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DATA PAPER

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A dataset of Neotropical liana research focusing on the strategies of control for forest restoration and management practices

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Abstract

***Key message*:** Forest fragmentation leads to a micro-environmental condition that favors the proliferation of liana, which infest trees, compete with them, and reduce their performance. To report the state of the art of the main actions to manage this structural component of tropical forests, we surveyed the control strategies in the literature in the last 71 years, highlighting research goals, tree-climber interactions, management, restoration, and conservation.

Dataset access is at https://doi.org/10.5281/zenodo.6678112. Associated metadata are available at

https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/712ff481-dfa2-4ddb-b4fa-fcbd7c517842

Context: Lianas (woody vines) are considered structural parasites of tropical trees because they start their development as terrestrial seedlings but need to reach a tree canopy for higher light availability. The tree-liana coexistence usually can damage tree species, thus removing lianas has been suggested as an alternative to reinforce forest regeneration.

Aims: The dataset compilation begun during the first author doctoral work and a first dataset on neotropical lianas was published (https://doi.org/10.5281/zenodo.4050477) in 2020. The present dataset (https://doi.org/10.5281/zenodo.6678112) presents an update of the 2020 dataset with additional amend (published articles from 2018 to 2021) and enhanced metadata descriptions. Our aim is providing an updated database extracted from scientific literature compiling information related to the effect of lianas on tree and forest structure and diversity, and to contribute to improve decision making on forest restoration and management.

Methods: We made a systematic literature review on lianas in the Neotropical region (native or restored) from 1950 to 2021. First, we selected studies on liana management and described each paper according to the following topics: vegetation status, positive (P), and negative (N) effects of lianas on each species, the species in focus, and the suggested management strategy.

Results: Almost 83% of the studies pointed out tree-climber interactions as negative to trees. Cutting was the management strategy adopted in 92% of the studies. Controlled burning, enrichment, and selective cutting were adopted in only one paper. Rainy and seasonal forests were the vegetation types with more studied sites (20 and

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17 respectively). Only one study suggested enhancing forest diversity through direct seeding of lianas. Four studies evaluated the impact of lianas on forest diversity and forest fauna.

Conclusion: The data collected showed the different impacts of liana management on the diversity and structure of tropical forests. It can endorse environmental control and management practices and evaluate the consequences of these techniques in recovering forests or improving timber production.

Keywords: Seasonal Forest, Cerrado Woodland, Rain Forest, Climbers, Climate change, Conservation, Management, Woody vines

1 Background

Several biomes in the Neotropical region are under harsh threats to biodiversity, especially tropical forests, savannas, and mountain ecosystems (Trigueiro et al. 2020). Many studies have documented the ecological impacts of human disturbance, especially fragmentation processes and edge effects, which favor liana proliferation over trees (Schnitzer and Carson 2000; Schnitzer and Bongers 2002, 2011; Ingwel et al. 2010; Magrach et al. 2014; Vargas et al. 2020). Forest fragmentation processes change microclimate conditions, which increases the presence of lianas in abundance and biomass (Schnitzer and Carson 2000; Schnitzer 2015; Magnago et al. 2016). Lianas are structural parasites that need other vegetation components, usually trees, to reach and remain in the canopy and compete with them for below and aboveground resources (Laurence et al. 2001; Schnitzer and Bongers 2002, 2011; Vargas et al. 2020). Although lianas may respond positively to raises in the atmospheric CO_2 concentration (Granados and Korner 2002), recently experiments have showed that both lianas and trees can physiologically benefit from CO_2 improvement (Marvin et al. 2015). The main consequence of liana proliferation is the reduction in the total forest biomass, carbon storage, and seedling recruitment (Schnitzer and Bongers 2011; Magnago et al. 2016; Estrada-Villegas and Schnitzer 2018).

Despite lianas negative effects on tree performance, especially on commercial timber trees, some studies have described the role of lianas on the food intake of mammalian folivores, frugivores, pollinators, and arthropods, helping the movement of fauna across forest fragments (e.g., Morellato and Leitão Filho 1996; Cudney-Valenzuela et al. 2021; DeLuycker 2021; Souza-Alves et al. 2021).

The number of papers on lianas and related topics, especially those discussing phylogeny, functional traits, and biomass, has consistently increased since 2002 (Fig. 1), but the knowledge about liana management and control techniques has been neglected in many biomes. Most papers evaluating the effect of lianas on tree performance agree with the positive effect of cutting lianas to manage forest remnants (Schnitzer 2015; César et al. 2016) and improve the harvest of marketable timber (Estrada-Villegas and Schnitzer 2018). Recently, some studies have evaluated the importance of lianas in the diversity of ants and used lianas to improve diversity strata in restoration programs (Le Bourlegat et al. 2013; Adams et al. 2019a, 2019b). Also, the effect of selective liana removal to minimize the negative impacts of indiscriminate liana removal has been object of study (Sfair et al. 2015).

