An Acad Bras Cienc (2023) 95(4): e20191091 DOI 10.1590/0001-3765202320191091
Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

ECOSYSTEMS

Insect galls of Atlantic Forest areas of Serra da Bodoquena (MS, Midwestern Brazil)

SHARLENE ASCENDINO & VALÉRIA CID MAIA

Abstract: An inventory of insect galls of Serra da Bodoquena (MS, Midwestern Brazil) was carried out in an area of semideciduous seasonal forest situated in the Califórnia Farm. Three field works were done in August/2011, December/2011 and April/2012, when the local vegetation was examined during 40 hours per expedition. Fifty-eight gall morphotypes were found on 40 host plants, 38 of them native. The host plants are distributed in 18 families. The native plants include eight endemic species in Brazil, which together totaled 14 gall morphotypes. *Zanthoxylum* L. sp. (Rutaceae), an endemic genus in Brazil, hosts one gall morphotype. The non endemic native plants totaled 26 gall morphotypes. Ten new host plants are recorded for the first time in Brazil. The medium number of gall morphotypes per plant species was 1.45. Salicaceae, Bignoniaceae, and Asteraceae presented the highest number of galled species and the greatest gall richness. Leaves were the most frequent galled plant organ and there was a predominance of globoid galls. Diptera (Cecidomyiidae) were the most frequent gallers, but Hemipteran and Thysanopteran galls were also found. The associated fauna was composed of inquilines (Diptera: Muscomorpha and Cecidomyiidae - *Trotteria* sp., and Thysanoptera), successors (Psocoptera), and parasitoids (Hymenoptera).

Key words: Host plants, gall richness, morphological characterization, semideciduous seasonal forest.

INTRODUCTION

Several inventories of insect galls have been developed in Atlantic forest areas of Brazil, mainly in the State of Rio de Janeiro (see Monteiro et al. 1994, Maia 2001, Oliveira & Maia 2005, Maia & Oliveira 2010, Maia & Souza 2013, Rodrigues et al. 2014, Maia & Carvalho-Fernandes 2016, Carvalho-Fernandes et al. 2016, Maia & Silva 2016, Flor et al. 2018) and less frequently in the states of Pernambuco (see Carvalho-Fernandes et al. 2009, Santos et al. 2011a, 2012a), Espírito Santo (see Bregonci et al. 2010, Maia et al. 2014), Minas Gerais (see Fernandes et al. 2001, Fernandes & Negreiros 2006, Coelho et al. 2013, Maia 2013, 2014), Mato Grosso do Sul (see Ascendino & Maia 2018, Urso-Guimarães et al. 2017), São Paulo (see Lima et al. 2000, Maia et al. 2008), Paraná (see Carvalho et al. 2015), and Rio Grande do Sul (see Toma & Mendonça 2013, Mendonça et al. 2014, Goetz et al. 2018).

Among all phytophysiognomies of this domain, restinga is the most investigated. Few data on semideciduous seasonal forest have been published, being found in seven studies (Ansaloni et al. 2018, Carvalho et al. 2015, Flor et al. 2018, Goetz et al. 2018, Maia & Carvalho-Fernandes 2016, Santos & Ribeiro 2015 and Urso-Guimarães et al. 2017). Consequently, the galling insect fauna remains little known.

The present inventory aims to contribute to the knowledge of the host plants, insect galls and associated fauna of a semideciduous seasonal forest situated in Mato Grosso do Sul.

MATERIALS AND METHODS

This study was carried out in an area of semideciduous seasonal forest situated in the Califórnia Farm (S 20° 41' 55.9''; W 056° 52' 49.4''), Serra da Bodoquena, municipality of Bodoquena, State of Mato Grosso do Sul, Midwestern Brazil.

Three field works were done, the first in August/2011 (dry season), the second in December/2011 (rainy season) and the third in April/2012 (dry season). The authors adopted the walking methodology (Oliveira & Maia 2005, Coelho et al. 2009). The local vegetation was examined for insect galls during two consecutive days in each expedition, totaling 40 hours of field works.

Three trails were investigated: cave California trail in August/2011, December/2011 and April/2012 (S 20°42'23''; W 56°51'08''), cave Beija-Flor trail and August/2011 and April/2012 (S 20°41'10''; W 56°51'82'') and a trail near the headquarters of the farm in August/2011, December/2011 and April/2012 (S 20°42'04.04''; W 56°52'51.6''), all inserted in riparian forest areas.

Samples of all host plants were collected and separated into morphospecies (each one received a number of reference). After that each morphospecies was labeled, photographed, stored in plastic bag and transported to the laboratory.

Galls were also collected, separated into morphotypes based on external features (galled organ, shape, color, and indumentum), labeled (with the following information: locality, date, collectors` name, number of the plant morphospecies, galled plant organ, and shape) and photographed. Each morphotype was stored individually in plastic bags and transported.

In the laboratory, each plant morphospecies was herborised in order to be identified by Dr. Gracilada Ferreira and Manoel dos Reis Cordeiro (Universidade Federal Rural da Amazonia). Some samples of each gall morphotype was dissected to count the number of internal chamber, observe the habit of the dwellers, determine which one is the inducer, and obtain immature specimens. Other samples were kept individually in labeled plastic pots until the insects' emergence or the gall putrefaction. These rearing pots were examined daily. Whenever emergence was observed, the pots with adults were taken to a refrigerator and kept there for some minutes until the insect lethargy. Then, the specimens were captured using a brush soaked in 70% alcohol, identified at order or family and stored in labeled microvials containing 70% alcohol.

The gall midges (Diptera, Cecidomyiidae) were later mounted on slides, following the methodology outlined in Gagné 1994, and then identified in genus based on Gagné' keys (Gagné 1994) and in species based on host plant species, gall morphology and original description. Parasitoids were identified at family level by Dra. Maria Antonieta Pereira de Azevedo.

The insects were deposited in the Entomological Collection of the Museu Nacional/UFRJ (MNRJ) and the exsiccates in the Universidade Federal Rural da Amazonia (UFRA, Pará).

Data on plants distribution, origin, endemism and conservational status were retrieved from Flora do Brasil 2020. The following abbreviations for conservational status were adopted: NE – not evaluated, LC – less concerning.

To compare our results with those from other studies in the same phytophysiognomy (Ansaloni et al. 2018 in São Paulo, Flor et al. 2018 in Rio de Janeiro, Goetz et al. 2018 in Rio Grande do Sul, Urso-Guimarães et al. 2017 in Mato Grosso do Sul and Santos & Ribeiro 2015 in Paraná), we adopted the Sørensen's similarity index (S= 2c/a+b) (Sørensen 1948). For this, we used only plants identified at species level.

RESULTS

Fifty-eight gall morphotypes were found on 40 host plants (21 identified in species, 18 in genus and one in family) (Table I). All plant genus and species are native, except *Citrus* sp. (Rutaceae), which is naturalized. There are no data on *Vernonia esculenta* Hemsl. (Asteraceae) origin. Besides, the endemism of *Ruellia* L. (Acanthaceae) is unknown. The host plants are distributed in 18 families. The native plants include eight endemic species in Brazil, *Aspidosperma discolor* A.DC (Apocynaceae), *Vernonanthura brasiliana* (L.) H. Rob (Asteraceae), *Adenocalymma allamandiflorum* (Bureau ex K.Schum.) L.G. Lohmann (Bignoniaceae), *Psychotria borjensis* Kunth (Rubiaceae), *Casearia decandra* Jacq. and *C. ulmifolia* Vahl ex Vent. (Salicaceae), *Paullinia racemosa* Wawra. (Sapindaceae), which together totaled 14 gall morphotypes. Furthermore, *Zanthoxylum* L. sp. (Rutaceae), an endemic genus in Brazil, hosts one gall morphotype. The non endemic native plants totaled 26 gall morphotypes. All host plant species were not evaluated for their conservational status, except *Salix humboldtiana* Willd. (Salicaceae) and *Paullinia racemosa*, both considered as less concerning.

Nine new host plants are recorded for the first time in Brazil: *Aspidosperma discolor*, *V. esculenta*, *A. allamandiflorum*, *Dalbergia foliosa* (Benth.) A. M. Carvalho (Fabaceae), *Eugenia patrisii* Vahl (Myrtaceae), *P. borjensis*, *Citrus* sp., *C. ulmifolia* and *S. humboldtiana*, all with a single gall morphotype, except the first and the last, with two.

The medium number of gall morphotypes per plant species was 1.45. Salicaceae, Bignoniaceae, and Asteraceae presented the highest number of galled species (seven, six and four, respectively) and the greatest gall richness (ten, seven and nine morphotypes, respectively) (Table I). The medium number of gall morphotypes per plant species differed among these families: 2.25 in Asteraceae, 1.43 in Salicaceae and 1.17 in Bignoniaceae.

Leaves were the most frequent galled plant organ, with 34 morphotypes, followed by stems with 19, bud with three, spines and tendril with one each (Table II). Twenty-one gall morphotypes were globoid, 18 fusiform, 10 lenticular, four conical, three marginal roll and two cylindrical (Table III).

Gallers of 31 morphotypes were determined. They included Diptera (responsible for 23 gall morphotypes, 22 of them induced by Cecidomyiidae and one by Tephritidae, Hemiptera (seven), and Thysanoptera (one) (Table IV). Among the gall midges, we identified *Clinodiplosis* sp. and Clinodiplosini sp. and among the Hemiptera, Psyllidae.

The associated fauna was composed of inquilines, successors, and parasitoids. The first guild included only Diptera (Muscomorpha and *Trotteria* sp.: (Cecidomyiidae)) and Thysanoptera, the second Psocoptera, and the third Hymenoptera. Among the last, two families were identified: Pteromalidae and Eulophidae. Other parasitoid records, presented at order level, were based on the larva or pupa presence.

The Sørensen's index showed low similarity of host plants between the present study and other previously published surveys: Bodoquena x São Paulo: 0.032, Bodoquena x Rio Grande do Sul: 0.031, both with only one species in common, *Celtis iguanaea* (Cannabaceae), and Bodoquena x Mato Grosso do Sul: 0,12 with three species plants in commom: *Vernonanthura brasiliana* (Asteraceae), *Celtis spinosa* (Cannabaceae) and *Casearia sylvestris* (Salicaceae). No similarity was found between Bodoquena x Rio de Janeiro and Bodoquena x Paraná, as no host plant was found in common to these localities. Concerning the galls, two morphotypes were shared between

Table I. Richness of insect galls per host plant in Serra da Bodoquena, Mato Grosso do Sul, Midwestern Brazil.

