Scientific Article

DEGREE OF INFESTATION AND PREFERENCES OF HEMIPARASITES IN URBAN ARBORIZATION

Theonizi Angélica Silva Albuês[2*], Daiane de Moura Borges Maria[2], João Paulo Sardo Madi[2], Sidney Fernando Caldeira[3] and Kamila Daiany Terres da Silva[4]

[1] Received on 11.04.2022 accepted for publication on 07.02.2023.
[2] Universidade Federal do Paraná, Programa de Pós-Graduação em Engenharia Florestal, Curitiba, PR - Brasil. E-mail: <theoniziangelica@yahoo.com.br> , <daianedemouraborgesmaria@gmail.com> and <joaosardomadi@gmail.com>.
[3] Universidade Federal de Mato Grosso, Departamento de Engenharia Florestal, Cuiabá, MT - Brasil. E-mail: <sidneycal@gmail.com>.
[4] Universidade Federal de Mato Grosso, Graduada em Engenharia Florestal, Cuiabá, MT - Brasil. E-mail: <kamilaterressilva@gmail.com>.
*Corresponding author.

ABSTRACT – Mistletoe is an important nutritional resource for the frugivorous ornithological fauna in several ecosystems. However, in great intensity, they can reduce the vigor of their host trees, requiring adequate management in urban afforestation, without depleting this source of food for birds. The hypothesis that there are hemiparasites with host specificity was the reason for this study. Thus, a floristic census of the trees was carried out at UFMT, *campus* Cuiabá; the infestation by genus of hemiparasite present was recorded, in quantity and degree of infestation, in addition to the quantification of seeds of the hemiparasite germinated without the development of the vegetative part, whose cotyledons necrotized and died. A total of 4265 tree individuals were evaluated, distributed in 46 families, in which 16,52% were identified of the genera *Phoradendron*, *Psittacanthus*, and *Struthanthus*, of which about 90,0% were *Psittacanthus*. The highest infestation occurred in 24 families, highlighting Fabaceae (28,3%) and Combretaceae (25,6%), and the species *Terminalia catappa*, *Anadenanthera peregrina*, and *Vatairea macrocarpa*. The presence of germinated seeds of the hemiparasite with dead cotyledons varies between tree species and between individuals of the same species. The highlight was in Rutaceae, Arecaceae, and Rubiaceae, and in the species *Acrocomia aculeata*, *Caryocar villosum*, and *Genipa americana L.* that present individuals with natural control potential, even with the presence of frugivorous ornithological fauna and the dispersion of the hemiparasite. In general, the intensity and degree of infestation are low, and there is no infestation in the Caryocaceae, Rutaceae, and Rubiaceae families, highlighting the species *Caryocar villosum*, *Murraya paniculata* and *Alibertia edulis*.

Keywords: Mistletoe; Loranthaceae; Urban Vegetation.

GRAU DE INFESTAÇÃO E PREFERÊNCIAS DE HEMIPARASITOS NA ARBORIZAÇÃO URBANA

RESUMO – As ervas-de-passarinho compõem um importante recurso nutricional para a fauna ornitológica frugívora em vários ecossistemas. Porém, em grande intensidade, podem diminuir o vigor de suas árvores hospedeiras sendo necessário manejo adequado na arborização urbana, sem exaurir essa fonte de alimento aos pássaros. A hipótese de que existam hemiparasitos com especificidade de hospedeiro foi a motivação para este trabalho. Assim, foi realizado censo florístico arbóreo na UFMT, ***campus*** *Cuiabá; registrada a infestação por gênero de hemiparasito presente, em quantidade e grau de infestação, além da quantificação de sementes do hemiparasito germinadas sem o desenvolvimento da parte vegetativa, cujos cotilédones necrosaram e morreram. Avaliaram-se 4265 indivíduos arbóreos, distribuídos em 46 famílias nas quais 16.52% foram identificados os gêneros* ***Phoradendron****,* ***Psittacanthus*** *e* ***Struthanthus****, dos quais cerca de 90.0% eram* ***Psittacanthus****. A maior infestação ocorreu em 24 famílias, destacando-se Fabaceae (28.3%) e Combretaceae (25.6%) e as espécies* ***Terminalia catappa****,* ***Anadenanthera peregrina*** *e* ***Vatairea macrocarpa****. A presença de sementes germinadas do hemiparasito com cotilédones mortos é variável entre as espécies arbóreas e entre os indivíduos da mesma espécie. O destaque foi em Rutaceae, Areacaceae e Rubiaceae, e nas espécies* ***Acrocomia aculeata****,* ***Caryocar***

villosum *e* ***Genipa americana L****. que apresentam indivíduos com potencial natural de controle, mesmo com a presença da fauna ornitológica frugívora e a dispersão do hemiparasito. De forma geral, a intensidade e o grau de infestação são baixos e não há infestação nas famílias Caryocaceae, Rutaceae e Rubiaceae, com destaque para as espécies* ***Caryocar villosum****,* ***Murraya paniculata*** *e* ***Alibertia edulis****.*

Palavras-Chave: Erva-de-passarinho; Loranthaceae; Vegetação urbana.

1. INTRODUCTION

Urban afforestation provides ecological, aesthetic, physical and health benefits to the population. However, there are numerous abiotic and biotic factors that interfere with the development of trees, and among the biotic are hemiparasites, also known as mistletoe.

Its infestation can affect development, as it alters the architecture of the trees and can compromise the afforestation program (Rotta, 2001). The application of techniques for its control, such as pruning, if performed incorrectly, causes injuries to the plant and its exposure to external agents and disfigures its structure (Martins et al., 2010).

The development of the hemiparasite occurs with the adherence of the seeds to the bark of the tree with the aid of the mucilaginous substance called viscin and, in places irregular, the haustoria of the hemiparasite form an intumescence in the host (Rotta et al., 2006). This structure enters the cortex and with the anastomosis there is a connection between the phloem and xylem cells of the hemiparasite and the tree, occupying part or almost all of the canopy (Tainter, 2002). Its structure differs from it and is used by the fauna as a shelter, perch, nesting, hibernation or refuge from predators (Griebel et al., 2017).

The action of hemiparasites results in harmful effects on host plants and relevance as a resource for frugivorous animals, such as birds (Arruda et al., 2012) and mammal, *Dromiciops gliroides*, in Argentina (García et al., 2009). Birds are an initial filter for the frequency and distribution of seeds for the available hosts, while the host is the final filter for the establishment of the hemiparasite (Arruda et al., 2012). Thus, the successful development of the hemiparasite only occurs when biologically, chemically and physically compatible with the host; these associated variables determine whether a tree is infected or not (Fadini, 2011). Consequently, the specificity of the hemiparasite to a host.

However, when the hosts have characteristics that confer resistance to the hemiparasite, due to a cellular response by the plant, such as a hypersensitivity reaction (Király et al., 2007) or biochemical resistance to toxic substances (Pascholati and Dalio, 2011b), prevent host infestation.

Thus, the objective was to analyze the infestation of hemiparasites in the trees of the UFMT *campus* Cuiabá, identify the host species, quantify the degree of hemiparasite infestation and the host species that react to the infestation process.

2. MATERIAL AND METHODS

The study was carried out at the Federal University of Mato Grosso - UFMT, *campus* Cuiabá. The region has a predominance of the Cerrado biome. The climate is tropical with a dry season (Aw), according to the Köppen-Geier classification (Souza et al., 2013).

