Characterization of galls, insect galls and associated fauna of Ecological Station of Jataí (Luiz Antônio, SP)

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Abstract: This is the first study about galls, gall makers and associated fauna of the Ecological Station of Jataí. Galls are plant structures formed by abnormal growth of cells, tissues or organs induced by several organisms, as fungous, nematoids and insects. Five areas of the conservation unity, two in the phytophysionomy of cerrado in regeneration and three in the cerradão area were studied, totalizing 69 morphotypes of galls on 41 host species from 24 families. This is the first record of Annonaceae as the richest family in morphotypes in Brazil; 34 gall makers and associated fauna were identified, which 23 Diptera (67.4%), eight Hymenoptera (23.5%), two Hemiptera (5.8%) and one Thysanoptera (2.9%). Were described 41 new morphotypes of gall and made the first characterization of gall on *Maprounea guianensis* Aubl., *Acosmium subelegans* (Mohlenbr.) Yakovlev., *Strychnos bicolor* Progel, *Eriotheca gracilipes* K. Schum., *Stryphnodendron obovatum* Benth., *Broyesum gaudichaudii* Trécul, *Psychotria suterella* Müll. Arg., *Psychotria trichophora* Müll. Arg. and *Serjania erecta* Radlk.
Keywords: *Annonaceae, Cecidomyiidae, Cerrado, galling species, geographic distribution, host plant, parasitoid.*

SAITO, V.S. & URSO-GUIMARÃES, M.V. **Caracterização de galhas, insetos galhadores e fauna associada de Estação Ecológica de Jataí (Luiz Antônio, SP).** Biota Neotrop. 12(3): http://www.biotaneotropica.org.br/v12n3/pt/abstract?article+bn02312032012

Resumo: Este é o primeiro estudo sobre galhas, insetos galhadores e fauna associada da Estação Ecológica de Jataí. Galhas são estruturas vegetais formadas por um crescimento anormal de células, tecidos ou órgãos induzido por vários organismos, como fungos, nematóides e insetos. Cinco áreas da unidade de conservação, dois na fitofisionomia de cerrado em regeneração e três na área de cerradão foram estudadas, totalizando 69 morfotipos de galhas em 41 espécies de plantas hospedeiras de 24 famílias. Este é o primeiro registro de Annonaceae como a família mais rica em morfotipos no Brasil; 34 insetos galhadores e fauna associada foram identificados, sendo 23 Diptera (67,4%), oito Hymenoptera (23,5%), dois Hemiptera (5,8%) e um Thysanoptera (2,9%). Foram descritos 41 novos morfotipos de galhas e foi feita a primeira caracterização de galhas em *Xylopia aromatica* (Lam.) Mart., *Connarus suberosus* Planch., *Maprounea guianensis* Aubl., *Acosmium subelegans* (Mohlenbr.) Yakovlev., *Strychnos bicolor* Progel, *Eriotheca gracilipes* K. Schum., *Stryphnodendron obovatum* Benth., *Broyesum gaudichaudii* Trécul, *Psychotria suterella* Müll. Arg., *Psychotria trichophora* Müll. Arg. e *Serjania erecta* Radlk.
Palavras-chave: *Annonaceae, Cecidomyiidae, Cerrado, espécies galhadoras, distribuição geográfica, planta hospedeira, parasitoide.*

Introduction

Galls are plant structures formed by abnormal growth of cells, tissues or organs in response to stimuli caused by other organisms (Carneiro et al. 2009, Rohfritsch & Shorthouse 1982). This abnormal growth is due to increase in cell volume (hypertrophy) and/or cell number (hyperplasia). A rich insect fauna is associated with the galls and includes predators, parasitoids, tenants and successors, so galls represent a true micro habitat where several tri-trophic relations are established (Maia 2001). A recent study estimated the richness of insect galls in about 120,000 species (Espirito Santo & Fernandes 2007), making knowledge of this group essential for ecological studies.

In Neotropic, six orders of insects are cited by having representatives galling species, Diptera, Lepidoptera, Hymenoptera, Coleoptera, Hemiptera and Thysanoptera (Maia et al. 2008). Among these, there is a wide prevalence of galls induced by Diptera, were recorded over a thousand morphotypes, mainly driven by species of family Cecidomyiidae (Maia et al. 2008), which represent the group of predominantly insect galls in all zoogeographical regions of world (Gagné 1994). Julião et al. (2005) discusses the use of such groups as bioindicators because they are easy objects of study, due to the bodies remain locatable for much of their life cycle and are abundant in their hosts, although they are still few studies on the characterization of this fauna (Lara & Fernandes 1996), despite efforts to work on characterization of galls and gall makers in areas of restinga (Maia 2005), Cerrado, rupestrian fields, semidecidual forest in the states of São Paulo and Minas Gerais (Urso-Guimarães & Scarelli-Santos 2006, Urso-Guimaraes et al. 2003, Lara & Fernandes 1996).

