Growth and Structural Damages of Trees hosting Lianas in Semi-Evergreen Tropical Forests in Northeastern Yucatan Peninsula (Mexico)

GROWTH AND STRUCTURAL DAMAGES OF TREES HOSTING LIANAS IN SEMI-EVERGREEN TROPICAL FORESTS IN NORTHEASTERN YUCATAN PENINSULA (MEXICO)

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To Paulina, Kathrin, Magnolia and Virgilio
(My Daugther, Wife, Mother and Father)
with all of the Love that fits in a Soul

To the Memory of Ingrid Olmsted
and Camilo Ancona

To the Honour of all the Men and Women
who, like the Mayans of Today,
developed a Culture of
respect to The Nature
and The Mankind

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CONTENTS

SUMMARY

Lianas are woody vines that reach the canopy by climbing trees. Their vascular tissues are able to conduct more water than those of trees. Consequently lianas are considered to be competitors for water and soil resources delaying the growth of trees, which was demonstrated by many studies. Other studies suggest that lianas are structural parasites reducing the reproduction of trees. Some tree species have been reported to be more affected than others. Therefore ecologists propose that lianas are a driving force in detremining the relative abundance of tree-species through time. According to different reports, lianas represent about 25% of the tropical forests flora, where 33% to 79% of all trees host lianas. The ecological relevance of lianas in the tropics may even increase since lianas colonize gaps and open areas rapidly. The abundance of gaps may increase in the future of the tropics due to increasing logging activities. Also, secondary areas covered by secondary forests are increasing due to the abandonment of crops because of economic reasons. Additionally, in the course of global change it is predicted that the frequency of hurricanes may increase, opening more gaps in forests. Even the rising atmospheric CO_2 concentration is suggested to enhance tree-fall dynamics by stimulating trees to grow faster which in result is making them fall faster. In a nutshell, the relative abundance of lianas with respect to trees in tropical forest will most likely increase and current evidences suggest that lianas are harmful to the growth and structure of trees. Furthermore, fallen trees are proposed to pull down other trees connected to them by lianas. In this research I determined the effects of lianas on the growth of different co-existing species of trees and saplings. They were located in semi-evergreen tropical forest stands in Mexico representing different successional age and land-use history. Moreover, during this research, the most powerful hurricane registered to date in the history of the Caribbean (Hurricane Wilma) hit the study site. This helped to determine the effects of lianas on tree-damaging by strong winds.

The study site is the peasants and Maya Community of Ejido Solferino, northeastern Yucatán Península, México. There, I made two, four, and six 20 m x 20 m plots in forests stands having the following successional ages respectively: ten, eighteen, and ≥ fifty five years old. Then I made a survey of all trees ≥ 10 cm circumference and lianas ≥ 1cm diameter. Trees and lianas were identified and tagged with unique codes. I recorded the number of lianas hosted per tree, and estimated the % of the woody area of each tree that was covered by lianas, and classified it into four liana-cover categories: (0)= no lianas, (1)= 1-25%, (2)= 25 –75%, and (3) > 75%. Six litter traps per plot were installed. All saplings between 30cm height and 10cm circumference were counted, identified and measured on ten $2m^2$ subplots per plot. Saplings's lower size-limits are heights and upper limits are widths but this is used by foresters, eco-physiologists and ecologist for many studies on saplings (more details in Box 2, Chapter 1). Notice that the upper limit of the size of saplings is the lower limit of the size of trees (and did not overlap) making this study more comprehensive by including a wide range of sizes of plants and helping to avoid confusions while studying plants in the field. In May 2004, I cut all lianas and vines (without pulling down their fragments from the canopy in order to do not harm trees) in half of the plots of each stand. The few liana re-sprouts were cut again every 2,5 to 3 months. Trees and saplings were re-measured fifteen months after liana-cutting, Hurricane Wilma hit the study site two months after such re-measurements.

In spite of the short time after liana-cutting, clear trends on the growth of trees arose. In the ≥ 55yr-old stand, *Pouteria campechiana*, *Zygia stevensonii*, and *Lonchocarpus xuul* grew less when hosting larger liana-coverages and this is consistent to other studies. In the same stand, the growth of *Bursera simaruba*, *P. campechiana*, *Metopium brownei* and *Vitex gaumeri* was hindered when lianas where not cut and this is also consistent to other studies. But contrary to other studies, one species (*Dendropanax arboreus*) grew faster in the 10-yr and 18-yr old liana-uncut stands, and three species grew faster when hosting larger liana coverages (*Coccoloba spicata*, *V. gaumeri* and *B. simaruba*). A legume liana (*Dalbergia glabra,* Papilionoideae) was dominant there and I propose that it helped trees by contributing to nitrogen fixation or, at least did not avoid high incidence of sunlight to reach trees there.