The floristic census used the methodologies of Silva Filho et al. (2002) and Finger (2011) with collections from 2014 to 2017. The number of occurrences of hemiparasites in each individual tree was counted. The infestation was the frequency of the hemiparasite in relation to the population and the degree of infestation was the proportional area occupied by the hemiparasites in relation to the total area of the host canopy, expressed as a percentage. The degree of infestation was considered low with up to 10% of crown occupation, medium above 10 to 30% and high, greater than 30%. The criterion was associated with the maximum recommended level for removing the volume of live branches from the canopy in the application of pruning or trimming of plants (Samek, 1974).

The crown area was visually obtained by its diameter and length, associated with the shape of the crown, according to the criteria of Ramalho (1976). On the trunk and branches of each individual tree, using a monocle, the presence of hemiparasite cotyledons expanded to germinate was observed and counted, but which were dry, necrotic, dead, and lacking in vegetative growth. Data were analyzed with descriptive statistics, with the structuring of tables and figures. With the use of *software* R version 4.0.5 (R *Development Core Team*, 2021) the box diagrams "*boxplot*" for the average number of expanded and dead cotyledons per species.

3. RESULTS

In the afforestation of UFMT, *campus* Cuiabá, 45 families and 4265 trees were found, of which 705 had hemiparasites (16.52%). The highest incidence of hemiparasites was in Fabaceae (28.34%) and in Combretaceae, Cannabaceae, Sapotaceae, Anacardiaceae and Bignoniaceae, above 20 %. The distribution between degrees of infestation was 60.36%, 21.24% and 18.39%, respectively for low, medium and high.

In the individuals analyzed, there was the presence of one to three species of hemiparasites, for the genera *Psittacanthus*, *Struthanthus* and *Phoradendron*, with a frequency of 14.8%, 2.0% and 1.4%, respectively. The average value of the low, medium and high degree of infestation was respectively 65.33%, 20% and 14.66%, in addition to 603 individuals of 76 species and grouped into 24 families that presented seeds with expanded and dead cotyledons (Figure 1).

The species with the presence of *Psittacanthus* spp. and *Phoradendron* spp. they were: *Albizia niopoides*, *Cecropia pachystachya*, *Eucalyptus* sp. 1, *Eucalyptus* sp., *Handroanthus aureus*, *Handroanthus heptaphyllus*, *Handroanthus serratifolius*, *Inga laurina*, *Simarouba versicolor*, *Eugenia jambolana* and *Tectona grandis*. While those who presented *Phoradendron* spp. and *Struthanthus* spp. they were: *Malpighia emarginata* and *Tamarindus indica*. The species parasitized by *Struthanthus* spp. and

Photos: Kamila Daiany Terres da Silva (1) e Sidney Fernando Caldeira (2).
Fotos: Kamila Daiany Terres da Silva (1) e Sidney Fernando Caldeira (2).

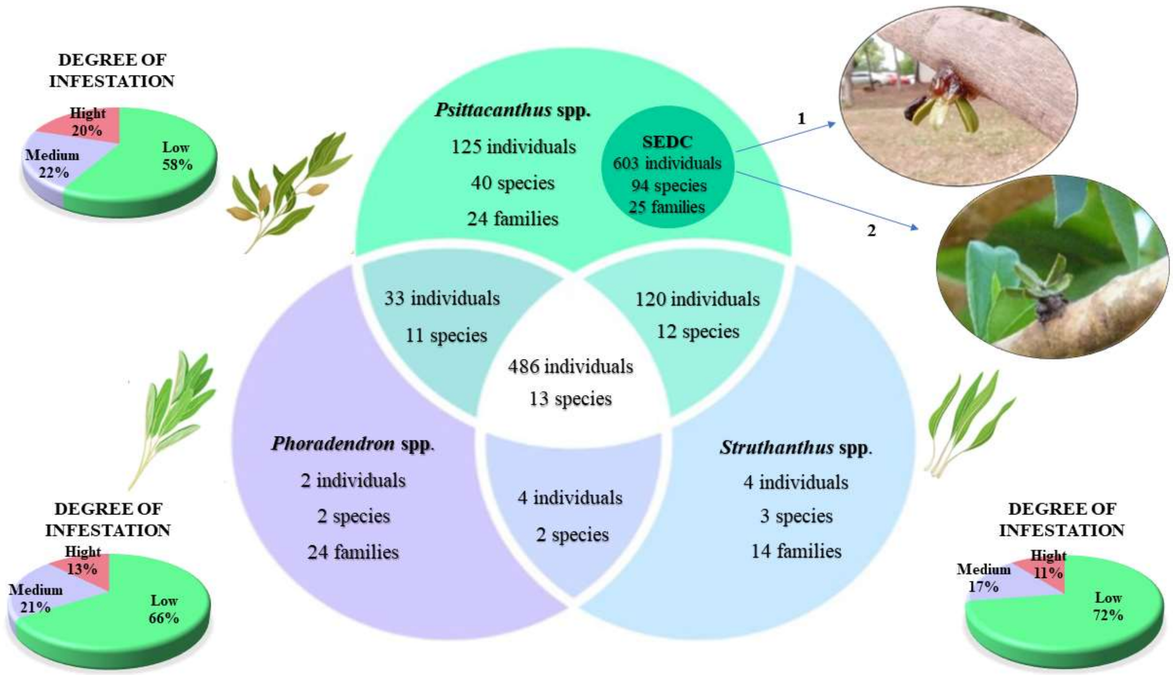


Figure 1 – Venn diagram for hosts with incidence of *Psittacanthus*, *Struthanthus* and *Phoradendron*, respective distribution by degree of infestation and emergence of Seeds with Expanded and Dead Cotyledons in *Psittachanthus* (SEDC): how gummy of *Anacardium occidentali* (1) and necrosis in *Vochysia* sp. (2) in the afforestation of UFMT, *campus* Cuiabá.

Figura 1 *– Diagrama de Venn para as hospedeiras com incidência de* ***Psittacanthus***, ***Struthanthus*** *e* ***Phoradendron****, respectiva distribuição por grau de infestação e surgimento de Sementes Com Cotilédones Expandidos e Mortos em* ***Psittachanthus*** *(SCCEM): com gomose em* ***Anacardium occidentale*** *(1) e necrose em* ***Vochysia*** *sp. (2) na arborização da UFMT,* ***campus*** *Cuiabá.*

Table 1 – Incidence and absence of *Psittacanthus* sp. in number (N), percentage of infestation (H) and respective percentages of distribution by degree of infestation by host species in the afforestation of UFMT, *campus* Cuiabá.
Tabela 1 *– Incidência e ausência de **Psittacanthus** sp. em número (N), percentual de infestação (H) e respectivos percentuais de distribuição por grau de infestação por espécie hospedeira na arborização da UFMT, **campus** Cuiabá.*