The Cerrado is a very devastated domain, especially in São Paulo, where only 5.48% of the original Cerrado is still available. There are few studies about galls in this biome in Sao Paulo, with only one gall characterization in Pé-de-Gigante Reserve (Urso-Guimarães & Scarelli-Santos, 2006). The Ecological Station of Jataí (ESJATAÍ) is the largest conservation area of Cerrado in São Paulo and yet few studies on biodiversity of invertebrate were made, as well in other Brazilian cerrado areas, and most groups and communities have not been studied (Peruquetti 2004).

Material and methods

1. Study area

The ES JATAÍ is located in the city of Luiz Antônio, São Paulo, between coordinates 21° 30' and 21° 40' S and 47° 40' and 47° 50' W (Figure 1), Unit of Water Resources Management nº 9 - Mogi Guaçu in region of Médio Mogi Guaçu (Pires et al. 2000). The climate is Aw of Koppen, or Tropical of central Brazil (Pires et al. 2000, Toppa et al. 2006). Altitude varies from 515 m to 835 m in altitude relative to sea level and located in the Paraná Sedimentary Basin (Toppa et al. 2006). In relation to vegetation types, ES JATAÍ has about 60% of cerradão, 20% of cerrado regeneration, 12% of Semideciduous Forest, 3% of lowland vegetation, 1% of campo sujo, 2% of recovery areas and less than 1% of Cerrado sensu stricto (Toppa et al. 2006, Fundação... et al. in prep).

2. Experimental procedures

2.1. Sampling

Five areas were chosen to sampling, three areas of cerradão and two of cerrado regeneration. These areas should have different degrees of conservation, as evidenced by the presence or absence of exotic grasses, palms and bromeliads.

Samples were collected in areas including the border of roads of ES Jataí, because as already described by Price et al. (1998), the border represent an environment with increased solar radiation and desiccation, where there is increased the richness of galls.

The coordinates of starting points of sampling:

1 - 21° 36' 19.44" S and 47° 47' 28.86" W (geographical)
2 - 21° 36' 14.10" S and 47 ° 46' 34.44" W (geographical)
3 - 21° 36' 2.81" S and 47 ° 45' 38.32" W (geographical)
4 - 21° 35' 33.27" S and 47 ° 45' 40.86" W (geographical)
5 - 21° 37' 48.48" S and 47° 42' 33.15" W (geographical)

The samples were obtained using methods described by Fernandes et al. (1995), Fernandes & Negreiros (2006), Julião et al. (2005), occurred on days 19, 20 and 21 April 2010 and consisted of three random routes of an hour for each area, totaling 15 hours of sampling. According to Fernandes et al. (1995), the sampling during a weather station is sufficient to evaluate the number of galls per habitat, because of the absence of statistical difference in the results obtained, which were conducted in two seasons, dry and rainy seasons. This is due to the galls are sessile and remain attached to host plants, which makes possible accounting of galls even after adult emergence.

The stems of plants with galls were collected and placed in individual plastic bags, tagged and taken to laboratory where were placed in plastic bottles covered with fine mesh to wait for the emergence of gall maker. Exsiccates were made from plants collected for later identification by specialists. The collection of sentinel plants is deposited in the Herbarium of the UFSCar campus Sorocaba.

2.2. Criteria for characterization of the galls

The morphology of gall is considered of great taxonomic value because of high specificity of galling species and host plant. Moreover, their characters are easier to observe than those of adults or immature stages of galling species, given the diminutive size of these (Maia 1995). By morphotype, understood to be the characters used as shape (Figure 2), color (Figure 3), pubescence (Figure 4), grouping (Figure 5) and organ of occurrence of gall on the host plant (Figure 6) (Maia 1995).

The characterization of galls was done using a synthesis of the nomenclatures presented in works in the area as Möhn (1961), Maia (2001), Urso-Guimarães et al. (2003), Urso-Guimarães & Scarelli-Santos (2006) and review of the specificity of galls made by Carneiro et al. (2009). Galls that were not found galling species the identification where made by similarity to several studies (Urso-Guimarães & Scarelli-Santos 2006, Maia & Fernandes 2004, Gonçalves-Alvim & Fernandes 2001, Maia et al. 2008, Carneiro et al. 2009, Urso-Guimarães et al. 2003).

