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OCCURRENCE AND CHARACTERIZATION OF INSECT GALLS IN THE FLORESTA NACIONAL DE SILVÂNIA, BRAZIL

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ABSTRACT

In the present paper we investigated the insect gall distribution along savanna and forest sites in the Floresta Nacional de Silvânia, Goiás, Brazil. The insect gall fauna was surveyed bi-monthly between December 2009 and June 2010. In total we found 186 insect gall morphotypes, distributed on 35 botanical families and 61 plant species. Ninety-nine insect gall morphotypes were recorded in the forest and 87 in the savanna. Gall-inducing insects belonged to Coleoptera, Diptera, Hemiptera, Lepidoptera and Thysanoptera, with highlight to Cecidomyiidae (Diptera) that induced 34.1% of the gall morphotypes. Parasitoids and/or inquiline were recorded in 38 morphotypes, mainly from the families Eulophidae, Eurytomidae and Torymidae (Hymenoptera). Fabaceae was the botanical family with the greatest richness of galls, followed by Asteraceae and Sapindaceae, being Protium (Burseraceae), Siparuna (Siparunaceae) and Serjania (Sapindaceae) the main host genera. This is the first systematic survey of insect galls realized in the Flona-Silvânia, which result in six plant species are recorded for the first time in Brazil as host of insect galls.

KEY-WORDS: Cecidomyiidae; Cerrado; Fabaceae; Plant-insect interaction.

INTRODUCTION

The Cerrado is the second largest phytogeographical domain of Brazil, occupying 23% of the national territory (Oliveira & Marquis, 2002). The region is composed by many different types of veg-

etation, which can be characterized in savanna (e.g., grasslands, rock fields and typical savannas) and forest formations (e.g., semideciduous forest and gallery forest) (Ribeiro & Walter, 2008). The great vegetation heterogeneity of Cerrado is caused by variations in fire, climate, water availability and soil fertility

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(Oliveira-Filho & Ratter, 2002), turning the region in a mosaic of xeric (*i.e.*, poor in water and nutrients) and mesic vegetation (*i.e.*, rich in water and nutrients). Because of this great structural and floristic diversity the Cerrado is one of the hotspots of insect gall diversity in the globe (Araújo *et al.*, 2014a), which justify the efforts to diminish temporal and spatial gaps in the group sampling (*e.g.*, Araújo, 2011; Maia *et al.*, 2014).

Taxonomic knowledge of galling insects in the Cerrado is scarce, because the most of galling species have not yet been described (Araújo *et al.*, 2014a). Because of this, inventories of insect galls in the Cerrado identify galling insects only at the order or family level, with Diptera (Cecidomyiidae), Lepidoptera and Hemiptera being the most speciose taxa (Gonçalves-Alvim & Fernandes, 2001; Maia & Fernandes, 2004; Araújo *et al.*, 2011). Cecidomyiidae is responsible for approximately 70% of all gall morphospecies from the Cerrado (Araújo *et al.*, 2014a), being this also the main group of galling insects in the Neotropical region (Gagné, 1994). Furthermore, insect gall inventories in the Cerrado found recurrently that the Fabaceae is the most important host plant family (Fernandes *et al.*, 1997; Gonçalves-Alvim & Fernandes, 2001; Maia & Fernandes, 2004; Urso-Guimarães & Scareli-Santos, 2006; Araújo *et al.*, 2011). Other host plant families often recorded in studies performed in the Cerrado are the Asteraceae and Myrtaceae (Maia & Fernandes, 2004; Urso-Guimarães & Scareli-Santos, 2006; Malves & Frieiro-Costa, 2012). All these fami-

lies are listed among those with the highest plant species richness in the Cerrado (Mendonça *et al.*, 2008).

The vast majority of insect gall inventories in the Cerrado have been performed in southeastern Brazil, whereas other regions which host the largest Cerrado area are still poorly studied (review in Araújo *et al.*, 2014a). The Floresta Nacional de Silvânia (Flona-Silvânia) is a sustainable use conservation unit located in the city of Silvânia, State of Goiás, Midwest Brazil. The area of the park is of 466.55 ha being mostly composed by a flat tableland at 900 m asl (Francener *et al.*, 2012). The Flona-Silvânia exhibits almost all types of Cerrado vegetation, but mainly typical savanna and forest (gallery forest and semideciduous forest), which occupy 70% of the area of the park (Araújo *et al.*, 2012). Recent studies in the park pointed a great phytophysiological complexity in the vegetation (Araújo *et al.*, 2012), and a high floristic diversity, with 244 phanerogamic species recorded (Francener *et al.*, 2012). Therefore, the objective of the present study was to inventory the galling insects and their host plants in forest and savanna areas in the Flona-Silvânia, Goiás, Brazil.

MATERIAL AND METHODS

Study site

The study was performed in the Flona-Silvânia (Fig. 1) in areas of typical savanna (16°38'11.79"S and

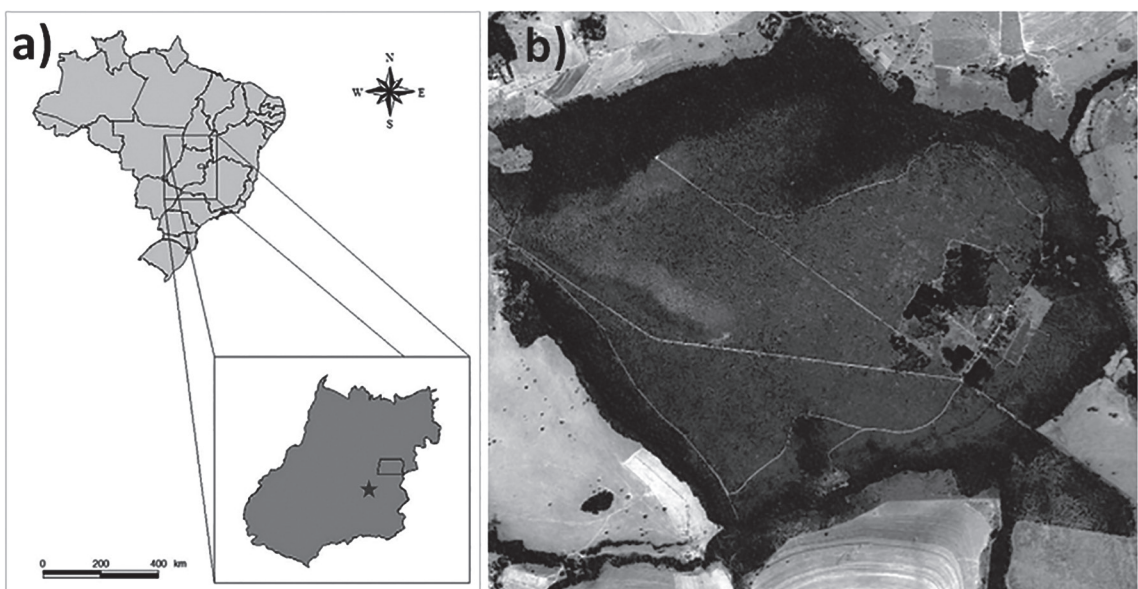


FIGURE 1: Location and characterization of the study area. (A) Location of the Flona-Silvânia (marked by the star) in the city of Silvânia, State of Goiás, Midwest of Brazil. (B) Map of the Flona-Silvânia showing the areas of savanna (clear areas) and forest (dark areas).

48°39'50.82"W) and gallery forest (16°37'52.90"S and 48°39'52.38"W). The typical savanna vegetation is characterized by spaced trees and a matrix of shrubs and grasses, while the gallery forest is located on the banks of a stream and dominated by trees and high and closed canopy (Araújo *et al.*, 2012). The climate of the Flona-Silvânia region is classified as Aw of Köppen (Alvares *et al.*, 2013), being humid tropical with well-defined dry (April to September) and rainy (October to March) seasons.

Data collection

The insect gall sampling was done bi-monthly between December 2009 and June 2010 through active searches, with duration of 01h30min, along four fixed transects, being two in each vegetation type. In each transect, two collectors inspected the epigeous parts of all host plants and all observed insect galls were registered (Araújo *et al.*, 2011; Santos *et al.*, 2012; Silva *et al.*, 2015). Samples of each insect galls were photographed, collected and transported individually in labeled plastic bags. Plant branches of each host plant were collected, part of the material being dried and mounted for botanical identification, the remainder being used to obtain the immature and adult insects, in the laboratory. The identification of the host plant species was made by comparison with the collection of UFG herbarium. We checked plant species nomenclature and synonymy using the database of The Plant List (2017) (<http://theplantlist.org>).

