NATURAL HISTORY AND ECOLOGY OF NEOTROPICAL MISTLETOES

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Summary

Mistletoes are an interesting group of plant species with an unusual behavior; they grow on another plant species, being considered hemiparasites. In this short review we present a few studies that have been conducted in the Neotropical region, especially in Brazil. These studies show that mistletoes are an excellent group to test ecological theories in the field. Such studies reveal that some relationship patterns are well established for temperate environments, and are not thoroughly elucidated in the Neotropical region. Revealing that is necessary to increase field effort to better

understand the mechanisms involved in mistletoe interaction with their hosts. As mistletoes are considered pests in some situations, the total understanding of their natural history and ecology may help the suggestion of management strategies thus minimizing economical losses.

1. Introduction

Mistletoes are a group of plant species with a very interesting feature; they establish and develop on another plant species. However, they are not true parasites for they present leaves and produce their own energy through photosynthesis. Since they fix in xylem vessel of hosts they are considered hemiparasites. It is likely that in many situations layman may confound mistletoes behavior and consider them as epiphyte. Furthermore, in field work, mistletoes have been mistaken with their host. In such cases, samplings of mistletoe were performed in the belief of collecting the host at flowering period. This situation is even more serious than the mere mistake of their behavior with epiphytism, for false information concerning phenology or species richness in a determined area is provided. Although there is a vast literature on mistletoes, still little is known of the natural history and ecology of this interesting group of species in the neotropics. In this work we present a small review of the group, mostly focusing on information produced in studies still being or already conducted in the Neotropical region.

Mistletoes have been studied on a regular basis in temperate countries. In the great majority of species, relations of specificity are widely known, as well as aspects of reproductive biology. The motivation of such studies in a temperate environment was the perception of the need to understand the possible impacts that mistletoe could cause on cultivated species or managed forests. The preliminary investigations were focused on host interaction. These studies aimed to quantify the effects of mistletoe presence on host growth, as well as to describe the mechanism involved on the ecology of their dispersion and establishment. Following studies focused on germination ecology, as well as the range of hosts used by mistletoe. These studies started to set the anatomic and physiologic basis of hemiparasitism, and a deepening of the understanding of frugivorous birds as seed vectors. This shows that mistletoes have always drawn attention mainly because of the unusual behavior they have to develop themselves on other plants.

In Europe there is a certain mysticism surrounding this group. In ancient times there was a superstition in which the bride and groom, shortly after the wedding ceremony, should place themselves right under the mistletoe species *Viscum album* and give their first kiss as husband and wife. People believed that such behavior would be interesting for the female fecundity, assuring a successful married life. Nowadays, there are three main lines of study concerning mistletoes (for details, see Mathiasen *et al.* 2008). The first is directed to the study of mistletoes effects over the natural environment. For instance, the majority of hemiparasite species form dense green foliage inside host crown. That brings birds in search of their branches to nest. Such an effect is enhanced in deciduous host species, as *Kielmeyera coriacea*, in Brazilian savannas. In certain periods of the year it is only possible to notice the presence of foliage in *Struthanthus polyanthus*, frequently found in *K. coriacea*, when leaves are completely off the tree. Another line study is directed towards research on mistletoe acting as the source of food

for a myriad of organisms. Insects and fungi feed on mistletoes's leaves, flowers and fruits; the hypothesis is that these groups are favored by the almost complete absence of structural defenses, as well as high nutritional quality of tissue of mistletoe. Even though, some hemiparasitic species present secondary compounds, their role on herbivory rates in this group are yet not clear. Moreover, frugivorous birds frequently feed on mistletoe fruits, which in turn rely almost exclusively on birds for dispersion. Lastly, a study line of mistletoe research is interested in understanding the interactions between mistletoe and the environment. In this case the goal is to determine the extent of mistletoe influence on the composition of plants and animals on natural environments, vertical and horizontal forest structure, uptake of water and forest succession.

Many of the interplay among mistletoe, their hosts and the organisms that rely on them as resource are still incipient on forest systems of terrestrial ecosystems. The lack of detail of such interactions is greater in the Neotropical region in comparison with Europe and Australia. Although they cause impacts on reproduction and growth of their hosts, recent studies suggests that mistletoes also act as a key resource in forest ecosystems. Additionally, studies suggest mistletoes are mutualistic in relation to the frugivorous birds that are their seed dispersers. So, more than merely pests, mistletoes can be regarded as an interesting group of plants and because they have a vast net of interactions with other organisms, can be used as efficient models for testing ecological hypothesis in the field.

2. Taxonomical Relationships, Geographical Distribution and Mistletoe Diversity in Brazil

Mistletoes belong to the Santalales order, which is formed by five families, Loranthaceae Misodendraceae, Olacaceae, Opiliaceae and Santalaceae. Of these five families, only Misodendraceae, native of the Andes, does not occur in Brazil. Recent phylogenetic studies few changed the Santalales's order classification; the Balanophoraceae family, however, was excluded. In addition, Eremolepidaceae and Viscaceae were included in the Santalaceae. This family has always been considered distinct from Eremolepidaceae and Viscaceae, but more recent phylogeny studies showed the need of compiling these families. Previously, Viscaceae was included inside the Loranthaceae, though some authors already acknowledged the need of treating them as different families.

