

# Forests in transformation

Vines are remodeling the Amazon Region, and bamboos are remodeling the Atlantic Forest

**Rodrigo de Oliveira Andrade**

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American ecologist Robyn Burnham gets up a little before dawn in a forest encampment 80 kilometers from the city of Manaus. She emerges from her hammock, takes two quick gulps of coffee and enters the dense forest in search of lianas, a type of climbing vine that winds around trees. Unfazed by the constant heat and sweat, she uses red bands to mark the species she finds among tangles of leaves, branches and trunks; the marks will enable her to monitor their growth over the years. Burnham and her assistants then measure

the stems of the plants that are larger than one centimeter (cm) in diameter, collect a few samples of branches and transport them to the laboratory for species identification and analysis.

On the basis of 35 years of field observations, Burnham and other researchers are seeing that liana populations are expanding in the midst of intact forests in the Amazonian interior. It is the first time that this phenomenon has been reported. According to previous research, lianas normally proliferate only in areas of degraded vegetation, such as forest

fragments surrounded primarily by pastures and roads.

Although the census conducted in the Atlantic Forest has not been as extensive, bamboos appear to be remodeling forest fragments, according to studies by researchers from the Botanical Institute of São Paulo (IBt). Both bamboos and lianas benefit from the fragile nature of environments that have been disturbed for land-clearing purposes. These two observations suggest that both Amazonia and the Atlantic Forest may now be subject to previously unknown environmental pressures.



It has long been known that burnoffs, the clearing of vast stretches of native forest for farming and fishing, and even selective logging interfere with forest dynamics by altering the variety and growth rates of plant species. Now researchers are beginning to realize that other factors may also affect these dynamics. American biologist William Laurance, the principal author of two 2014 papers published in the journal *Ecology* on liana behavior in the Amazon, thinks that one possible explanation for the increasing proliferation of these plants in non-degraded areas is the rising levels of carbon dioxide (CO<sub>2</sub>) in the atmosphere.

Although lianas are abundant and diverse in forests worldwide, they are found in greater abundance, richness and variety of shapes and sizes in the tropics. Some lianas have fragile green-

ish stems that are nearly invisible in forest interiors; others have tree-like bark and lounge moodily atop the forest canopy.

Lianas are distributed across a variety of environments. They can produce up to 40% of the leaves that cover trees, in addition to producing seeds and small fruits that provide food for birds and small mammals. Lianas generally climb the trunks of trees in a spiral pattern, winding around as if to strangle them. Liana-covered trees grow more slowly, are less reproductive and die sooner, and many trees cannot support the weight of these vines.

In light of this behavior, researchers are now finding that lianas can reconnect tree communities and remodel

In the Amazon, liana populations are gaining ground in areas of continuous forest without any history of disturbance

environments by promoting the survival of some species to the detriment of others.

In connection with her work on the identification of liana species, Burnham is gradually mapping the distribution of these plants in some parts of the Amazon. She has now identified 300 species, many of which have not yet been described. “We found more than 80 species in half a hectare!” says the University of Michigan-based ecologist, who visits the Amazon at least twice a year. “We hope this census will help us identify which liana species are benefiting most from this scenario and gaining more ground,” says Burnham, who, along with Laurance, is working on the Biological Dynamics of Forest Fragments Project (PDBFF) at Brazil’s National Institute

for Research in the Amazon (INPA). For over 30 years, this project has monitored developments in more than a thousand square kilometers (km<sup>2</sup>) of fragmented and continuous forests in Amazonia. Burnham's work is also broadening other researchers' understanding of the composition of liana communities and helping them to achieve a more in-depth understanding of the proliferation of these plants.

Over the course of 35 years, researchers involved in this program have gone into the field to analyze the growth and death rates of 60,000 trees and 178,295 saplings (less than 10 cm diameter at chest height) in 55 hectares of continuous forest and 39 hectares of fragmented forest. The continuous monitoring has resulted in a sophisticated database of information pertaining to the behavior of these forests. More recently, the researchers have also kept records of the populations of lianas, which represent a significant portion of the forests' biomass and diversity but were not targeted in earlier forest censuses. They have monitored the growth of 35,000 lianas in 66 one-hectare plots of continuous forest and in fragments that vary in size from one to 100 hectares.

Through computer simulations, the researchers have observed that liana populations are expanding in forested areas with no history of disturbance. "This

Ecologist Robyn Burnham and her assistant, João Batista da Silva, during field work in 2013, when they collected and measured liana specimens

## Higher levels of atmospheric CO<sub>2</sub> appear to accelerate the growth of trees and, to a greater extent, that of lianas, in Amazonia

was a surprise," says José Luís Camargo, an ecologist based in São Paulo State who is the scientific coordinator of the PD-BFF. "Liana proliferation is common in areas adjacent to the edges of fragmented forests."