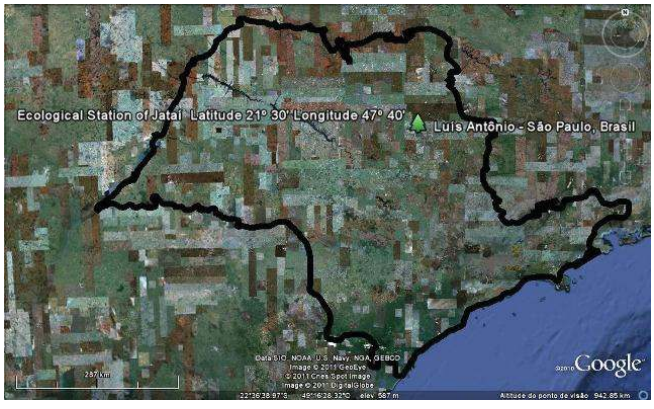

Figure 1. Location of Ecological Station of Jataí, SP (fonte: Google Earth Free).

Were made permanent slides with cecidomyiids according to procedures of Gagné (1989). To identify the cecidomyiids was used identification key of Gagné (1994). The parasitoids were identified to family using identification keys of Kristensen (1991). Specimens of insect galls and their associated fauna sampled are deposited in the Didactic and Scientific Collection of Invertebrates of UFSCar Campus Sorocaba.

Results

Were found 69 morphotypes of galls in 41 plant species from 24 families (Table 1). Of all the insects identified, 23 are Diptera (67.6%), eight are Hymenoptera (23.5%), two are Hemiptera (5.9%) and one Thysanoptera (2.9%) (Figure 7). If we consider only the galling habit (n = 25), the percentage of Cecidomyiidae (single

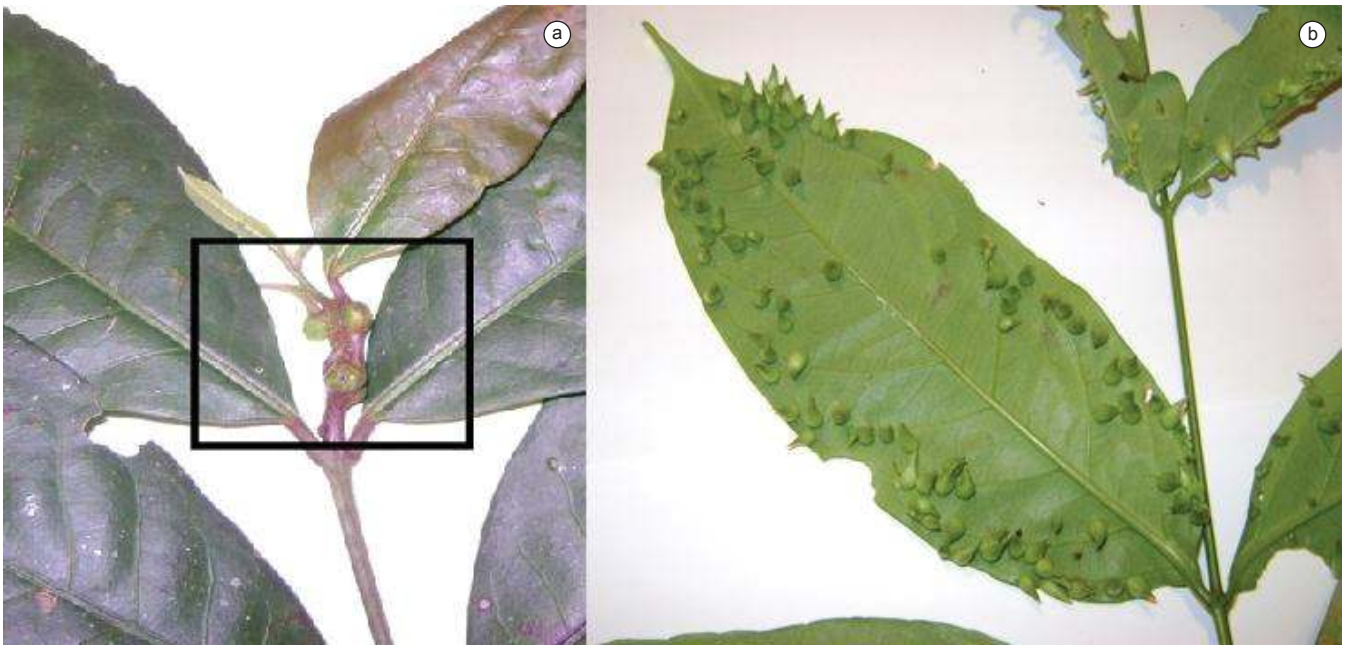

Figure 2. Example of shapes of galls characterized in the Ecological Station of Jataí (SP). a) globoid form (*Siparuna guianensis* Aubl), b) conic form (*Banisteriopsis pubipetala* (A. Juss.) Cuatrec.).