Results from saplings were also uneven. In the ≥ 55yr-old stand, *Chrysophyllum cainito* and *Malmea depressa* grew less where lianas were not cut. In contrast, lianas favoured *Eugenia axillaris* and *Lonchocarpus rugosus* in the 10yr- and 18yr old stands. For many species, liana-cutting had no effects on both forest ages. Though being pioneers, the mentioned sapling species have different wood-densities (when adults), suggesting that reported liana-effects may apply for a wide gradient of light-demands (and life histories) within the guild of the pioneers. Also, after pooling saplings of all species, saplings grew faster in liana-uncut plots of the 10yr- and 18yr old stands. It occurred even where litter input was lower compared to liana-cut plots, while larger inputs of litter are expected to enhance the growth of saplings because of a larger input of nutrients. Also, soil moisture was decoupled to saplings growth; for example, there were locations with high soil moisture but saplings grew less there compared to plots with dryer soil. All this suggests that soil moisture and litter input did not affect the results during the study, being the intact lianas a potential factor favoring saplings. These results indicate that lianas may stimulate better growth of many saplings in younger forest stands. However, further studies with more subplots and more measurments of litter and abiotic factors are needed to test this hypothesis and to determine for which sapling species this may apply.

Hurricanes themselves are amazing and results of Hurricane Wilma related to lianas were amazing too. Trunk snapping and Tree uprooting, the two most severe damages of trees producing larger tree-fall gaps, occurred independently of: liana-cutting, number of lianas per tree, and liana-coverage per tree. This applied for all forest stands. A less severe damage, namely Crown removal, was more frequent in the 10-18yr-old stand, dominated by *D.glabra*. For the ≥ 55yr-old stands, Crown removal affected larger-vertical (emergent) trees, the ones more exposed to strong winds. Also in the ≥ 55yr-old stand, individuals hosting larger liana-coverages suffered more crown removal. In contrast, trees hosting more lianas suffered less crown removals in the 10yr- and 18yr-old stands where the canopy is more homogeneous compared to the rough canopy of the ≥ 55yr-old stand. Since liana-cutting did not have any effect on crown removal, it may not be proposed that lianas pulled or fixed trees to the ground. Instead, I propose that lianas: a) contributed to remove crowns in the ≥ 55yr-old forest by displacing the gravity center of the crowns, and b) reduced crown removal in the 10yr and 18yr old stands by binding crowns (both are hypotheses of Putz, 1984a). I propose that just heavy and rigid lianas like *D. glabra* played such a role and that many lianas rarely enhance structural damages on trees in the study site.

In total, the results confirm previous studies showing that lianas have a speecies-specific effect on co-existing tree species. However, it does not imply that lianas are a driving force determining tree species turn-over throughout time. The growth of many tree and some sapling species of my study were negatively affected in some stands, but positively affected in other, close-by stands. At a landscape level, given the short distance among stands, both, negatively- and positively affected trees may belong to the same populations, so liana-induced reduction of some individuals may be compensated by the enhancement of others, avoiding local extinction. It may also occur in patches of different successional ages within a single forest. Indeed, no tree species may tend to local extinction due to lianas. Also, species-specific liana-tree engagements should occur in order to lianas to alter tree species compositions in a temporally consistent way. There are studies suggesting that there are no species specific liana-tree associations in different forests. Moreover, fundamental theories on plant evolution and liana biogeography suggest that they evolved in environments where tree diversity was already high. Indeed species-specific interactions and driving effects of lianas on trees of the same functional group (e.g. pioneers) have always been poorly likely. All these suggest that the role of lianas on tree-species relative abundance is less important than normally assumed.

I also discuss what role lianas might play in a habitat where hurricanes are so common (semi-evergreen tropical forests of northeastern Yucatan Peninsula). The literature suggests that lianas may proliferate since hurricanes produce gaps and large open areas. However, although it can imply that a certain number of trees will grow less due to “liana-competition”, colonizing lianas will rarely make trees to suffer more structural collapses during hurricanes.

Cutting lianas is a common practice in forest management in order to enhance the growth and avoid damages of trees. However, this research and the amount of literature consulted indicate that there is no general rule for saying when and where lianas should be cut. Liana-cutting seems only profitable for trees hosting larger liana-coverage of some target species (e.g. *Pouteria campechiana* at my ≥ 55yr-old forests and *Spondias mombin* and other species at my 10-18yr-old forest). But since the growth of no species seemed to be significantly hindered by lianas in every of my studied stands, there is no reason to take such results as a general rule: Ecologists still have not enough evidences.

Moreover, hurricanes must be taken into account for tree-protection aspects in North Eastern Yucatán Peninsula. For avoiding trunk snapping and tree up-rooting, cutting lianas is not particulary helpful because such damages occurred independently of liana-cutting. Crown removal by hurricanes also represents severe damage by potentially reducing further wood production of affected trees. But lianas were not related to such damages in my ≥ 55yr-old stand, suggesting that cutting there is not necessary. Moreover, although heavy-bodied lianas (especially *Dalbergia glabra*) may have caused pronounced damages where it dominates (my 10yr- and 18yr-old forests), cutting it there was even worse; in *D.glabra* “saturated” areas, the Hurricane removed more crowns of trees hosting *lower* numbers of lianas. Finally, because in the 10yr-and 18yr-old stands trees grew better when *D. glabra* was not cut and while having larger liana-coverage, further studies on the role of this liana species are recommended.