***Psittacanthus* sp.**	**Or.**	**TN**	**TNH**	**TNWS**	**H (%)**	**Degree of infestation (%)**		
						Low	**Average**	**High**
Bauhinia rufa (Bong.) Steud. **	E*	1	1	0	100	0,00	100,00	0,00
Vatairea macrocarpa (Benth.) Ducke**	N*	23	12	11	52,17	4,35	26,09	21,74
Anadenanthera peregrina (L.) Ex.	N*	200	100	100	50,00	25,00	14,50	10,50
Pouteria gardneri (Mar. & Mig.) Baehni**	N*	4	2	2	50,00	50,00	0,00	0,00
Syzygium cumin (L.) Skeels**	E	2	1	1	50,00	0,00	50,00	0,00
Anadenanthera peregrina var. falcata (Benth.) Altschul	N*	34	16	18	47,06	23,53	8,82	14,71
Albizia lebbeck (L.) Benth.	E	49	23	26	46,94	16,33	18,37	12,24
Handroanthus chrysotrichus (Mart. ex DC.) Mattos**	N*	7	3	4	42,86	28,57	14,29	0,00
Terminalia catappa L.	E	12	5	7	41,67	16,67	16,67	8,33
Jacaranda cuspidifolia Mart.	N*	276	108	168	39,13	23,19	8,33	7,61
Astronium fraxinifolium Schott	N*	134	52	82	38,81	14,18	6,72	17,91
Handroanthus avellanedae (Lorentz ex Griseb.) Mattos	N	53	20	33	37,74	32,08	3,77	1,89
Myracrodruon urundeuva Allemão**	N*	48	18	30	37,5	33,33	4,17	0,00
Ceiba speciosa (A.St.-Hil.) Ravenna**	N*	11	4	7	36,36	36,36	0,00	0,00
Machaerium acutifolium Vogel	N*	6	2	4	33,33	16,67	0,00	16,67
Azadirachta indica A. Juss.**	E	3	1	2	33,33	0,00	33,33	0,00
Eucalyptus sp L'Hér 3**	E	3	1	2	33,33	33,33	0,00	0,00
Inga sp. Mill	N*	7	2	5	28,57	28,57	0,00	0,00
Eugenia jambolana Lam.	E	7	2	5	28,57	28,57	0,00	0,00
Terminalia argentea Mart.& Zucc.**	N*	7	2	5	28,57	28,57	0,00	0,00
Magonia pubescens A. St.-Hil.	N*	24	6	18	25	4,17	16,67	4,17
Ceiba boliviana Britten & Baker f.**	N*	20	5	15	25	20,00	5,00	0,00
Trema micrantha (L.) Blume **	N*	4	1	3	25	0,00	0,00	25,00
Psidium guajava L.**	E	62	14	48	22,58	17,74	3,23	1,61
Senna siamea (Lam.) H.S. Irwin & Barneby	N*	33	7	26	21,21	9,09	6,06	6,06
Handroanthus heptaphyllus (Vell.) Mattos	N*	15	3	12	20	20,00	0,00	0,00
Eriotheca gracilipes (K. Schum.) A. Robyns**	N*	5	1	4	20	0,00	20,00	0,00
Maclura tinctoria (L.) D. Don ex Steud. *tinctoria* **	N*	5	1	4	20	0,00	20,00	0,00
Vitex polygama Cham.**	N*	5	1	4	20	0,00	0,00	20,00
Cedrela fissilis Vell.**	N*	11	2	9	18,18	9,09	9,09	0,00
Handroanthus impetiginosus (Mart. ex DC.) Mattos	N*	238	42	196	17,65	10,92	3,78	2,94
Enterolobium contortisiliquum (Vell.) Morong**	N*	46	8	38	17,39	15,22	0,00	2,17
Guazuma ulmifolia Lam.	N*	42	7	35	16,67	9,52	2,38	4,76
Vochysia haenkeana Mart.**	N*	12	2	10	16,67	8,33	8,33	0,00
Pseudobombax longiflorum (Mart.) A. Robyns**	N*	6	1	5	16,67	16,67	0,00	0,00
Aspidosperma riedelii Müll. Arg**	N	13	2	11	15,38	15,38	0,00	0,00
Cassia fistula L.**	E	13	2	11	15,38	15,38	0,00	0,00
Eucalyptus sp. Mill 1**	E	13	2	11	15,38	15,38	0,00	0,00
Ficus benjamina L.**	N*	13	2	11	15,38	15,38	0,00	0,00
Hymenaea stigonocarpa Mart. ex Hayne**	N*	13	2	11	15,38	7,69	7,69	0,00
Vitex cymosa Bertero ex Spreng.**	N*	7	1	6	14,29	14,29	0,00	0,00
Casearia sylvestris Sw.	N*	22	3	19	13,64	9,09	4,55	0,00
Hymenaea courbaril L.	N*	15	2	13	13,33	13,33	0,00	0,00
Qualea grandiflora Mart.**	N*	15	2	13	13,33	6,67	6,67	0,00
Simarouba versicolor A.St.-Hil.	N*	15	2	13	13,33	6,67	0,00	6,67
Dipteryx alata Vogel**	N*	123	16	107	13,01	4,88	3,25	4,88
Mangifera indica L.	E	328	39	289	11,89	6,10	2,74	3,05
Guazuma ulmifolia Lam.	N*	9	1	8	11,11	11,11	0,00	0,00
Tectona grandis L. f.	E	9	1	8	11,11	11,11	0,00	0,00

Continued ...
Continua...

Table 1 ...
Tabela 1 ...

Amburana acreana (Duck) A.C. sm.	N	19	2	17	10,53	5,26	0,00	5,26
Andira cujabensis Benth.**	N*	10	1	9	10	0,00	10,00	0,00
Platymiscium pinnatum (Jacq.) Dugand**	N	10	1	9	10	10,00	0,00	0,00
Copaifera langsdorffii Desf.**	N*	11	1	10	9,09	0,00	9,09	0,00
Eucalyptus sp. Mill	E	11	1	10	9,09	9,09	0,00	0,00
Tabebuia roseoalba (Ridl.) Sandwith	N*	11	1	10	9,09	9,09	0,00	0,00
Spondias purpúrea L.	E	11	1	10	9,09	0,00	9,09	0,00
Samanea tubulosa (Benth.) Barneby & J.W. Grimes	N*	58	5	53	8,62	8,62	0,00	0,00
Cordia glabrata (Mart.) A.DC.	N*	96	8	88	8,33	4,17	1,04	3,13
Buchenavia tomentosa Eichler**	N*	24	2	22	8,33	8,33	0,00	0,00
Licania tomentosa (Benth.) Fritsch	N	375	29	346	7,73	7,20	0,53	0,00
Handroanthus serratifolius (Vahl) S.O. Grose	N*	27	2	25	7,41	7,41	0,00	0,00
Protium heptaphyllum (Aubl.) Marchand**	N*	14	1	13	7,14	7,14	0,00	0,00
Leucaena lanceolata S. Watson	E	29	2	27	6,9	3,45	0,00	3,45
Cecropia pachystachya Trécul	N*	59	4	55	6,78	3,39	3,39	0,00
Luehea paniculata Mart.**	N*	15	1	14	6,67	6,67	0,00	0,00
Bowdichia virgilioides Kunth**	N*	21	1	20	4,76	4,76	0,00	0,00
Albizia niopoides (Benth.) Burkart	N	22	1	21	4,55	0,00	0,00	4,55
Delonix regia (Hook.) Raf.**	E	53	2	51	3,77	1,89	0,00	1,89
Mimosa caesalpiniifolia Benth.**	N*	30	1	29	3,33	3,33	0,00	0,00
Swietenia macrophylla King	N*	100	3	97	3	3,00	0,00	0,00
Handroanthus aureus Mattos	N*	42	1	41	2,38	2,38	0,00	0,00
Inga laurina (Sw.) Wild	N*	47	1	46	2,13	2,13	0,00	0,00
Hevea brasiliensis (Willd. ex A. Juss.) Müll. Arg.	N	67	1	66	1,49	0,00	0,00	1,49
Cariniana rubra Gardner ex Miers	N*	163	2	161	1,23	1,23	0,00	0,00
Genipa americana L.**	N*	162	2	160	1,23	0,62	0,62	0,00
Acrocomia aculeata (Jacq.) Solder. ex Mart.**	N*	83	1	82	1,2	0,00	1,20	0,00
Total		3593	631	2962		58,16	21,87	19,97