Figure 3. Example of the coloration of galls characterized in the Ecological Station of Jataí (SP). a) green (*Andira* sp.), b) cream (*Miconia albicans* Sw.).

Figure 4. Example of the presence and absence of pubescence in the galls characterized in the Ecological Station of Jataí (SP). a) glabrous (without trichomes) (*Nectandra* sp.), b) pubescent (with trichomes) (*Bauhinia rufa* Graham).

Figure 5. Example of isolated (a) (*Duguetia furfuracea* (A. St.-Hil.) Saff.) and grouped (b) (*Arrabidaea* sp.) galls characterized in the Ecological Station of Jataí (SP).

Figure 6. Example of occurence organs of galls characterized in the Ecological Station of Jataí (SP). a) apical gem (*Byrsonima cf intermedia* A. Juss.),b) leaf (*Acosmium cf subelegans* (Mohlenbr.) Yakovlev.).

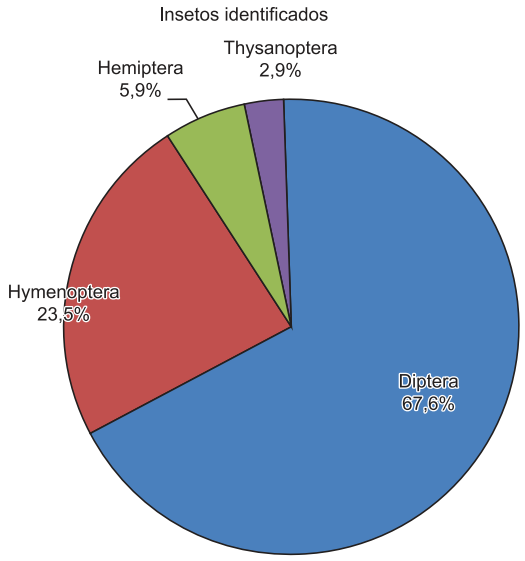

Figure 7. Percentage of the orders of insects found in galls of Ecological Station of Jataí, SP.

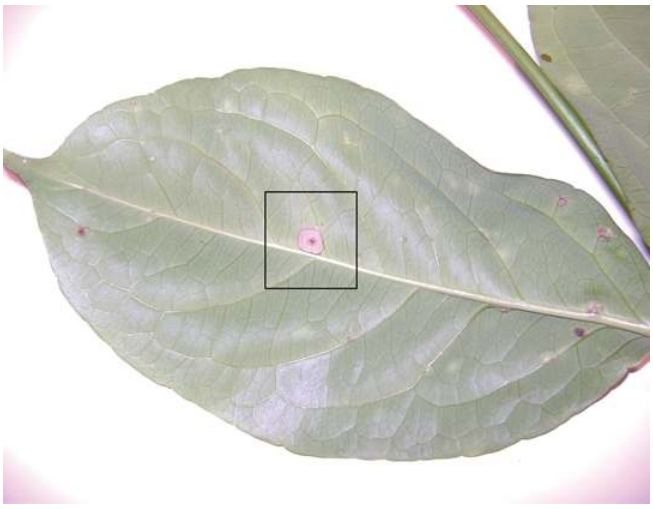

Figure 8. Example of gall characterized in the Ecological Station of Jataí (SP) with discoid form and may be a scar from another form.

Table 1. Table of characterization of the morphotypes of galls found in the Ecological Station of Jataí, SP, by species of host plant.