The collected insect galls were taken to the laboratory of Universidade Federal de Goiás (UFG) and packed in plastic container with moistened paper. Insect galls were classified into morphotypes using the host plant species and external morphology (organ of occurrence, shape, color, pubescence and size). Nomenclature of the insect gall morphotypes was standardized according to the proposed by Isaías *et al.* (2013). In laboratory, the galls were daily observed to verify the emergence of adult insects or dissected to obtainment of immature insects. All insects were fixed in 70% alcohol and identified using the insect gall literature from Neotropic and Brazil (*e.g.*, Gagné, 1994; Maia & Fernandes, 2004; Araújo *et al.*, 2011). Gall morphotypes were used as a surrogate for species of gall-inducing insects because there is a consensus in the literature about host-specificity and morphological-fidelity of insect galls (reviewed in Carneiro *et al.*, 2009a). Galls, insects and host plants were deposited in the insect gall collection of the Laboratory of Entomology of UFG.

RESULTS

A total of 186 insect gall morphotypes from five insect orders, and 61 species of host plants from 35 plant families were recorded in the Flona-Silvânia (Table 1, Figs. 2-6). The average number of gall morphotypes per plant species was 3.0. We found gall-inducing insects belonging to Coleoptera, Diptera, Hemiptera, Lepidoptera and Thysanoptera (Table 2). The most common insect taxon was Cecidomyiidae (Diptera), which induced 64 (34.4%) gall morphotypes. Insect galls induced by other insect orders summed 9.7% of the insect gall morphotypes. The taxa of gall-inducing insects could not be determined for 55% of the gall morphotypes. Other insects such as hymenopteran parasitoids (Chalcididae, Braconidae, Elasmidae, Eulophidae, Eupelmidae, Eurytomidae, Tetracampidae, Torymidae and Trichogrammatidae), and dipteran (Sciaridae and Brachycera), hymenopteran (Tanaostigmatidae) and thysanopteran (Phlaeothripidae) inquilines occurred in 38 (20%) insect galls (see Table 1).

The plant families that showed the greatest richness of insect galls were Fabaceae, with 18 morphotypes, Asteraceae with 17, Sapindaceae with 16, Burseraceae and Myrtaceae with 14, Siparunaceae with 12, and Celastraceae and Rubiaceae with 10 morphotypes (Table 3). The remaining families had less than 10 insect gall morphotypes each. The plant genera *Protium* (Burseraceae), *Siparuna* (Siparunaceae), *Serjania* (Sapindaceae) and *Bauhinia* (Fabaceae) were the richest hosts in number of insect gall morphotypes (14, 12, 12 and 10, respectively). Also noteworthy are the plant species *Protium heptaphyllum* (Aubl.) Marchand, *Siparuna guianensis* Aubl. and *Serjania* sp. that hosted 14, 12 and 12 insect gall morphotypes, respectively.

About the gall occurrence and morphology, most of the recorded insect galls occurred on leaf lamina (68.2%), and were fusiform (38.7%), greens (38.7%) and glabrous (37.6%). Among the 61 host plant species listed in the survey, six species (9.8%) have the

TABLE 2: Insect order, number of insect gall morphotypes and number of host plant species recorded in the Flona-Silvânia, Goiás, Brazil.

Insect order	Insect gall morphotypes		Host plant species	
	Richness	%	Richness	%
Diptera	64	34.40	28	45.90
Hemiptera	8	4.30	8	13.11
Lepidoptera	8	4.30	8	13.11
Coleoptera	1	0.54	1	1.64
Thysanoptera	1	0.54	1	1.64
Undetermined	104	55.91	43	70.49

TABLE 1: Characterization of the insect gall morphotypes recorded in host plants of gallery forest (F) and typical savanna (S) vegetation in the Flona-Silvânia, Goiás, Brazil.

Plant family	Host plants		Insect gall morphology						Insect taxa		
	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects	
Acanthaceae	Acanthaceae sp.	Gall 1	Leaf/midvein	Fusiform	Brown	Glabrous	0.7	F	—	—	
		Gall 2	Leaf/midvein	Fusiform	Green	Pubescent	—	F	Lepidoptera	—	
		Gall 3	Leaf/midvein	Fusiform	Green	Roughened	0.5	F	—	—	
		Gall 4	Leaf/midvein	Fusiform	Yellow	Glabrous	—	F	—	Chalcididae (Hymenoptera) (parasitoid)	
Anacardiaceae	Anacardiaceae sp.	Gall 5	Leaf	Globoid	Green	Roughened	0.2	F	—	Eurytomidae (Hymenoptera) (parasitoid)	
		Gall 6	Leaf	Lenticular	Green	Roughened	0.2	S	Coccoidea (Hemiptera)	—	
Annonaceae	<i>Litsea molleoides</i> (Vell.) Engl	Gall 7	Leaf	Lenticular	Pink	Roughened	0.3	S	—	—	
		Gall 8	Leaf	Fusiform	Green	Pubescent	0.8	F	—	—	
Apocynaceae	<i>Xylopia sericea</i> A. St.-Hil.	Gall 9	Leaf	Globoid	Green	Glabrous	0.2	F	—	—	
		Gall 10	Leaf	Lenticular	Green	Glabrous	0.5	S	Coccoidea (Hemiptera)	—	
Asteraceae	<i>Aspidosperma tomentosum</i> Mart.	Gall 11	Leaf	Cylindrical	Yellow	Pubescent	0.2	S	Hemiptera	—	
		Gall 12	Leaf	Lenticular	Yellow	Glabrous	0.2	S	—	—	
		Gall 13	Leaf	Globoid	Green	Pubescent	0.2	S	—	Eulophidae (Hymenoptera) (parasitoid)	
		Gall 14	Leaf/midvein/petiole	Fusiform	Green	Pubescent	1.0	S	—	—	
		Gall 15	Stem	Fusiform	Brown	Roughened	1.5	S	—	—	
Asteraceae	Asteraceae sp.	Gall 16	Stem	Fusiform	Green	Pubescent	1.0	S	—	—	
		Gall 17	Stem	Globoid	Brown	Pubescent	0.7	S	—	—	
		Gall 18	Stem	Globoid	Green	Glabrous	5.0	S	—	—	
		Gall 19	Leaf	Lenticular	Brown	Glabrous	0.2	S	—	—	
		Gall 20	Leaf	Globoid	Yellow	Roughened	0.5	S	—	—	
		Gall 21	Stem	Globoid	Brown	Roughened	1.0	S	—	—	

Host plants		Insect gall morphology						Insect taxa				
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects		
Bignoniaceae	<i>Gochmatia barrosii</i> Cabrerá	Gall 22	Leaf	Lenticular	Green	Pubescent	0.2	S	—	—		
		Gall 23	Leaf	Lenticular	Yellow	Roughened	0.5	S	—	—		
		Gall 24	Leaf	Globoïd	Brown	Pubescent	—	S	—	Cecidomyiidae (Diptera)	—	
		Gall 25	Leaf	Globoïd	Yellow	Pubescent	0.3	S	—	—	—	
		Gall 26	Stem	Fusiform	Gray	Roughened	1.3	S	—	—	Sciariidae (Diptera) (inquiline)	
		Gall 27	Leaf	Fusiform	Brown	Roughened	1.0	S	—	—	—	
	Bignoniaceae	<i>Piptocarpha rotundifolia</i> (Less.) Baker	Gall 28	Leaf	Fusiform	Green	Pubescent	0.5	S	—	Cecidomyiidae (Diptera)	—
			Gall 29	Stem	Globoïd	Brown	Roughened	1.0	S	—	—	—
			Gall 30	Stem	Fusiform	Brown	Roughened	1.2	F	—	Cecidomyiidae (Diptera)	—
			Gall 31	Stem	Fusiform	Green	Roughened	0.5	F	—	Cecidomyiidae (Diptera)	—
			Gall 32	Stem	Fusiform	Green	Roughened	1.5	F	—	Cecidomyiidae (Diptera)	—
			Gall 33	Stem	Fusiform	Yellow	Roughened	1.0	S	—	Curculionidae (Coleoptera)	—
			Gall 34	Leaf	Cylindrical	Green	Pubescent	0.2	F	—	Cecidomyiidae (Diptera)	—
			Gall 35	Leaf	Lenticular	Brown	Roughened	0.1	F	—	Cecidomyiidae (Diptera)	—
			Gall 36	Leaf	Lenticular	Green	Glabrous	0.2	F	—	Cecidomyiidae (Diptera)	—
			Gall 37	Leaf	Fusiform	Green	Glabrous	0.8	F	—	Cecidomyiidae (Diptera)	—
	Burséraceae	<i>Tabebuia</i> sp. <i>Protium heptaphyllum</i> (Aubl.) Marchand	Gall 38	Leaf	Fusiform	Yellow	Glabrous	0.9	F	—	Phlaeothripidae	—
			Gall 39	Leaf	Globoïd	Green	Roughened	0.3	F	—	Cecidomyiidae (Diptera)	—
			Gall 40	Leaf/midvein	Lenticular	Green	Roughened	0.3	F	—	Cecidomyiidae (Diptera)	—
			Gall 41	Leaf/midvein	Fusiform	Brown	Roughened	0.7	F	—	Cecidomyiidae (Diptera)	—
			Gall 42	Leaf/midvein	Fusiform	Green	Glabrous	0.3	F	—	Cecidomyiidae (Diptera)	—
			Gall 43	Leaf/midvein	Fusiform	Yellow	Glabrous	0.3	F	—	Cecidomyiidae (Diptera)	—
			Gall 44	Leaf/midvein	Fusiform	Yellow	Roughened	0.5	F	—	Cecidomyiidae (Diptera)	—
			Gall 45	Leaf/stem	Fusiform	Green	Glabrous	1.0	F	—	Cecidomyiidae (Diptera)	—
			Gall 46	Leaf/stem	Globoïd	Green	Glabrous	0.8	F	—	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)
			Celastraceae	Celastraceae sp.	Gall 47	Stem	Globoïd	Brown	Roughened	—	F	—
Gall 48	Leaf	Conical			Green	Glabrous	0.1	F	—	—	—	
Gall 49	Leaf	Lenticular			Brown	Glabrous	—	F	—	—	—	
Gall 50	Leaf	Lenticular			Brown	Roughened	0.4	F	—	—	—	

