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

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HIGHLIGHTS

- lianas and host-tree interaction are complex and diverse worldwide
- liana’s colonization rate and crown position could indicate negative interaction
- the control or eradication of lianas might affect biodiversity patterns and functions
- sustainable management trade-offs accounting for biodiversity conservation

Abstract

Although lianas play an important role in forest composition, structure, and functions, they are considered as structural parasites of the tree-host. Both contrasting ideas on the role of lianas in forest ecosystems challenge the practitioners and decision might be taken without specific information. Here we present a preliminary result, applied in a unique, small, old-growth forest in the Chilean Mediterranean Forest, to assess the interference degree that lianas might cause to the trunk or to the crown of the host-tree. Results showed that almost half of the trees were colonized by lianas between 1-6 cm DBH, with a continuous regeneration. Also, most lianas were hanging from lower branches but not tangling the main trunk, while most of them did not reach the topmost section of the crown, likely not competing for light resources with the tree-host. Although we did not assess the host responses, we found no strong evidence indicative of a structural parasitism; therefore, no control or eradication of lianas can be recommended in this particular case. Moreover, it seems the species might be an important component of the old-growth Mediterranean Forest, and could be include the lianas into the planning to increase biodiversity and other ecological functions. A rapid assessment could facilitate the decisions in other forest ecosystems, while gaining more information on the ecological function and processes that utterly would help enhancing conservation and restoration outcomes.

Keywords: Epiphyte, Tree-host colonization, Valdivian Temperate Rainforest hotspot, 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* and coined the concept. Among others, the main negative effects that lianas could cause to the trees are: trunk constriction, light competition, soil nutrients competition, tree overloading, or regeneration suppression (Putz & Mooney, 1991; Stevens, 1987). This negative interaction can cause a decreasing host biomass accumulation and productivity (Estrada-Villagas et al., 2020; Schnitzer & Bongers, 2002), increasing the lianas frequency (Perring et al., 2020), diminishing the host fruit production (Stevens, 1987), or affecting the gross transpiration rate (Schnitzer & Bongers, 2002).

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

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

During a field course in a public protected area, we were asked by the rangers whether to cut lianas in order to protect a unique, small, old-growth Mediterranean forest remnant. We set up a small study case attempting to respond to three questions that might help to assess the interference degree and damage that lianas might cause to the host-tree: i) What is the lianas colonization rate per host-tree, ii) how lianas are damaging the trunk of the host-tree and iii) are the lianas' crowns competing for light resources up in the canopy. Although we did not assess the host responses, we used this measures as indicators. 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 forest and made applicable resolutions.

Methodology

The study was conducted in the Rio Clarillo National Park (RCNP) (33°43’S) in the Chilean Mediterranean zone, a biodiversity hotspot. RCNP is located ~35 km SE close to 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. Notwithstanding, within the RCNP, a small patch (~1 ha) of unlogged forest still survives and thus selected to carry out this study. In the RCNP, the studied forest is a small, old-growth stand of ~1 ha, a remnant from past intervention. Within the stand, we established a permanent plot of 1000 m^2 (50x20 m), at ~900 m asl, to capture the current structure and composition of the vegetation. Every tree in the plot >5 cm DBH was identified at the species level and measured its respective dbh. Trees were tagged too. In 500 m^2, we recorded the species' identity and DBH of lianas that formed wood following standard protocol (Gerwing et al., 2006). In absence of previous information for lianas in Chile, in the field we realized the species start forming wood above ~0.5 cm diameter in some sections, thus adapting to the local traits of the species and considering stems >0.5 cm DBH forming wood clearly.

To characterize the habit and assess the threat potential, 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' crown regarding the tree host crown (Fig. 1.b). Species nomenclature follows Rodriguez et al. (2018).