The present database organizes 71 years of research on lianas in the Neotropical region. We extracted from papers scientific knowledge on liana control, management, and conservation (Vargas et al. 2022). All papers surveyed are organized per country and offers a map with precise coordinates of all vegetation and biomes as well as key research topics (https://doi.org/10.5281/zenodo.6678112) (Fig. 2). We aim to provide an updated information related to the effect of lianas on tree and forest structure and diversity, offering essential information to decision-making on forest restoration and management.

2 Methods

The studies presented in this data paper were searched in the Web of Science, Google Scholar, and Scielo using the following words: liana*, climb* plant*, vine*, trepad*, with no country or year limitation. We selected only those studies conducted in the Neotropical region (26°N–26°S) from 1950 (first record 1957) to 2021. Among all the papers found (more than 1100), we excluded studies related to agricultural and cultivated species and included those addressing native or restored vegetation in the Neotropical region. The remaining 535 papers were classified by biome, country, vegetation type, study focus (lianas or lianas and trees), and research topic. We adopted nine vegetation types following Mendoza et al. (2017) and Vargas et al. (2021) based on the ecoregions and biomes proposed by Olson et al. (2001) to define the vegetation category of studied sites. We added the ecotone vegetation type when the study site was in transition zones (between ecoregions or biomes) (Vargas et al. 2020). Studies that included more than one country or vegetation type were separated and evaluated as independent datasets (e.g., Mendoza et al. 2017), even when the vegetation types had the same geographical

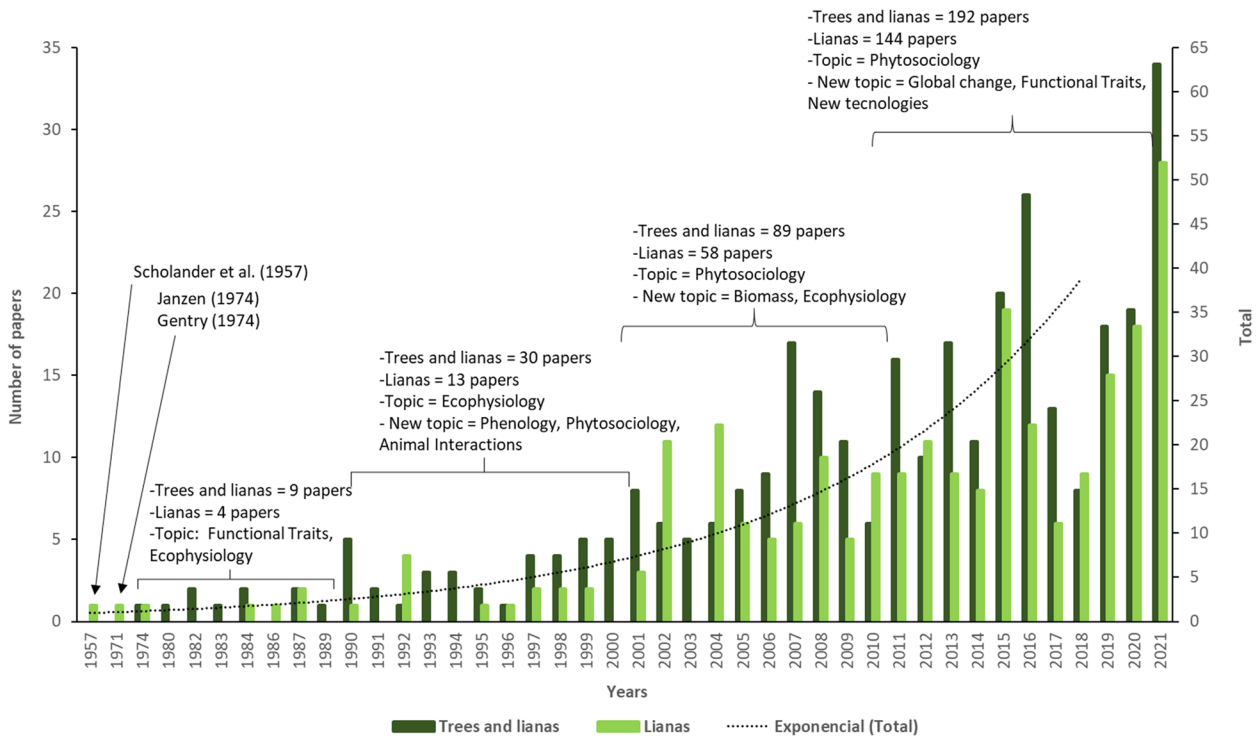

Fig. 1 Literature produced on neotropical region by country from 1957 to 2021. Light green bars indicate research papers focused just on lianas and dark green bars papers comparing lianas and trees