Host plant	Number of gall morphotypes (n=58)	
Family (n=19)	**Genus/ species (n=43)**	
Acanthaceae Juss.	*Ruellia* sp.	2
	Total	2
	Medium of gall morphotypes/family	2
Apocynaceae	*Aspidosperma discolor* A.DC	2
	Aspidospema pyricollum Müll.Arg.	1
	Aspidospema sp.	1
	Total	4
	Medium of gall morphotypes/family	1.33
Asteraceae	*Eupatorium* sp.	1
	Mikania sp.	1
	Vernonanthura brasiliana (L.) H. Rob	5
	Vernonia cf. *esculenta* Hemsl.	1
	Vernonia esculenta Hemsl.	1
	Total	9
	Medium of gall morphotypes/family	1.8
Bignoniaceae	*Anemopaegma* sp.	2
	Bignonia sp. 1	1
	Bignonia sp. 2	1
	Mansoa sp. 1	1
	Adenocalymma allamandiflorum (Bureau ex K.Schum.)	1
	Adenocalymma sp.	1
	Total	7
	Medium of gall morphotypes/family	1.17
Boraginaceae	*Cordia* sp.	1
	Total	1
	Medium of gall morphotypes/family	1
Cannabaceae	*Celtis* cf. *iguanaea* (Jacq.) Sarg.	3
	Celtis spinosa Spreng.	3
	Total	6
	Medium of gall morphotypes/family	3
Convolvulaceae	*Ipomoea* sp.	1
	Total	1
	Medium of gall morphotypes/family	1
Dilleniaceae	*Doliocarpus dentatus* Standtl.	1
	Total	1
	Medium of gall morphotypes/family	1
Fabaceae	*Abarema* sp.	1
	Dalbergia foliosa (Benth.) A.M.Carvalho	1
	Total	2
	Medium of gall morphotypes/family	1
Lauraceae	*Nectandra* sp.	1
	Total	1
	Medium of gall morphotypes/family	1
Meliaceae	*Guarea guidonia* (L.) Sleumer	1
	Total	1
	Medium of gall morphotypes/family	1
Moraceae	*Maclura tinctoria* (L.) D.Don ex Steud.	1
	Total	1
	Medium of gall morphotypes/family	1
Myrtaceae	*Eugenia patrisii* Vahl	1
	Total	1
	Medium of gall morphotypes/family	1
Rubiaceae	*Psychotria borjensis* Kunth	1
	Total	1
	Medium of gall morphotypes/family	1
Rutaceae	*Citrus* sp.	1
	Zanthoxylum sp.	1
	Undetermined	1
	Total	3
	Medium of gall morphotypes/family	1
Salicaceae	*Casearia aculeata* Jacq	2
	Casearia decandra Jacq.	2
	Casearia sylvestris Sw.	1
	Casearia ulmifolia Vahl ex Vent.	1
	Casearia sp. 1	1
	Casearia sp. 2	1
	Salix humboldtiana Willd.	2
	Total	10
	Medium of gall morphotypes/family	1.43
Sapindaceae	*Paullinia pinnata* L.	3
	Paullinia racemosa Wawra.	1
	Total	4
	Medium of gall morphotypes/family	2
Vochysiaceae	*Qualea parviflora* Mart	2
	Vochysia sp.	1
	Total	3
	Medium of gall morphotypes/family	1.5

Bodoquena x Rio Grande do Sul (S=0.032) and a single one between Bodoquena x Goiás, and between Bodoquena x Mato Grosso do Sul (S=0.015 and 0.023 respectively). No morphotypes in commom was observed between Bodoquena x Rio de Janeiro and Bodoquena x Paraná.

Data on gall morphotypes are presented below (Table V). They were arranged under host plant families, genera and species in alphabetical and included gall characterization (galled organ, gall shape, color, indumentum, number of internal chamber, galler), associated fauna (parasitoids, inquilines and successors), collection date and previous records of galls on the same plant species, genus or family in Brazil in chronological order). Data on plant genera and species origin and endemism were retrieved from Flora do Brasil 2020. The new records were indicated after the botanical taxa as well as the number of gall morphotypes in each host family and species (in brackets).

Acanthaceae Juss. (n=2)

Ruellia L. sp. (n=2)

Native plant genus, unknown endemism. Distribuition: Norte (Acre, Amazonas, Amapá, Pará, Rondônia, Tocantins), Nordeste (all states), Centro-Oeste (all states), Sudeste (all states), Sul (all states). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 01): on bud, conical, green, pubescent, one-chambered Galler: Cecidomyiidae (Diptera). Date: August/2011.

Gall (Fig. 02): on stem, fusiform, brown, glabrous, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Mendonça et al. 2014 on *Ruellia* sp. (RS), Maia & Mascarenhas 2017/RJ and MG, Silva et al. 2018a/BA.

Apocynaceae Juss. (n=4)

Aspidosperma discolor A.DC (n=2) (new record of host plant species)

Table II. Richness of insect galls per plant organ in Serra da Bodoquena, Mato Grosso do Sul, Midwestern Brazil.

Plant organ	Number of gall morphotypes (n=58)
Leaf	34
Stem	19
Bud	3
Spines	1
Tendril	1
Flower	0
Fruit	0

Endemic plant species. NE. Distribution: Northestern (Alagoas, Bahia). Biome: Caatinga.

Gall (Fig. 03): on leaf, lenticular, green, glabrous. Galler: Hemiptera. Date: April/2012.

Gall (Fig. 04): on leaf, conical, green, glabrous, one-chambered. Galler: Undetermined. Date: August/2011.

No previous records.

Aspidosperma pyricollum Müll.Arg. (n=1)

Native, non endemic plant species. NE. Distribution: Northestern (Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte), Midwest (Distrito Federal), Southestern (all states), Southern (Paraná, Santa Catarina). Biome: Atlantic forest.

Gall (Fig. 05): on leaf, lenticular, green, glabrous, one-chambered. Galler: Psyllidae (Hemiptera). Date: August/2011.

Previous records: Monteiro et al. 1994/RJ, Maia 2001/RJ, Maia & Oliveira 2010/RJ, Rodrigues et al. 2014/RJ, Maia & Silva 2016/RJ.

Aspidosperma Mart. and Zucc. sp. (n=1)

Native, non endemic plant genus. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest.

Gall (Fig. 06): on leaf, cylindrical abaxially and lenticular adaxially, green, glabrous, one-chambered. Galler: Hemiptera. Date: December/2011.

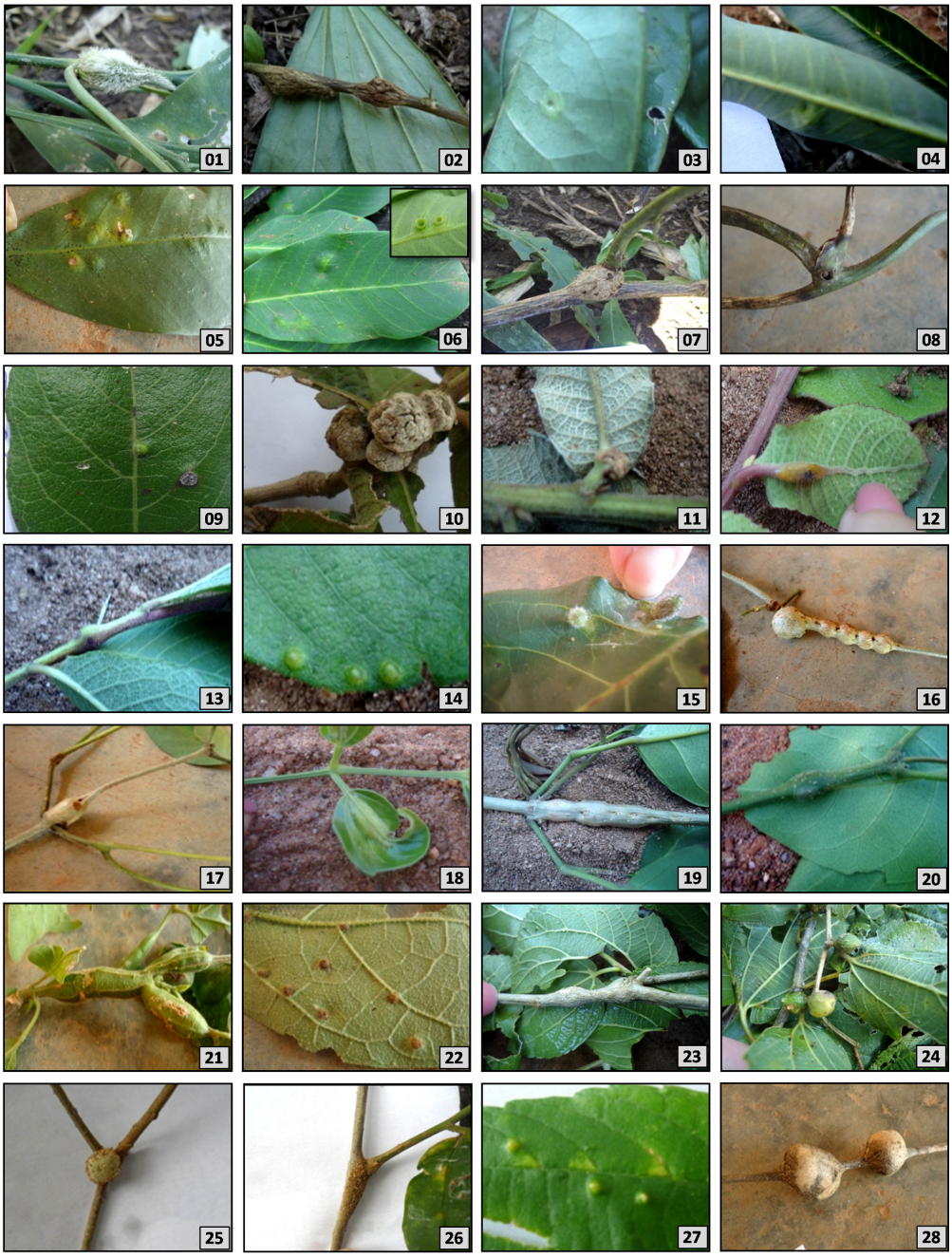

Figure 01-28. Insect galls of Serra da Bodoquena (MS, Brazil). (01-02) On ***Ruellia***, 01. conical bud gall, 02. fusiform stem gall. (03-04) On ***Aspidosperma discolor***, 03 lenticular leaf gall, 04. conical leaf gall. 05. On ***Aspidosperma pyricollum***, lenticular leaf gall. 06. On ***Aspidosperma* sp.**, cylindrical leaf abaxially and lenticular adaxially gall. 07. On ***Eupatorium***, globoid stem gall. 08. On ***Mikania***, globoid stem gall. (09-13). On ***Vernonanthura brasiliana***, 09. lenticular leaf gall, 10. globoid stem gall, 11. globoid bud gall, 12. fusiform leafvein gall, 13. fusiform stem gall. 14. On ***Vernonia esculenta***, lenticular leaf gall. 15. On ***Adenocalymma allamandiflorum***, cylindrical leaf gall. 16. On ***Adenocalymma***, globoid stem gall. (17-18) On ***Anemopaegma* sp.**, 17. globoid stem gall, 18. lenticular leafvein gall. 19. On ***Bignonia* sp1,** fusiform stem gall. 20.On ***Bignonia* sp2,** fusiform stem gall. 21. On ***Mansoa* sp.**, fusiform stem gall. 22. On ***Cordia* sp.**, globoid leaf gall. (23-24) On ***Celtis* cf. *iguanaea***, 23. fusiform stem gall, 24. globoid petiole gall. (25-27) On ***Celtis spinosa***, 25. globoid spine gall, 26. fusiform stem gall, 27. lenticular leaf gall. 28. On ***Ipomoea* sp.**, globoid stem gall.

Previous records on undetermined species of *Aspidosperma*: Fernandes et al. 1997/MG, Almada & Fernandes 2011/PA, Maia 2014/MG, Maia & Carvalho- Fernandes 2016/RJ, Bergamini et al. 2017/GO, Silva et al. 2018b/GO.

Several galls have been recorded on several species of *Aspidosperma*: Fernandes et al. 1988/MG, Monteiro et al. 1994/RJ, Fernandes et al. 1997/MG, Gonçalves-Alvim & Fernandes 2001/MG, Maia 2001/RJ, Julião et al. 2002/MS, Oliveira & Maia 2005/RJ, Araujo et al. 2007/GO, Maia et al. 2008/SP, Coelho et al. 2009/MG, Maia & Oliveira 2010/RJ, Almada & Fernandes 2011/PA, Araújo et al. 2011/GO, Santos et al. 2012b/GO, Coelho et al. 2013/MG, Araújo et al. 2014/GO, Maia 2014/MG, Rodrigues et al. 2014/RJ, Araújo et al. 2015/GO, Maia & Carvalho-Fernandes 2016/RJ, Maia & Silva 2016/RJ, Urso-Guimarães et al. 2017/MS, Ascendino & Maia, (personal communication)/MS.

Asteraceae Bercht. and J.Presl (n=09)

Eupatorium L. sp. (n=1)

Native, non endemic plant genus. Distribution: Centro-Oeste (Goiás, Mato Grosso), Sudeste (Minas Gerais, São Paulo), Sul (Paraná). Biome: Cerrado.

Gall (Fig. 7): on stem, globoid, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Maia 2014/MG, Maia et al. 2014/ES.