* Origin (Or.): Native to Brazil (N), Exotic (E). Natural occurrence in the Cerrado phytogeographic domain (*); TN = total number of tree individuals per species; TNW = total number without hemiparasite; TNH = total number with incidence of hemiparasite; H (%) = percentage of infestation by tree species; **Specialized tree species: the only ones found with the hemiparasite.
** Origem (Or.): Nativa do Brasil (N), Exótica (E). Ocorrência natural no domínio fitogeográfico do Cerrado (*); TN = número total de indivíduos arbóreos por espécie; TNW = número total sem hemiparasito; TNH = número total com incidência de hemiparasito; H (%) = percentual de infestação por espécie arbórea; **Espécie arbórea especialista: as únicas encontradas com o hemiparasito.*

Psittacanthus spp. they were: *Amburana acreana*, *Astronium fraxinifolium*, *Cariniana rubra*, *Casearia sylvestris*, *Cordia glabrata*, *Guazuma ulmifolia*, *Tabebuia roseoalba*, *Hevea brasiliensis*, *Hymenaea courbaril*, *Leucaena lanceolata*, *Licania tomentosa* and *Machaerium acutifolium*.

Finally, the species with the three hemiparasites (generalist) were: *Albizia lebbeck*, *Anadenanthera peregrina var*. *falcata*, *Anadenanthera peregrina*, *Senna siamea*, *Guazuma ulmifolia*, *Handroanthus avellanedae*, *Handroanthus impetiginosus*, *Jacaranda cuspidifolia*, *Magonia pubescens*, *Mangifera indica*, *Samanea tubulosa*, *Swietenia macrophylla* and *Terminalia catappa*.

The highest frequency of infestation, 14.8%, was *Psittacanthus* sp., both for species native to Brazil, native to the Cerrado and exotic, with a distribution of 9.46%, 71.62% and 18.92%, respectively (Table 1).

For the gender *Struthanthus* sp. an infestation of 2.0% was recorded, whose distribution among natives of Brazil, natives of the Cerrado and exotics was respectively 20.0%, 60.0% and 20.0% (Table 2).

The lowest frequency of infestation, 1.4%, was *Phoradrendon*, and for native, Cerrado native and exotic species, the distribution was respectively 7.41%, 62.96% and 19.63%. Hosts with greater abundance had less infestation by *Phoradrendon*, however, for the species *Senna siamea*, S*imarouba versicolor* and *Terminalia catappa* infestation was greater than 10% (Table 3).

Of the analyzed trees, 582 individuals had very low incidence and degree of infestation or the absence of hemiparasites. With highlight on the families Lechytidaceae, Rubiaceae, Arecaceae, Dilleniaceae, Caryocaceae and Ruthaceae. The most frequent species were *Cariniana rubra*, 29.5%, *Genipa americana*,

Table 2 – Incidence and absence of *Struthanthus* sp. in number (N), percentage of infestation (H) and respective percentages of distribution by degree of infestation by host species in the afforestation of UFMT, *campus* Cuiabá.
Tabela 2 *– Incidência e ausência de* ***Struthanthus*** *sp. em número (N), percentual de infestação (H) e respectivos percentuais de distribuição por grau de infestação por espécie hospedeira na arborização da UFMT,* ***campus*** *Cuiabá.*

***Struthanthus* sp.**	**Or.**	**TN**	**TNH**	**TNW**	**H(%)**	**Degree of infestation (%)**		
						Low	**Average**	**High**
Terminalia catappa L.	E	12	3	9	25,00	25,00	0,00	0,00
Machaerium aculeatum Raddi**	N*	8	2	6	25,00	0,00	0,00	25,00
Machaerium acutifolium Vogel	N*	6	1	5	16,67	16,67	0,00	0,00
Senna siamea (Lam.) H.S. Irwin & Barneby	N*	33	5	28	15,15	6,06	6,06	3,03
Guazuma ulmifolia Lam.	N*	42	6	36	14,29	14,29	0,00	0,00
Anadenanthera peregrina var. falcata (Benth.) Altschul	N*	34	4	30	11,76	11,76	0,00	0,00
Anadenanthera peregrina (L.) Ex.	N*	200	23	177	11,50	8,00	2,50	1,00
Guazuma ulmifolia Lam	N*	9	1	8	11,11	0,00	0,00	11,11
*Malpighia emarginat*a DC.	N	9	1	8	11,11	11,11	0,00	0,00
Tabebuia roseoalba (Ridl.) Sandwith	N*	11	1	10	9,09	9,09	0,00	0,00
Hymenaea courbaril L.	N*	15	1	14	6,67	6,67	0,00	0,00
Handroanthus avellanedae (Lorentz ex Griseb.) Mattos	N	53	3	50	5,66	5,66	0,00	0,00
Amburana acreana (Duck) A.C. sm.	N	19	1	18	5,26	5,26	0,00	0,00
Samanea tubulosa (Benth.) Barneby & J.W. Grimes	N*	58	3	55	5,17	3,45	0,00	1,72
Tamarindus indica L.	E	21	1	20	4,76	4,76	0,00	0,00
Casearia sylvestris Sw.	N*	22	1	21	4,55	4,55	0,00	0,00
Artocarpus heterophyllus Lam.**	N	23	1	22	4,35	0,00	4,35	0,00
Cordia myxa L.**	E	24	1	23	4,17	0,00	0,00	4,17
Magonia pubescens A. St.-Hil.	N*	24	1	23	4,17	4,17	0,00	0,00
Leucaena lanceolata S. Watson	E	29	1	28	3,45	3,45	0,00	0,00
Handroanthus impetiginosus (Mart. ex DC.) Mattos	N*	238	7	231	2,94	2,10	0,84	0,00
Cordia glabrata (Mart.) A.DC.	N*	96	2	94	2,08	1,04	1,04	0,00
Albizia lebbeck (L.) Benth.	E	49	1	48	2,04	2,04	0,00	0,00
Jacaranda cuspidifolia Mart.	N*	276	5	271	1,81	1,45	0,00	0,36
Hevea brasiliensis (Willd. ex A. Juss.) Müll. Arg.	N	67	1	66	1,49	1,49	0,00	0,00
Swietenia macrophylla King	N*	100	1	99	1,00	1,00	0,00	0,00
Astronium fraxinifolium Schott	N*	134	1	133	0,75	0,00	0,75	0,00
Cariniana rubra Gardner ex Miers	N*	163	1	162	0,61	0,00	0,61	0,00
Licania tomentosa (Benth.) Fritsch	N	375	2	373	0,53	0,53	0,00	0,00
Mangifera indica L.	E	328	1	327	0,30	0,00	0,30	0,00
Total		2478	83	2395		72,29	16,87	10,84

* Origin (Or.): Native to Brazil (N), Exotic (E). Natural occurrence in the Cerrado phytogeographic domain (*); TN = total number of tree individuals per species; TNW = total number without hemiparasite; TNH = total number with incidence of hemiparasite; H (%) = percentage of infestation by tree species. **Specialized tree species: the only ones found with the hemiparasite.
** Origem (Or.): Nativa do Brasil (N), Exótica (E). Ocorrência natural no domínio fitogeográfico do Cerrado (*); TN = número total de indivíduos arbóreos por espécie; TNW = número total sem hemiparasito; TNH = número total com incidência de hemiparasito; H (%) = percentual de infestação por espécie arbórea; **Espécie arbórea especialista: as únicas encontradas com o hemiparasito.*

29.3%, and *Acrocomia aculeata*, 15.0%, which stood out due to hemiparasite infestation of around 1%.