coordinates. Sixteen research topics were established to group the 535 papers: taxonomy, phylogeny, floristics, ontogeny and development, anatomy, phytosociology, biomass, control and management, functional traits (habit, seed dispersal, climbing mode, morphology of supporting trees), ecophysiology (structure, chemistry and physiology of leaf and canopy, and spectral reflectance), phenology, ethnobotany, plant-animal interaction, new technologies (remote sensing), global change, review paper, and environmental heterogeneity (Vargas et al. 2020). Each study was classified into one or more topics. A complete list of the literature reviewed, and corresponding classifications is available at https://doi.org/10.5281/zenodo.6678112 .

2.1 Access to the data and metadata description

The dataset was organized in an Excel spreadsheet with four tabs (https://doi.org/10.5281/zenodo.6678112). The first tab in the database, labelled "Review", included the core search information organized into five subjects, each one in a column:

- bibliographic information (4 columns): ID_Org, study number, author(s) of the study, year, and DOI/URL stable;
- geographic information (5 columns): country, latitude, longitude, biome, and vegetation;
  focus (2 columns): lianas and trees, and lianas; and research topics (16 columns): taxonomy, phylogeny, floristics, ontogeny and development, anatomy, phytosociology, biomass, control and management, functional traits (seed dispersal, climbing strategy, morphology of supporting trees), ecophysiology (leaf and canopy structure, chemistry and physiology, and spectral reflectance), phenology, ethnobotany, plant-animal interaction, new technologies (remote data), global change, and review paper

The second tab, called "Definitions", explained each item presented in the Review tab.

The third tab, named "Control and management", included papers that investigated liana management and control strategies. Besides the bibliographic and geographic informations, we considering the following topics: vegetation status (pristine, fragment/secondary, restored), data collection strategy (experimental or observational studies), the positive (P), negative (N), or not described (ND) effect of lianas on the species in focus, the species in focus, and the suggested management strategy (cutting, burning, selective cutting, diversity species, enrichment).

