Revista Brasileira de Entomologia 70(1):e20250085, 2026

SOCIEDADE BRASILEIRA DE ENTOMOLOGIA
FUNDADA EM 1937

REVISTA BRASILEIRA DE
Entomologia
A Journal on Insect Diversity and Evolution



# New records of entomogenous galls, inducers, and associated fauna at the Jataí Ecological Station (Luiz Antônio, SP, Brazil)

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ARTICLE INFO

*Article history:*
Received 09 September 2025
Accepted 06 January 2026
Available online 06 March 2026
Associate Editor: Lucas Kaminski

*Keywords*
Inventory
Cerrado
Cecidomyiidae
Conservation Unit
Insect-plant interactions

ABSTRACT

Studies on entomogenous galls in the Brazilian savannah of the State of São Paulo are very scarce, and the diversity of gall-forming insects in these areas is barely known. The Ecological Station of Jataí (ESJataí), located in Luiz Antônio, is the largest protect area of Cerrado in the state of São Paulo, Brazil, covering 9,074 hectares. This study builds on the 2012 survey of entomogenous galls, extending it to new areas and phytophysiognomies within the ESJataí. A total of 103 gall morphotypes were identified on 47 plant species belonging to 22 families in these new samples. The results showed that only ten host plant species and ten morphotypes were present in both surveys. Another difference from the previous study are that Fabaceae (N=33), rather than Annonaceae (N=10), presented the highest richness of gall morphotypes and the super-host plant species is *Copaifera langsdorffii* Desf. (Fabaceae) (N=15) instead of *Byrsonima cf intermedia* A. Juss. (Malpighiaceae) (N=6). *Duguetia furfuracea* (A. St.-Hil.) Saff. (Annonaceae) was found to be a super-host species in both surveys (N=5 in 2012 and N=9 in 2024). The associated fauna is composed of four guilds, inducers (N=17), parasitoids (N=25), inquilines (N=4), and successors (N=17). Most of the gall-inducing insects belonged to the Cecidomyiidae family (Diptera) (N=17), with *Clinodiplosis bellum* Urso-Guimarães and Carmo-Neto, 2015, *Alycaulus hexadentatus* Urso-Guimarães, 2018, and *Lopesia curupirae* Urso-Guimarães, Garcia and Ospina, 2024 reported for the first time to this area.

## Introduction

Entomogenous galls are abnormal cell growth in plant tissues or organs induced by insects (Mani, 1964; Rohfritsch and Shorthouse, 1982; Carneiro et al., 2009). Gall-inducer insects are an important component of biodiversity, particularly due to their permanent, species-specific interactions with host plants, and the high richness of species. Six insect orders have gall-forming species: Coleoptera, Diptera, Lepidoptera, Hemiptera, Hymenoptera and Thysanoptera. The most notable of these are the cecidomyiid midges which richness is estimated to be about 1,8 – 2 million of species in the world (Hebert et al., 2016; Srivathsan et al., 2023), but they are relatively unknown and understudied in Brazilian biomes (Araújo et al., 2019; Urso-Guimarães et al., 2024).

Recognized as a hotspot for the diversity of gall-inducing insects, the Cerrado hosts species diversity and insect-plant interactions, where the family Cecidomyiidae (Diptera) is the most diverse family among the gall inducers (Maia and Silva., 2021). In Brazil, just over 300 species of galling cecidomyiids have been described, 70 of which have been recorded in the Cerrado, of which 56 are gall inducers (Urso-Guimarães et al., 2024).

Although there is a long tradition of inventories of entomogenous galls in Brazil (Araújo et al., 2019; Urso-Guimarães et al., 2024), there is an imbalance in terms of accumulated knowledge concerning Brazilian regions and biomes. Few of such inventories have been carried out in the state of São Paulo in the last 35 years, with only three in Cerrado areas in the state (Urso-Guimarães and Scareli-Santos, 2006; Saito and Urso-Guimarães, 2012; Ribeiro et al., 2019).

The savanna biome in Brazil and the second largest in the country and South America, the Cerrado once covered 14% of São Paulo State, but due to human activity, only 0.81% of the original vegetation remains (Kronka et al., 2005; Durigan et al., 2007; Bueno et al., 2018; Le Stradic et al., 2021). The Ecological Station of Jataí (ESJataí) is a State Conservation Unit that represents the largest area of continuous Cerrado vegetation in São Paulo (Durigan et al., 2007; Bueno et al., 2018). Although there is a previous survey at the ESJataí (Saito and Urso-Guimarães, 2012) conducted in Cerradão and regenerating Cerrado areas, a new collection of entomogenous galls was carried out to extend the data, to new phytophysiognomies, including forest, savannah and grassland formations.