The non-hosts were *Caryocar villosum*, *Caryocar brasiliense*, *Murraya paniculata* (L.) Jack, *Alibertia edulis*, *Rubiaceae*, *Spondias dulcis* Parkinson, *Tapirira guianensis* Aubl., *Zanthoxylum rhoifolium* Lam., *Morinda citrifolia* L., *Citrus* sp. L., *Copernicia alba* Moron., *Pouteria ramiflora* (Mart.) Radlk., *Spondias mombin* L., *Cybistax antisyphilitica* (Mart.) Mart., *Moringa oleífera* Lam., *Pouteria caimito* (Ruiz & Pav.) Radlk., *Handroanthus ochraceus* (Cham.) Mattos, *Spathodea campanulata* P. Beauv., *Bertholletia excelsa*, *Attalea phalerata* March. Ex Spreng. and *Copernicia prunifera* (Mill.) H.E. Moore.

The highlight is that in 14.2% of individuals the seeds of the hemiparasite *Psittacanthus* germinated, as the cotyledons expanded, but they were necrotic and dead. Although the mean number of expanded and dead cotyledons is 22.93%, there is only one individual of *Bertholletia excelsa* with 100%, while *Caryocar villosum* and *Caryocar brasiliense* were the only ones present in the fourth quartile. Of the ten species with expanded and dead cotyledons, seven were below the median (Table 4).

Table 3 – Incidence and absence of *Phoradrendon* sp in number (N), percentage of infestation (H) and respective percentages of distribution by degree of infestation by host species in the afforestation of UFMT, *campus* Cuiabá.
Tabela 3 *– Incidência e ausência de* ***Phoradrendon*** *sp. em número (N), percentual de infestação (H) e respectivos percentuais de distribuição por grau de infestação por espécie hospedeira na arborização da UFMT,* ***campus*** *Cuiabá.*

***Phoradrendron* sp.**	**Or.**	**TN**	**TNH**	**TNW**	**H(%)**	**Degree of infestation (%)**		
						Low	**Average**	**High**
Bauhinia sp L. 1**	N*	1	1	0	100,00	100,00	0,00	0,00
Eugenia jambolana Lam	E	7	2	5	28,57	28,57	0,00	0,00
Bauhinia variegata L.**	N*	5	1	4	20,00	20,00	0,00	0,00
Terminalia catappa L.	E	12	2	10	16,67	8,33	8,33	0,00
Simarouba versicolor A. St.-Hil.	N*	15	2	13	13,33	6,67	6,67	0,00
Senna siamea (Lam.) H.S. Irwin & Barneby	N*	33	4	29	12,12	6,06	3,03	3,03
Malpighiae marginata	N	9	1	8	11,11	0,00	0,00	11,11
Tectona grandis L. f.	E	9	1	8	11,11	11,11	0,00	0,00
Eucalyptus sp. Mill	E	11	1	10	9,09	9,09	0,00	0,00
Magonia pubescens A. St.-Hil	N*	24	2	22	8,33	0,00	8,33	0,00
Eucalyptus sp 1 Mill	E	13	1	12	7,69	7,69	0,00	0,00
Handroanthus heptaphyllus (Vell.) Mattos	N*	15	1	14	6,67	6,67	0,00	0,00
Handroanthus avellanedae (Lorentz ex Griseb.) Mattos	N	53	3	50	5,66	5,66	0,00	0,00
Anadenanthera peregrina (L.) Ex.	N*	200	11	189	5,5	3,50	1,00	1,00
Tamarindus indica L.	E	21	1	20	4,76	4,76	0,00	0,00
Handroanthus serratifolius (Vahl) S.O. Grose	N*	27	1	26	3,70	3,70	0,00	0,00
Anadenanthera peregrina var. falcata (Benth.) Altschul	N*	34	1	33	2,94	0,00	2,94	0,00
Guazuma ulmifolia Lam.	N*	42	1	41	2,38	2,38	0,00	0,00
Handroanthus aureus Mattos	N*	42	1	41	2,38	2,38	0,00	0,00
Inga laurina (Sw.) Wild	N*	47	1	46	2,13	0,00	2,13	0,00
Handroanthus impetiginosus (Mart. ex DC.) Mattos	N*	238	5	233	2,10	2,10	0,00	0,00
Albizia lebbeck (L.) Benth.	E	49	1	48	2,04	0,00	2,04	0,00
Swietenia macrophylla King	N*	100	2	98	2,00	2,00	0,00	0,00
Mangifera indica L.	E	328	6	322	1,83	0,91	0,61	0,30
Samanea tubulosa (Benth.) Barneby & J.W. Grimes	N*	58	1	57	1,72	1,72	0,00	0,00
Cecropia pachystachya Trécul	N*	59	1	58	1,69	0,00	0,00	1,69
Jacaranda cuspidifolia Mart.	N*	276	1	275	0,36	0,00	0,00	0,36
Total		1728	56	1672		66,07	21,43	12,50

* Origin (Or.): Native to Brazil (N), Exotic (E). Natural occurrence in the Cerrado phytogeographic domain (*); TN = total number of tree individuals per species; TNW = total number without hemiparasite; TNH = total number with incidence of hemiparasite; H (%) = percentage of infestation by tree species. **Specialized tree species: the only ones found with the hemiparasite.
** Origem (Or.): Nativa do Brasil (N), Exótica (E). Ocorrência natural no domínio fitogeográfico do Cerrado (*); TN = número total de indivíduos arbóreos por espécie; TNW = número total sem hemiparasito; TNH = número total com incidência de hemiparasito; H (%) = percentual de infestação por espécie arbórea; **Espécie arbórea especialista: as únicas encontradas com o hemiparasito.*

The species *Genipa americana*, *Cariniana rubra* and *Acrocomia*, without the incidence of hemiparasites, they presented a greater abundance of specimens. However, the average number of dead cotyledons per host was 5.3%. In specimens of the Rutaceae family, there was no record of the hemiparasite or its dead cotyledons, likewise the species *Attalea phalerata*, *Copernicia alba*, *Copernicia prunifera*, *Moringa citrifolia* and *Moringa oleífera*.

Of 61 individuals from *Anacardium occidentale*, six had dead cotyledons with the presence of gummosis at the site of penetration of the hemiparasite's haustorium (Figure 1) and in the remaining 55, dead cotyledons and hemiparasites were not observed.