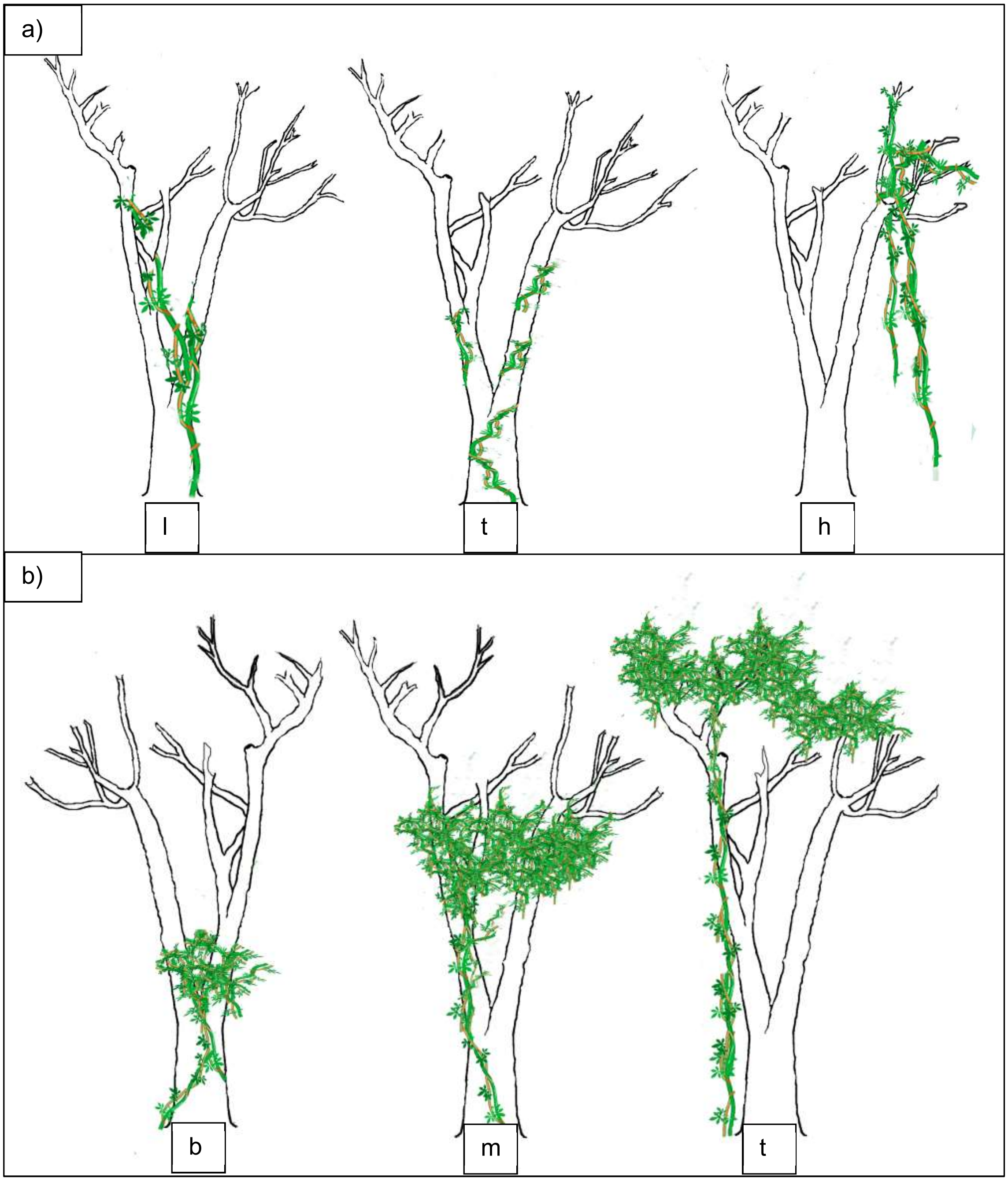
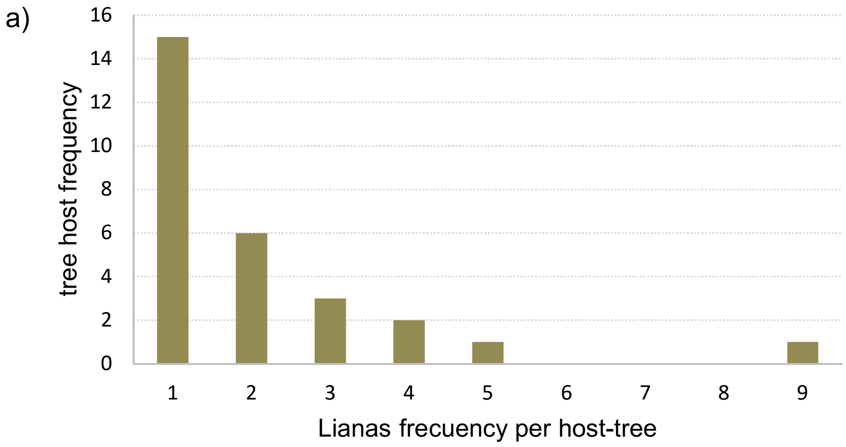


Figure 1. Schematic representation between the tree-host and, a) of lianas climbing habit: (l) leaning on the tree trunk, (t) tangling the trunk or (h) hanging from branches (separated from the main trunk); and b) the position of the liana's crown regarding the host-tree crown: (b) bottom, (m) middle,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

Results

In the 500 m^2 plot we counted 57 trees, distributed between 5-110 cm dbh (more abundantly about 20-30 cm dbh. Further descriptions on the forest structure, see Diaz et al in prep.). 28 trees were colonized by lianas. Of these trees, 15 were colonized by only 1 liana, while only 1 tree 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*. Within the plot we tallied 61 individual of liana. Although *C. striata* were represented by small diameter, we found that they formed wood at ~0.95 cm. The mean diameter of the lianas is 2.6±1.4 cm, ranging between 0.95-6.4 cm. Diameter distribution also showed an inverted J (Figure 2.b). Individuals between 1-2 cm were scarce and individuals smaller than half centimeter were not tallied because did not form wood. However, many trees hosted abundant lianas smaller than 1cm dbh.