Host plants			Insect gall morphology						Insect taxa		
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects	
Chrysobalanaceae		Gall 51	Leaf	Lenticular	Green	Glabrous	0.5	F	—	—	
		Gall 52	Leaf	Lenticular	Yellow	Glabrous	0.6	F	—	—	
		Gall 53	Leaf	Globoïd	Brown	Pubescent	0.2	F	—	—	
		Gall 54	Leaf	Globoïd	Green	Glabrous	0.2	F	—	Eulophidae (Hymenoptera) (parasitoid)	
	Gall 55	Stem	Fusiform	Brown	Roughened	2.0	F	—	—	—	
		Gall 56	Stem	Fusiform	Green	Roughened	1.4	F	—	—	
		Gall 57	Stem	Globoïd	Brown	Roughened	0.4	F	—	Eurytomidae, Torymidae (Hymenoptera) (parasitoid)	
Gall 58	Leaf	Globoïd	Brown	Pubescent	0.3	F	—	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)		
Clusiaceae	<i>Kielmeyera</i> sp.	Gall 59	Leaf	Lenticular	Green	Glabrous	—	S	—	—	
		Gall 60	Leaf	Lenticular	Yellow	Glabrous	—	S	—	—	
		Gall 61	Leaf	Lenticular	Green	Glabrous	0.3	S	—	Cecidomyiidae (Diptera)	Hymenoptera (parasitoid)
Dilleniaceae		Gall 62	Stem	Fusiform	Brown	Roughened	1.4	S	—	—	
		Gall 63	Leaf	Lenticular	Brown	Roughened	0.2	S	—	Cecidomyiidae (Diptera)	—
		Gall 64	Leaf	Lenticular	Yellow	Pubescent	0.3	S	—	Cecidomyiidae (Diptera)	Eulophidae (Hymenoptera) (parasitoid)
			Stem	Fusiform	Brown	Pubescent	1.5	S	—	—	—
Ebenaceae		Gall 65	Stem	Globoïd	Green	Pubescent	1.5	F	—	Cecidomyiidae (Diptera)	—
		Gall 66	Apical bud	Globoïd	White	Pubescent	1.6	F	—	Lepidoptera	—
		Gall 67	Apical bud	Fusiform	Brown	Roughened	4.0	F	—	—	—
		Gall 68	Stem	Cylindrical	Pink	Pubescent	2.0	F	—	—	—
		Gall 69	Stem	Fusiform	Brown	Roughened	2.0	F	—	—	—
Erythroxylaceae	<i>Diospyros</i> sp.	Gall 70	Leaf	Globoïd	Brown	Pubescent	0.5	S	—	—	—
		Gall 71	Leaf	Fusiform	Brown	Glabrous	—	S	—	Cecidomyiidae (Diptera)	—
Erythroxylaceae	<i>Erythroxylum deciduum</i> A. St.-Hil.	Gall 70	Leaf	Globoïd	Brown	Pubescent	0.5	S	—	—	—
		Gall 71	Leaf	Fusiform	Brown	Glabrous	—	S	—	Cecidomyiidae (Diptera)	—

Plant family	Host plants		Insect gall morphology					Insect taxa		
	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects
Euphorbiaceae	<i>Erythroxylum</i> sp.	Gall 72	Stem	Globoid	Brown	Roughened	0.9	F	—	—
	<i>Erythroxylum suberosum</i> A. St.-Hil.	Gall 73	Leaf	Lenticular	Yellow	Glabrous	0.2	S	Cecidomyiidae (Diptera)	—
		Gall 74	Leaf	Globoid	Red	Pubescent	3.0	S	<i>Myciarijama admirabilis</i> Maia, 2007 (Diptera, Cecidomyiidae)	—
Euphorbiaceae		Gall 75	Stem	Globoid	Yellow	Roughened	0.9	S	—	Eurytomidae (Hymenoptera) (parasitoid)
	<i>Manihot</i> sp.	Gall 76	Leaf	Cylindrical	Red	Glabrous	0.5	S	<i>Iatrophobia</i> sp. (Diptera, Cecidomyiidae)	—
Fabaceae	<i>Andira paniculata</i> Benth.	Gall 77	Leaf	Lenticular	Green	Glabrous	0.4	S	Cecidomyiidae (Diptera)	—
	<i>Bauhinia rufa</i> (Bong.) Steud.	Gall 78	Leaf	Lenticular	Yellow	Glabrous	0.1	S	Cecidomyiidae (Diptera)	—
		Gall 79	Leaf	Lenticular	Yellow	Glabrous	0.3	S	—	—
		Gall 80	Leaf	Fusiform	Yellow	Roughened	0.5	S	Cecidomyiidae (Diptera)	Eulpeimidae, Torymidae (Hymenoptera) (parasitoid)
		Gall 81	Leaf	Globoid	Yellow	Pubescent	0.2	S	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)
Fabaceae		Gall 82	Leaf/midvein	Fusiform	Brown	Roughened	0.8	S	—	—
		Gall 83	Pulvine	Lenticular	Green	Glabrous	0.5	S	—	—
		Gall 84	Stem	Fusiform	Brown	Pubescent	2.0	S	Cecidomyiidae (Diptera)	Eulpeimidae (Hymenoptera) (parasitoid)
		Gall 85	Stem	Fusiform	Brown	Roughened	1.5	S	Cecidomyiidae (Diptera)	Eulpeimidae, Terracampidae (Hymenoptera) (parasitoid)
Fabaceae		Gall 86	Stem	Fusiform	Green	Pubescent	2.5	S	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)
	<i>Bauhinia</i> sp.	Gall 87	Leaf	Globoid	Brown	Pubescent	0.4	F	Cecidomyiidae (Diptera)	Braconidae, Eulophidae, Torymidae (Hymenoptera) (parasitoid)

Host plants			Insect gall morphology						Insect taxa		
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects	
Lamiaceae	<i>Copaifera langsdorffii</i> Desf.	Gall 88	Stem	Fusiform	Brown	Roughened	0.8	F	—	—	
		Gall 89	Leaf	Globoid	Brown	Glabrous	0.1	F	—	—	
	Fabaceae sp.	Gall 90	Leaf	Globoid	Brown	Pubescent	Pubescent	0.2	F	—	—
		Gall 91	Leaf	Globoid	Green	Pubescent	Pubescent	0.2	F	—	—
		Gall 92	Leaf	Globoid	Yellow	Roughened	Roughened	0.4	F	—	—
		Gall 93	Leaf	Lenticular	Yellow	Glabrous	Glabrous	—	S	—	—
		Gall 94	Leaf/stem	Globoid	Brown	Pubescent	Pubescent	0.4	F	—	—
		Gall 95	Stem	Fusiform	Brown	Pubescent	Pubescent	1.0	S	—	—
	Lauraceae	Lauraceae sp.	Gall 96	Leaf	Lenticular	Yellow	Pubescent	—	S	—	—
			Gall 97	Leaf	Globoid	Green	Glabrous	—	F	—	—
Gall 98			Leaf	Globoid	White	Pubescent	—	F	—	—	
Gall 99			Leaf	Conical	Green	Glabrous	Glabrous	0.1	F	Hemiptera	—
Loganiaceae	<i>Strychnos pseudoquinina</i> A. St.-Hil.	Gall 100	Leaf	Lenticular	Yellow	Glabrous	0.4	S	—	—	
		Gall 101	Stem	Globoid	Green	Glabrous	0.8	S	—	Brachycera (Diptera) (inquinine)	
Malpighiaceae	<i>Byrsonima verbascifolia</i> (L.) DC.	Gall 102	Leaf	Conical	Brown	Pubescent	0.5	S	Cecidomyiidae (Diptera)	Eulophidae (Hymenoptera) (parasitoid)	
		Gall 103	Leaf/midvein	Fusiform	Brown	Pubescent	0.3	S	Cecidomyiidae (Diptera)	—	
		Gall 104	Leaf/midvein	Fusiform	Brown	Roughened	Roughened	0.9	S	—	—
		Gall 105	Stem	Fusiform	Brown	Roughened	Roughened	1.0	S	—	—
		Gall 106	Stem	Fusiform	Brown	Roughened	Roughened	1.2	S	Lepidoptera	Eurytomidae (Hymenoptera) (parasitoid)
		Gall 107	Leaf	Globoid	Yellow	Pubescent	Pubescent	0.3	S	—	Hymenoptera (parasitoid)
Malvaceae	<i>Peixotoa goiana</i> C.E. Anderson	Gall 108	Leaf	Globoid	Yellow	Roughened	0.3	S	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid) Phlaeothripidae (Thysanoptera) (inquinine)	
		Gall 109	Leaf/stem	Globoid	Brown	Roughened	0.6	S	—	—	
Malvaceae	Malvaceae sp.	Gall 110	Leaf	Lenticular	Brown	Pubescent	0.1	F	—	—	