Family	Specie	Organ	Shape	Pubescence	Ocurrence	Color	nº of type
Anacardiaceae	*Tapirira guianensis*Aubl.	leaf	point	no	isolated	Black	1
Annonaceae	*Annona coriacea* Mart.	Leaf	discoid	no	isolated	Green and brown	2
	Annona crassiflora Mart.	Leaf	discoid	no	isolated	Green and brown	3
	Duguetia furfuracea (A. St.-Hil.) Saff.	Leaf	globular	no	isolated	Brown	4
		Leaf	discoid	no	isolated	Brown	5
		Leaf	winding	no	isolated	Green	6
		Leaf	swelling	no	isolated	Green	7
		Leaf	cylindrical	no	isolated	Green	8
	Xylopia aromatica (Lam.) Mart.	Leaf	discoid	no	isolated	Brown	9
		Leaf	globular	no	grouped	Black	10
		Leaf	discoid	yes	isolated	Red	11
Asteraceae	*Gochnatia pulchra* Cabrera	Leaf	globular	yes	isolated	Cream	12
Bignoniaceae	*Arrabidaea* sp.	Leaf bud	globular	yes	grouped	Brown	13
		Leaf	globular	yes	grouped	Brown	14
		Stem	swelling	no	isolated	Brown	15
		Leaf	discoid	no	isolated	Green and brown	16
Chrysobalanaceae	*Couepia grandiflora* Mart. &Zucc.	Leaf	globular	no	isolated	Green	17
		Leaf	swelling	no	isolated	Red	18
Connaraceae	*Connarus suberosus* Planch.	Leaf	discoid	no	isolated	Brown	19
Erythroxylaceae	*Erythroxylum suberosum* A. St. –Hill.	Stem	swelling	no	isolated	Brown	20
		Leaf	discoid	no	isolated	Brown	21
Euphorbiaceae	*Mabea fistulifera* Mart.	Leaf	discoid	no	isolated	Green	22
	Manihot caerulescens Pohl	Leaf	cylindrical	no	isolated	Brown	23
	Maprounea guianensis Aubl.	Stem	swelling	no	isolated	Brown	24
		Leaf	winding	no	isolated	Green	25
Fabaceae	*Acosmium cf subelegans* (Mohlenbr.) Yakovlev.	Leaf	discoid	no	isolated	Red	26
	Andira sp.	Leaf	ravioli	no	isolated	Green	27
	Bauhinia rufa Graham	Leaf	globular	yes	isolated	Brown	28
	Hymenaea sp.	Leaf	discoid	no	isolated	Brown	29
		Leaf	globular	no	isolated	Green	30
	Senna sp.	Leaf	discoid	yes	isolated	Brown	31
Lauraceae	*Nectandra* sp.	Leaf	globular	no	isolated	Brown	32

Table 1. Continued...

Family	Specie	Organ	Shape	Pubescence	Ocurrence	Color	nº of type
	Ocotea corymbosa (Meisn.) Mez	Leaf	point	no	isolated	Green	33
Loganiaceae	*Strychnos bicolor* Progel	Stem	swelling	no	isolated	Brown	34
Malpighiaceae	*Byrsonima cf intermedia* A. Juss.	Leaf bud	swelling	no	isolated	Brown	35
		Leaf	triangular	no	isolated	Green-brown	36
		Stem	swelling	no	isolated	Brown	37
		Apical bud	globular	no	grouped	Brown	38
		Stem	globular	no	grouped	Brown	39
		Leaf	discoid	no	isolated	Brown	40
	Banisteriopsis pubipetala (A. Juss.) Cuatrec.	Leaf	conical	no	isolated	Green	41
		Leaf	discoid	no	isolated	Brown	42
		Leaf	triangular	no	isolated	Green	43
Malvaceae	*Eriotheca gracilipes* K. Schum.	Leaf	discoid	yes	isolated	Red	44
Melastomataceae	*Miconia albicans* Sw.	Leaf	globular	no	grouped	Brown	45
Minasaceae	*Stryphnodendron obovatum* Benth.	Leaf	discoid	no	isolated	Green and brown	46
Moraceae	*Broyesum gaudichaudii* Trécul	Leaf	discoid	no	isolated	Brown	47
Myrtaceae	*Eugenia aurata* O. Berg	Stem	swelling	no	isolated	Brown	48
		Leaf	discoid	no	isolated	Brown	49
	Eugenia bimarginata DC.	Leaf	discoid	no	isolated	Brown	50
	Eugenia punicifolia Kunth (DC.)	Leaf	triangular	no	isolated	Green and brown	51
		Leaf bud	swelling	no	isolated	Green	52
	Myrcia cf lingua O. Berg (Mattos)	Leaf	discoid	no	isolated	Brown	53
	sp. 1	Leaf	discoid	no	isolated	Green	54
Ochnaceae	*Ouratea spectabilis* Mart. exEngl.	Leaf	discoid	no	isolated	Brown	55
Proteaceae	*Roupala montana* Aubl.	Leaf	discoid	no	isolated	Green	56
		Stem	globular	no	isolated	Brown	57
Rubiaceae	*Psychotria carthagenensis* Jacq.	Leaf	globular	no	isolated	Brown	58
	Psychotria cf suterella Müll.Arg.	Leaf	swelling	no	isolated	Green	59
		Stem	swelling	no	isolated	Green	60
	Psychotria cf trichophora Müll.Arg.	Leaf	discoid	yes	isolated	Brown	61
Sapindaceae	*Serjania cf erecta* Radlk.	Leaf	discoid	no	isolated	Green-brown	62
		Stem	swelling	no	isolated	Brown	63
Sapotaceae	*Pouteria torta* (Mart.) Radlk.	Leaf	cylindrical	yes	isolated	Green	64
		Stem	swelling	no	isolated	Brown	65
Siparunaceae	*Siparuna guianensis* Aubl.	Leaf	swelling	no	isolated	Green	66
		Stem	globular	no	grouped	Green	67
		Leaf	globular	yes	isolated	Brown	68
Vochysiaceae	*Qualea grandiflora* Mart.	Stem	swelling	no	isolated	Brown	69