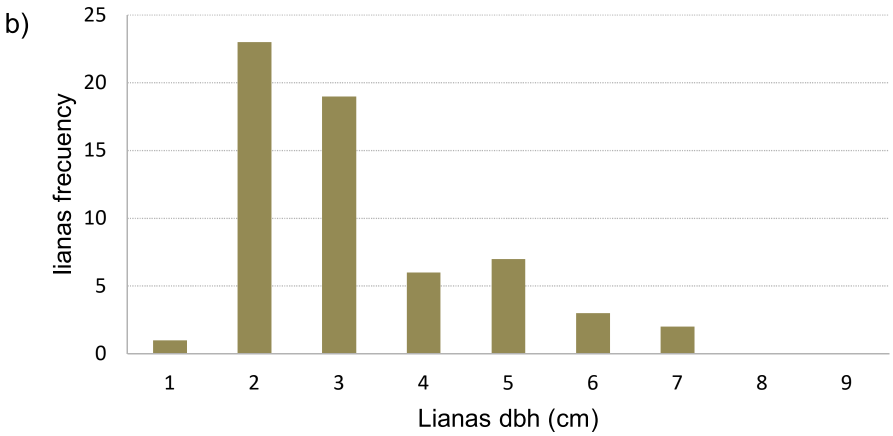


Figure 2. a) shows the amount of lianas colonizing a single tree; b) Lianas diameter distribution.

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**

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In this study, of 61 lianas registered, ~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 positioning 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, 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 tree was 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 other ~20% was 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 part 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.

Ecological implications for local conservation and restoration.

Land-use change has affected the vegetation dramatically in many Mediterranean ecosystems whilst nowadays undisturbed, old-growth reference forests are scarce in the ecoregion, 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 (Diaz et al., in review), worth to keep as a goal in restoration projects and worth to conserve as it is. The same authors show that *C. striata* was scarcely found in the matorral surrounding the studied old-growth patch, thus it suggests that lianas are a conspicuous component of the old-growth Mediterranean forest. Likewise, the information we have so far indicates a lack of old-growth habitat for *C. striata* in the Mediterranean region, thus compromising its conservation status and the still unknown related species in the region.

This brief communication is part of ongoing investigations on the ecological patterns, processes and functions of lianas in the Valdivian Temperate Rainforest. Moreover, the data set we provided here is small and lack of replicability in the study area, while negative interactions, such as nutrient or water, cannot be assessed with the presented categorization. However, the outcomes of a simple method allow a rapid assessment in the field 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. For our study case, 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. It seems that *C. striata* in this forest is benefited by the support of the trees, and because no symptom affecting negatively the host tree, the species interaction suggests a 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* ecology functions in the Valdivian Temperate Rainforest, it is recognized as one of the more abundant in these forests but not the biggest. For instance, whether its presence reduce biomass accumulation or if they are more abundant due to management, fragmentation or climate change as documented in tropical forest xx. likely it contributes to increase the biodiversity by supporting several interactions, as it has a fleshy edible fruit (Marticorena et al., 2010) and flowers are visited by insects (personal observations). Studies have not been conducted so far, but possibly lianas can be considered as canopy ecosystems engineers (e.g., Ortega-Solís et al., 2017). Recently Diaz (unpublished data) found in this forest Yuca (*Thylamis elegans*), a rare and endangered marsupial, climbing at 17 m up in the tree-crown with abundant lianas. Previous record of the Yuca indicates that the species commonly is eating, mating and nesting on shrubs and small trees. But, imaginably 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 Yuca population and other marsupial species, creating structures that facilitate reaching high altitude on the tree and move between crown; thanks to its small prehensile hand, which might allow 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. Likely, propagation of lianas as *C. striata* to recover or maintain ecological structure and function might enhance ecological outcomes by for example giving old-growth attributes to a young forest stands.

Sustainable management 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 a forest can provide. 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 the original proposal of 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. Here we argue lianas should not be seen as forest enemies everywhere, since it does not been documented in all the forest such reduction in biomass accumulation (i.e., Estrada-Villegas et al., 2021). We call for sustainable forestry projects to include lianas in order 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). Perhaps, in productive forest lianas can save money during the early forest stages -when no significant products can be obtained- by eventually thinning selectively less vigorous young trees. Same might happen in forest restoration where practitioners could just wait until lianas accelerate succession (Sfair et al., 2015), recover rapidly 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 such as measures of the tree-ring width or physiological performance 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).

Each ecosystem and species therein have their own peculiarities, and there are many forest ecosystems in temperate areas 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 for all the species. Forest restoration in areas affected by recent massive fires and the persistence of drought in Chile are challenging. Practitioners will need to increase the knowledge about the natural history of target liana before cutting prescriptions, embracing the complexity in order to improve biodiversity conservation outcomes (e.g., Evans et al., 2017).

CRediT authorship contribution statement

Ricardo Moreno-Gonzalez: Conceptualization, writing – review & editing, Investigation, data collection and analysis. **Gabriel Ortega-Solis**: data collection, writing – review & editing, Investigation **Javier Godoy-Güinao:** data collection, writing – review & editing, Investigation **Felipe Gonzalez**: data collection, writing – review & editing, Investigation; **Iván A. Díaz:** Funding acquisition, Conceptualization. Writing – review & editing, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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