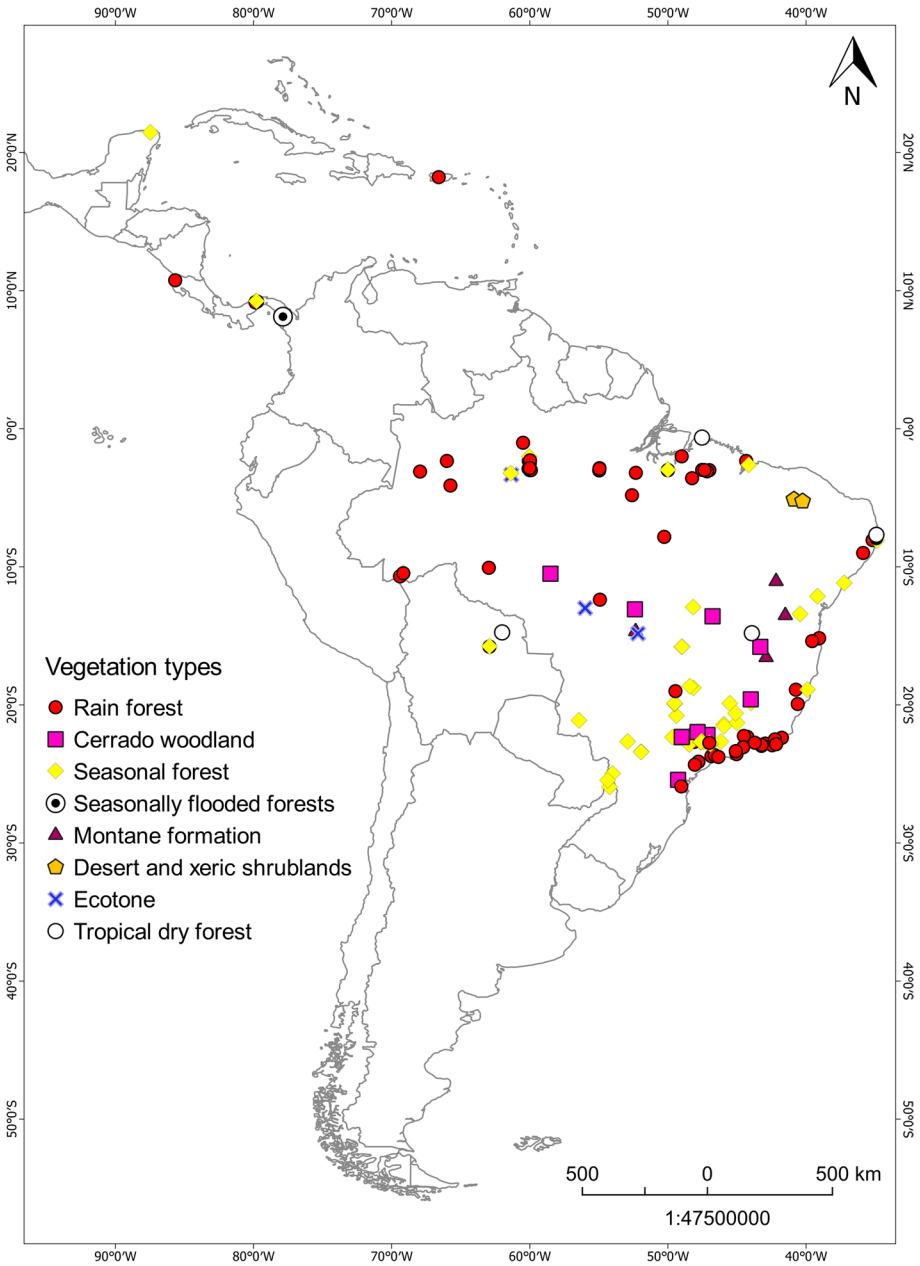

Fig. 2 Geographical distribution of the studies that evaluated strategies of management occurring on lianas across neotropical region. Vegetation classification follows Mendoza et al. (2017) after Olson et al. (2001)

The fourth tab denominated "Definitions M_C", explained each item presented in the "Control and management.

Associated metadata are available at : https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/712ff481-dfa2-4ddb-b4fa-fcbd7c517842

A map was created in QGIS 3.8.2-Zanzibar (https://qgis.org/) to display the studies addressing management and control in Neotropics by vegetation type. The Geodesic Referential is WGS-84, and the cartographic projection is in geographic coordinate systems. The map scale is 1:34000000. Cartographic Sources: Brazil's map (Brazilian Institute of Geography and Statistics–IBGE, 2015, downloaded from https://mapas.ibge.gov.br/bases-e-referenciais/bases-cartograficas/malhas-digitais). South America's map (Carlos Efraín Porto Tapiquén, Orogénesis Soluciones Geográficas. Porlamar, Venezuela, 2015) was based on the shapes by the Enviromental

Systems Research Institute (ESRI-Free Distribution. Downloaded from http://tapiquen-sig.jimdo.com).

2.2 Technical validation

This dataset included a total of 535 research papers searched in reliable databases from 1950 to 2021. Each paper was thoroughly examined for data extraction by the authors. The geographic position described in the papers was recalculated using INPE's geographic calculator to accurately localize and map the study area (coordinates, locality, municipality, state).

2.3 Reuse potential and limitations

Our neotropical liana dataset provides scientific support for researchers looking for specific study subjects. The dataset-built timelines of research knowledge and maps and identified gaps in liana research. It allows researchers to build graphics or lists illustrating, for instance, where and to what extent lianas have a negative (or positive) effect on trees (e.g., wet and dry tropics), verify how liana species richness/diversity changes across vegetation types in the Neotropics, uncover the trends of the impacts of lianas on trees. Other aspect of interest is the number of liana species used by herbivores, frugivores, folivores, and flower visitors across Neotropical vegetation types. Finally, and most importantly, our liana database can be used to identify management strategies in different Neotropical biomes and vegetation and guide new conservation plans and restoration programs. These data can assist biome revegetation, help control environmental factors that can favor the proliferation of lianas, monitor the overpopulation of some species, and promote the conservation of rare species of lianas. At present, we did not foresee any reuse limitation of the dataset. We hold no responsibility for misuses of published papers.

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Code availability
Not applicable

Authors' contributions
BCV, MTGG, and LPCM designed the study. All authors researched data and helped in data compilation. MTGG curated the data, LPCM resource acquisition and management, BCV and MTGG wrote the manuscript. All authors read the manuscript and contributed with suggestions. The author(s) read and approved the final manuscript.

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Availability of data and materials
All data created during this research is openly available at Zenodo repository: https://doi.org/10.5281/zenodo.6678112. Associated metadata are available at: https://metadataafs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/712ff481-dfa2-4ddb-b4fafcbd7c517842

Declarations

Ethics approval and consent to participate
Not applicable

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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