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https://doi.org/10.1590/1806-9665-RBENT-2025-0085
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This study presents new records of gall morphotypes, host plants, gall inducers, and associated fauna from the ESJataí sampling area. It broadens the distribution of galls and gallers to different phytophysiognomies and updates the list of host plant species, gall inducers and associated fauna in the area. This contributes to our understanding of local biodiversity and provides relevant data on the interactions between galling insects and their host plants in a Cerrado neglected area. The undocumented diversity of these interactions, as well as the new cecidomyid taxa identified in this study — a neglected taxon — highlight the importance of ongoing monitoring of such areas.

## Material and methods

### *Study area*

The Ecological Station of Jataí (ESJataí) was established by State Decree No. 37,536 of June 15, 1982, with a total area of 9,074 hectares, representing the largest contiguous area of Cerrado in the State of São Paulo (Fig. 1), a biome characterized as savanna type (Toppa et al., 2005). In the ESJataí, the phytophysiognomies are quite heterogeneous, from grassland formations such as campo sujo; savannah formations such as campo cerrado and cerrado sensu stricto; and forest formations such as cerradão and seasonal semideciduous forest (Toppa et al., 2005, 2006).

### *Data collection and samples treatment*

Five areas with different Cerrado phytophysiognomies were sampled (Table 1): campo cerrado, campo sujo, cerradão, cerrado sensu stricto and floresta estacional semidecidual (Fig. 1). The sampling of each of these phytophysiognomies was carried out according to the methodology outlined in Price et al. (1998) and Araújo et al. (2021), which consists in actively collecting branches of plants with galls in random routes of an hour for each trail, over five days, totaling twenty-five hours of total effort.

Branches containing galls were labelled and photographed (Figs. 2-7). Branches of all plant species were herborized in exsiccates to identify

**Table 1**
Distance, altitude and coordinates of the trails in the phytophysiognomies sampled at the Ecological Station of Jataí, SP, Brazil.

| Phytophysiognomies | Geographical Coordinates of starting points | Route length |
|---|---|---|
| Campo cerrado | 21°35'24" S 47°47'45" W | 213.31 m |
| Campo sujo | 21°36'39" S 47°45'33" W | 201.64 m |
| Cerradão | 21°36'09" S 47°46'33" W | 249.94 m |
| Cerrado sensu stricto | 21°35'51" S 47°47'19" W | 192.3 m |
| Floresta estacional semidecidual | 21°35'56" S 47°49'33" W | 200.8m |