Host plants			Insect gall morphology					Insect taxa		
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects
Melastomataceae		Gall 111	Leaf	Fusiform	Green	Pubescent	1.5	F	—	Torymidae, Eurytomidae (Hymenoptera) (parasitoid)
Melastomataceae	Melastomataceae sp.	Gall 112	Leaf	Globoid	Green	Pubescent	0.3	F	—	—
Meliaceae	<i>Guarea</i> sp.	Gall 113	Stem	Globoid	Green	Pubescent	0.5	F	—	Sciaridae (Diptera) (inquiline)
Meliaceae	Meliaceae sp.	Gall 114	Stem	Globoid	Brown	Roughened	—	F	—	—
		Gall 115	Leaf	Globoid	Brown	Roughened	0.2	F	—	Eulophidae (Hymenoptera) (parasitoid)
Monimiaceae	Monimiaceae sp.	Gall 116	Leaf	Lenticular	Yellow	Glabrous	—	F	—	—
		Gall 117	Stem	Fusiform	Green	Glabrous	0.8	F	—	—
Myrtaceae	<i>Eugenia bimariginata</i> DC.	Gall 118	Stem	Fusiform	Brown	Roughened	1.2	S	—	—
		Gall 119	Stem	Fusiform	Yellow	Roughened	1.5	S	—	—
	Myrtaceae sp.	Gall 120	Leaf	Lenticular	Brown	Glabrous	0.1	F	—	—
		Gall 121	Leaf	Lenticular	Brown	Roughened	0.4	F	—	Eulophidae (Hymenoptera) (parasitoid)
		Gall 122	Leaf	Lenticular	Green	Glabrous	0.6	F	—	—
		Gall 123	Leaf	Lenticular	Green	Pubescent	0.2	S	Cecidomyiidae (Diptera)	Hymenoptera (parasitoid)
		Gall 124	Leaf	Fusiform	Yellow	Glabrous	0.8	S	—	Eurytomidae (Hymenoptera) (parasitoid)
		Gall 125	Leaf	Fusiform	Yellow	Pubescent	0.3	S	Cecidomyiidae (Diptera)	—
		Gall 126	Leaf	Marginal leaf roll	Brown	Pubescent	1.5	F	—	—
		Gall 127	Stem	Fusiform	Brown	Roughened	1.2	F	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)
		Gall 128	Stem	Fusiform	Yellow	Roughened	0.3	S	—	—
		Gall 129	Stem	Fusiform	Yellow	Roughened	1.2	F	—	—
		Gall 130	Leaf	Cylindrical	Pink	Pubescent	0.7	F	Hemiptera	—
	<i>Psidium</i> sp.	Gall 131	Leaf	Globoid	Brown	Pubescent	0.4	S	Psyllidae (Hemiptera)	—
Ochnaceae	<i>Ourotea hexasperma</i> (A. St.-Hil.) Baill.	Gall 132	Leaf	Lenticular	Green	Glabrous	0.2	S	Cecidomyiidae (Diptera)	—

Host plants			Insect gall morphology					Insect taxa		
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects
Ochnaceae	<i>Ouvateca</i> sp.	Gall 133	Leaf	Lenticular	Green	Glabrous	0.3	F	Cecidomyiidae (Diptera)	—
Piperaceae	<i>Piper arboreum</i> Aubl.	Gall 134	Leaf	Lenticular	Green	Glabrous	0.5	F	Cecidomyiidae (Diptera)	—
Proteaceae	<i>Roupala montana</i> Aubl.	Gall 135	Leaf	Conical	Green	Glabrous	0.8	S	Lepidoptera	—
	<i>Roupala</i> sp.	Gall 136	Leaf	Conical	Green	Pubescent	0.4	S	Hemiptera	—
		Gall 137	Leaf	Lenticular	Brown	Glabrous	0.3	F	Cecidomyiidae (Diptera)	—
		Gall 138	Leaf	Lenticular	Green	Glabrous	0.6	F	Cecidomyiidae (Diptera)	—
		Gall 139	Stem	Fusiform	Brown	Roughened	3.5	F	—	—
Rubiaceae	<i>Condiera macrophylla</i> (K. Schum.) Kuntze	Gall 140	Leaf	Globoïd	White	Glabrous	0.4	F	Coccoidea (Hemiptera)	—
	<i>Palicourea rigida</i> Kunth	Gall 141	Leaf	Fusiform	Yellow	Glabrous	0.3	S	Cecidomyiidae (Diptera)	—
	Rubiaceae sp.	Gall 142	Leaf	Lenticular	Brown	Roughened	0.3	F	—	—
		Gall 143	Leaf	Lenticular	Green	Roughened	0.1	F	—	—
		Gall 144	Leaf/midvein	Fusiform	Green	Glabrous	—	F	—	—
		Gall 145	Leaf/stem	Lenticular	Green	Pubescent	0.4	S	Cecidomyiidae (Diptera)	—
		Gall 146	Stem	Fusiform	Brown	Roughened	1.0	F	Cecidomyiidae (Diptera)	Eupelmidae, Tanaostigmatidae (Hymenoptera) (inquiline)
		Gall 147	Stem	Fusiform	Green	Glabrous	1.6	F	Cecidomyiidae (Diptera)	Torymidae (Hymenoptera) (parasitoid)
		Gall 148	Stem	Fusiform	Green	Roughened	1.0	F	—	—
Salicaceae	<i>Casuaria sylvestris</i> Sw.	Gall 149	Stem	Globoïd	Green	Glabrous	0.5	F	—	—
		Gall 150	Leaf	Globoïd	Yellow	Glabrous	0.1	S	—	—
		Gall 151	Leaf	Lenticular	Green	Glabrous	—	S	—	—
		Gall 152	Stem	Fusiform	Brown	Roughened	—	S	—	Hymenoptera (parasitoid)
Sapindaceae	Sapindaceae sp.	Gall 153	Leaf	Lenticular	Brown	Roughened	0.2	F	—	—
		Gall 154	Leaf	Fusiform	Green	Glabrous	1.0	F	—	—
		Gall 155	Stem	Fusiform	Brown	Roughened	0.5	F	—	—
		Gall 156	Stem	Fusiform	Green	Pubescent	—	F	Lepidoptera	—
	<i>Serjania</i> sp.	Gall 157	Leaf	Lenticular	Green	Glabrous	0.3	S	Cecidomyiidae (Diptera)	Eulophidae, Torymidae (Hymenoptera) (parasitoid)
		Gall 158	Leaf	Lenticular	Green	Roughened	0.3	S	Lepidoptera	—

