Abundance of climbing vines on a neotropical tree species (*Terminalia oblonga*): potential adaptive mechanisms for vine deterrence and herbaceous vine survival

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Abstract: Climbing vines have important impacts on tropical trees and forest communities. Not only do they compete with their host trees for light, space, water, and nutrients, but their cumulative weight also substantially burdens host support tissue, potentially causing death and treefall. I hypothesized that *Terminalia oblonga*, a tree species that periodically exfoliates its outer layer of bark, would host fewer and shorter climbing vines than other tree species that do not shed their bark. I also hypothesized that *Monstera tenuis*, an herbaceous climbing vine that holds its young leaves flat (shingled) against the host tree, would constitute a greater proportion of total vine abundance on *T. oblonga* than on other tree species. I found that *T. oblonga* does indeed host significantly fewer and shorter vines than other tree species and that *M. tenuis* is proportionately more common on *T. oblonga*. These results suggest that bark-exfoliation and shingle leaves, if they have positive effects on tree and vine fitness, respectively, may have adaptive significance to *T. oblonga* and *M. tenuis*.

Key Words: Araceae, leaf morphology, Monstera tenuis, *tree bark*

Introduction

Herbaceous and woody climbing vines, commonly found on trees of tropical forests, play an important role in defining the diversity and structure of forest communities, especially in the tropics. Not only do they compete with host trees for light, space, water, and nutrients, but their cumulative weight also substantially burdens host support tissue (Forsyth 1984). Often these stresses can contribute to tree deaths and subsequent tree falls, and resulting canopy gaps can stimulate new tree recruitment and growth. Given these stresses, deterrence of vine growth is likely advantageous to trees.

Hartshorn (1983) observed that tropical trees with exfoliating bark often host fewer epiphytes and climbing vines than do other tree species. *Terminalia oblonga* (Combretaceae), a species of large canopy tree found in alluvial soils of Costa Rican lowland tropical wet forest, exfoliates its bark in thin, ragged sheets (Hartshorn 1983). Consistent with Hartshorn's observations, I hypothesized that *T. oblonga* would host significantly fewer climbing vines than other tree species without exfoliating bark. Furthermore, as older (and therefore taller) vines growing on *T. oblonga* are more likely to be shed through periodic bark exfoliation over time, I predicted that *T. oblonga* would host fewer tall vines than other tree species.

Monstera tenuis (Araceae; formerly *M. gigantea*) is a species of herbaceous climbing vine commonly found on trees of Costa Rican tropical wet forests. It is unique among most other vines in that its leaf morphology changes with leaf age: younger leaves are round and held flat against the host tree (shingled), while older leaves are larger, pinnatifid, and held horizontally away from the host tree (Ray 1983). I hypothesized that the shingled pattern of young *M. tenuis* leaves would allow it to more effectively remain attached to *T. oblonga* bark, as the shingled leaves would be less exposed to the forces of wind, rain, and falling debris that could potentially tear the vine (and the bark to which it clings) away from the host tree. Leaves without this shingled morphology would not have this advantage and would therefore have an increased likelihood of being torn away from *T. oblonga* host trees. Thus, I predicted that the proportion of *M. tenuis* vine abundance to total vine abundance would be higher on *T. oblonga* than on other tree species.

Methods

I sampled both *T. oblonga* and non-*T. oblonga* trees on the alluvial soil terraces south of the Rios Puerto Viejo and Sarapiqui at La Selva Biological Station, Costa Rica. For each *T. oblonga* found I counted both the total number of climbing vine stems and the number of *M. tenuis* stems in contact with the tree trunk at eye level (approximately 1.75 m). *Monstera tenuis* counts were converted to proportions of total vines in each tree by dividing by total number of vines. I estimated the total height distribution of all vines on each tree using an index on a scale of 0 to 5, with 0 corresponding to no ground-level vines extending to the lowest branches of the tree (just below the canopy) and 5 corresponding to all ground-level vines extending to the lowest branches of the tree.