The results provided by previously published phylogenetic studies did not carry out an adequate sampling of representatives of families of the Santalales order. Therefore, the phylogenetic trees presented a low resolution highlighting the need to sequence new DNA regions. This triggered the search for improvement of representativeness of species belonging to the Santalales family, as well as the addition of new DNA sequences to increase the comprehension of relationships among the families and species of the order Santalales. Unfortunately, the phylogenetic relations of Brazilian specimens have been poorly explored.

Loranthaceae has a pantropical distribution presenting approximately 70 genera and 800 species. In Brazil there are around 10 genera and 100 species (Table 1). Loranthaceae

species are commonly found in many regions of Brazil, and are generally called mistletoe. The Loranthaceae family included genera that were later moved to Eremolepidaceae and Viscaceae, and subsequently allocated to Santalaceae, due to the inclusion of Eremolepidaceae and Viscaceae in Santalaceae. The Cerrado vegetation has the best data bank available concerning Loranthaceae ocurrence in Brazil. In all the other biomes of Brazil there is a lack of enough sampling effort. In Cerrado vegetation, *Psittacanthus robustus* stands out with showy flowers and are mainly found in the Vochysiaceae family.

Family	Genera
Loranthaceae	*Cladocolea*
	Ixocactus
	Ligaria
	Notanthera (=*Phrygilanthus*)
	Oryctanthus
	Oryctina
	Phthirusa
	Psittacanthus (=*Psathyranthus*)
	Struthanthus
	Tripodanthus
Olacaceae	*Aptandra*
	Brachynema
	Cathedra
	Chaunochiton
	Curupira
	Douradoa
	Dulacia (=*Liriosma*)
	Heisteria
	Minquartia
	Ptychopetalum
	Schoepfia
	Tetrastylidium
	Ximenia
Opiliaceae	*Agonandra*
Santalaceae	*Acanthosyris*
	Antidaphne
	Arjona
	Dendrophthora
	Eremolepis
	Eubrachion
	Jodina
	Phoradendron
	Thesium

Table 1: Number of genera of Santalaceae found in Brazil

Olacaceae has pantropical distribution presenting approximately 27 genera and 200 species. In Brazil there are around13 genera and 60 species (Table 1). In Brazil, the representatives of this family are more common in the Amazon. In other biomes the *Ximenia* and *Heisteria* stand out. *Ximenia americana* is the most common species inside this genus with wide distribution in Brazil. *Heisteria silvianii* is found mostly in the Atlantic Forest.

Opiliaceae has a pantropical distribution presenting approximately 10 genera and 30 species. In Brazil there is only one genus with five species (Table 1). *Agonandra brasiliensis* and *A. excelsa* are the most widely distributed in Brazil, being mostly found in riparian and seasonal forests of Cerrado, as well as in other vegetation types of Brazil. *Agonandra silvatica* and *A. peruviana* occur mainly in the Amazon, and *A. fluminensis* occurs in Atlantic Forest.

Santalaceae presents a cosmopolitan distribution of approximately 50 genera and 1000 species. In Brazil there are around 9 genera and 80 species (Table 1). Species of the Santalaceae family are commonly found in different regions of Brazil, with special attention to the *Phoradendron* genus, more widely distributed, and *Thesium*, found mainly in the Southeast and South regions of the country. The distinction between lorantacea and santalacea can be observed analyzing the inflorescence, which is spiciform with flowers inserted in depressions on the santalacea, and of different forms with sessile or pedicellated flowers, but not inserted in cavities on the lorantaceae.

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Biographical Sketches

Rafael Arruda graduated in Biological Sciences at Universidade Federal de Mato Grosso do Sul (UFMS), where he studied fruiting pheology and dispersal syndromes in Pantanal wetland forest patches. He obtained his MSc degree at Universidade Federal de Uberlândia (UFU) investigating the ecological interactions of mistletoe *Struthanthus polyanthus* and their hosts in Brazilian tropical savanna, the Cerrado biome. He did his PhD at Instituto Nacional de Pesquisas da Amazônia (INPA), working on geographical distributions and genetic variability in *Heliconia acuminata*. Currently he is a professor at the Universidade Federal de Mato Grosso (UFMT). His main interests include natural history, ecology and taxonomy of tropical plants, as well as vertebrate-plant interactions and experimental design in plant ecology.

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Fabiana Alves Mourão obtained her MSc degree at the Federal University of Minas Gerais (UFMG), studying the patterns of parasitism of the Loranthaceae *Struthanthus flexicaulis* in a plant community on ironstone outcrops in SE Brazil. She is currently a PhD student at the same university, experimentally evaluating top-down effects of the parasite and modeling its spread in rupestrian landscapes. She has worked with plant-plant interactions, population structure, and environmental education.

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