Host plants		Insect gall morphology						Insect taxa			
Plant family	Plant species	Morphotype	Organ	Shape	Color	Surface	Size (cm)	Occurrence	Galling insects	Other insects	
Siparunaceae	<i>Siparuna guianensis</i> Aubl.	Gall 159	Leaf	Lenticular	Yellow	Glabrous	0.1	S	Cecidomyiidae (Diptera)	—	
		Gall 160	Leaf	Fusiform	Green	Glabrous	0.3	S	Cecidomyiidae (Diptera)	—	
		Gall 161	Leaf	Fusiform	Yellow	Glabrous	1.0	S	Cecidomyiidae (Diptera)	—	
		Gall 162	Leaf	Globoid	Brown	Roughened	0.5	F	Cecidomyiidae (Diptera)	—	
		Gall 163	Leaf	Globoid	Green	Glabrous	0.2	F	Cecidomyiidae (Diptera)	—	
		Gall 164	Leaf/midvein	Fusiform	Green	Glabrous	0.5	F	Cecidomyiidae (Diptera)	—	
		Gall 165	Leaf/midvein	Fusiform	Green	Glabrous	1.2	S	Cecidomyiidae (Diptera)	—	
		Gall 166	Stem	Fusiform	Brown	Roughened	1.5	F	—	—	
		Gall 167	Stem	Globoid	Brown	Roughened	0.7	F	—	—	
		Gall 168	Stem	Fusiform	Green	Glabrous	—	F	—	—	
		Gall 169	Leaf	Cylindrical	Green	Pubescent	0.3	F	—	Cecidomyiidae (Diptera)	—
		Gall 170	Leaf	Lenticular	Leaf	Green	Glabrous	0.4	F	Cecidomyiidae (Diptera)	—
		Gall 171	Leaf	Fusiform	Leaf	Brown	Roughened	0.5	F	Cecidomyiidae (Diptera)	—
		Gall 172	Leaf	Fusiform	Leaf	Green	Glabrous	0.8	F	Cecidomyiidae (Diptera)	—
		Gall 173	Leaf	Fusiform	Leaf	Yellow	Glabrous	—	F	—	—
		Gall 174	Leaf	Globoid	Leaf	Brown	Pubescent	—	S	—	—
		Gall 175	Leaf/midvein	Fusiform	Leaf/midvein	Green	Glabrous	0.5	F	—	—
		Gall 176	Stem	Fusiform	Stem	Green	Glabrous	1.0	F	—	Torymidae (Hymenoptera) (parasitoid)
Syracaceae	<i>Syrax ferrugineus</i> Nees and Mart.	Gall 177	Stem	Fusiform	Green	Roughened	—	F	—	—	
		Gall 178	Stem	Globoid	Brown	Roughened	0.4	F	—	—	
		Gall 179	Stem	Globoid	Green	Glabrous	1.5	F	—	—	
		Gall 180	Stem/petiole	Globoid	Brown	Roughened	0.5	F	—	—	
Vochoysiaceae	<i>Qualea grandiflora</i> Mart.	Gall 181	Leaf	Lenticular	Yellow	Glabrous	0.4	S	Cecidomyiidae (Diptera)	—	
		Gall 182	Stem	Fusiform	Brown	Pubescent	1.5	S	—	—	
		Gall 183	Stem	Fusiform	Brown	Roughened	1.5	S	Lepidoptera	—	
		Gall 184	Leaf	Lenticular	Brown	Glabrous	0.2	S	Lepidoptera	—	
Syracaceae	<i>Syrax ferrugineus</i> Nees and Mart.	Gall 185	Leaf	Lenticular	Brown	Roughened	0.2	S	Cecidomyiidae (Diptera)	—	
		Gall 186	Stem	Globoid	Brown	Roughened	1.3	S	Cecidomyiidae (Diptera)	—	

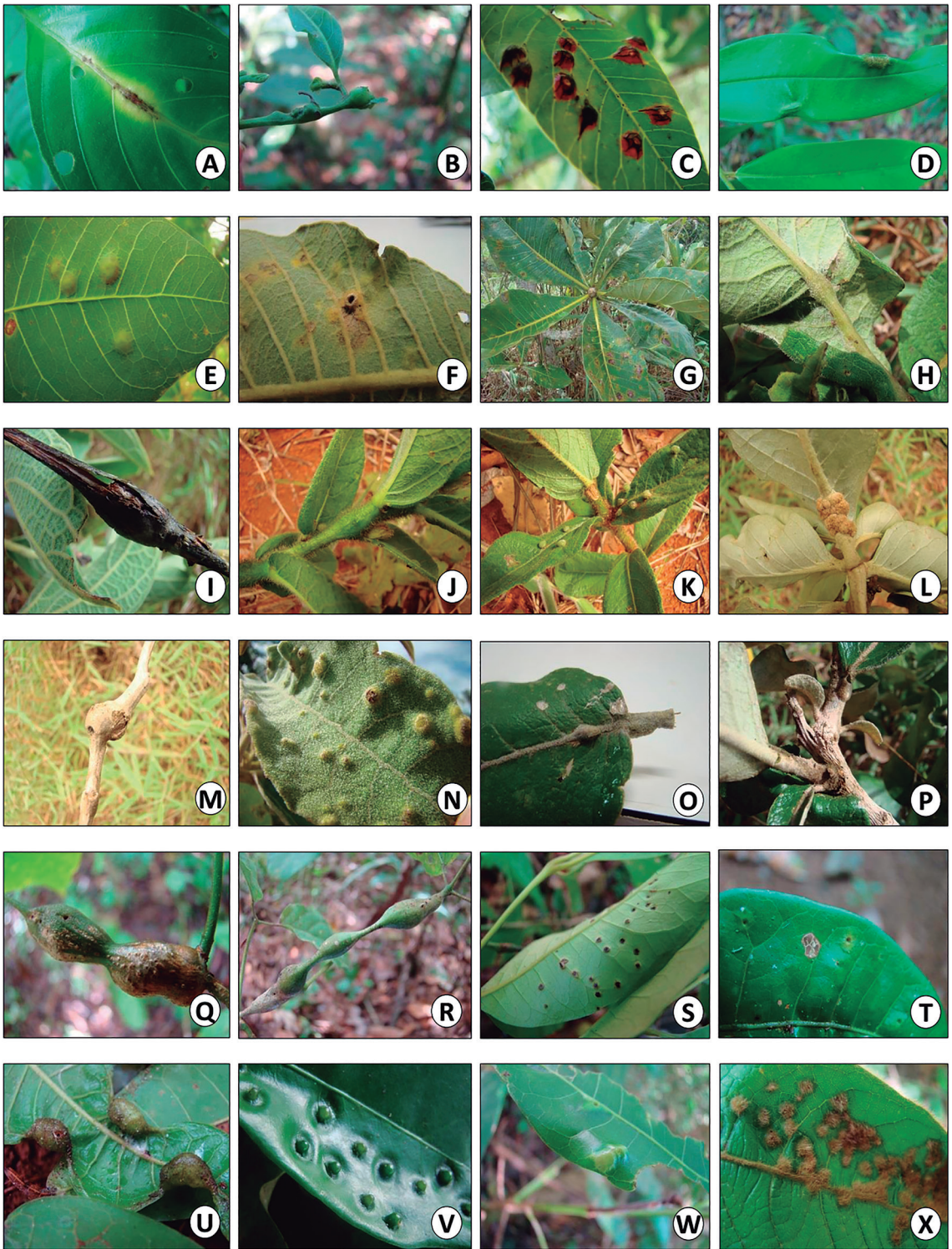


FIGURE 2: Insect galls of Flona-Silvânia, Goiás, Brazil. (A) Acanthaceae sp. (Gall 1), (B) Anacardiaceae sp. (Gall 5), (C) *Lithraea molleoides* (Vell.) Engl (Gall 7), (D) *Xylopia sericea* A. St.-Hil. (Gall 8), (E) *Aspidosperma* sp. (Gall 10), (F) *Aspidosperma tomentosum* Mart. (Gall 11), (G) *A. tomentosum* (Gall 12), (H) Asteraceae sp. (Gall 14), (I) Asteraceae sp. (Gall 15), (J) Asteraceae sp. (Gall 16), (K) *Eremanthus* sp. (Gall 19), (L) *Eremanthus* sp. (Gall 20), (M) *Gochnatia barrosii* Cabrera (Gall 21), (N) *G. barrosii* (Gall 22), (O) *Piptocarpha rotundifolia* (Less.) Baker (Gall 27), (P) Asteraceae sp. (Gall 29), (Q) *Fridericia* sp. (Gall 31), (R) *Fridericia* sp. (Gall 32), (S) *Protium heptaphyllum* (Aubl.) Marchand (Gall 35), (T) *P. heptaphyllum* (Gall 36), (U) *P. heptaphyllum* (Gall 37), (V) *P. heptaphyllum* (Gall 39), (W) *P. heptaphyllum* (Gall 43), (X) *Hirtella* sp. (Gall 58).