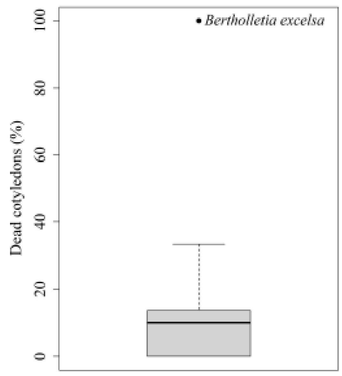
4. DISCUSSION

Pazini et al. (2020) observed in the UFMT floristic composition 48 tree families, greater frequency of Fabaceae (24.2%), Malvaceae (7.9%), Myrtaceae (6.8%) and Bignoniaceae (5.8%), with 72.6% autochthonous species, 23.7% allochthonous species and 3.7% were not identified. These families are among the ten with the highest incidence of hemiparasites, but of the most abundant hosts, *Anadenanthera peregrina*, *Handroanthus impetiginosus*, and *Mangifera indica* infestation rates of 55.0%, 19.7% and 12.5%, respectively.

Thus, hemiparasites are plants that occupy a habitat with a distinct spatial structure (Overton,

Table 4 – Number of specimens per species with germinated hemiparasite seeds and dead cotyledons associated with the boxplot of the number of dead cotyledons, in the afforestation of UFMT, *campus* Cuiabá.
Tabela 4 *– Número de espécimes por espécie com sementes do hemiparasito germinadas e com os cotilédones mortos associado ao box-plot da quantidade de cotilédones mortos, na arborização da UFMT,* ***campus*** *Cuiabá.*

Species	TNs	NsDC	DC (%)	TNDC	MDCs
Bertholletia excelsa Bonpl	1	1	100,0	3	3.0
Caryocar villosum (Aubl.) Pers.	3	1	33,3	2	2.0
Caryocar brasiliense A. St.-Hil	27	8	29,6	43	5.4
Genipa americana L.	162	24	14,8	113	4.7
Rubiaceae sp. Law.	8	1	12,5	1	1.0
Alibertia edulis (Rich.) A. A.Rich. ex DC.	9	1	11,1	5	5.0
Cariniana rubra Gardner ex Miers	163	17	10,4	57	3.4
Anacardium occidentale L.	61	6	9,8	45	7.5
Curatella americana L.	61	4	6,6	24	6.0
Acrocomia aculeata (Jack.) Lottery. ex March.	83	1	1,2	15	15.0
Average	57.8	6.4	22,93	30,8	5.3



TNs = total number of specimens per species; NsDC = number of specimens with dead cotyledons; DC (%) = percentage of specimens with dead cotyledons; TNDC = total number of dead cotyledons per species; MDCs = mean number of dead cotyledons per specimen according to NsDC.
TNs = número total de espécimes por espécie; NsDC = número de espécimes com cotilédones mortos; DC (%) = porcentagem de espécimes com cotilédones mortos; TNDC = número total de cotilédones mortos por espécie; MDCs = média de cotilédones mortos por espécime de acordo com a NsDC.

1994). The author mentions that this habitat is composed of hosts that are colonized trees; non-host trees that are not colonized; and an inhospitable matrix that is the area between the trees. Thus, the monitoring of hemiparasites is facilitated, which allows the measurement of colonization, recolonization and extinction. Therefore, the classic metapopulational dynamics is characterized between colonization and extinction rates of hemiparasites (Arruda et al., 2012), as observed in (Figure 1).

The infestation recorded in this research was lower than that found by Coelho et al. (2020) in São Joaquim-SC (38.1%) and in Urubici-SC (21.2%), and higher than in Urupema-SC (1.0%), however, the authors did not identify the hemiparasites. Leal et al. (2006) found 28.19% with *Tripodanthus* sp. and *Struthanthus* sp. in Curitiba-PR, while White et al. (2011) 8.15% with *Struthanthus* sp. in São Cristóvão SE.

Differences in results may be associated with the greater or lesser presence of fruit trees, the intensity of flow of ornithological fauna and the application or not of eradicating pruning in the analyzed areas. However, in Macapá-AP, Soares et al. (2021), detected an average of 12.42% with hemiparasitism, mostly in the Anacardiaceae family. Similar result to the present study, where hosts from the same family, among others, also suffered greater infestation.

The low infestation of hemiparasites, from an ecological point of view, contributes to the supply of food for the local fauna without harming the host plant. Meanwhile, the lowest percentage of trees with medium and high degrees of infestation would require greater urban monitoring for the control of hemiparasites. Pazini et al. (2020) state that afforestation of the *campus* of the UFMT in Cuiabá is rich, with great diversity of species with ideal proportions of native Brazilian species. Corroborating with Silva and Fadini (2017), who claim that population diversity with native species can reduce the infestation of hemiparasites and costs with urban afforestation.

A 26.7% infestation of native and exotic trees was recorded in the *campus* from Aquidauana of the Federal University of Mato Grosso do Sul, by hemiparasite of the genus *Psittacanthus* (Gabriel et al. 2021). Still, the authors recorded the greatest specificity with native species, with emphasis on *Inga laurina*, *Jacaranda cuspidifolia*, and *Sapium haematospermum* Mull. Arg. In the present study *Psittacanthus* had a greater number of hosts compared to the others (Tables 1, 2 and 3).

Pazini et al. (2020) highlighted the most frequent species: *Licania tomentosa* (8.9%) *Mangifera indica* (7.8%), *Jacaranda cuspidifolia* (6.3%), *Handroanthus impetiginosus*, (5.4%), and *Anadenanthera peregrina* (4.4%). In the most frequent species, belonging to six families, an infestation greater than 50% was recorded, with emphasis on *Terminalia catappa*, *Combretaceae*, from *Anadenanthera peregrina*, Fabaceae, and *Pouteria gardneri*, Sapotaceae.

Pouteria gardneri presented only *Psithacanthus*, already *Terminalia catappa* and *Anadenanthera peregrina* were infested by the three hemiparasites. Plant parasites can be considered keystone species, and their impacts are dictated by the host range of the parasite and by its preference and selection of particular host species (Press and Phoenix, 2005). The authors reinforce that they can change the physical environment around them and, therefore, can be considered as ecosystem engineers, which can modify the supply of resources and behavior of other organisms, within communities of parasitic plants.

Phytopathogenic microorganisms access the host, by direct penetration, natural openings or injuries, and if the reaction is not efficient, tissue colonization will occur, necessary for the pathogens to remove the nutrients stored in the form of carbohydrates in the host tissues, for their growth and reproduction. For this purpose, the pathogen uses substances such as enzymes, toxins and hormones (Pascholati et al., 1998; Pascholati and Dalio, 2011a), in addition to genes, whose mechanisms are important to prevent the activation of the plant's defense system (Medeiros et al., 2003).

Usually, hosts with greater hemiparasite intensity in an ecological niche are competitive dominants. In this case, parasitism will facilitate the maintenance of competitively subordinate species (Press and Phoenix, 2005). In addition, the leaves of hemiparasites are rich in nutrients, and their deposition along the litter provides an increase in soil fertility (Mellado et al., 2016).

In urban afforestation, management for plant fertilization is more complex, therefore, the low-grade incidence of these hemiparasites adds the *campus*. Given that, hemiparasites can also alter the spatial and temporal distribution of nutrient cycling while increasing the amount of nutrients available to host plants (Arruda et al., 2012). These authors point out that in nutrient-poor ecosystems, such as tropical grasslands and savannas, their presence was considered of great importance. According to Ndagurwa et al. (2018), the soils under hemiparasite hosts showed higher levels of silt, organic matter, sodium, potassium, magnesium and nitrate.