Because of complications due to the presence of large buttresses, I measured tree diameter at 4.5 m above ground level using the following procedure: at a distance of 4.5 m from the base of the tree I used a clinometer to sight a point on the tree at an angle of 45° from the ground, thereby creating an isosceles right triangle between myself, the tree base, and the sighted point. Using simple trigonometric calculations, I determined the height of this point to be 4.5 m and the hypotenuse of the triangle (the distance from me to the sighted point on the tree) to be 636 cm. Then, with a centimeter ruler held in my outstretched left hand and with one eye closed, I measured the diameter of the tree in centimeters (as seen along the ruler) from my perspective on the ground. On level ground, I determined that, over a distance of 4.5 m, 100 cm of actual width equaled 11 cm sighted through the centimeter ruler held in my outstretched left hand. In this way, for example, a tree that I measured as 7 cm from the ground would have an actual diameter of 64 cm (7 * 100/11). Testing this technique using DBH tape on easily measurable trees, I found my estimated diameters to be sufficiently accurate.

For each *T. oblonga* sampled, I performed the same measurements on a non-*T. oblonga* tree, chosen as the tree within a 20 pace radius of the focal *T. oblonga* with the diameter closest to that of the focal *T. oblonga*. I log-transformed vine counts to achieve normality of distribution and tested for differences between pairs using a paired t-test. Non-parametric Wilcoxon signed-rank tests were used to test for differences between pairs of *M. tenuis* proportions and pairs of vine height indices, as transformations could not normalize these data distributions.

Results

There were significantly more climbing vines per cm of tree diameter on non-*T. oblonga* trees than on *T. oblonga* trees (paired-t = 5.26, df = 29, $P < 0.0001$; Fig. 1). Maximum heights of vines on *T. oblonga* trees were consistently shorter than on other tree species (Wilcoxon signed-rank = 203, P = 0.000; Fig. 2). Of total vines, *M. tenuis* constituted a greater proportion on *T. oblonga* than on other tree species (Wilcoxon signed-rank = -193, P = 0.000; Fig. 3).

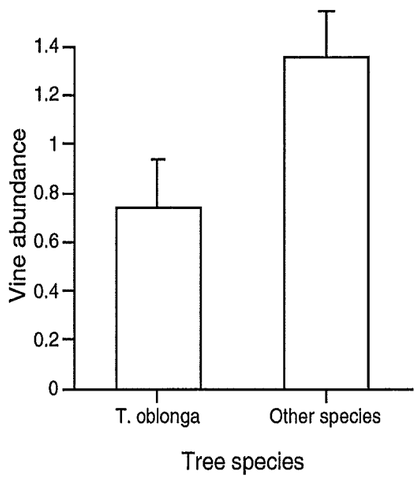

Fig. 1. Mean number of vines (± 1 SE) per cm of tree trunk diameter on *T. oblonga* and non-*T. oblonga* trees (n = 30 for both bars) at La Selva Biological Station.

Discussion

My findings that *T. oblonga* hosts significantly fewer and shorter climbing vines than other tree species were consistent with my initial hypothesis. I suggest that these results and the fact that *T. oblonga* periodically exfoliates its bark are related, and that bark exfoliation is a mechanism for deterring climbing vines on *T. oblonga* tree trunks. Selective pressures for such an adaptation would likely be strong, as climbing vines and epiphytes are a potential burden to trees, both in competition for resources and in instability caused by added weight. A tree that could effectively deter climbing vines could potentially live longer, thereby increasing its fitness. Though this scenario seems plausible, it does not rule out other possible mechanisms responsible for the lack of climbing vines on *T. oblonga*, such as chemical defenses (Forsyth 1984). Further study should include other species that shed their bark, such as *Dipteryx panamensis* (pers. observation), to determine whether comparatively low abundance of climbing vines is common to other bark-exfoliating species and if this trait has fitness implications.