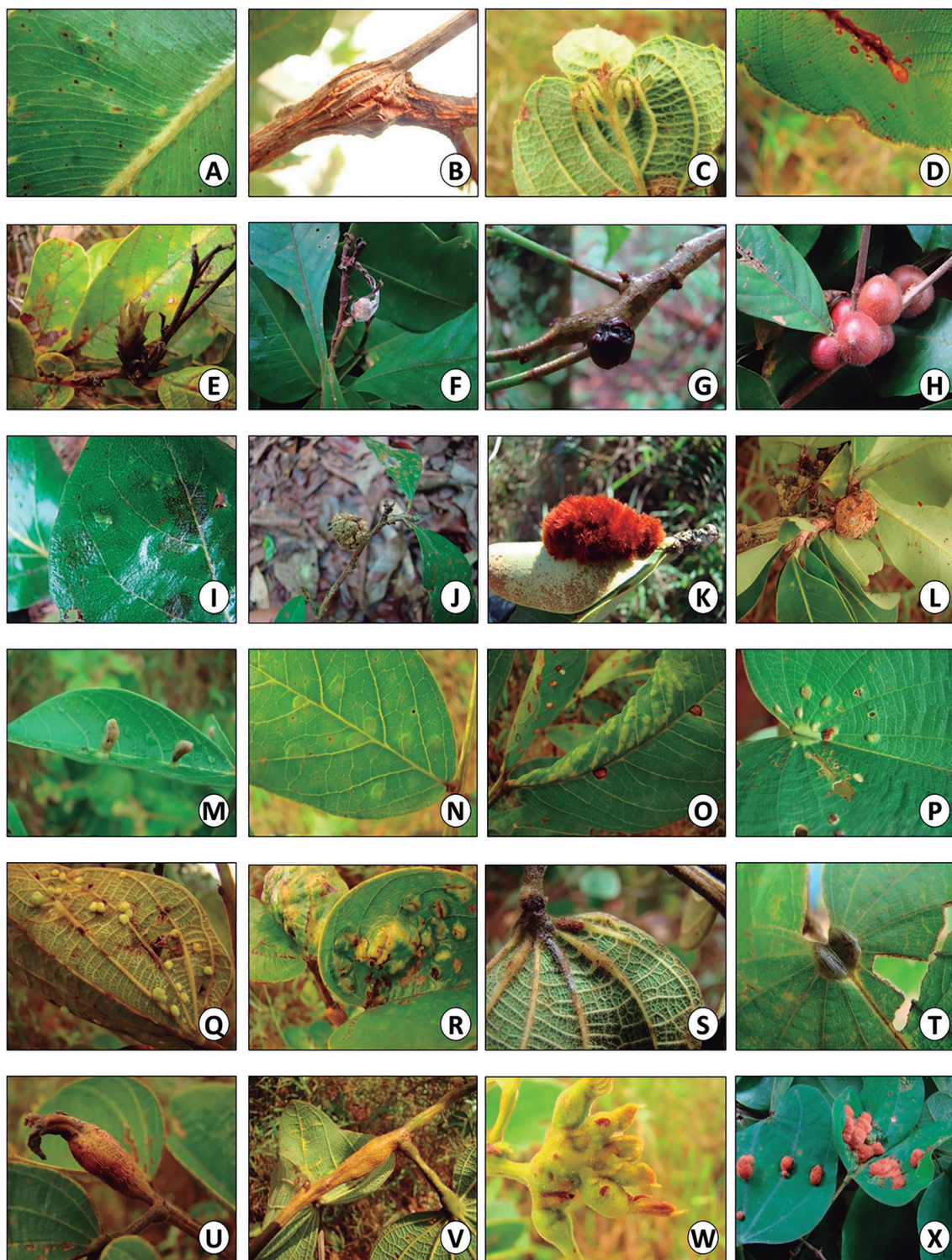


FIGURE 3: Insect galls of Flona-Silvânia, Goiás, Brazil. (A) *Kielmeyera* sp. (Gall 60), (B) *Connarus suberosus* Planch. (Gall 62), (C) *Davilla elliptica* A. St.-Hil. (Gall 63), (D) *D. elliptica* (Gall 64), (E) *D. elliptica* (Gall 65), (F) Dilleniaceae sp. (Gall 67), (G) Dilleniaceae sp. (Gall 68), (H) *Doliocarpus* sp. (Gall 69), (I) *Diospyros* sp. (Gall 70), (J) *Erythroxylum* sp. (Gall 72), (K) *Erythroxylum suberosum* A. St.-Hil. (Gall 74), (L) *E. suberosum* (Gall 75), (M) *Manihot* sp. (Gall 76), (N) *Andira paniculata* Benth. (Gall 77), (O) *A. paniculata* (Gall 78), (P) *Bauhinia rufa* (Bong.) Steud. (Gall 79), (Q) *B. rufa* (Gall 80), (R) *B. rufa* (Gall 81), (S) *B. rufa* (Gall 82), (T) *B. rufa* (Gall 83), (U) *B. rufa* (Gall 84), (V) *B. rufa* (Gall 85), (W) *B. rufa* (Gall 86), (X) *Bauhinia* sp. (Gall 87).

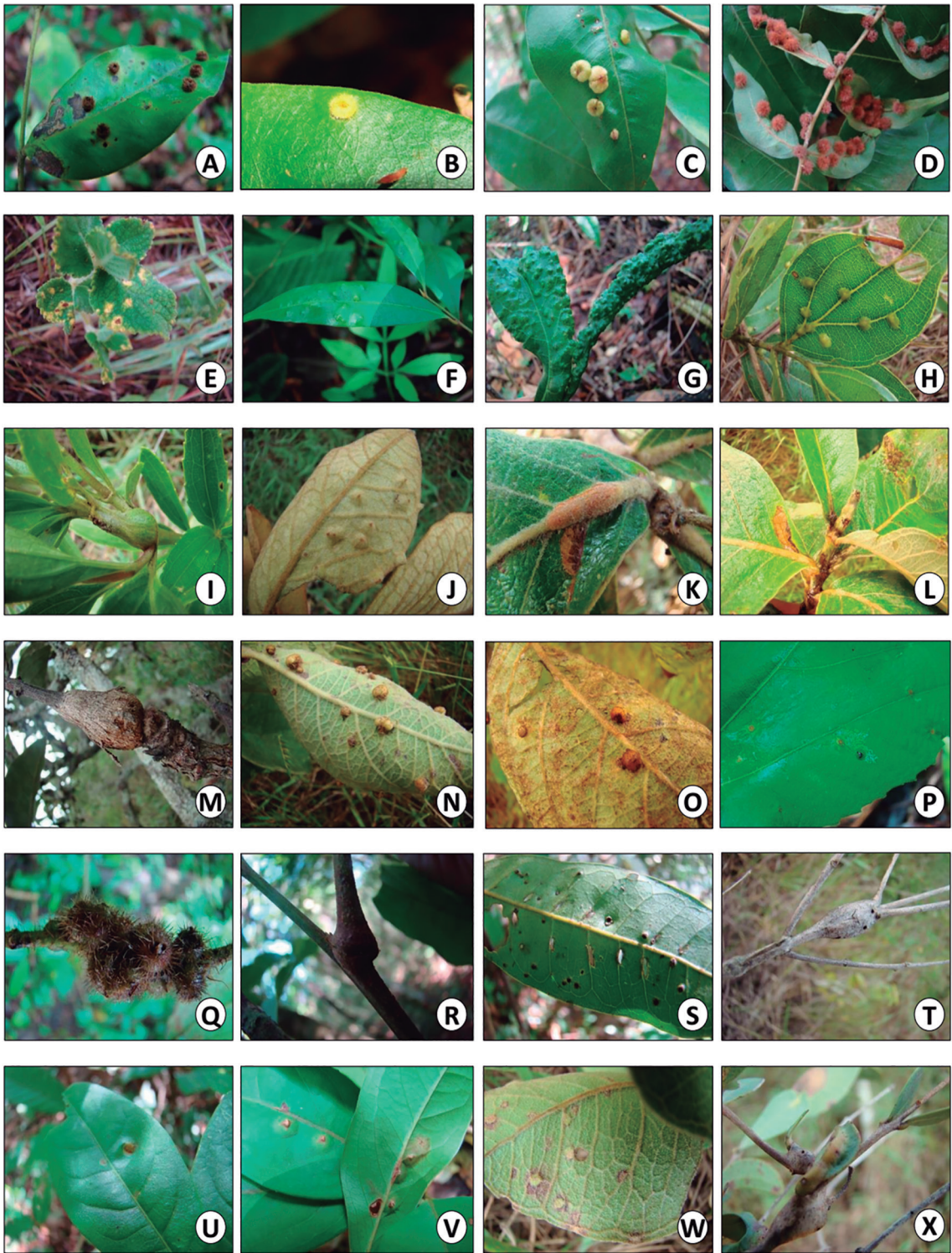


FIGURE 4: Insect galls of Flona-Silvânia, Goiás, Brazil. (A) *Copaifera langsdorffii* Desf. (Gall 90), (B) *C. langsdorffii* (Gall 91), (C) *C. langsdorffii* (Gall 92), (D) *Inga* sp. (Gall 94), (E) Lamiaceae sp. (Gall 96), (F) Lauraceae sp. (Gall 97), (G) *Nectandra* sp. (Gall 99), (H) *Strychnos pseudoquina* A. St.-Hil. (Gall 100), (I) *Diplusodon* sp. (Gall 101), (J) *Byrsonima verbascifolia* (L.) DC. (Gall 102), (K) *B. verbascifolia* (Gall 103), (L) *B. verbascifolia* (Gall 105), (M) *B. verbascifolia* (Gall 106), (N) *Peixotoa goiana* C.E. Anderson (Gall 107), (O) *P. goyana* (Gall 108), (P) Malvaceae sp. (Gall 110), (Q) Melastomataceae sp. (Gall 113), (R) *Guarea* sp. (Gall 114), (S) Meliaceae sp. (Gall 115), (T) *Eugenia bimarginata* DC. (Gall 118), (U) Myrtaceae sp. (Gall 120), (V) Myrtaceae sp. (Gall 122), (W) Myrtaceae sp. (Gall 123), (X) Myrtaceae sp. (Gall 124).