Pruning branches with hemiparasite infestation is recommended when the incidence in the crown is greater than 50%, or replacing the individual with autochthonous species with greater resistance (Coelho et al., 2020). However, individuals with an infestation greater than 30% may have a developmental deficit and reduced vigor. When there is no removal of hemiparasites, such as *Psittacanthus* spp. and *Struthanthus* spp., there may be crown covering, affecting the photosynthesis of the host tree (Caldeira, 2013).

Although some hemiparasite species are harmful agents to plants, most do not affect economically valuable crops and forest products, but play key roles in forest ecosystems (Mathiasen et al., 2008). The spatial distribution of hosts and the high incidence of light in isolated host trees can lead to high prevalence in urban areas (Maruyama et al., 2012). The authors argue that the eradication of hemiparasites in urban areas should be replaced by ecological management, their importance for the conservation of bird species should be considered and studies should be carried out to determine which bird species are favored by hemiparasites in these regions.

The specificities of the hemiparasites regarding their host are highlighted in the results found. Some hemiparasites have a greater number of hosts in different tree families, while others manage to parasitize only one host species (Mathiasen et al., 2008). In addition, the authors point out that some hemiparasites have host specificity, and some of them are prone to parasitize other hemiparasites.

Generally, non-host species have prominent spines, thorns or the presence of lenticels on stems, leaves and/or fruits. Especially in some species of the Caryocaceae, Rutaceae, Rubiaceae, Lecythidaceae and Arecaceae (Table 4). It is believed that such structures make it difficult for birds to land and reduce the dispersion of the hemiparasite. In addition to the angle of the branches, roughness and thickness of the host bark, which are important characteristics to determine the frequency of distribution of hemiparasites in the host, do not interfere with its diversity (Fadini 2011; Wagner et al., 2015). In addition, by choosing tree species with these characteristics, it can be a way to avoid hemiparasites in urban afforestation.

In species that did not show developed hemiparasites and dead cotyledons (Table 4), such as *Genipa americana*, *Cariniana rubra* and *Acrocomia aculeata*, it was initially interpreted as a reaction to the hemiparasite. According to Király et al. (2007), for pathogenic microorganisms, the hypersensitivity reaction is shown to be an extreme cellular response on the part of the plant, which can cause the high degree of resistance to the pathogen, however, no information was found that can associate this fact with the absence of hemiparasites.

Thus, the presence of dead cotyledons is an indication of the frequency of avifauna in these hosts, and the non-infestation of hemiparasites. The bird lands and the deposition of the hemiparasite seed occurs, the seed swells with water absorption, the cotyledons expand, but the seed necroses and dies. In a study with germination of hemiparasite seeds, it was not possible to observe the effect of tree species, whether host or non-host (Maruyama et al., 2012). However, the authors observed that the radicle of the germinated seeds did not manage to penetrate the bark and the seedlings invariably died in the non-host species. According to Pascholati and Dalio (2011b), some trees have the ability to delay or prevent the entry and development of a foreign body in their tissues.

Plants can defend themselves against phytopathogens either passively or actively, and their resistance mechanisms can be subdivided into two categories: pre-formed and post-formed. In the first case, the plant resists through existing mechanisms, such as the cuticle, which works as a structural barrier, and toxic substances. If, even so, the phytopathogenic agent overcomes the surface structures of the host, it continues to defend itself with new structural barriers, with the formation of halos and lignification around the penetration site (Pascholati and Dalio, 2011b).

These authors also report the biochemical resistance of the host, with phytoanticipins being examples of pre-formed substances, and can be converted into extremely toxic substances, while phytoalexins are post-formed substances in response to the presence of the pathogen. In addition to morphological mechanisms related to the non-infestation of the hemiparasite, the possibility of reaction mechanisms should be studied in relation to the origin of the process, with anatomical studies, as well as the chemical constituents of these substances, similarly to what is understood for the diseases caused by phytopathogens. Gummosis is often produced by plants as a protection mechanism when their cortex is attacked (Andrade et al., 2013), observed in *Anacardium occidentale* (Figure 1).

The fact that individuals of the same species present different behaviors in relation to hemiparasite infestation may be related to the characteristics of the specimen and not the species. Similar to disease resistance, whose expression is not morphological but physiological, and behaves as a variable characteristic in the population and specific in some individuals.

The subject lacks studies and, once the individual characteristic is proven, the vegetative multiplication of individuals that are not infested by the hemiparasite is possible. These will be able to compose the vegetation with other individuals of seminal origin and that, as hosts of the hemiparasite, will exercise the function of offering this source of food to the ornithological fauna.

5. CONCLUSIONS

The presence of hemiparasites varies between tree species and between individuals of the same species. In some individuals there is the presence of fauna, the deposition of dispersion units of the hemiparasite without vegetative development. These individuals have potential for the natural control of the infestation and for researches that clarify the morphological or physiological process involved. In the afforestation of UFMT, *campus* Cuiabá, the intensity and general degree of infestation by hemiparasites are low and variable for the genders *Struthanthus*, *Phoradendron* and *Psittacanthus* and contributes to the availability of food for the frugivorous ornithological fauna in the urban area.

AUTHOR CONTRIBUTIONS

Theonizi Angélica Silva Albuês designed the research Project, wrote the paper obtained and discussed the statistical, experimental, and estimated data. Daiane de Moura Borges Maria and João Paulo Sardo Madi wrote the paper and supported the data analysis. Kamila Daiany Terres da Silva supported the data analysis and the obtaining of experimental results. Sidney Fernando Caldeira obtained the experimental results and supported the writing of the paper and statistical procedures.

6. REFERENCES

Andrade K, de Carvalho CW, Takeiti CY. Goma de cajueiro (*Anacardium occidentale*): avaliação das modificações químicas e físicas por extrusão termoplástica. Polímeros 2013; 23(5):667-671. doi: http://dx.doi.org/10.4322/polimeros.2013.004

Arruda R, Fadini RF, Carvalho LN, Del-Claro K, Mourão FA, Jacobi CM, et al. Ecology of neotropical mistletoes: an important e canopy-dwelling component of Brazilian ecosystems. Acta Botanica Brasilica [Internet]. 2012; 26(2): 264-274. Available: https://www.scielo.br/j/abb/a/NvnG8q9XRN9tD3Lqkcz4xFy/?format=pdf&lang=en.

Caldeira SF. Doenças abióticas e bióticas da Teca no Brasil. In: Patologia Florestal: Desafios e Perspectivas. São Carlos, Brasil: Suprema Gráfica e Editora, 2013.

Coelho CC, Vitorino MD, Rode BJG, Boschetti AC, Silva PAGDA, Fenilli TAB, et al. Análise Estrutural E Espacial Do Componente Arbóreo Como Elemento De Paisagem Turística. MIX Sustentável. 2020; 7(1): 159-170. doi: http://dx.doi.org/10.29183/2447-3073.MIX2020.v7.n1.159-170

Fadini R. Non-overlap of hosts used by three congeneric and sympatric loranthaceo us mistletoe species in Amazonian savanna: host generalization to extreme specialization. Acta Botanica Brasilica. 2011; 25(2): 337-345. doi: 10.1590/S0102-33062011000200010.

