captions and figure

Table 1. The lianas' frequency regarding the climbing habits (columns) and their position within the crown of the host-tree.

	Climbing habit			
Crown position	hanging	leaning	tangling	Total
top	1			**1**
middle	11		5	**16**
bottom	31	12	1	**44**
Total	**43**	**12**	**6**	**61**

Figure 1. Schematic representation between the tree-host and, a) of lianas climbing habit: (l) leaning on the tree trunk, (t) tangling the trunk or (h) hanging from branches (separated from the main trunk); and b) the position of the liana's crown regarding the host-tree crown: (b) bottom, (m) middle, (t) top. Statistical result: chi-sqr = 14.88; $p < 0.01$.

Figure 2. a) shows the number of lianas colonizing a single tree; b) Lianas' diameter distribution.

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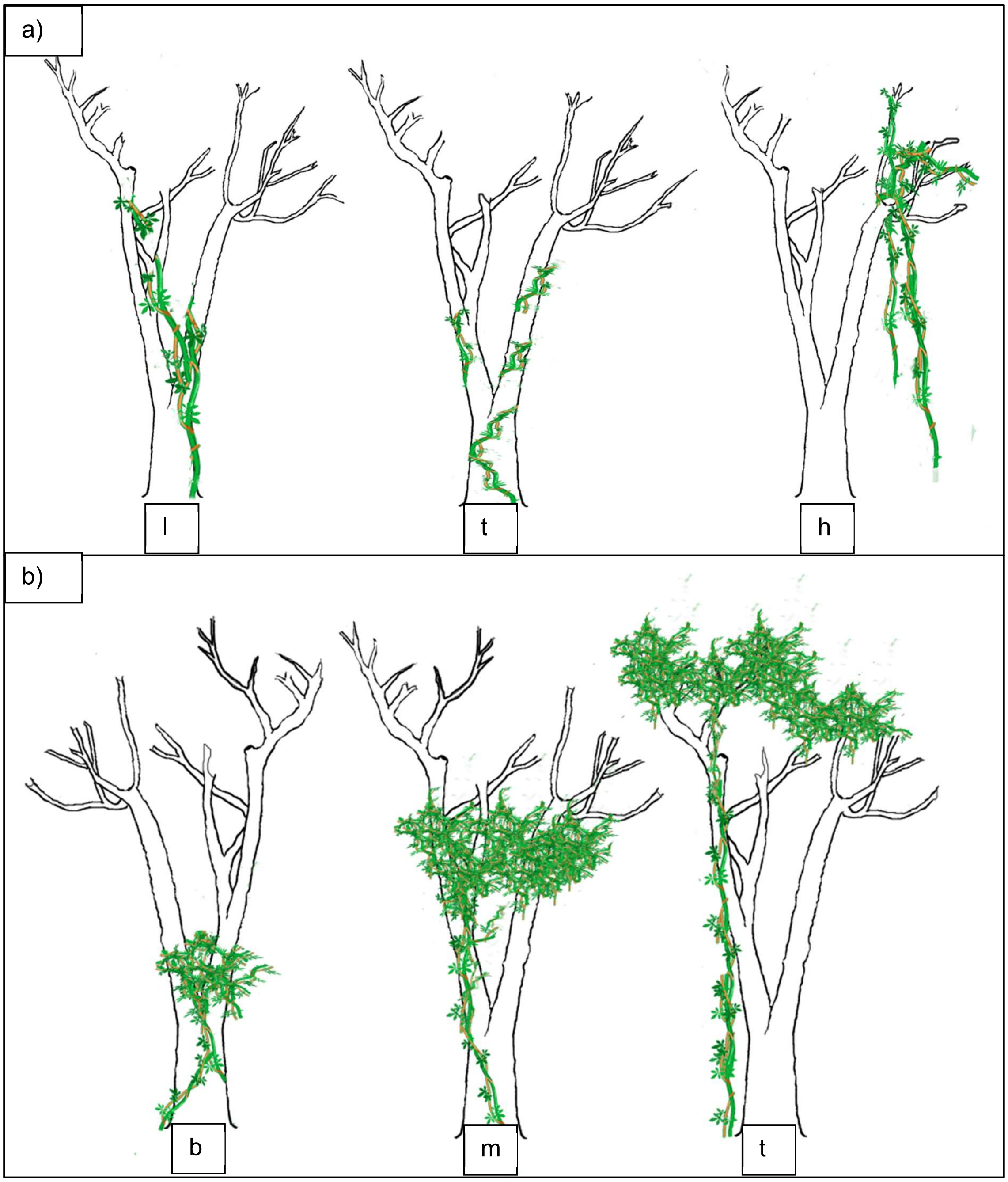

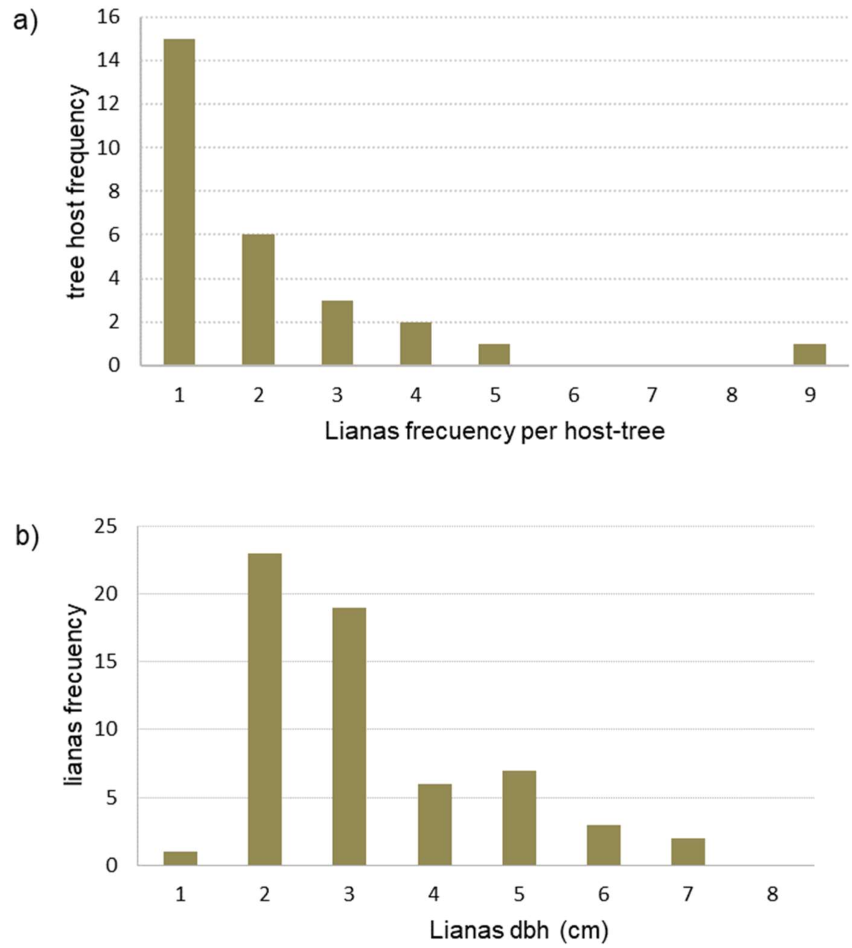

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