Mikania Willd. sp. (n=1)

Native, non endemic plant genus. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 8): on stem, globoid, glabrous, green, one-chambered. Galler:

Clinodiplosis sp. (Cecidomyiidae, Diptera). Date: August/2011.

Previous records: Maia & Oliveira 2010/RJ, Santos et al. 2011a/PE, Fernandes et al. 2001/MG, Malves & Frieiro-Costa 2012/MG, Maia 2014/MG, Maia et al. 2014/ES, Urso-Guimarães et al. 2017/MS.

Vernonanthura brasiliana (L.) H. Rob. (= *Vernonia brasiliana* (L.) Druce) (n=5) Endemic plant species. NE. Distribuition: Northern (Acre, Pará, Tocantins),

Northestern (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco), Midwest (all states), Southeastern (all states), Southern (Paraná). Biomes: Amazonan, Caatinga, Cerrado.

Gall (Fig. 9): on leaf, lenticular, micropubescent, green, one-chambered. Galler: Undetermined. Date: December/2011.

Gall (Fig. 10): on stem, globoid, glabrous, green, multichambered. Galler: Cecidomyiidae (Diptera). Other insects: Psocoptera (successor). Date: December/2011.

Gall (Fig. 11): on bud, globoid, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: April/2012.

Gall (Fig. 12): on leafvein, fusiform, glabrous, orange. Galler: Undetermined.

Date: April/2012.

Gall (Fig. 13): on stem, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Date: April/2012.

Previous records: Julião et al. 2002/MS, Urso-Guimarães et al. 2017/MS.

Vernonia* cf. *esculenta Hemsl. (n=1)

Gall (no fig.): on stem, globoid, glabrous, brown, one-chambered. Galler: Tephritidae (Diptera). Date: August/2011.

Vernonia esculenta Hemsl. (n=1) (new record of host plant) No data in Flora do Brasil 2020.

Gall (Fig. 14): on leaf, lenticular, glabrous, green, one-chambered. Galler: Clinodiplosini (Cecidomyiidae, Diptera). Date: April/2012.

No previous records.

Bignoniaceae Juss. (n=7)

Adenocalymma allamandiflorum (Bureau ex K.Schum.) L.G. Lohmann (= *Memora* cf. *allamandiflora* Bureau ex K.Schum. (n=1) (new record of host plant species)

Table III. Number of insect galls per shape in Serra da Bodoquena, Mato Grosso do Sul, Midwestern Brazil.

Gall shape	Number of gall morphotypes (n=58)
Globoid	21
Fusiform	18
Lenticular	10
Conical	4
Marginal roll	3
Cylindrical	2

Table IV. Richness of insect galls per galling taxa in Serra da Bodoquena, Mato Grosso do Sul, Midwestern Brazil.

Galling order	Number of gall morphotypes (n=31)
Diptera	23
Cecidomyiidae	22
Tephritidae	1
Hemiptera	7
Thysanoptera	1
Coleoptera	0
Lepidoptera	0
Hymenoptera	0

Endemic plant species. NE. Distribution: Northern (Amapá, Pará), Northeastern (Maranhão). Biomes: Amazon, Atlantic Forest.

Gall (Fig. 15): on leaf, cylindrical, pubescent, green, one-chambered. Galler: Cecidomyiidae (Diptera). Other insects: *Trotteria* sp. (Cecidomyiidae, Diptera) (Inquiline). Date: August/2011.

No previous records.

Adenocalymma Mart. ex. Meisn. emend L.G. Lohmann sp. (= *Memora* sp.) (n=1) Native and non endemic plant genus. Distribution: All Brazilian states, except RS. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 16): on stem, globoid, glabrous, brown. Galler: Undetermined. Date: August/2011.

Previous records Almada & Fernandes 2011/PA, Maia 2011/PA, Araújo et al. 2012/PA, Santos et al. 2012a/PE, Rodrigues et al. 2014/RJ, Maia et al. 2014/ES, Maia & Carvalho-Fernandes 2016/RJ, Urso-Guimarães et al. 2017/MS, Brito et al. 2018/BA.

Anemopaegma Mart. ex Meisn. sp. (n=2)

Native and non endemic plant genus. Distribution: Norte (all states), Nordeste (Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí), Centro-Oeste (all states), Sudeste (all states), Sul (all states). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal.

Gall (Fig. 17): on stem, globoid, glabrous, brown, one-chambered. Galler: Undetermined. Date: August/2011.

Gall (Fig. 18): on leafvein, lenticular, glabrous, green, one-chambered. Galler: Undetermined. Other insects: Hymenoptera. Date: April/2012.

Previous records on *Anemopaegma* spp.: Fernandes et al. 2001/MG, Maia et al. 2008/SP.

Bignonia L. sp. 1 (=*Clytostoma* Miers ex Bureau) (n=1)

Native and non endemic plant genus. Distribution: All Brazilian states, except RN.

Gall (Fig. 19): on stem, fusiform, glabrous, brown, one-chambered. Galler: Undetermined. Other insects: Hymenoptera. Date: April/2012.

Bignonia L. sp. 2 (n=1)

Gall (Fig. 20): on stem, fusiform, glabrous, green, one-chambered. Galler: Cecidomyiidae. Date: April/2012.

Previous records: Fernandes et al. 2001/MG, Maia & Carvalho-Fernandes 2016/RJ, Ascendino & Maia, (personal communication)/MS.

Mansoa DC. sp. (n=1)

Native and non endemic plant genus. Distribution: Norte (Acre, Amazonas, Pará, Rondônia), Nordeste (all states), Centro-Oeste (Mato Grosso do Sul, Mato Grosso), Sudeste (all states), Sul (all states). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal

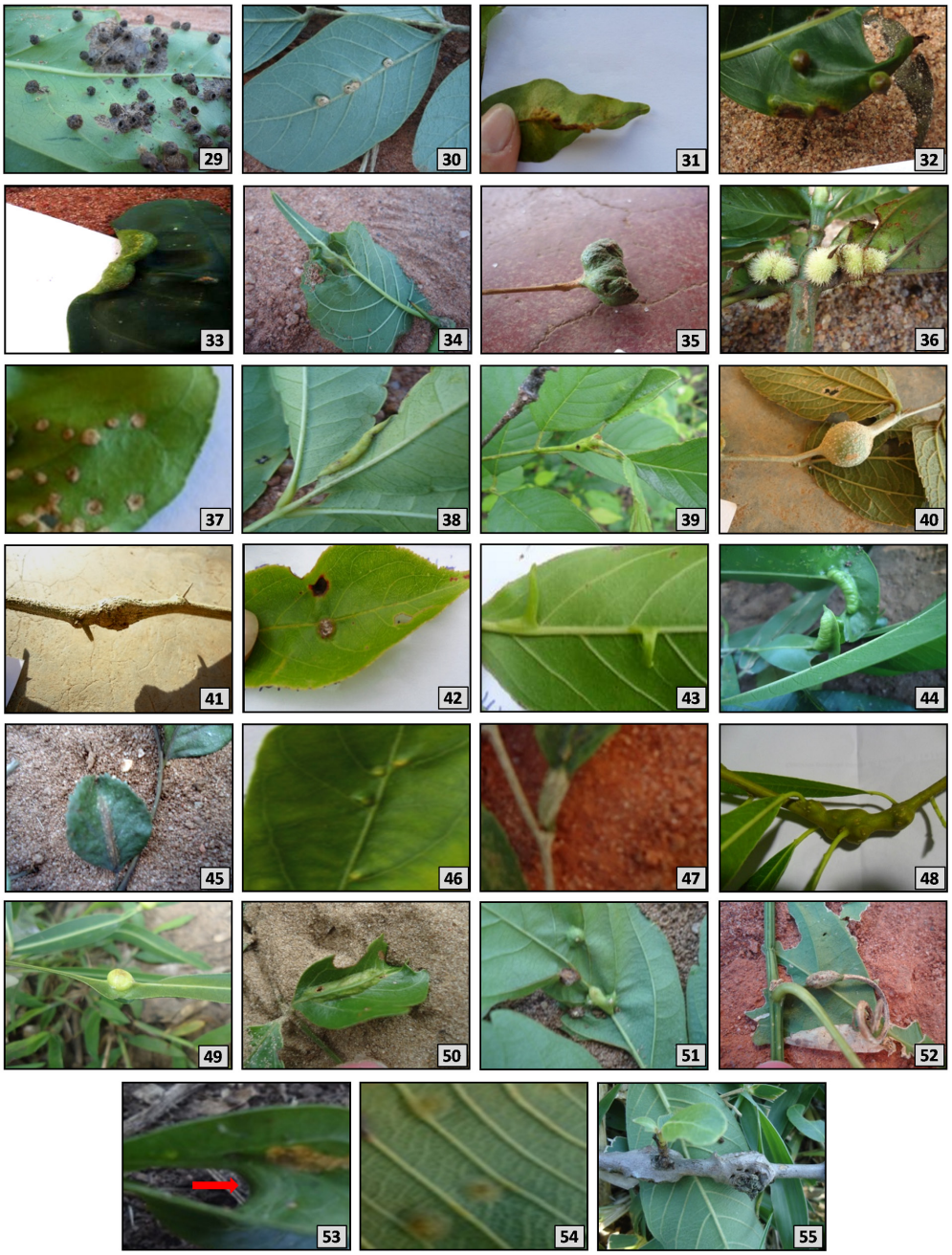

Figure 29-55. Insect galls of Serra da Bodoquena (MS, Brazil). 29. On ***Doliocarpus dentatus***, globoid leaf gall. 30. On ***Abarema***, globoid leaf gall. 31. On ***Dalbergia foliosa***, fusiform leafvein gall. 32. ***Nectandra* sp.**, globoid leaf gall. 33. On ***Guarea guidonia***, marginal roll leaf gall. 34. On ***Maclura tinctoria***, fusiform leafvein gall. 35. On ***Eugenia patrisii***, globoid bud gall. 36. On ***Psychotria borjensis***, globoid leaf gall. 37. On ***Citrus* sp.**, lenticular leaf gall. 38. ***Zanthoxylum* sp.**, marginal roll leaf gall. 39. On Rutaceae not determined, fusiform stem gall. (40-41) On ***Casearia aculeata***, 40. globoid stem gall, 41. fusiform stem gall. (42-43) On ***Casearia decandra***, 42. lenticular leaf gall, 43. conical leaf gall. 44. On ***Casearia sylvestris***, fusiform leafvein gall. 45. On ***Casearia ulmifolia***, fusiform leaf vein gall. 46. On ***Casearia* sp1**, lenticular leaf gall. 47. On ***Casearia* sp2**, fusiform petiole gall. (48-49) On ***Salix humboldtiana***, 48. globoid stem gall, 49. globoid leaf gall. (50-52) On ***Paullinia pinnata***, 50. fusiform leaf vein, 51. conical leaf gall, 52. fusiform tendril gall. 53. On ***Paullinia racemosa***, fusiform leafvein gall. 54. On ***Qualea parviflora***, lenticular leaf gall. 55. On ***Vochysia* sp.** globoid stem gall.

Table V. Characterization of the insect gall morphotypes in host plants (as to the organ of occurrence, shape, pubescence, coloration, number of internal chambers and inductor) in Serra de Bodoquena – MS.