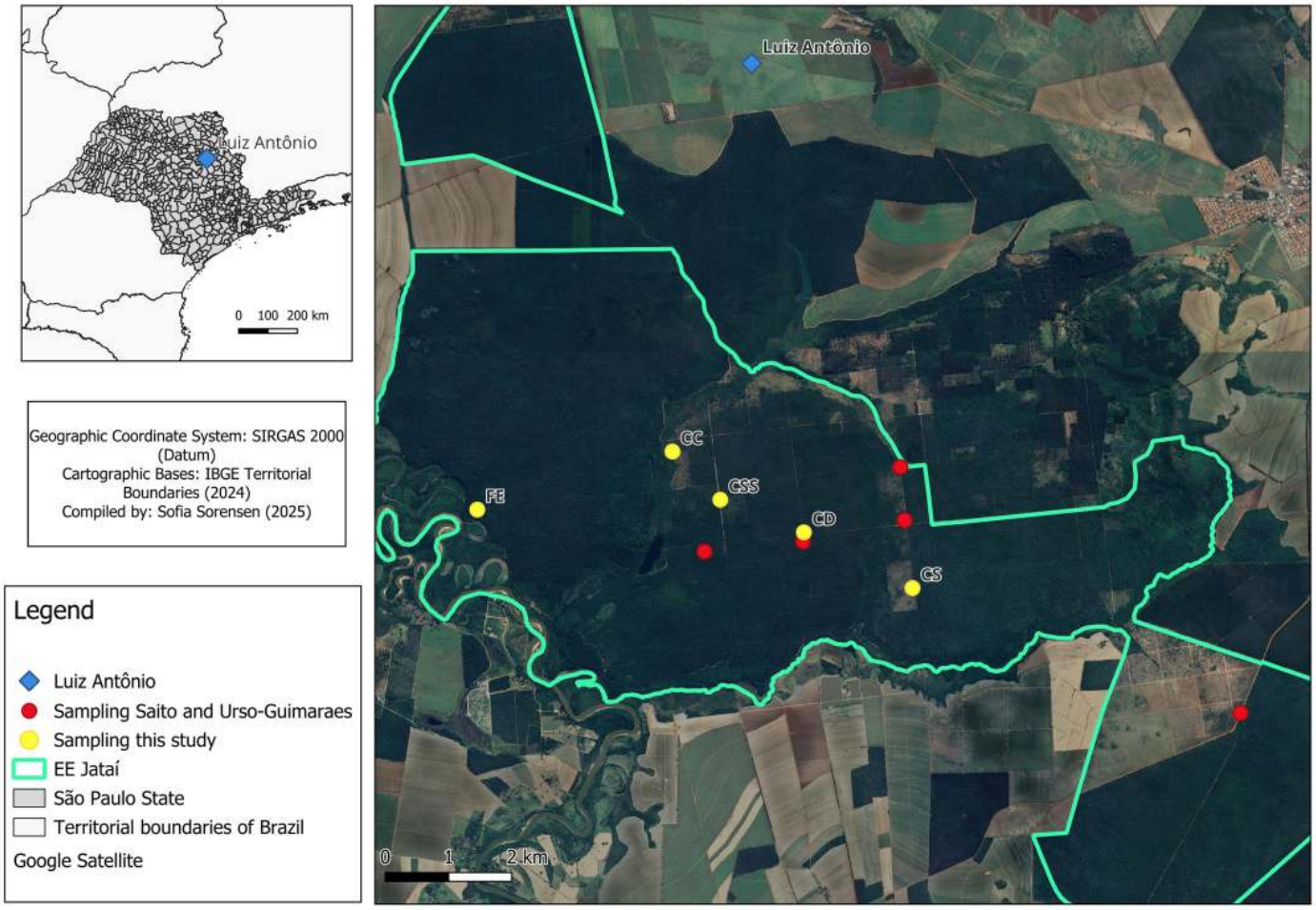



**Figure 1.** a. Territorial map of Brazil showing the location of Luiz Antônio, State of São Paulo, Brazil. b. Map of the Jataí Ecological Station with the sampling points of this study and those of Saito and Urso-Guimarães (2012) marked.




**Figure 2.** Anacardiaceae. a. Anacardiaceae sp. Annonaceae. b-i. *Duguetia furfuracea* (A.St.-Hil.) Saff, j-m. *Xylopia sericea* A.St.-Hil. Apocynaceae. n. *Forsteronia glabrescens* Müll. Arg. o. *Chromolaena squalida* (D.C) R.M. King and H. Rob Asteraceae. p-r. *Moquiniastrum pulchrum* (Cabrera) G.Sancho, s. *Moquiniastrum* sp., t. *Adenocalymma peregrinum* (Miers) L.G.Lohmann.




**Figure 3.** Bignoniaceae. a. *Adenocalymma peregrinum* (Miers) L.G.Lohmann, b. *Amphilophium magnoliifolium* (Kunth) L.G.Lohmann, c-e. *Amphilophium elongatum* (Vahl) L.G.Lohmann, f. *Handroanthus ochraceus* (Cham.) Mattos., g-h. Bignoniaceae sp. 2, i-j. Bignoniaceae sp. 3. Burseraceae. k. *Protium heptaphyllum* (Aubl.) Marchand. Caryocaraceae. l. *Caryocar brasiliense* Cambess. Chrysobalanaceae. m. *Couepia grandiflora* (Mart. and Zucc.) Benth, n. *Licania* sp. Connaraceae. o. *Rourea induta* Planch. Erythroxylaceae. p. *Erythroxylum suberosum* A.St.-Hil. Fabaceae. q-r. *Anadenanthera colubrina* (Vell.) Brenan, s-t. *Andira humilis* Mart. ex Benth.




**Figure 4.** Fabaceae. a. *Andira humilis* Mart. ex Benth, b-d. *Bauhinia holophylla* (Bong.) Steud, e. *Bauhinia* sp., f-t. *Copaifera langsdorffii* Desf.