Over the past 14 years, the population of lianas in intact forests near Manaus has increased at a rate 1% higher than expected each year, according to Camargo. The researchers believe that these plants have proliferated in this area because of higher levels of CO<sub>2</sub> in the atmosphere. CO<sub>2</sub> appears to act as a fertilizer that accelerates the growth of both lianas and



3

trees, but especially lianas, thereby promoting forest remodeling. In the case of lianas, the rising concentrations of CO<sub>2</sub> may be partly responsible for lower light levels in these environments, causing them to proliferate at a faster pace. In addition, the trees may be facing fiercer competition for space. "The competition for water, nutrients and light in continuous forests is also more intense between trees and lianas," says Camargo. Under this scenario, trees of some species die earlier, while others succumb to liana proliferation. "It makes forest behavior more dynamic," explains Laurance, who



1



2



lived in Brazil for five years and now works at James Cook University in Australia.

Lianas generally adapt better to disturbed forests, owing in part to a phenomenon known as the edge effect, which creates 32,000 km of new forest edge in the Amazon each year (see *Pesquisa FAPESP* Issue No. 205). In the transitional areas between dense forest and open fields, trees fall, dry up and die more easily as a result of excessive light, heat and wind. With more light, lianas—which are more drought-resistant and grow more efficiently—proliferate and easily reach the treetops. “These changes can reduce carbon storage, alter several aspects of forest ecology and reduce the diversity of tree species,” Camargo says. For this reason, he explains, lianas generally help researchers understand the degree of disturbance in forests.

#### INTENSE COMPETITION

Every day from November 2008 to August 2009, biologist Maria Tereza Grombone-Guaratini and her team from the Botanical Institute of São Paulo measured and counted the lianas they found in sites, with and without bamboos, one kilometer apart in Fontes do Ipiranga State Park. The park, the third largest fragment of Atlantic Forest in the state

Shoot of the bamboo species *Aulonemia aristulata*, which is native to the Atlantic Forest (left)

Specimen of the liana species *Bauhinia guianensis* in Amazonia (above)

of São Paulo, is located 14 km from the center of the state capital. In this area, they also observed something unexpected: the lianas have to contend with the troublesome presence of bamboos, which similarly require light and space to occupy the environment. “In this competition, bamboos have an advantage over lianas,” says Grombone-Guaratini.

In this study, Grombone-Guaratini and her colleagues observed that woody bamboos of the species *Aulonemia aristulata*, which is native to the Atlantic Forest, release chemical compounds into the soil that inhibit tree growth and even the germination of lianas. Without trees, there is no support medium for lianas in their search for light, and they cannot wind around the smooth stems of bamboos. The researchers identified a total of 1,031 liana specimens more than 1 cm in diameter, of which 277 were located in areas dominated by bamboos and 754 were found elsewhere. Many of the lianas observed in environments with *A. aristulata* had thick stems, which, according to Grombone-Guaratini, suggests that these plants existed there prior to the invasion of bamboo.

As in Amazonia, the bamboo proliferation may be related to rising concentrations of atmospheric CO<sub>2</sub>. In 2013,

Grombone-Guaratini put this hypothesis to the test by growing young specimens of the species *A. aristulata* in two types of chambers: one with a high concentration of CO<sub>2</sub> and one with normal conditions.

After seven weeks, the bamboos grown in the chamber with higher CO<sub>2</sub> levels showed a 70% increase in photosynthesis, were 92% taller and displayed a 104% larger leaf area than those grown in the other chamber. Under a global climate-change scenario, bamboos could dominate increasingly higher numbers of environments and affect the composition of tree species, Grombone-Guaratini says. Her observations among bamboos in the Atlantic Forest may also hold true for lianas in Amazonia. ■

#### Project

Influence of *Paradiolyra micrantha* on the regeneration of an urban fragment of the Atlantic Forest (Nº. 05/51747-2); **Grant mechanism** Regular Line of Research Project Award; **Principal Investigator** Maria Tereza Grombone Guaratini (IBT-SP); **Investment** R\$45,219.86 (FAPESP).

#### Scientific articles

LAURANCE, W. F. *et al.* Long-term changes in liana abundance and forest dynamics in undisturbed Amazonian forests. **Ecology**. V. 95, Nº. 6, pp. 1604–11. 2014.

GROMBONE-GUARATINI, M. T. *et al.* Atmospheric CO<sub>2</sub> enrichment markedly increases photosynthesis and growth in a woody tropical bamboo from the Brazilian Atlantic Forest. **New Zealand Journal of Botany**. V. 51, Nº. 4, pp. 275–85. December 2013.