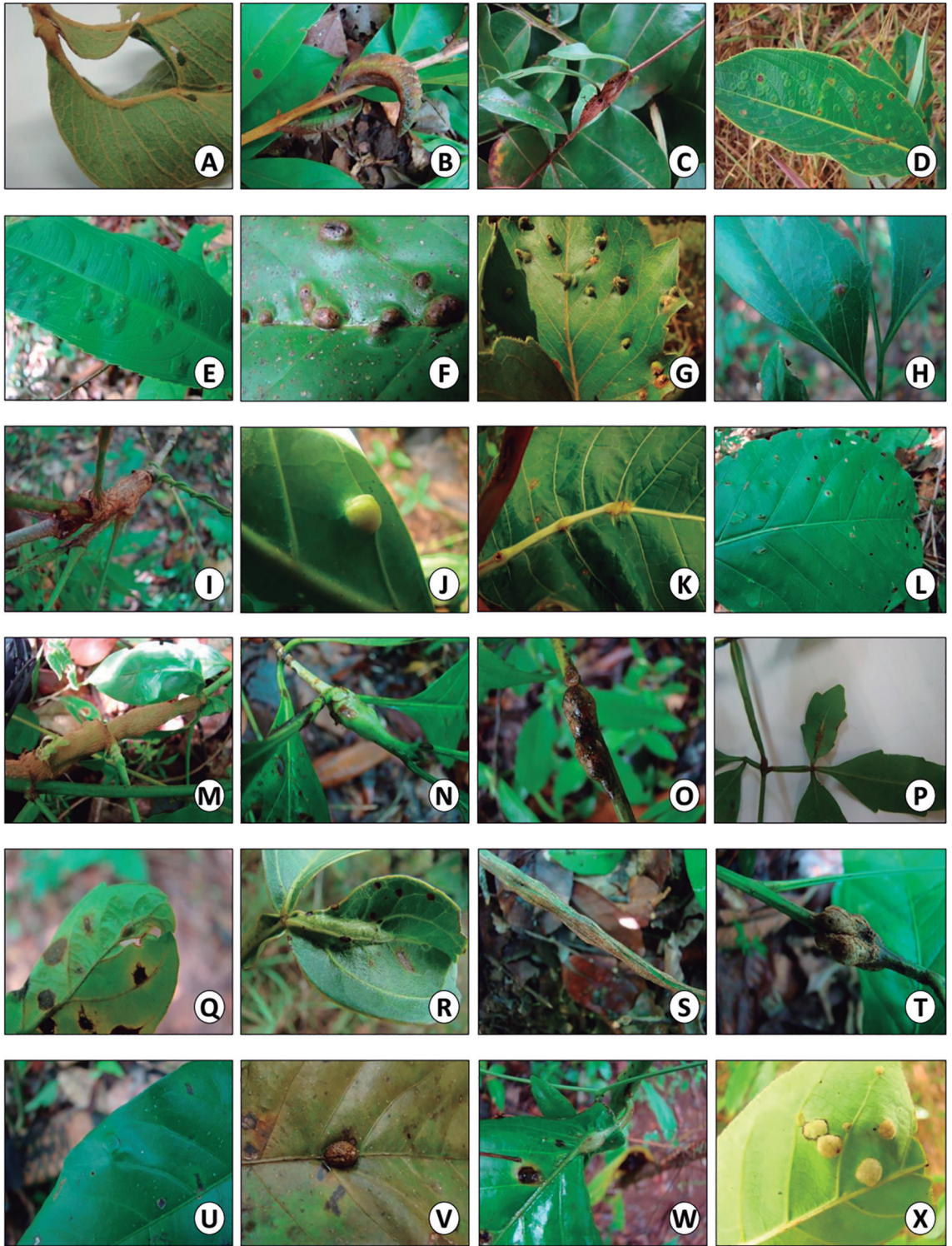


FIGURE 5: Insect galls of Flona-Silvânia, Goiás, Brazil. (A) Myrtaceae sp. (Gall 125), (B) Myrtaceae sp. (Gall 126), (C) Myrtaceae sp. (Gall 127), (D) *Ouratea hexasperma* (A. St.-Hil.) Baill. (Gall 132), (E) *Ouratea* sp. (Gall 133), (F) *Piper arboreum* Aubl. (Gall 134), (G) *Roupala montana* Aubl. (Gall 135), (H) *Roupala* sp. (Gall 137), (I) *Roupala* sp. (Gall 139), (J) *Cordia macrophylla* (K. Schum.) Kuntze (Gall 140), (K) *Palicourea rigida* Kunth (Gall 141), (L) Rubiaceae sp. (Gall 143), (M) Rubiaceae sp. (Gall 146), (N) Rubiaceae sp. (Gall 149), (O) Sapindaceae sp. (Gall 155), (P) *Serjania* sp. (Gall 161), (Q) *Serjania* sp. (Gall 164), (R) *Serjania* sp. (Gall 165), (S) *Serjania* sp. (Gall 166), (T) *Serjania* sp. (Gall 167), (U) *Siparuna guianensis* Aubl. (Gall 170), (V) *S. guianensis* Gall 171), (W) *S. guianensis* (Gall 173), (X) *S. guianensis* (Gall 174).

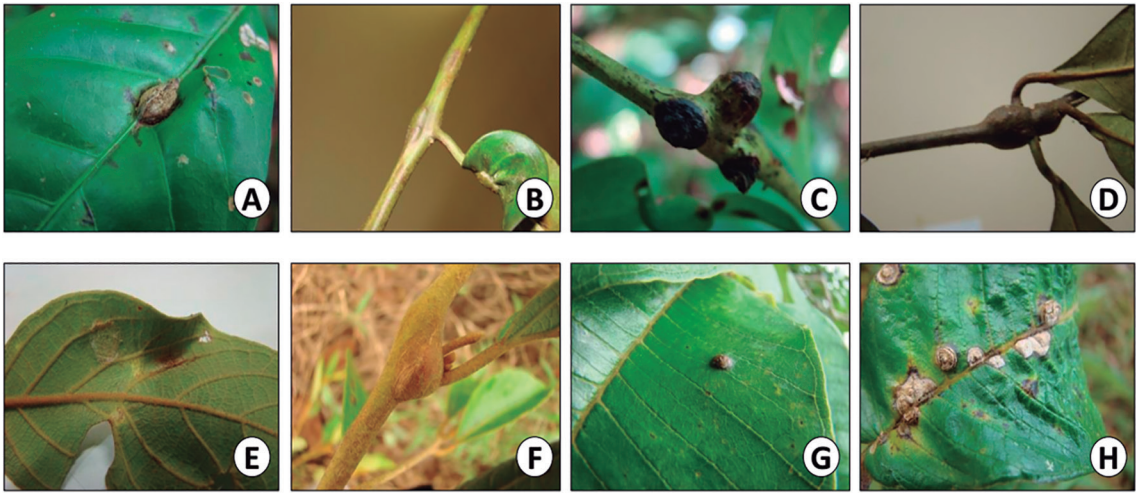


FIGURE 6: Insect galls of Flona-Silvânia, Goiás, Brazil. (A) Gall 175), (B) *Siparuna guianensis* Aubl. (Gall 176), (C) *S. guianensis* (Gall 178), (D) *S. guianensis* (Gall 179), (E) *Styrax ferrugineus* Nees and Mart. (Gall 181), (F) *S. ferrugineus* (Gall 182), (G) *Qualea grandiflora* Mart. (Gall 184), (H) *Q. grandiflora* (Gall 185).

first report hosting galls: *Cordia macrophylla* (K. Schum.) Kuntze, *Eugenia bimarginata* DC., *Gochnatia barrosii* Cabrera, *Lithraea molleoides* (Vell.) Engl, *Peixotoa goiana* C.E. Anderson and *Xylopia sericea* A. St.-Hil. These plant species combined hosted 15 gall morphotypes, representing 8.0% of total. Considering the different sampled habitats, we recorded 99 insect gall morphotypes in the forest and 87 morphotypes in the savanna vegetation, being that none insect gall morphotype occurred in both habitats (Table 1).

DISCUSSION

Compared to previous inventories of insect galls in the Brazilian Cerrado (Table 4), our results indicated high insect gall diversity in the Flona-Silvânia. For example, the number of insect gall morphotypes recorded in our study stays behind only of the 241 morphotypes recorded in the Serra do Espinhaço by Carneiro *et al.* (2009b) and of the 236 morphotypes registered in the Vale do Jequitinhonha by Fernandes *et al.* (1997), both localities situated in the State of Minas Gerais, Southeastern Brazil). It is important to note that in both these studies the authors sampled, for less time, a higher number of localities along the Espinhaço mountain ranges (60 sites sampled one single time by Carneiro *et al.*, 2009b and 10 sites sampled two times by Fernandes *et al.*, 1997), unlike our study that sampled only two sites by four times. We also found that the average number of gall morphotypes per plant species was 3.0, which is high when compared to other Cerrado areas (Table 4). These variations in the insect gall richness and number of gall morphotypes per plant

species can be explained by differences in the sampling type (*e.g.*, fixed transects, random walks), collection effort (*e.g.*, sampling duration and number of collectors) and sampled host plants (*e.g.*, only woody plants or all herbs, shrubs and trees).