family found for Diptera) is even greater, with 88%. In addition, all Hymenoptera found in the galls are parasitoids of the families Eurytomidae, Torymidae and Eulophidae (Table 2). Of the 41 host plants, in 20 of them were identified insects with galling habit, tenant or parasitoid. Were identified 34 insects in galls, 25 were galling habit, one tenant and eight parasitoids. Only nine insects were obtained and identified from the rearing and emergence of the gall, the other 25 were determined based on the similarity to the description of the gall in several studies (Table 1).

The galls characterized for *Maprounea guianensis* Aubl. (Euphorbiaceae), *Acosmium subelegans* (Mohlenbr.) Yakovlev. (Fabaceae), *Strychnos bicolor* Progel (Loganiaceae), *Eriotheca gracilipes* K. Schum. (Malvaceae), *Stryphnodendron obovatum* Benth. (Minasaceae), *Broyesum gaudichaudii* Trécul (Moraceae), *Psychotria suterella* Müll. Arg., *Psychotria trichophora* Müll. Arg. (Rubiaceae) and *Serjania erecta* Radlk. (Sapindaceae) are the first records of gall in these species. According to the list of species of Management Plan of ES JATAÍ (2010), from 41 plant species found in this study, four of which do not appear on the list of species. The new species recorded are *Psychotria carthagenensis* Jacq., *P. tricophora* Müll. Arg., *P. suterella* Müll. Arg. (Rubiaceae) and *Serjania erecta* Radlk. (Sapindaceae).

For the organ were where found galls, 75% were on leaves, 19% on stems, 4,5% on leaf buds and 1.5% on the apical bud (Table 1). Regarding the shape of galls sampled, about 35% had discoid pattern, 23% swelling, 23% globular, 6% cylindrical, 4% triangular, 3% point, other patterns found were rolling around 3%, 1.5 % ravioli and 1.5% conical (Table 1). Regarding the color of the galls, about 52.1% were

Table 2. Table of the presented insects in the galls sampled in the Ecological Station of Jataí, SP, their habits and the identification method.