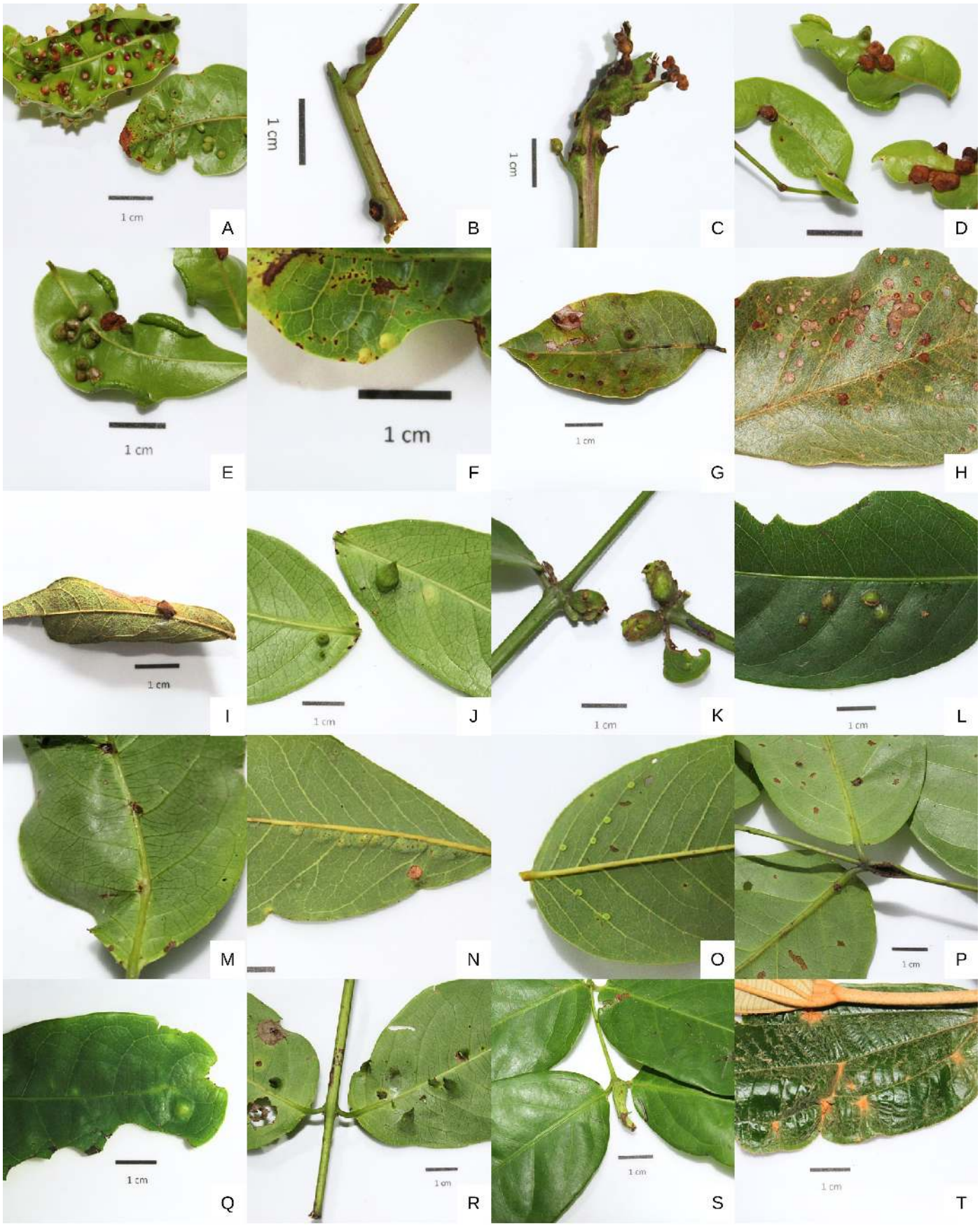



**Figure 5.** Fabaceae. a-g. *Diptychandra aurantiaca* Tul, h. *Hymenaea stigonocarpa* Mart. ex Hayne, i. *Periandra mediterranea* (Vell.) Taub. Malpighiaceae. j-m. *Banisteriopsis adenopoda* (A.Juss.) B.Gates, n-o. *Banisteriopsis* sp., p-s. *Diplopterys pubipetala* (A.Juss.) W.R.Anderson and C.C.Davis. Melastomataceae. t. *Miconia albicans* (Sw.) Steud.