Host plants		morphology		Insect gall		Insect taxa	
Plant family	**Plant species**	**Organ**	**Shape**	**Color**	**Pubescence**	**Inductor**	**Other insects**
Acanthaceae	*Ruellia* sp.	Bud	Conical	Green	Pubescent	Cecidomyiidae (Diptera)	
		Stem	Fusiform	Brown	Glabrous	Cecidomyiidae (Diptera)	
Apocinaceae	*Aspidosperma discolor*	Leaf	Lenticular	Green	Glabrous	Hemiptera	
		Leaf	Conical	Green	Glabrous	Undetermined	
	Aspidosperma pyricollum	Leaf	Lenticular	Green	Glabrous	Psyllidae (Hemiptera)	
	Aspidosperma sp.	Leaf	Cylindrical abaxially and lenticular adaxially	Green	Glabrous	Hemiptera	
Asteraceae	*Eupatorium* sp.	Stem	Globoid	Brown	Glabrous	Cecidomyiidae (Diptera)	
	Mikania sp.	Stem	Globoid	Green	Glabrous	*Clinodiplosis* sp. (Cecidomyiidae, Diptera)	
	Vernonanthura brasiliana	Leaf	Lenticular	Green	Micropubescent	Undetermined	
		Stem	Globoid	Green	Glabrous	Cecidomyiidae (Diptera)	Psocoptera (successor)
		Bud	Globoid	Brown	Glabrous	Cecidomyiidae (Diptera)	
		Leafvein	Fusiform	Orange	Glabrous	Undetermined	
		Stem	Fusiform	Green	Glabrous	Undetermined	
	Vernonia cf. *esculenta*	Stem	Globoid	Brown	Glabrous	Tephritidae (Diptera)	
	Vernonia esculenta	Leaf	Lenticular	Green	Glabrous	Clinodiplosini (Cecidomyiidae, Diptera)	
Bignoniaceae	*Adenocalymma allamandiflorum*	Leaf	Cylindrical	Green	Pubescent	Cecidomyiidae (Diptera)	*Trotteria* sp. (Cecidomyiidae, Diptera) (Inquiline)
	Adenocalymma sp.	Stem	Globoid	Brown	Glabrous	Undetermined	
	Anemopaegma sp.	Stem	Globoid	Brown	Glabrous	Undetermined	
		Leafvein	Lenticular	Green	Glabrous	Undetermined	Hymenoptera
	Bignonia sp.1	Stem	Fusiform	Green	Glabrous	Undetermined	Hymenoptera
	Bignonia sp.2	Stem	Fusiform	Green	Glabrous	Cecidomyiidae (Diptera)	

Table V. Continuation.

Host plants		morphology		Insect gall		Insect taxa	
Plant family	**Plant species**	**Organ**	**Shape**	**Color**	**Pubescence**	**Inductor**	**Other insects**
	Mansoa sp.	Stem	Fusiform	Green	Glabrous	Cecidomyiidae (Diptera)	
Boraginaceae	*Cordia* sp.	Leaf	Globoid	Brown	Pubescent	Cecidomyiidae (Diptera)	
Cannabaceae	*Celtis* cf. *iguanaea*	Stem	Fusiform	Brown	Glabrous	Cecidomyiidae (Diptera)	
		Leaf petiole	Globoid	Green	Glabrous	Cecidomyiidae (Diptera)	
		Leafvein	Globoid	Brown	Glabrous	Cecidomyiidae (Diptera)	
	Celtis spinosa	Spine	Globoid	Brown	Glabrous	Undetermined	
		Stem	Fusiform	Brown	Glabrous	Cecidomyiidae (Diptera)	Hymenoptera (parasitoid)
		Leaf	Lenticular	Green	Glabrous	Undetermined	
Convolvulaceae	*Ipomoea* sp.	Stem	Globoid	Brown	Glabrous	Cecidomyiidae (Diptera)	
	Doliocarpus dentatus	Leaf	Globoid	Brown	Pubescent	Undetermined	
Fabaceae	*Abarema* sp.	Leaf	Globoid	Yellow	Glabrous	Undetermined	
	Dalbergia foliosa	Leafvein	Fusiform	Green	Glabrous	Undetermined	
Lauraceae	*Nectandra* sp.	Leaf	Globoid	Green	Glabrous	Cecidomyiidae (Diptera)	
	Guarea guidonia	Leaf	Marginal roll	Green	Glabrous	Hemiptera	
Moraceae	*Maclura tinctoria*	Leafvein	Fusiform	Green	Glabrous	Undetermined	
Myrtaceae	*Eugenia patrisii*	Bud	Globoid	Green	Glabrous	Undetermined	Eulophidae sp. (Hymenoptera), Pteromalidae sp. (Hymenoptera) (parasitoids)
Rubiaceae	*Psychotria borjensis*	Leaf	Globoid	Yellow	Pubescent	Cecidomyiidae (Diptera)	
Rutaceae	*Citrus* sp	Leaf	Lenticular	Brown	Glabrous	Undetermined	
	Zanthoxylum sp.	Leaf	Marginal roll	Green	Glabrous	Hemiptera	Psocoptera (successor) and Thysanoptera (inquiline).
Rutaceae not determined		Stem	Fusiform	Green	Glabrous	Undetermined	Cecidomyiidae and Lepidoptera
Salicaceae	*Casearia aculeata*	Stem	Globoid	Brown	Glabrous	Cecidomyiidae (Diptera)	
		Stem	Fusiform	Brow	Glabrous	Cecidomyiidae (Diptera)	
	Casearia decandra	Leaf	Lenticular	Green	Glabrous	Undetermined	

Table V. Continuation.

Host plants		morphology		Insect gall		Insect taxa	
Plant family	**Plant species**	**Organ**	**Shape**	**Color**	**Pubescence**	**Inductor**	**Other insects**
		Leaf	Conical	Green	Glabrous	Undetermined	
	Casearia sylvestris	Leafvein	Fusiform	Green	Glabrous	Thysanoptera	
	Casearia ulmifolia	Leafvein	Fusiform	Green	Glabrous	Cecidomyiidae (Diptera)	Muscomorpha (inquiline)
	Casearia sp.1	Leaf	Lenticular	Green	Glabrous	Undetermined	
	Casearia sp. 2	Leaf petiole	Fusiforme	Brown	Glabrous	Cecidomyiidae (Diptera)	
	Salix humboldtiana	Stem	Globoid	Green	Glabrous	Undetermined	
		Leaf	Globoid	Yellow	Glabrous	Hemiptera	
Sapindaceae	*Paullinia pinnata*	Leafvein	Fusiform	Green	Glabrous	Undetermined	
		Leaf	Conical	Green	Glabrous	Undetermined	
		Tendril	Fusiform	Brown	Glabrous	Undetermined	
	Paullinia racemosa	Leafvein	Fusiform	Green	Glabrous	Undetermined	
Vochysiaceae	*Qualea parviflora*	Leaf	Lenticular	Green	Glabrous	Cecidomyiidae (Diptera)	Hymenoptera (parasitoids)
		Leaf	Marginal roll	Green	Glabrous	Hemiptera	
	Vochysia sp.	Stem	Globoid	Brown	Glabrous	Undetermined	

Table VI. Relationship of number of morphotypes, families, genus and species of host plants in other surveys of area of semideciduous seasonal forest. In bold is our work.

Locality	Number of gall morphotype	Nr. Galled plant families	Nr. Galled plant genera	Nr. Galled plant species	Medium number of gall per host plant species	Reference
Maringá, PA	N/I	7	2	0	N/A	Carvalho et al. 2015
Aquidauana, Bodoquena, Corumbá, and Porto Murtinho, MS	186 (65)	35 (21)	73(27)	115(25)	1.66(2.6)	Urso-Guimarães et al. 2017
Estação Ecológica Estadual de Guaxindiba, São Francisco de Itabapoana, RJ	143	31	60	82	1.74	Maia & Carvalho-Fernandes 2016
Saquarema, Araruama, Arraial do Cabo and Cabo Frio, RJ	151	34	61	82	1.84	Carvalho- Fernandes et al. 2016
Sorocaba, SP	113	24	42	54	2.1 (2.09)	Ansaloni et al. 2018
Floresta da Cicuta, RJ	43	15	18	24	1.79	Flor at al. 2018
Bodoquena, MS	58	18	28	21	**1.45**	**Ascendino & Maia**
Canela, RS	57	21	28	29	1.96	Goetz et al. 2018
Telêmaco Borba, PR	41	14	10	13	3.15	Santos & Ribeiro, 2015

Gall (Fig. 21): on stem, fusiform, glabrous, green, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Ascendino & Maia, (personal communication)/MS , Maia & Mascarenha 2017/RJ and MG.

Boraginaceae Juss.(n=1)

Cordia L. sp. (n=1)

Native and non endemic plant genus. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal.

Gall (Fig. 22): on leaf, globoid, pubescent, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Fernandes et al. 1988/MG, Fernandes et al. 1997/MG, Julião et al. 2002/MS, Fernandes & Negreiros 2006/MG**,** Maia et al. 2008/SP, Coelho et al. 2009/MG, Almada & Fernandes 2011/PA, Maia 2011/PA, Santos et al. 2011b/PE, Araújo et al. 2012/PA, Carvalho-Fernandes et al. 2012/Northestern Brazil, Santos et al. 2012a/PE, Araújo et al. 2015/GO, Maia & Mascarenhas 2017/RJ.

Cannabaceae Martinov (n=6)

Celtis* cf. *iguanaea (Jacq.) Sarg. (n=3) (=*Celtis membranacea* Miq.)

Native and non endemic plant species. NE. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 23): on stem, fusiform, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: April/2012.

Gall (Fig. 24): on leaf petiole, globoid, green, glabrous, one-chambered. Galler: Cecidomyiidae (Diptera). Date: April/2012.

Gall (no fig): on leafvein, globoid, brown, glabrous, one-chambered. Galler: Cecidomyiidae (Diptera). Date: April/2012.

Previous records: Santos et al. 2010/GO, Santos et al. 2012a/PE (as *Celtis membranacea* Miq.), Maia & Mascarenhas 2017/RJ and MG, Ansaloni et al. 2018/SP, Goetz et al. 2018/RS, Silva et al. 2018a/BA, Ascendino & Maia, (personal communication)/MS.

Celtis spinosa Spreng. (n=3)

Native and non endemic plant species. NE. Distribution: Nordeste (Bahia), Centro-Oeste (Mato Grosso do Sul), Sudeste (Rio de Janeiro, São Paulo), Sul (Paraná, Rio Grande do Sul). Biomes: Cerrado, Atlantic Forest, Pantanal.

Gall (Fig. 25): on spine, globoid, glabrous, brown, one-chambered. Galler: Undetermined. Date: December/2011.

Gall (Fig. 26): on stem, fusiform, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Other insects: Hymenoptera (parasitoids). Date: December/2011.

Gall (Fig. 27): on leaf, lenticular, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011.

Previous records: Urso-Guimarães et al. 2017/MS, Ascendino & Maia, (personal communication)/MS.

Convolvulaceae Juss. (n=1)

Ipomoea L. sp. (n=1)

Native and non endemic plant genus. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 28): on stem, globoid, glabrous, brown, multichambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Gonçalves-Alvim & Fernandes 2001/MG, Julião et al. 2002/MS, Ansaloni et al. 2018/SP, Brito et al. 2018/BA, Viera et al. 2018/BA.

Dilleniaceae Salisb. (n=1)

Doliocarpus dentatus Standtl. (n=1)

Native and non endemic plant species. NE. Distribution: All Brazilian states, except SC and RS. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal

Gall (Fig. 29): on leaf, globoid, pubescent, brown, one-chambered. Galler: Undetermined. Date: April/2012.

Previous records: Almada & Fernandes 2011/PA

Fabaceae Lindl. (n=2)

Abarema Pittier sp. (n=1)

Native and non endemic plant genus. Distribution: Norte (all states), Nordeste (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Rio Grande do Norte, Sergipe), Centro-Oeste (Mato Grosso), Sudeste (all states), Sul (all states). Biomes: Amazonian forest, Cerrado, Atlantic forest.

Gall (Fig. 30): on leaf, globoid, glabrous, yellow, one-chambered. Galler: Undetermined. Date: April/2012.

Previous records: Maia et al. 2014 on *Abarema laeta* (Benth.) Barneby and J W Grimes/ES, Maia et al. 2008 on *Abarema brachystachya* (DC.) Barneby and J. W. Grimes/SP.

Dalbergia foliosa (Benth.) A.M.Carvalho (n=1)

Native and non endemic plant species. NE. Distribution: Norte (Amazonas, Pará, Roraima). Biome: Amazonian forest.

Gall (fig. 31): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011.

Previous records: Maia 2013/MG, Maia & Mascarenhas 2017/RJ and MG.

Lauraceae Juss. (n=1)

Nectandra Rol. ex. Rottb. sp. (n=1)

Native and non endemic plant genus. Distribution: All Brazilian states, except four states in the Northeastern (PI, RN, PB, SE). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal.