Host plant	Insect	Habit	Reference	Nº of type
Duguetia furfuraceae	*Bruggmanniella duguetiae* Urso-Guimarães & Amorim, 2005 (Cecidomyiidae)	galling	Urso-Guimarães & Scarelli-Santos (2006)	6
	Hymenoptera	parasitoid	Urso-Guimarães & Scarelli-Santos (2006)	6
	Cecidomyiidae sp.1	galling	Urso-Guimarães & Scarelli-Santos (2006)	10
	Eulophidae (Hymenoptera)	parasitoid	Obtained	4
Annona crassiflora	Hemiptera	galling	Maia & Fernandes (2004)	7
Annona coriacea	Lasiopteridi sp.1 (Cecidomyiidae)	galling	Urso-Guimarães & Scarelli-Santos (2006)	8
Gochnatia pulchra	Cecidomyiidae sp.2	galling	Urso-Guimarães & Scarelli-Santos (2006)	12
***Arrabidaea* sp.**	Cecidomyiidae sp.3	galling	Gonçalves-Alvim & Fernandes (2001)	13
	Cecidomyiidae sp.4	galling	Gonçalves-Alvim & Fernandes (2001)	14
Erythroxylum suberosum	Cecidomyiidae sp.5	galling	Maia & Fernandes (2004)	20
	Thysanoptera	galling	Obtained	21
	Hymenoptera	parasitoid	Obtained	21
Manihot caerulescens	*Iatrophobia brasiliensis* Rübsaamen, 1916 (Cecidomyiidae)	galling	Maia et al. (2008)	22
***Andira* sp.**	*Andirodiplosis bahiensis* Tavares, 1920 (Cecidomyiidae)	galling	Carneiro et al. (2009)	26
Bauhinia rufa	*Neolasioptera* sp. 1 (Cecidomyiidae)	galling	Urso-Guimarães et al. (2003)	30
Ocotea corymbosa	Coccicidae (Hemiptera)	galling	Maia et al. (2008)	32
***Nectandra* sp.**	*Neolasioptera* sp. 2 (Cecidomyiidae)	galling	Maia et al. (2008)	33
Byrsonima* cf *intermedia	Cecidomyiidae sp.6	galling	Gonçalves-Alvim & Fernandes (2001)	35
	Cecidomyiidae sp.7	galling	Gonçalves-Alvim & Fernandes (2001)	43
Banisteriopsis pubipetala	*Clinodiplosis* sp. (Cecidomyiidae)	galling	Urso-Guimarães & Scarelli-Santos (2006)	36
	Eurytomidae (Hymenoptera)	parasitoid	Obtained	39
Miconia albicans	Cecidomyiidae sp.8	galling	Maia & Fernandes (2004)	45
Eugenia aurata	Cecidomyiidae sp.9	galling	Obtained	49
Eugenia aurata	Hymenoptera	parasitoid	Obtained	49
Eugenia punicifolia	Cecidomyiidae sp.10	galling	Gonçalves-Alvim & Fernandes (2001)	52
Eugenia aurata	Lasiopteridi sp.2 (Cecidomyiidae)	galling	Maia et al. (2008)	50
Eugenia bimarginata	Lasiopteridi/*Asphondylia* (Cecidomyiidae)	galling	Maia et al. (2008) and Scarelli-Santos et al. (2005)	53
Roupala montana	Cecidomyiidae sp.11	galling	Gonçalves-Alvim & Fernandes (2001)	56
Psychotria carthaginensis	Oligotrophini (Cecidomyiidae)	galling	Maia et al. (2008)	58
Pouteria torta	*Youngomyia pouteriae* Maia, 2001(Cecidomyiidae)	galling	Urso-Guimarães & Scarelli-Santos (2006)	64
	Trotteria quadridentata Maia, 2001(Cecidomyiidae)	Tenant	Obtained	64
	Eurytomidae (Hymenoptera)	parasitoid	Obtained	64
	Torymidae (Hymenoptera)	parasitoid	Obtained	64
Qualea grandiflora	Hymenoptera	parasitoid	Gonçalves-Alvim & Fernandes (2001)	69

brown, 27.5% were green, 7% were green and brown (depending on the stage that was the gall), 5.6% were red, 2, 8% were black, 2.8% were green-brown and cream were 1.4% (Table 1). Galls were found isolatly (74.2%) or grouped (25.8%) (Table 1). For pubescence, 85.5% were glabrous and 14.4% present trichomes (Table 1).

Discussion

This study reported the galling insects, the associated fauna and their host plants in cerrado vegetation in the state of São Paulo, an area with limited studies. In this work the first records of galls in nine plant species were made, which shows how galls, gall makers and associated insects were little studied in the cerrado lato sensu the state of São Paulo, with many areas yet to be characterized. For 69 morphotypes characterized were found similar descriptions of only 24 in literature. Considering the high specificity of the relationship gall- gall maker, revised by the recent work of Carneiro et al. (2009), which indicates that each gall is specific as to their host plant and that his gall is a unique interaction between them, this indicates possibly 45 morphotypes (65.2%) who have never been described representing unknown species to science. This high percentage of unknown galls shows the lack of studies that characterize the galling community for cerrado of São Paulo, and which make the identification of gall maker with the use of the gall a more reliable methodology.

The sampling effort was 15 hours, a low figure compared to the monthly sampling for one year made by Bregonci et al. (2010), the monthly samplings for six months by Gonçalves-Alvim & Fernandes (2001), the monthly samplings for over a year of Urso-Guimarães & Scarelli-Santos (2006) and the 66 hours of samplings of Fernandes & Negreiros (2006). Of these works, only Fernandes & Negreiros (2006) used the same methodology, yet despite the difference in

sampling methodology, we can consider that all other studies had higher samplings effort that the present study. Despite the relatively low sampling effort, the richness of galls morphotypes found in this study was higher than three of them (Bregonci et al. 2010, Urso-Guimarães & Scarelli-Santos 2006, Fernandes & Negreiros 2006).

The richest family in diversity gall morphotypes was Annonaceae, followed by Malpighiaceae, Myrtaceae and Fabaceae. These data differs slightly from the expected. In literature, Fabaceae, Myrtaceae and Euphorbiaceae are cited as the richest families of galls (Gagné 1994), for example, Fabaceae was appointed as the richest in the cerrado by Gonçalves-Alvim & Fernandes (2001) and Urso-Guimarães & Scarelli-Santos (2006). It is therefore the first record of Annonaceae as the richest family in galls in a study area.