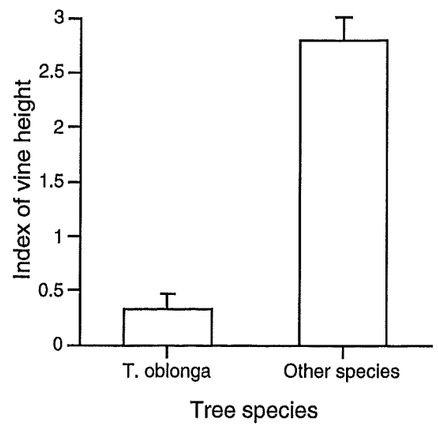

Fig. 2. Mean index of vine height (± 1 SE) on *T. oblonga* and non-*T. oblonga* trees (n = 30 for both bars) at La Selva Biological Station. Index scored on a scale of 0-5: 0 = no vines seen at ground level extend to lowest tree branches; 5 = all vines seen at ground level extend to lowest tree branches.

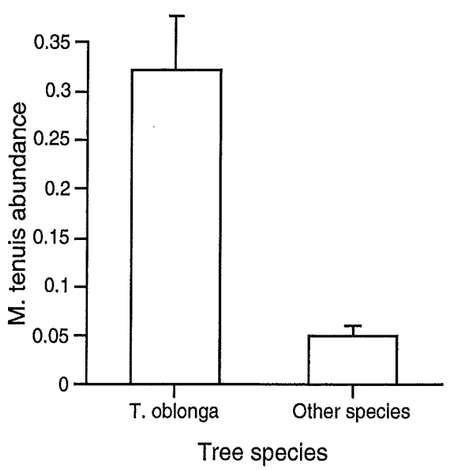

Fig. 3. Mean proportion of *M. tenuis* stems (± 1 SE) to total vine stems on *T. oblonga* and non-*T. oblonga* trees (n = 30 for both bars) at La Selva Biological Station.

My hypothesis that *M. tenuis* would constitute a higher proportion of total vine growth on *T. oblonga* than on other species was also supported by my results. I suggest that the shingle-leaf growth habit of *M. tenuis* may be responsible for this pattern. Compared to other climbing vine species, the flat, shingled leaves of *M. tenuis* may be more sheltered from the forces of wind, rain, and falling debris that could potentially tear the plant from the host tree. Oberbauer and Noudali (1998) found that shingled *M. tenuis* leaves sacrifice a 75% potential increase in carbon gain by growing vertically rather than horizontally. However, they suggested that the benefits of shingle growth may outweigh its costs. These potential benefits include a smaller interception surface for nutrient-leaching raindrops, the lack of construction costs needed for a horizontal petiole, the ability to trap and utilize respiratory carbon dioxide from the host tree bark, and protection from leaf damage caused by falling debris. Similar to this last benefit, I suggest that shingle leaves may protect the entire vine from being torn off the host tree, particularly in the case of *T. oblonga*, on which shedding bark may form a particularly unstable substrate for vine growth. Thus, *M. tenuis* may have a selective advantage over other vine species growing on *T. oblonga*. On host trees without exfoliating bark, however, *M. tenuis* may not have such a distinct advantage and may be outcompeted by other vine species. This would explain the observed patterns in *M. tenuis* abundance on *T. oblonga* and non-*T. oblonga* tree species, though it does not rule out the possibility of other mechanisms. Further research, in addition to exploring in greater detail the potential benefits of shingle growth, could test the ability of *M. tenuis* to remain attached to various types of tree barks when subjected to simulated wind, rain, or falling debris. Relative fitness of *M. tenuis* and other climbing vines should also be studied, both on *T. oblonga* and on other tree species.

Climbing vines and epiphytes strongly influence forest community structure, both through their direct effects on their host trees and through the canopy gaps they can create through treefalls. By understanding these interactions between host trees and the plants that they support, as well as the adaptive strategies that both may employ, we may better understand the complex nature of forest community structure and dynamics.

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