Gall (Fig. 32): on leaf, globoid, glabrous, green, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records on *Nectandra* spp.: Maia et al. 2008/SP, Ansaloni et al. 2018/SP, Santos et al. 2010/GO, Saito & Urso-Guimarães 2012/SP, Santos et al. 2012a/PE, Toma & Mendonça 2013/RS, Maia 2014/MG, Maia et al. 2014/ES, Mendonça et al. 2014/RS, Araújo et al. 2015/GO, Maia & Mascarenhas 2017/RJ and MG, Bergamini et al. 2017/GO, Goetz et al. 2018, Silva et al. 2018b/GO.

Meliaceae A.Juss. (n=1)

Guarea guidonia (L.) Sleumer (n=1)

Native and non endemic plant species. NE. Distribution: All Brazilian states.

Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest.

Gall (Fig. 33): on leaf, marginal roll, glabrous, green, one-chambered. Galler: Hemiptera. Date: April/2012.

Previous records: Fernandes et al. 2001/MG, Maia et al. 2014/ES, Rodrigues et al. 2014/RJ, Urso-Guimarães et al. 2017/MS.

Moraceae Gaudich. (n=1)

Maclura tinctoria (L.) D.Don ex Steud. (n=1) (new record of host plant species)

Native and non endemic plant species. NE. Distribution: All Brazilian states, except RN and AL (Northeastern) and AP, RR (Northern). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 34): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Date: April/2012.

Previous records on *M. tinctoria*: Rubsaamen 1905/RJ.

Myrtaceae Juss. (n=1)

Eugenia patrisii Vahl (n=1) (new record of host plant species)

Native and non endemic plant species. NE. Distribution: Norte (Acre, Amazonas, Amapá, Pará, Tocantins), Nordeste (Maranhão), Centro-Oeste (Mato Grosso). Biome: Amazonian forest.

Gall (Fig. 35): on bud, globoid, glabrous, green, one-chambered. Galler: Undetermined. Other insects: Eulophidae sp. (Hymenoptera), Pteromalidae sp. (Hymenoptera) (parasitoids). Date: August/2011.

Table VII. Previous records of plants with insect galls parasitized by Eulophidae in Brazil.

Host Plant	Locality	Reference
Andira humilis Mart. ex Benth (Fabaceae)	BA	Lima & Calado 2018
Andira fraxinifolia Benth. (Fabaceae)	RJ	Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Andira nitida Mart. ex Benth. (Fabaceae)	ES	Bregonci et al. 2010
Andira sp. (Fabaceae)	MG	Maia & Fernandes 2004
Annona coriacea Mart. (Annonaceae)	GO	Araújo et al. 2011
Baccharis microcephala (Less.) DC. (Asteraceae)	MG	Maia & Fernandes 2004
Bauhinia brevipes Vogel (Fabaceae)	BA/GO	Lima & Calado 2018, Silva et al. 2018b
Bauhinia sp. (Fabaceae)	GO	Araújo et al. 2011, Bergamini et al. 2017, Silva et al. 2018b
Borreria verticillata (L.) G.Mey. (Rubiaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Byrsonima sericea DC. (Malpighiaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Byrsonima variabilis A. Juss. (Malpighiaceae)	MG	Maia & Fernandes 2004
Byrsonima verbascifolia A. Juss. (Malpighiaceae)	MG/GO	Maia & Fernandes 2004, Bergamini et al 2017
Caryocar brasiliense A. St.Hil. (Caryocaraceae)	GO	Silva et al. 2018b
Calophyllum sp. (Calophyllaceae)	MG	Maia & Fernandes 2004
Clusia lanceolata Camb. (Clusiaceae)	RJ	Maia & Azevedo 2009
Connarus sp. (Connaraceae)	GO	Silva et al. 2018b
Couepia ovalifolia (Schott) Benth. ex Hook.f. (Chrysobalanaceae)	RJ	Maia & Azevedo 2009
Davilla elliptica A. St.-Hil. (Dilleniaceae)	GO	Araújo et al. 2011, Bergamini et al. 2017
Diodia sp. (Rubiaceae)	RJ	Fernandes-Carvalho et al. 2016
Diplopterys pubipetala (A. Juss.) W.R.Anderson & C.Davis (Malpighiaceae)	GO	Silva et al. 2018b
Doliocarpus sp. (Dilleniaceae)	GO	Bergamini et al. 2017
Drimys brasiliensis Miers (Winteraceae)	MG	Maia & Fernandes 2004
Duguetia furfuraceae (A. St.-Hil.) Jaff. (Annonaceae)	SP	Saito & Urso-Guimarães 2012, Costa et al. 2015
Erythroxylum ovalifolium Peyr. (Erythroxylaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Erythroxylum suberosum A. St.Hil. (Erythroxylaceae)	GO	Silva et al. 2018b
Erythroxylum sp. (Erythroxylaceae)	GO	Silva et al. 2018b
Eugenia astringens (=*Eugenia rotundifolia* Camb.) (Myrtaceae)	RJ	Maia 2001, Maia et al. 2002, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Eugenia copacabanensis Kiaersk. (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016

Table VII. Continuation.

Host Plant	Locality	Reference
Eugenia ovalifolia Camb. (Myrtaceae)	MG	Fernandes et al. 1988
Eugenia multiflora Camb. (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Eugenia uniflora L. (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Guapira opposita (Vell.) Reitz. (Nyctaginaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Guapira pernambucensis (Casar.) Lundell (Nyctaginaceae)	ES	Bregonci et al. 2010
Guapira sp. (Nyctaginaceae)	ES/GO	Bregonci et al. 2010, Silva et al. 2018b
Heteropterys nitida (Lam.) DC. (Malpighiaceae)	RJ	Maia & Azevedo 2009
Heteropterys sp. (Malpighiaceae)	GO	Silva et al. 2018b
Inga cilindrica (Vell.) Mart. (Fabaceae)	GO	Santos et al. 2010
Inga laurina (Sw.) Willd. (Fabaceae)	RJ	Maia et al. 2002, Maia & Azevedo 2009
Lantana camara L. (Verbenaceae)	RJ	Maia & Azevedo 2009
Machaerium aculeatum Raddi. (Fabaceae)	MG	Fernandes et al. 1988
Malpighiaceae (not determined)	GO	Araújo et al. 2011
Microstachys corniculata (Vahl.) Griseb (=*Sebastiania glandulosa* (Mart.) Pax) (Euphorbiaceae)	RJ	Maia & Azevedo 2009
Mikania hoehnei Rob. (Asteraceae)	RJ	Maia 2001, Maia & Azevedo 2009
Manihot sp. (Euphorbiaceae)	GO	Araújo et al. 2011
Manilkara subsericea (Mart.) Dubard. (Sapotaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Maytenus obtusifolia Mart. (Celastraceae)	RJ	Maia & Azevedo 2009
Myrcia itambensis Berg. (Myrtaceae)	MG	Fernandes et al. 1988
Myrcia ovata Camb. (Myrtaceae)		Maia 2001, Maia et al. 2002, Maia & Azevedo 2009
Myrcia rostrata DC. (Myrtaceae)	GO	Santos et al. 2010
Myrciaria floribunda (West. ex Will) Berg. (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Myrsine parvifolia A. DC. (=*Rapanea parvifolia* (A.DC.) Mez) (Primulaceae)	RJ	Maia & Azevedo 2009
Nectandra cuspidata Ness. (Lauraceae)	GO	Santos et al. 2010, Silva et al. 2018b
Neomitranthes obscura (DC.) N. Silveira (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Ouratea cuspidata (A.St.-Hil.) Engl. (Ochnaceae)	RJ	Maia & Azevedo 2009
Paullinia weimanniaefolia Mart. (Sapindaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Paullinia sp. (Sapindaceae)	GO	Santos et al. 2018b
Peixotoa sp. (Malpighiaceae)	GO	Silva et al. 2018b

Table VII. Continuation.

Host Plant	Locality	Reference
Peplonia asteria (Vell.) Font. and Schw. (Asclepiadaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Piper arboreum Aubl. (Piperaceae)	GO	Santos et al. 2010, Araújo et al. 2011
Pouteria caimito (Ruiz and Pav.) Radlk. (Sapotaceae)	RJ	Maia & Azevedo 2009
Pouteria venosa (Mart.) Baehni. (Sapotaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Protium brasiliensis (Spr.) Engl. (Burseraceae)	RJ	Maia et al. 2002, Maia & Azevedo 2009
Protium heptaphyllum March. (Burseraceae)	GO	Santos et al. 2010
Psidium pohlianum O. Berg. (Myrtaceae)	GO	Araújo et al. 2011
Psittacanthus dichroos (Mart.) Mart. (Loranthaceae)	RJ	Maia & Azevedo 2009
Roupala montana Aubl. (Proteaceae)	GO	Santos et al. 2018b
Schefflera morototoni Aubl. (Araliaceae)	GO	Santos et al. 2010
Sebastiania sp. (Euphorbiaceae)	GO	Araújo et al. 2011
Serjania obtusidentata Radlk. (Sapindaceae)	GO	Santos et al. 2010
Serjania sp. (Sapindaceae)	GO	Bergamini et al. 2017
Smilax rufescens Griseb. (Smilacaceae)	RJ, ES	Maia 2001, Maia & Azevedo 2009, Bregonci et al. 2010, Fernandes-Carvalho et al. 2016
Smilax sp. (Smilacaceae)	GO	Santos et al. 2018b
Solanum affine Sendth (Solanaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Styrax pohlii A. DC. (Styracaceae)	GO	Santos et al. 2010
Tapirira guianensis Aubl. (Anacardiaceae)	MG	Urso-Guimarães et al. 2003
Trichilia sp. (Meliaceae)	GO	Silva et al. 2018b
Varronia curassavica Jacq. (=*Cordia verbenacea* DC.) (Boraginaceae)	RJ	Maia 2001, Maia & Azevedo 2009, Fernandes-Carvalho et al. 2016
Qualea grandiflora Mart. (Vochysiaceae)	GO	Araújo et al. 2011
Qualea multiflora Mart. (Vochysiaceae)	GO	Santos et al. 2018b
Qualea parviflora Mart. (Vochysiaceae)	GO	Araújo et al. 2011

No previous records.

Rubiaceae Juss. (n=1)

Psychotria borjensis Kunth (n=1) (new record de host plant species)

Endemic plant species. NE. Distribution: Norte (Acre, Amazonas, Pará, Rondônia), Nordeste (Maranhão), Centro-Oeste (Mato Grosso). Biome: Amazonian forest.

Gall (Fig. 36): on leaf, globoid, pubescent, yellow, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

No previous records.

Rutaceae A.Juss. (n=4)

Citrus L. sp. (n=1) (new record of host plant genus)

Naturalized plant genus. Distribution: Nordeste (Bahia), Centro-Oeste (Distrito Federal, Goiás, Mato Grosso do Sul), Sudeste (Minas Gerais, São Paulo), Sul (Paraná, Rio Grande do Sul, Santa Catarina). Biomes: Cerrado, Atlantic forest.

Gall (Fig. 37): on leaf, lenticular, glabrous, brown, massive. Galler: Undetermined. Date: December/2011.

No previous records.

Zanthoxylum L. sp. (n=1)

Endemic plant genus. NE. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 38): on leaf, marginal roll, glabrous, green, one-chambered. Galler: Hemiptera. Other insects: Psocoptera (successor) and Thysanoptera (inquiline). Date: December/2011 and April/2012.

Previous records: Fernandes et al. 1997 on *Zanthoxylum* sp./MG, Mendonça et al. 2014 on *Zanthoxylum* sp./RS, Urso-Guimarães et al. 2017 on *Z. riedelianum* Engl. and *Zanthoxylum* sp./MS, Ascendino & Maia 2018 on *Zanthoxylum* sp./MS, Ansaloni et al. 2018 on *Z. riedelianum* Engl./SP, Silva et al. 2018b/GO.