Finger Z. Fitossociologia Florestal. 1ª Ed. Cuiabá: Departamento de Engenharia Florestal, Universidade Federal de Mato Grosso, 2011. 242 p.

Gabriel AL, Coene AC, dos Santos CC, Cozer MS, Aoki C. Existe especificidade de hospedeiros por Psittacanthus acinarius (Loranthaceae) em área verde urbana? Revista Geociências. 2021; 20(2). doi: 10.33947/1981-741X-v20n2-4830.

García D, Rodríguez-Cabal MA, Amico GC (2009). Seed dispersal by a frugivorous marsupial shapes the spatial scale of a mistletoe population. Journal of Ecology 2009; 97(2): 217-229. doi: 10.1111/j.1365-2745.2008.01470.x.

Griebel A, Watson D, Pendall E. Mistletoe, friend and foe: synthesizing ecosystem implications of mistletoe infection. Environ. Res. Lett. 12.2017. 115012. doi: https://doi.org/10.1088/1748-9326/aa8fff.

Kiraly L, Barna B, Király, Z. Resistência de plantas à infecção por patógenos: formas e mecanismos de resistência inata e adquirida. Journal of Phytopathology. 2007; 155(7-8): 385-396. doi: https://doi.org/10.1111/j.1439-0434.2007.01264.x.

Leal L, Bujokas WM, Biondi D. Análise da infestação de erva-de-passarinho na arborização de ruas de Curitiba, PR. Floresta [Internet]. 2006; 36(3). Available: https://revistas.ufpr.br/floresta/article/viewFile/7512/5373.

Martins LFV, Andrade HHBDE, Angelis BLDDE. Relação entre podas e aspectos fitossanitários em árvores urbanas na cidade de Luiziana, Paraná. Revista da Sociedade Brasileira de Arborização Urbana. 2010; 5(4): 141–155. doi: http://dx.doi.org/10.5380/revsbau.v5i4.66324.

Maruyama PK, Mendes-Rodrigues C, Silva EA, Cunha AF. Parasites in the neighbourhood: Interactions of the mistletoe *Phoradendron affine* (Viscaceae) with its dispersers and hosts in urban areas of Brazil. Flora-Morphology, Distribution, Functional Ecology of Plants. 2012; 207(10): 768-773. doi: 10.1016/j.flora.2012.08.004.

Mathiasen RL, Nickrent DL, Shaw DC, Watson DM. Viscos: patologia, sistemática, ecologia e manejo. Plant disease [Internet]. 2008. 92(7): 988-1006. Available: https://doi.org/10.1094/PDIS-92-7-0988

Medeiros RB, Ferreira MASV, Dianese JC. Mecanismos de agressão e defesa nas interações planta-patógeno. Brasília: Editora Universidade de Brasília, 2003. ISBN-10: 8523007628.

Mellado A, Morillas L, Gallardo A, Zamora R. Temporal dynamic of parasite-mediated linkages between the Forest canopy and soil processes and the microbial community. New Phytol. 2016; 211: 1382–92. doi: 10.1111/nph.13984.

Ndagurwa HGT, Maponga TS, Dube B, Nzuma TM, Muvengwi. Termitariavc. mistletoe: effects on soil properties and plant structure in a semi-arid savanna. Acta Oecologica [Internet]. 2018: 35-42. Available: https://doi.org/10.1016/j.actao.2018.06.002.

Overton JM. Dispersal and infection in mistletoe metapopulations. Journal of Ecology [Internet]. 1994; 82: 711. British Ecological Society. Available: https://www.jstor.org/stable/2261437.

Pascholati SF, Leite B, Krf S. Mecanismos de patogenicidade em fungos. Revisão Anual de Fitopatologia de Plantas.1998; 6:1-47.

Pascholati SF, Dalio RJD. Fisiologia do parasitismo: como os patógenos atacam as plantas. Manual de fitopatologia: princípios e conceitos. 2011a; 4:543-589.

Pascholati SF, Dalio RJD. Fisiologia do parasitismo: como as plantas se defendem dos patógenos. Manual de fitopatologia. 2011b; 1: 593-636.

Pazini PPP, Martinez DT, Caldeira SF, Silva RA, Antonieto FA. Green Area in Urban Cuiabá: The Case of the Universidade Federal do Mato Grosso. Floresta e Ambiente. 2020; 27(4). doi: https://doi.org/10.1590/2179-8087.015418.

Press MC, Phoenix GK. Impactos de plantas parasitas em comunidades naturais. Novo fitologista. 2005; 166 (3): 737-751. doi: https://doi.org/10.1111/j.1469-8137.2005.01358.xCi.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing [Internet], Vienna, Austria. Available: https://www.R-project.org/.

Ramalho, RS. Dendrologia. Terminologia. 1º Vol. Viçosa: UFV, 1976. 123p.

Rotta, E. Erva-de-passarinho (Loranthaceae) na arborização urbana: passeio público de Curitiba, um estudo de caso [tese]. Curitiba: Setor de Ciências Agrárias, Universidade Federal do Paraná; 2001.

Rotta E, Araujo AJDE, Oliveira YMMDE. A Infestação da Vegetação Arbórea do Passeio Público de Curitiba, Paraná, por Erva-de-Passarinho: Um Estudo de Caso. Embrapa Florestas [Internet]. 2006; 26. Available: http://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/284775.

Samek V. Elementos de silvicultura de los bosques latifolios. La Habana: Instituto Cubano del Libro, 1974. 291 p.

Silva FP, Fadini RF. Observational and experimental evaluation of hemiparasite resistance in trees in urban afforestation of Santarém, Pará, Brazil. Acta Amazonica. 2017; 47(4), 311-320. doi: https://doi.org/10.1590/1809-4392201700033.

Silva Filho DF, Pizetta PUC, Almeida JBSA, Pivetta KFL, Ferraudo AS. Banco de dados relacional para cadastro, avaliação e manejo da arborização em vias públicas. Revista Árvore. 2002; 26(5): 629-642. doi: https://doi.org/10.1590/S0100-67622002000500014.

Soares ACS et al. Hemiparasitos e suas relações com a arborização urbana no Município de Macapá, Amapá, Brasil. Research, Society and Development. 2021; 10(13). doi: http://dx.doi.org/10.33448/rsd-v10i13.21240.

Souza APDE. et al. Classificação climática e balanço hídrico climatológico no Estado de Mato Grosso. Nativa. 2013; 1(1): 34-43. doi: 10.31413/nativa.v1i1.1334.

Tainter, FH. What does mistletoes have to do with Christmas? Feature Story. St. Paul: The American Phytopathological Society [Internet]. 2002. Available: https://www.apsnet.org/edcenter/apsnetfeatures/Pages/Mistletoe.aspx.

Wagner K, Mendieta-Leiva G, Zotz G. Host specificity in vascular epiphytes: a review of methodology, empirical evidence and potential mechanisms. AoBPlants [Internet]. 2015. Available: https://www.researchgate.net/publication/270565939.

White BLA, Ribeiro ADES, White, LAS, Nascimento Júnior JEDO. Análise da ocorrência de erva-de-passarinho na arborização da Universidade Federal de Sergipe, campus São Cristóvão. Floresta. 2011; 41(1): 1-8. doi: http://dx.doi.org/10.5380/rf.v41i1.21174