Our results are in agreement with previous studies in the Brazilian savannas that point the dominance of gall-midges as gallers (Maia & Fernandes, 2004; Santos *et al.*, 2010; Araújo *et al.*, 2011, 2014b; Nogueira *et al.*, 2016; Urso-Guimarães *et al.*, 2016). Cecidomyiidae is considered the main galling insect group in the world with more of 6,000 known species (Gagné & Jaschhof, 2014), and a huge estimated number of species not yet known (Araújo *et al.*, 2014a; Grandez-Rios *et al.*, 2015). In the Cerrado, cecidomyiids are responsible for approximately 70% of all known gall morphospecies (Araújo *et al.*, 2014a). Although in the present study gall-midges induced only 34.4% of gall morphotypes, since we could not get the insect inducers for most galls, Cecidomyiidae galls accounted for approx. 76% of the morphotypes when considering only galls for which the inducer was obtained. Hemiptera and Lepidoptera were other important groups of galling insects obtained from Flona-Silvânia, which is in accordance with the general pattern found in Cerrado areas (reviewed in Araújo *et al.*, 2014a).

Possible explanations for the low emergence of gall-inducers in the laboratory can be the immature insects have not completed their development after the galls were detached from the plants or galls collected were already empty. Because insect galls remain in the plant even after insects have hatched, some galls may have been collected after the emergence of insects. Other possible explanation can be the high

TABLE 3: Number of insect gall morphotypes and host plant species in the different host plant families recorded in the Flona-Silvânia, Goiás, Brazil.

Host plant family	Host plant species	Insect gall morphotypes	Host plant family	Host plant species	Insect gall morphotypes
Fabaceae	6	18	Salicaceae	1	3
Asteraceae	5	17	Styracaceae	1	3
Sapindaceae	3	16	Vochysiaceae	1	3
Burseraceae	1	14	Annonaceae	1	2
Myrtaceae	3	14	Clusiaceae	1	2
Siparunaceae	1	12	Connaraceae	1	2
Celastraceae	1	10	Lamiaceae	2	2
Rubiaceae	3	10	Meliaceae	2	2
Malpighiaceae	2	8	Monimiaceae	1	2
Dilleniaceae	3	7	Ochnaceae	2	2
Erythroxylaceae	3	5	Chrysobalanaceae	1	1
Proteaceae	2	5	Ebenaceae	1	1
Acanthaceae	1	4	Euphorbiaceae	1	1
Bignoniaceae	2	4	Loganiaceae	1	1
Anacardiaceae	2	3	Lythraceae	1	1
Apocynaceae	2	3	Melastomataceae	1	1
Lauraceae	2	3	Piperaceae	1	1
Malvaceae	1	3	TOTAL	61	186

TABLE 4: Number of insect gall morphotypes, host plant species, host plant families and mean number of galls per host plant species in different localities of the Brazilian Cerrado. Modified of Araújo *et al.* (2014a).

Locality	Insect gall morphotypes	Host plant species	Host plant families	Gall morphotypes per host plant species	Reference
Floresta Nacional de Silvânia – GO	186	61	35	3.0	Present study
Serra Geral – BA	49	14	13	3.5	Nogueira <i>et al.</i> (2016)
Aquidauana – MS	68	46	20	1.5	Urso-Guimarães <i>et al.</i> (2016)
Mata da Veterinária da UFG – GO	42	22	20	1.9	Silva <i>et al.</i> (2015)
Parque Nacional das Emas – GO	97	44	24	2.2	Araújo <i>et al.</i> (2014b)
Caldas Novas – GO	56	34	21	1.6	Santos <i>et al.</i> (2012)
Reserva Biológica Boqueirão – MG	57	43	18	1.3	Malves & Friero-Costa (2012)
Serra dos Pireneus – GO	62	51	28	1.2	Araújo <i>et al.</i> (2011)
Semidecidual Forest in Goiânia – GO	34	20	12	1.7	Santos <i>et al.</i> (2010)
Serra do Espinhaço – MG	241	142	29	1.7	Carneiro <i>et al.</i> (2009a)
Fazenda Bulcão – MG	29	24	12	1.2	Fernandes & Negreiros (2006)
Santa Rita do Passa Quatro – SP	36	24	15	1.5	Urso-Guimarães & Scareli-Santos (2006)
Serra de São José – MG	137	73	30	1.9	Maia & Fernandes (2004)
Delfinópolis – MG	22	19	19	1.2	Urso-Guimarães <i>et al.</i> (2003)
Estação Ecológica de Pirapitinga – MG	92	62	28	1.5	Gonçalves-Alvim & Fernandes (2001)
Vale do Jequitinhonha – MG	236	134	27	1.8	Fernandes <i>et al.</i> (1997)
Campus Pampulha – MG	37	22	11	1.7	Fernandes <i>et al.</i> (1988)

incidence of parasitoids. We found hymenopteran parasitoids from several families in 20% of the gall morphotypes. Hymenopteran parasitoids are very frequent in Neotropical insect galls (Araújo *et al.*, 2014a) and are among the main causes of galler mortality (Maia & Azevedo, 2009).

Many inventories on the gall diversity in the Cerrado indicate Fabaceae (Fernandes *et al.*, 1997; Maia & Fernandes, 2004; Urso-Guimarães & Scare-

li-Santos, 2006; Santos *et al.*, 2010; Araújo *et al.*, 2014b; Nogueira *et al.*, 2016) and Asteraceae (Carneiro *et al.*, 2009b; Fernandes *et al.*, 1997; Malves & Friero-Costa, 2012) as the most important host families, which were also observed in the present study. Araújo *et al.* (2014a) discussed that the main explanation for the high insect gall richness hosted by Fabaceae and Asteraceae in the Cerrado is its high number of plant species. There is the expectation that

the higher the species number in the plant family higher is the galling diversity that they host (Araújo, 2011; Gonçalves-Alvim & Fernandes, 2001). Additionally, we found that the host plants of the genera *Protium* (Burseraceae), *Siparuna* (Siparunaceae), *Serjania* (Sapindaceae) and *Bauhinia* (Fabaceae) were the most diverse in insect gall morphotypes, in line with recent studies in the Brazilian Cerrado (Silva *et al.*, 2015; Nogueira *et al.*, 2016; Urso-Guimarães *et al.*, 2016). Insect gall morphotypes vary greatly in the occurrence and morphology, which can be explained by high specificity of gall-inducing insects associated to their host plants (Carneiro *et al.*, 2009a). In the present study, the most of insect gall occurred in the leaves (leaf lamina), and the more common gall morphology was fusiform shape, green color and absence of pubescence, which also was observed in previous studies in the Cerrado (Urso-Guimarães *et al.*, 2003; Maia & Fernandes, 2004; Araújo *et al.*, 2011; Malves & Friero-Costa, 2012).

Comparisons between different vegetation types in the Cerrado have pointed higher insect gall richness in the sclerophyllous habitats, with savannas often having greater species richness than the forests (review in Araújo *et al.*, 2014a). Our results contrast with this pattern of higher frequency of insect galls in xeric habitats than in mesic ones. A possible explanation to this distinct pattern is the greater frequency of super-host taxa in the forest (*e.g.*, *Protium*, *Serjania* and *Siparuna*), which can increment significantly the insect gall richness at the local level (Araújo *et al.*, 2014a). Even though some of these plant genera also occur in the savanna, they are more common in the forest, where most of their gall morphotypes were registered.

This is the first systematic survey of insect galls realized in the Flona-Silvânia. In this context, 186 gall morphotypes have been described for this area and six new records of host plants were presented from Brazil. The higher number of insect galls recorded in the park, compared to previous studies in the Brazilian Cerrado, demonstrates the importance of the inventories of insect galls. In front of growing fragmentation and loss of vegetation cover of the biome, which have caused the extinction of many species and threatened the Cerrado biodiversity (Klink & Machado, 2005), inventories of insect gall diversity in the region must be done emergently (Araújo, 2011).

RESUMO

No presente estudo foi investigada a distribuição de galhas de insetos ao longo de áreas de cerrado e floresta na

Floresta Nacional de Silvânia, Goiás, Brasil. A fauna de insetos galhadores foi amostrada bimensalmente entre dezembro de 2009 e junho de 2010. No total foram encontrados 186 morfotipos de galhas de insetos, distribuídos em 35 famílias botânicas e 61 espécies de plantas. Foram registrados 99 morfotipos de galhas de insetos na floresta e 87 no cerrado. Os insetos galhadores pertenceram à Coleoptera, Diptera, Hemiptera, Lepidoptera e Thysanoptera, com destaque para Cecidomyiidae (Diptera) que induziu 34,1% dos morfotipos de galhas. Parasitoides elou inquilinos foram registrados em 38 morfotipos de galhas, principalmente das famílias Eulophidae, Eurytomidae e Torymidae (Hymenoptera). Fabaceae foi a família botânica com maior riqueza de galhas, seguida por Asteraceae e Sapindaceae, enquanto Protium (Burseraceae), Siparuna (Siparunaceae) e Serjania (Sapindaceae) foram os principais gêneros hospedeiros. Este é o primeiro levantamento sistemático de galhas de insetos na Flona-Silvânia, o que resultou em seis espécies de plantas sendo registradas pela primeira vez no Brasil como hospedeiras de galhas de insetos.

PALAVRAS-CHAVE: Cecidomyiidae; Cerrado; Fabaceae; Interação inseto-planta.

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