Rutaceae not determined (n=1)

Gall (Fig. 39): on stem, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Other insects: Cecidomyiidae and Lepidoptera. Date: December/2011.

Salicaceae Mirb. (n=10)

Casearia aculeata Jacq. (n=2)

Native and non endemic plant species. NE. Distribution: Norte (Acre, Amazonas, Pará, Rondônia, Roraima), Nordeste (Bahia, Maranhão), Centro- Oeste (Goiás, Mato Grosso do Sul, Mato Grosso), Sudeste (Espírito Santo, Minas Gerais, São Paulo), Sul (Paraná). Biomes: Amazonian forest, Cerrado, Atlantic forest.

Gall (Fig. 40): on stem, globoid, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Gall (Fig. 41): on stem, fusiform, glabrous, brown, multichambered. Galler: Cecidomyiidae (Diptera). Date: August/2011.

Previous records: Fernandes & Negreiros 2006/MG, Maia & Mascarenhas 2017/RJ and MG.

Casearia decandra Jacq. (n=2)

Endemic plant species. NE. Distribution: All Brazilian states, except Amapá.

Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest.

Gall (Fig. 42): on leaf, lenticular, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011 and April/2012.

Gall (Fig. 43): on leaf, conical, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011 and April/2012.

Previous records: Mendonça et al. 2014/RS.

Casearia sylvestris Sw. (n=1)

Native and non endemic plant species. NE. Distribution: All Brazilian states.

Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 44): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Thysanoptera. Date: April/2012.

Previous records: Maia & Mascarenhas 2017/RJ and MG, Santos et al. 2012a/PE, Maia 2011/PA, Araújo et al. 2011/GO, Luz et al. 2012/MG, Mendonça et al. 2014/RS, Bergamini et al. 2017/GO.

Casearia ulmifolia Vahl ex Vent. (n=1) (new host plant species)

Endemic plant species. NE. Distribution: Norte (Acre, Amazonas, Pará, Rondônia, Roraima), Nordeste (Bahia, Maranhão, Piauí), Centro-Oeste (Mato Grosso), Sudeste (Espírito Santo, Minas

Gerais). Biomes: Amazonian forest, Caatinga, Cerrado.

Gall (Fig. 45): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Cecidomyiidae. Other insects: Muscomorpha (inquiline). Date: April/2012.

No previous records.

Casearia Jacq. sp. 1 (n=1)

Native and non endemic plant genus. Distribution: All Brazilian states. Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pampa, Pantanal.

Gall (Fig. 46): on leaf, lenticular, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011.

Casearia sp. 2 (n=1)

Gall (Fig. 47): on leaf petiole, fusiform, glabrous, brown, one-chambered. Galler: Cecidomyiidae (Diptera). Date: April/2012.

Several galls have been recorded on *Casearia* spp.: Coelho et al. 2009/MG, Almada & Fernandes 2011/PA, Araújo et al. 2012/PA, Maia 2011/PA, Araújo et al. 2014/GO, Santos et al. 2011a/PE, Santos et al. 2012a/PE, Maia et al. 2014/ES, Rodrigues et al. 2014/RJ, Maia & Carvalho-Fernandes 2016/RJ, Urso-Guimarães et al. 2017/MS.

Salix humboldtiana Willd. (n= 2) (new record of host plant species)

Native and non endemic plant. LC. Distribution: Norte (Acre, Amazonas, Pará) Sudeste (Minas Gerais, São Paulo), Sul (Paraná, Rio Grande do Sul, Santa Catarina). Biomes: Amazonian forest, Atlantic forest, Pampa.

Gall (Fig. 48): on stem, globoid, glabrous, green, one-chambered. Galler: Undetermined. Date: December/2011.

Gall (Fig. 49): on leaf, globoid, glabrous, yellow, one-chambered. Galler: Hemiptera. Date: April/2012.

Previous records: Ascendino & Maia (2018) /MS.

Sapindaceae

Paullinia pinnata L. (n=3)

Native and non endemic plant species. Distribution: Norte (Amazonas, Pará, Rondônia, Tocantins), Nordeste (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe). Centro-Oeste (Goiás, Mato Grosso do Sul, Mato Grosso), Sul (Paraná). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest, Pantanal.

Gall (Fig. 50): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Date: April/2012

Gall (Fig. 51): on leaf, conical, glabrous, green, one-chambered. Galler: Undetermined. Date: April/2012.

Gall (Fig. 52): on tendril, fusiform, glabrous, brown, one-chambered.

Galler: Undetermined. Date: April/2012.

Previous records: Santos et al. 2011a/PE, Julião et al. 2002/MS, Santos et al.

2012a/PE, Ascendino & Maia, (personal communication)/MS.

Paullinia racemosa Wawra. (n=1)

Endemic plant species. LC. Distribution: Norte (Pará), Nordeste (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Rio Grande do Norte), Sudeste (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo). Biomes: Amazonian forest, Atlantic forest.

Gall (Fig. 53): on leafvein, fusiform, glabrous, green, one-chambered. Galler: Undetermined. Date: August/2011.

Previous records: Santos et al. 2011a/PE, Maia & Souza 2013/RJ, Maia & Carvalho-Fernandes 2016/RJ.

Vochysiaceae A.St.-Hil. (n=3)

Qualea parviflora Mart. (n=2)

Native and non endemic plat species. NE. Distribution: Norte (Amazonas, Pará, Rondônia, Tocantins), Nordeste (Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí), Centro-Oeste

Table VIII. Previous records of plants with insect galls parasitized by Pteromalidae in Brazil.

Host Plant	Locality	Reference
Allophylus edulis (A. St.-Hil. Et al.) Hieron. Ex Niederl (Sapindaceae)	RJ	Flor et al. 2018
Andira nitida Mart. ex Benth. (Fabaceae)	ES	Bregonci et al. 2010
Aspidosperma sp. (Apocynaceae)	GO	Santos et al. 2018b
Bauhinia ungulata L. (Fabaceae)	GO	Santos et al. 2010
Bauhinia sp. (Fabaceae)	GO	Santos et al. 2018b
Byrsonima sericea DC. (Malpighiaceae)	RJ	Maia & Azevedo 2009
Calophyllum sp. (Calophyllaceae)	MG	Maia & Fernandes 2004
Copaifera langsdorffii Desf. (Fabaceae)	MG	Fernandes et al. 1988
Couepia ovalifolia (Schott) Benth. ex Hook.f. (Chrysobalanaceae)	RJ	Maia & Azevedo 2009
Dalbegia frutescens (Vell.) Button (Dilleniaceae)	MG	Fernandes et al. 1988
Erythroxylum ovalifolium Peyr. (Erythroxylaceae)	RJ	Maia & Azevedo 2009
Erythroxylum sp. (Erythroxylaceae)	GO	Santos et al. 2018b
Inga edulis Mart. (Fabaceae)	MG	Urso-Guimarães et al. 2003
Lantana camara L. (Verbenaceae)	RJ	Maia & Azevedo 2009
Leandra cf. *ionopogon* (Mart.) Cogn. (Melastomataceae)	SP	Maia et al. 2008
Manihot sp. (Euphorbiaceae)	GO	Santos et al. 2018b
Manilkara subsericea (Mart.) Dubard. (Sapotaceae)	RJ	Maia & Azevedo 2009
Matayba guianensis Aubl. (Sapindaceae)	SP	Maia et al. 2008
Microstachys corniculata (Vahl.) Griseb (=*Sebastiania glandulosa* (Mart.) Pax) (Euphorbiaceae)	RJ	Maia & Azevedo 2009
Mikania cf. *biformis* DC. (Asteraceae)	SP	Maia et al. 2008
Myrciaria floribunda (West. ex Will) Berg. (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Myrsine parvifolia A. DC. (=*Rapanea parvifolia* (A.DC.) Mez) (Primulaceae)	RJ	Maia & Azevedo 2009
Nematanthus fritschii Hoehne (Gesneriaceae)	SP	Maia et al. 2008
Neomitranthes obscura (DC.) N. Silveira (Myrtaceae)	RJ	Maia 2001, Maia & Azevedo 2009
Piptocarpha cf. *cinerea* Baker (Asteraceae)	SP	Maia et al. 2008
Psittacanthus dichroos (Mart.) Mart. (Loranthaceae)	RJ	Maia & Azevedo 2009
Varronia curassavica Jacq. (=*Cordia verbenacea* DC.) (Boraginaceae)	RJ	Maia 2001, Maia & Azevedo 2009

(all states), Sudeste (Minas Gerais, São Paulo). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic Forest.

Gall (Fig. 54): on leaf, lenticular, glabrous, green, one-chambered. Galler: Cecidomyiidae (Diptera). Other insects: Hymenoptera (parasitoids). Date: April/2012.

Gall (no fig.): on leaf, marginal roll, glabrous, green, one-chambered. Galler: Hemiptera. Date: April/2012.

Previous records: Fernandes et al. 1997/MG, Gonçalves-Alvim & Fernandes 2001/MG, Urso-Guimarães et al. 2003/MG, Maia & Fernandes 2004/MG, Araújo et al. 2007/GO, Araújo et al. 2011/GO, Santos et al. 2012b/GO, Araújo et al. 2014/GO, Araújo et al. 2015/GO, Silva et al. 2018a/BA, Silva et al. 2018b/GO.

Vochysia Aubl. sp. (n=1)

Native and non endemic plant genus. Distribution: Norte (Acre, Amazonas, Pará, Rondônia, Roraima, Tocantins), Nordeste (Bahia, Ceará, Maranhão, Pernambuco, Piauí, Sergipe), Centro-Oeste (Distrito Federal, Goiás, Mato Grosso do Sul, Mato Grosso), Sudeste (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo), Sul (Paraná, Santa Catarina). Biomes: Amazonian forest, Caatinga, Cerrado, Atlantic forest.

Gall (Fig. 55): on stem, globoid, glabrous, brown, multichambered. Galler: Undetermined. Date: April/2012.

Previous records: Fernandes et al. 1997 on *Vochysia elliptica* Mart. and *Vochysia* sp./MG, Almada & Fernandes 2011 on *V. vismiifolia* Spruce ex Warm. and *Vochysia* spp./PA, Fernandes et al. 2001 on *V. tucanorum* Mart. and *Vochysia* sp., Coelho et al. 2013 on *V. elliptica*/MG, Maia 2013 on *Vochysia* cf. *maxima* Ducke/MG, Araújo et al. 2014 on *Vochysia* sp./GO, Maia 2014 on *Vochysia* sp./MG, Araújo et al. 2015 on *Vochysia* sp./GO.

DISCUSSION

Fifty-eight gall morphotypes on 40 host plants were found in the present study. In other gall inventories of semideciduous forest areas, the number of gall morphotypes was 143 on 82 host plants (Maia & Carvalho-Fernandes 2016) and 65 on 40 (Urso- Guimarães et al. 2017). There is a third inventory published by Carvalho et al. (2015) where the number of gall morphotypes was not informed, but the authors recorded 35 host plants. Urso-Guimarães et al. (2017) and Carvalho et al. (2015) stablished transects, whereas Maia & Carvalho-Fernandes (2016) adopted the walking methodology as in the present work. The collecting effort also varied: Maia & Carvalho-Fernandes (2016) performed five expeditions, Urso-Guimarães et al. (2017) three and in Carvalho et al. (2015) this information is lacking. These differences can affect the results. Nevertheless, the number of galls found in the present work and that in Urso-Guimarães et al. (2017) was similar (Table VI).

The presence of endemic plants highlights the importance of the investigated areas. As the galling insects are species-specific, there is a great probability that the gallers associated with these species are endemic too. The conservational status of the host plants can not be discussed as most were not evaluate. The new records widened the knowledge of the host plants.

The average number of gall morphotypes per plant species was 1.45. Maia & Carvalho-Fernandes (2016) recorded a value of 1.74 and Urso-Guimarães et al. (2017) 2.6 (this medium was not informed by the authors, but it was calculated based on their data). Inventories in other Brazilian physiognomies and biomes recorded values from 1.20 to 2.70 (Maia 2011). So our medium fits with the known range.