The richest host plant on types of galls was *Byrsonima cf intermedia* A. Juss. (Malpighiaceae) with six different morphotypes, followed by *Duguetia furfuracea* (A. St.-Hil.) Saff. (Annonaceae), with five. Urso-Guimarães & Scarelli-Santos (2006) found *Duguetia furfuracea* (A. St.-Hil.) Saff. (Annonaceae) as the richest host plant in another cerrado area of São Paulo and this results indicates the importance of this host plant to the gall makers and associated fauna in this vegetation.

The fact that 75% of the galls have been found in leaves, corroborate the pattern found in studies in Brazil, that indicates the leaf as organ most commonly attacked by gall makers (Maia et al. 2008, Maia 2001, Urso-Guimarães et al. 2003, Fernandes & Negreiros 2006) and with the world pattern found by Mani (1964). This pattern of occurrence in the leaves happens because the leaves are abundant resources and constant (Maia 2001), besides having a continuous flow of nutrients needed for the maintenance of photosynthesis (Whitham 1978). Another important factor is that females of Cecidomyiidae, most of the gall makers, has a very small size (1-5 mm), their ovipositor is fragile and can only lay eggs on tender tissues (Gagné 1994). The leaves are in constant renewal and derives most tender tissues of the host plants, which may also explain this preference.

The patterns for gall shape found in this study corroborate the patterns found in other studies, (Fernandes & Negreiros 2006, Bregonci et al. 2010, Santos et al. 2011) with the predominance of discoid shape (34.7%), followed by swellings and globular (23.1% each). The fact that more discoid was found should be viewed with caution, because this shape may mean an early stage of a globular gall or even a scar of gall of another shape, as conical or globular (Figure 8).

Another point to note is the subjectivity present in the descriptions of the galls in the literature. Although several studies using the same characteristics (shape, pubescence, distribution, organ attacked and color), the descriptions are discrepant and the nomenclature used is not always the same. To standardize the descriptions in this study were examined pictures of the shapes of galls, in addition to the table.

As for pubescence, in 14.2% of galls with parasitoids, were observed trichomes, while the percentage of trichomes described for all galls is 14.4%. These data reinforce Urso-Guimarães et al. (2003) whose found parasitic Hymenoptera in all galls with trichomes of their study, not sharing the hypothesis of Fernandes & Price (1988) who attribute the presence of trichomes protection against parasitoids.

The galls of *Eugenia punicifolia* Kunth (DC.) *Stryphnodendron obovatum* Benth. and *Arrabidaea* sp. were found in the color green and also brown (Figure 9). Urso-Guimarães & Scarelli-Santos (2003) found three morphotypes those had different colors and also indicated those this change was related to the maturation time of the galls. These data indicates that the use of color as a characteristic to identify galls should be used with caution because galls will change color according to the maturation stage and this should be analyzed in the characterizations of galls.

Figure 9. Example of galls of *Eugenia punicifolia* Kunth (DC.) in two stages of development with green and brown coloration of Ecological Station of Jataí (SP).

Another data was the new record of the species, *Psychotria carthagenensis* Jacq., *P. tricophora* Müll.Arg., *P. suturella* Müll.Arg. (Rubiaceae) and *Serjania erecta* Radlk. (Sapindaceae) in ES JATAÍ, as they are species of vines, not sampled by Toppa (2004) in his inventory of woody species. This record extends geographic distribution of these species.

The Diptera of the family Cecidomyiidae were responsible for the highest percentage of induction galls found (67.4%), and for the galling habit (88%). This result corroborate another data reported in other major studies in the literature, those indicates 58% of galls induced by Cecidomyiidae, according to Maia et al. (2008), 54% Urso-Guimarães et al. (2006), and 93%, according to Fernandes & Negreiros (2006), demonstrating the importance of the family in community of gall makers.

The Hymenoptera parasitoids found are of the families Eurytomidae, Torymidae and Eulophidae, within the superfamily Chalcidoidea, which are known parasitoids wasp of Cecidomyiidae galls (Urso-Guimarães et al. 2003).

All Diptera identified are unpublished occurrences for ES JATAÍ, because as mentioned, there are no studies related to galling insects in that area. The occurrence of these species in ES JATAÍ increases their known geographical distribution.

More studies are needed to understand the heterogeneous distribution of fauna and flora within the various vegetation types of ES JATAÍ. Including studies that aim to explain the distribution of galls and gall makers of these environments, because as mentioned earlier, this fauna has great potential as bioindicator, but you need to know how it behaves under different vegetation types and changes in conservation status of areas.

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