The Sørensen's index showed low similarity of host plants between the present study and other previously published surveys. No morphotypes in commom was observed between Bodoquena x Rio de Janeiro and Bodoquena x Paraná. These results showed how the galling insect guild and the host plant composition vary among Atlantic Forest localities, evidencing the importance of preserving different areas of the same phytophysiognomy.

Salicaceae, Bignoniaceae, and Asteraceae were the superhost plant families, differing from Maia & Carvalho-Fernandes (2016), which

indicated Fabaceae, Myrtaceae and Sapindaceae as the superhosts. These authors also found galls on Salicaceae and Bignoniaceae, but not on Asteraceae. In Urso-Guimarães et al. (2017), Bignoniaceae, Rutaceae, Rubiaceae and Asteraceae were the plant families which hosted the highest number of gall morphotypes in semidecidous forest and they also found galls on Salicaceae. No botanical information was given by Carvalho et al. (2015). So, the status of superhost of Bignoniaceae and Asteraceae, previously indicated by Urso-Guimarães et al. (2017), are confirmed in the present study.

In our study, Asteraceae and Salicaceae presented the same gall richness. Nevertheless, they differ in the medium number of gall morphotypes per plant species: 2.25 in Asteraceae and 1.43 in Salicaceae. This happened because Asteraceae included a lower number of host species than that of Salicaceae.

Leaves were the most frequent galled plant organ as in all other inventories, confirming a pattern already known.

Globoid galls predominated. Carvalho et al. (2015), Maia & Carvalho- Fernandes (2016), Ansaloni et al. (2018), Silva et al. (2018a, b), Brito et al. (2018) and Vieira et al. (2018) found similar results, while Urso-Guimarães et al. (2017) and Bergamini et al. (2017) indicated lenticular galls as the most frequent. The internal space of globoid galls is wider than that of other shapes, such as lenticular and fusiform, for example. We think a wide space can prevent attacks of potencial enemies, especially parasitoids which lay eggs directly in the host. In a wide chamber, the galler can kept far from the gall surface and consequently from the reach of the enemy ovipositor.

Most galls were green or brown, the same color of the most galled plant organs – leaves and stems. These galls are visually less conspicuous than colorfull galls and this trait, in our opinion, can protect them against natural enemies. Colorfull galls can be easily detected by potencial enemies, so they can be attacked by them, unless these galls present some defensive traits, as chemical compounds, mechanical barriers and others. Inbar et al. (2010) proposed that colorfull galls which can be easily distinguished from the surrounding host plant organs are chemically protected and their aposematic coloration advertises their unpalatable qualities.

Glabrous galls were more common than galls with trichomes. According to Richardson (1943), trichomes can act as structural defenses against enemies as they impair feeding and mobility. As in our study most galls have the same color of the host organs, we believe that their criptic coloration assumes the defensive role.

One-chambered galls predominated and they were occupied by a single galling larva. We think that this feature avoid a more extensive mortality when the gall is attacked by enemies or when the galled organ suffers earlier senescence as only one galling individual is involved, differing from multichambered galls, where an attack can result in the death of several individuals.

The most frequent gallers were Cecidomyiidae (Diptera), the most important galling family throughout the world (Gagné 1994). In the present work, these midges are associated with *Adenocalymma allamandiflorum* (Bignoniaceae), *Psychotria borjensis* (Rubiaceae) and *Casearia ulmifolia* (Salicaceae) for the first time. Tephritidae have been recorded as galler on other *Vernonia* species in Brazil, as *V. rufogrisea* A. St.-Hill in RJ (Maia 2001), *V. polyanthes* Less. in MG (Maia & Fernandes 2004) and *V. beyrichii* Less. in SP (Maia et al. 2008). Galls induced Hemiptera and Thysanoptera are less frequent than those induced by Cecidomyiidae. Although the former have been recorded on 37 plant families in Latin

America (Maia 2006), including Salicaceae, this is their first report on *Salix humboldtiana*.

The associated fauna was composed of several taxa, all already recorded in other Brazilian inventories. Only four previous records of Muscomorpha as gall inquilines are known: on *Myrciaria tenella (*DC). O. Berg (Myrtaceae) in MG (Maia & Fernandes 2004), on Sapindaceae sp. in ES (Maia et al. 2014), on *Securidaca* sp. (Polygalaceae) in RJ (Rodrigues et al. 2014), and on *Selenicereus setaceus* (Salmi-Duck) A. Berg. ex Werderm. in RJ (Maia & Souza 2013). The present record on *Casearia ulmifolia* (Salicaceae) is new.

Nine records of *Trotteria* were already known: on *Eugenia copacabanensis* Kiaersk (Myrtaceae) in RJ (Maia 1995), on *Mikania* cf. *biformis* DC. (Asteraceae), *Ocotea lobbii* (Meisn.) Rohwer, *O. pulchella* (Ness.) Mez. (Lauraceae), and *Myrcia fallax* (Rich.) DC. (Myrtaceae) in SP (Maia et al. 2008), on *Myrcia* sp. (Myrtaceae) in ES (Maia et al. 2014), on *Pouteria caimito* (R. and P.) Radlk. (Sapotaceae) in RJ (Maia 2001), on *Pouteria torta* (Mart.) Radlk. (Sapotaceae) in SP (Saito & Urso-Guimarães 2012), and on *Serjania lethalis* A.St.-Hil in SP (Ansaloni et al. 2018). The record on *Adenocalymma allamandiflorum* (Bignoniaceae) is new.

Psocopteran successors were previously reported in galls on ten plants species: *Smilax coriifolia* A. DC. (Smilacaceae) in MG (Urso-Guimarães et al. 2003), *Mikania* cf. *biformis*, *Maytenus robusta* Reiss. (Celastraceae), and *Pouteria venosa* (Mart.) Baehni (Sapotaceae) in SP (Maia et al. 2008), *Chaetocarpa myrsinites* Baill. (Euphorbiaceae) in ES (Bregonci et al. 2010), *Eugenia bunchosiifolia* Nied. (Myrtaceae) in RJ (Maia & Carvalho-Fernandes 2016), *Protium heptaphyllum* (Aubl.) Marchand (Burseraceae), *Bauhinia longifolia* (Bong.) Steud. (Fabaceae), *Copaifera langsdorffii* Desf. (Fabaceae) in SP (Ansaloni et al. 2018), and *Senegalia langsdorffii* (Benth.) Seigler & Ebinger (Fabaceae) in BA (Brito et al. 2018). The records on *Vernonanthura brasiliana* and *Zanthoxylum* L. (Rutaceae) are new.

Eulophidae are one of the most frequent parasitoids of galling insects in Brazil (Maia & Azevedo 2009), with records on 65 plant species (Table VII). Pteromalidae are other common parasitoids of gallers in Brazil, but less frequent than Eulophidae, occurring on 22 plant species (Table VIII). In the present study, both families are associated for the first time with *Eugenia patrisii* (Myrtaceae).

The investigated area comprised 58 gall morphotypes on 40 host plants, and probably 14 endemic galling species. The medium number of gall morphotypes per plant species fit with the known Brazilian range.

Bignoniaceae and Asteraceae were confirmed as super host families, whereas Salicaceae were indicated for the first time.

Leaves were the most frequent galled plant organ. Galls with globoid shape, green and brown colors, glabrous surface, and a single internal chamber predominated. Cecidomyiidae were the most common gallers and a diverse associated fauna was found. Thus, patterns already known in Brazil were confirmed.

Several new records were presented, which contributed to increase the current knowledge of galling insect–host plant interaction.

Acknowledgments

S. Ascendino thanks to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the master's scholarship. VCM thanks to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (Process: 301481/2017- 2) for the productivity grant. We thank to the CNPq) (Process: 563256/2010-9) and Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (Process: 10/52314-0) for the financial assistence.

REFERENCES

ALMADA ED & FERNANDES GWA. 2011. Insetos indutores de galhas em florestas de terra firme e em reflorestamentos com espécies nativas na Amazonian Forest Oriental, Pará, Brasil. Bol Mus Para Emílio Goeldi Sér Ciênc Nat 6(2): 163-196.

ANSALONI LS, SALMAZO JR & URSO GUIMARÃES MV. 2018. Entomogen galls in a Seasonal Semideciduous Forest area in Sorocaba, Southeast of São Paulo State, Brazil. Biota Neotropic 18(4): e20180523.

ARAÚJO WS, SANTOS BB, FERREIRA HD & LOUSA TC. 2007. Ocorrência de galhas entomógenas na vegetação do Campus da UFG, em Goiânia, Goiás. Rev Bras Biociênc 5(1): 57-59.

ARAÚJO WS, SANTOS BB & GOMES-KLEIN VL. 2011. Insect galls from Serra dos Pirineus, GO, Brazil. Biota Neotrop 11(2): 357-365.

ARAÚJO WS, PORFÍRIO JUNIOR ED, JORGE VA & ESPIRITO-SANTO FILHO K. 2012. Plantas hospedeiras e galhas entomógenas em sub-bosques de florestas tropicais do Pará, Brasil. Insula 41: 59-72.

ARAÚJO WS, SOBRAL FL & MARACAHIPES L. 2014. Insect galls of the Parque Nacional das Emas (Mineiros, GO, Brazil). Check List 10(6): 1445-1451.

ARAÚJO WS, PORFÍRIO JUNIOR ED, RIBEIRO BA, SILVA TM, SILVA EC, GUILHERME FAG, SCARELI-SANTOS C & SANTOS BB. 2015. Checklist of host plants of insect galls in the state of Goiás in the Midwest region of Brazil. Biodivers Data J (3): e6835.

ASCENDINO S & MAIA VC. 2018. Insects galls of Pantanal areas in the State of Mato Grosso do Sul, Brazil: characterization and occurrence. An Acad Bras Cienc 90: 1543-1564. https://doi.org/10.1590/0001-3765201820170535.

BERGAMINI BAR, BERGAMINI LL, SANTOS BB & ARAÚJO WS. 2017. Occurrence and characterization of insect galls in the Floresta Nacional de Silvânia, Brazil. Pap Avulsos Zool 57(32): 413-431.

BREGONCI JM, POLYCARPO PV & MAIA VC. 2010. Galhas de insetos do Parque Estadual Paulo César Vinha (Guarapari, ES, Brasil). Biota Neotrop 10(1): 265-274.

BRITO GP, COSTA EC, CARVALHO-FERNANDES SP & SANTOS-SILVA J. 2018. Riqueza de galhas de insetos em áreas de Caatinga com diferentes graus de antropização do estado da Bahia, Brasil. Iheringia Sér Zool 108: e2018003.

CARVALHO-FERNANDES SP, ALMEIDA-CORTEZ J & FERREIRA ALN. 2012. Riqueza de galhas entomógenas em áreas antropizadas e preservadas de caatinga. Rev Árvore 36(2): 269-277.

CARVALHO-FERNANDES SP, ASCENDINO S, MAIA VC & COURI MS. 2016. Diversity of insect galls associated with coastal shrub vegetation in Rio de Janeiro, Brazil. An Acad Bras Cienc 88: 1407-1418. https://doi.org/10.1590/0001-3765201620150658.

CARVALHO-FERNANDES SP, CASTELO-BRANCO BP, ALBUQUERQUE FA, FERREIRA ALN, BRITO-RAMOS AB, BRAGA DVV & ALMEIDA-CORTEZ J. 2009. Galhas entomógenas em um fragmento urbano de Atlantic forest no centro de endemismo de Pernambuco. Rev Bras Biociênc 7(3): 240-244.

CARVALHO LLG, SANTOS RNS & BARBOSA JF. 2015. Ocorrência de galhas entomógenas em plantas do Parque Florestal dos Pioneiros em Maringá, Paraná, Brasil. Rev Uningá Review 23(1): 21-23.

COELHO MS, ALMADA ED, FERNANDES GW, CARNEIRO MAA, SANTOS RM, QUINTINO AV & SANCHES-AZOFEIFA A. 2009. Gall inducing arthropods from a seasonally dry tropical forest in Serra do Cipó, Brazil. Rev Bras Entomol 53(3): 404-414.

COELHO MS, CARNEIRO MAA, BRANCO CA & FERNANDES GW. 2013. Gall-inducing insects from Serra do Cabral, Minas Gerais, Brazil. Biota Neotrop 13(3): 102-108.

FERNANDES GW, ARAÚJO RC, ARAÚJO SC, LOMBARDI JA, PAULA AS, LOYOLA JUNIOR R & CORNELISSEN TG. 1997. Insect galls from savana and rocky fields of the Jequitinhonha Valley, Mina Gerais, Brazil. Naturalia 22: 221-244.

FERNANDES GW, JULIÃO GR, ARAÚJO RC, ARAÚJO SC, LOMBARDI JA, NEGREIROS D & CARNEIRO MA. 2001. Distribution and morphology of insect galls the Rio Doce Valley, Brazil. Naturalia 26: 211-244.

FERNANDES GW & NEGREIROS D. 2006. A comunidade de insetos galhadores da RPPN Fazenda Bulcão, Aimorés, Minas Gerais, Brasil. Lundiana 7(2): 111-120.

FERNANDES GW, TAMEIRÃO NETO ET & MARTINS RP. 1988. Ocorrência e caracterização de galhas entomógenas do Campus Pampulha da Universidade Federal de Minas Gerais. Rev Bras Zool 5(1): 11-29.

FLORA DO BRASIL. 2020. em construção. Jardim Botânico do Rio de Janeiro. Available from: <http://floradobrasil.jbrj.gov.br/>. Accessed in: 27.mar.2017.

FLOR IC, FLOR JCR & FURTADO PSN. 2018. Insect galls of the Floresta da Cicuta (Volta Redonda, RJ, Brazil). Pap Avulsos Zoo 58: e20185824.

GAGNÉ RJ. 1994. The gall midges of the Neotropical region. Ithaca, Cornell University Press, 352 p.

GOETZ APM, LUZ FA, TOMA TSP & MENDONÇA JUNIOR MS. 2018. Gall-inducing insects of deciduous and semideciduous forests in Rio Grande do Sul State, Brazil. Iheringia Sér Zool 108: e2018015.

GONÇALVES-ALVIM S & FERNANDES GW. 2001. Comunidades de insetos galhadores (Insecta) em diferentes fisionomias do cerrado em Minas Gerais, Brasil. Rev Bras Zool 18 (Supl. 1): 289-305.

INBAR M, IZHAKI I, KOPLOVICH A, LUPO I, SILANIKOVE N, GLASSER T, GERCHMAN Y, PEREVOLOTSKY A & LEV-YADUNS S. 2010. Why do many galls have conspicuous colors? A new hypothesis. Arthropod-Plant Interactions 4: 1-6.

JULIÃO GR, AMARAL MEC & FERNANDES GW. 2002. Galhas de insetos e suas plantas hospedeiras no pantanal Sul-Mato-Grossense. Naturalia 24: 47-74.

LIMA VP & CALADO D. 2018. Morphological characterization of insect galls and new records of associated invertebrates in a Cerrado area in Bahia State, Brazil. Braz J Bio 78(4): 636-643.

LIMA ES, MAGENTA MAG, KRAUS JE, VECHI C & MARTINS SE. 2000. Levantamento preliminar de galhas entomógenas ocorrentes em plantas das restingas de Bertioga (SP). Anais do V Simpósio de Ecossistemas Brasileiros: Conservação, ACIESP 109(III): 39-46.

LUZ GR, FERNANDES GW & SILVA JO. 2012. Galhas de insetos em *habitat*s xérico e mésico em região de transição Cerrado-Caatinga no norte de Minas Gerais, Brasil. Neotrop Biol Conserv 7(3): 171-187.

MAIA VC. 1995. Chaves para classificação de galhas de Cecidomyiidae (Diptera) em Myrtaceae na restinga da Barra de Maricá, Rio de Janeiro. Rev Bras Zool 12(41): 1009-1013.

MAIA VC. 2001. The gall midges (Diptera, Cecidomyiidae) from three restingas of Rio de Janeiro State, Brazil. Rev Bras Zool 18(2): 305-656.

MAIA VC. 2006 Galls of Hemiptera, Lepidoptera and Thysanoptera from Central and South America. Publicações Avulsas do Museu Nacional 110: 01-24.

MAIA VC. 2011. Characterization of insect galls, gall makers, and associated fauna of Platô Bacaba (Porto de Trombetas, Pará, Brazil). Biota Neotrop 11(4): 37-53.

MAIA VC. 2013. Insect galls of São Tomé das Letras (MG, Brazil). Biota Neotrop 13(4): 164-189.

MAIA VC. 2014. Insect galls of Itamonte (Minas Gerais, Brazil): characterization and occurrence. Biota Neotrop 14(1): 1-17.

MAIA VC & AZEVEDO MAP. 2009. Micro-himenópteros associados com galhas de Cecidomyiidae (Diptera) em Restingas do Estado do Rio de Janeiro (Brasil). Biota Neotrop 9(2): 151-164.

MAIA VC, CARDOSO JLT & BRAGA JMA. 2014. Insect galls from Atlantic Forest areas of Santa Teresa, Espírito Santo, Brazil: characterization and occurrence. Bol Mus Biol Mello Leitão, Nova Ser 33: 47-129.

MAIA VC & CARVALHO-FERNANDES SP. 2016. Insect galls of a protected remnant of the Atlantic Forest tableland from Rio de Janeiro State (Brazil). Rev Bras Entomol 60(1): 40-56.

MAIA VC & FERNANDES GW. 2004. Insect galls from Serra de São José (Tiradentes, MG, Brazil). Braz J Biol 64(3A): 423-445.

MAIA VC, MAGENTA MAG & MARTINS SE. 2008. Ocorrência e caracterização de galhas de insetos em áreas de restinga de Bertioga (São Paulo, Brasil). Biota Neotrop 8(1): 167-197.

MAIA VC & MASCARENHAS B. 2017. Insect Galls of the Parque Nacional do Itatiaia (Southeast Region, Brazil). An Acad Bras Cienc 89: 505-575. https://doi.org/10.1590/0001-3765201720160877.

MAIA VC & OLIVEIRA JC. 2010. Galhas de insetos da Reserva Biológica Estadual da Praia do Sul (Ilha Grande, Angra dos Reis, RJ). Biota Neotrop 10(4): 227-238.

MAIA VC & SILVA LO. 2016. Insect galls of Restinga de Marambaia (Barra de Guaratiba, Rio de Janeiro, RJ). Braz J Biol 76(3): 787-795.

MAIA VC & SOUZA MC. 2013. Insect galls of the xeric vegetation of Ilha do Cabo Frio (Arraial do Cabo, RJ, Brazil). Biota Neotrop 13(3): 278-288.

MALVES K & FRIEIRO-COSTA FA. 2012. List of plants with galls induced by insects from the UNILAVRAS/Boqueirão Biological Reserve, Ingaí, State of Minas Gerais, Brazil. Check List 8(3): 426-439.

MENDONÇA MS, TOMA TSP & SILVA JS. 2014. Galls and galling arthropods of Southern Brazil. In: Fernandes GW & Santos JC (Eds), Neotropical Insect Galls, London. Springer, p. 221-256.

MONTEIRO RF, FERRAZ FFE, MAIA VC & AZEVEDO MAP. 1994. Galhas entomógenas em restingas: uma abordagem preliminar. ACIESP 3: 210-220.

OLIVEIRA JC & MAIA VC. 2005. Ocorrência e caracterização de galhas de insetos na restinga de Grumari (Rio de Janeiro, RJ, Brasil). Arq MusNac 63(4): 669-676.

RICHARDSON H. 1943. The action of bean leaves against the bedbug. J Econ Entomol 36(1): 543-545.

RODRIGUES AR, MAIA VC & COURI MS. 2014. Insect galls of restinga areas of Ilha da Marambaia, Rio de Janeiro, Brazil. Rev Bras Entomol 58(2): 173-197.

SAITO VC & URSO-GUIMARÃES MV. 2012. Characterization of galls, insect galls and associated fauna of Ecological Station of Jataí (Luiz Antônio, SP). Biota Neotrop 12(3): 99-107.

SANTOS BB, FERREIRA HD & ARAÚJO WS. 2010. Ocorrência e caracterização de galhas entomógenas em uma área de floresta estacional semidecídua em Goiânia, Goiás, Brasil. Acta Bot Bras 24(1): 243-249.

SANTOS JC, ALMEIDA-CORTEZ JS & FERNANDES GW. 2011a. Diversity of gall-inducing insects in the high altitude wetland forests in Pernambuco, Northeastern Brazil. Braz J Biol 71(1): 47-56.

SANTOS JC, ALMEIDA-CORTEZ JS & FERNANDES GW. 2011b. Richness of gall-inducing insects in the tropical dry forest (caatinga) of Pernambuco. Rev Bras Entomol 55(1): 45-54.

SANTOS JC, ALMEIDA-CORTEZ JS & FERNANDES GW. 2012a. Gall-inducing insects from Atlantic forest of Pernambuco, Northeastern Brazil. Biota Neotrop 12(3): 197-213a.

SANTOS JC, RIBEIRO BA, SILVA TM & ARAUJO WS. 2012b. Galhas de insetos em uma área de cerrado sentido restrito na região semi-urbana de Caldas Novas (Goiás, Brasil). Rev Bras Biociênc 10(4): 439-445.

SANTOS PO & RIBEIRO JELS. 2015. Ocorrência e caracterização de galhas em fragmento de Floresta Estacional Semidecidual em Telêmaco Borba, Paraná, Brasil. Semin Ciênc Biol Saúde 36(2): 15-24.

SILVA ARF, NOGUEIRA RM, COSTA EC, CARVALHO-FERNANDES SP & SILVA JS. 2018a. Occurrence and characterization of entomogenic galls in an area ofCerrado sensu stricto and Gallery forest of the state of Bahia, Brazil. An Acad Bras Cienc 90: 2903-2919. https://doi.org/10.1590/0001-3765201820170522.

SILVA EC, SANTOS BB & ARAÚJO WS. 2018b. Insect gall occurrence in savanna and forest remnant sites of Hidrolândia, GO, Brazil Central. Pap Avulsos Zool 58: e20185804.

SØRENSEN TA. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content, and its application to analyses of the vegetation on Danish commons. Kongelige Danske videnskabernes selskab. Biol. skr. 5: 1-34.

TOMA TSP & MENDONÇA JUNIOR MS. 2013. Gall-inducing insects of an Araucaria Forest in southern Brazil. Rev Bras Entomol 57(2): 225-233.

URSO-GUIMARÃES MV, CASTELLO ACD, KATAOKA EY & KOCH I. 2017. Characterization of entomogen galls from Mato Grosso do Sul, Brazil. Rev Bras Entomol 61(1): 25-42.

URSO-GUIMARÃES MV, SCARELI-SANTOS C & BONIFÁCIO-SILVA AC. 2003. Occurrence and characterization of entomogen galls from natural vegetation areas in Delfinópolis, MG, Brazil. Braz J Biol 63(4): 705-715.

VIEIRA LG, NOGUEIRA RM, COSTA EC, CARVALHO-FERNANDES SP & SILVA JS. 2018 Insect galls in Rupestrian field and Cerrado stricto sensu vegetation in Caetité, Bahia, Brazil. Biota Neotropic 18(2): e20170402.

Manuscript received on September 11, 2019;
accepted for publication on January 15, 2020

SHARLENE ASCENDINO
https://orcid.org/0000-0002-1742-7364

VALÉRIA CID MAIA
https://orcid.org/0000-0001-9396-5618

Museu Nacional, Depto. De Entomologia, Quinta da Boa Vista, São Cristóvão, 20940-040 Rio de Janeiro, RJ, Brazil

Correspondence to: **Sharlene Ascendino**
E-mail: ascendinosh@gmail.com

Author contributions

Sharlene Ascendino carried out fieldworks, laboratory procedures, analysus and writing and Valéria Cid Maia carried out analysys and writing.

CC BY