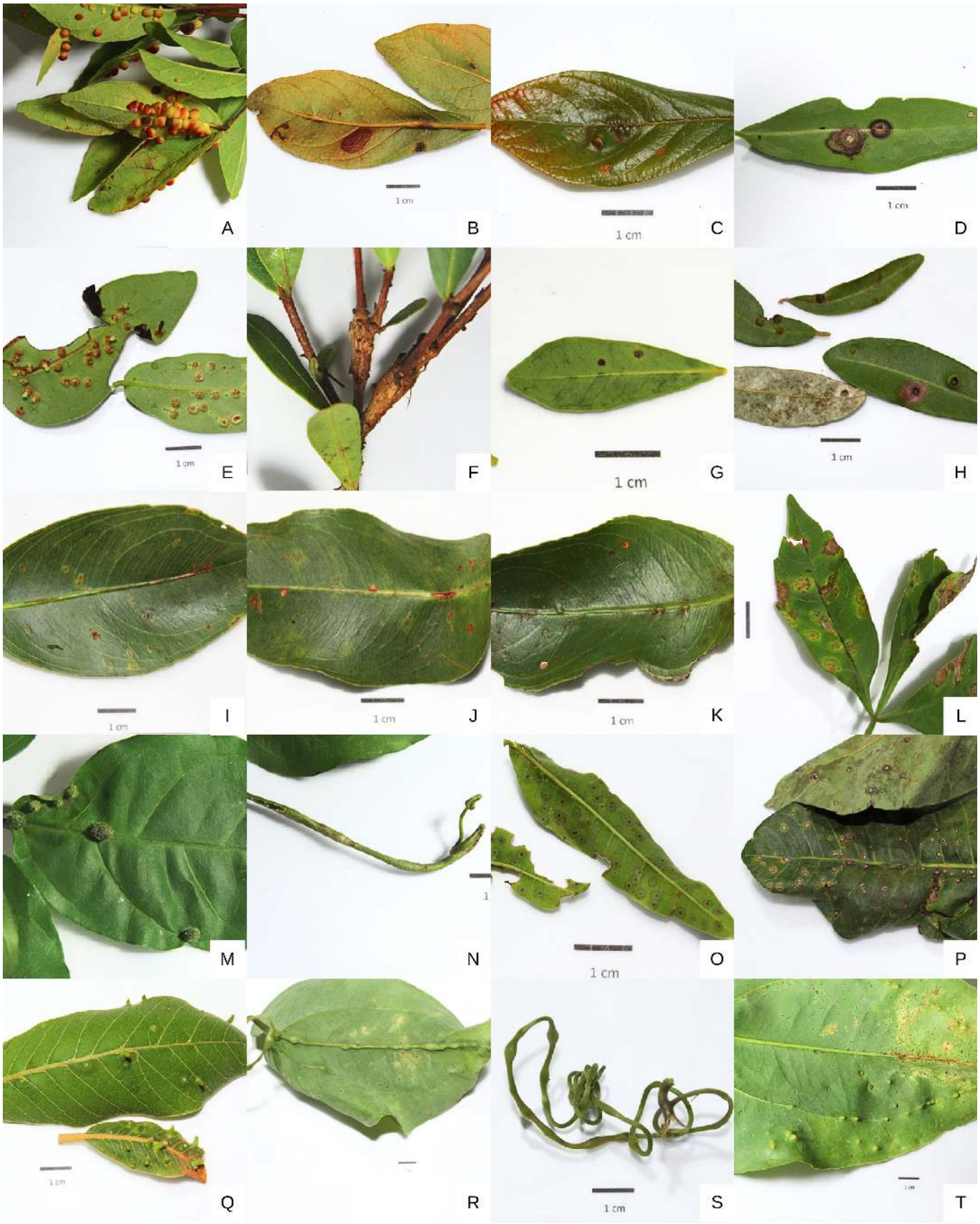



**Figure 6.** Myrtaceae. a-c. *Campomanesia adamantium* (Cambess.) O.Berg, d. *Eugenia aurata* O.Berg, e. *Eugenia bimarginata* DC, f-h. *Eugenia punicifolia* (Kunth) DC. Ochnaceae. i-k. *Ouratea spectabilis* (Mart.) Engl. Sapindaceae. l. Serjania lethalis A.St.-Hil, m-n. Sapindaceae sp., o. *Talisia angustifolia* Radlk. Sapotaceae. p. *Pouteria ramiflora* (Mart.) Radlk, q. *Pouteria torta* (Mart.) Radlk. Smilacaceae. r-t. *Smilax* sp.

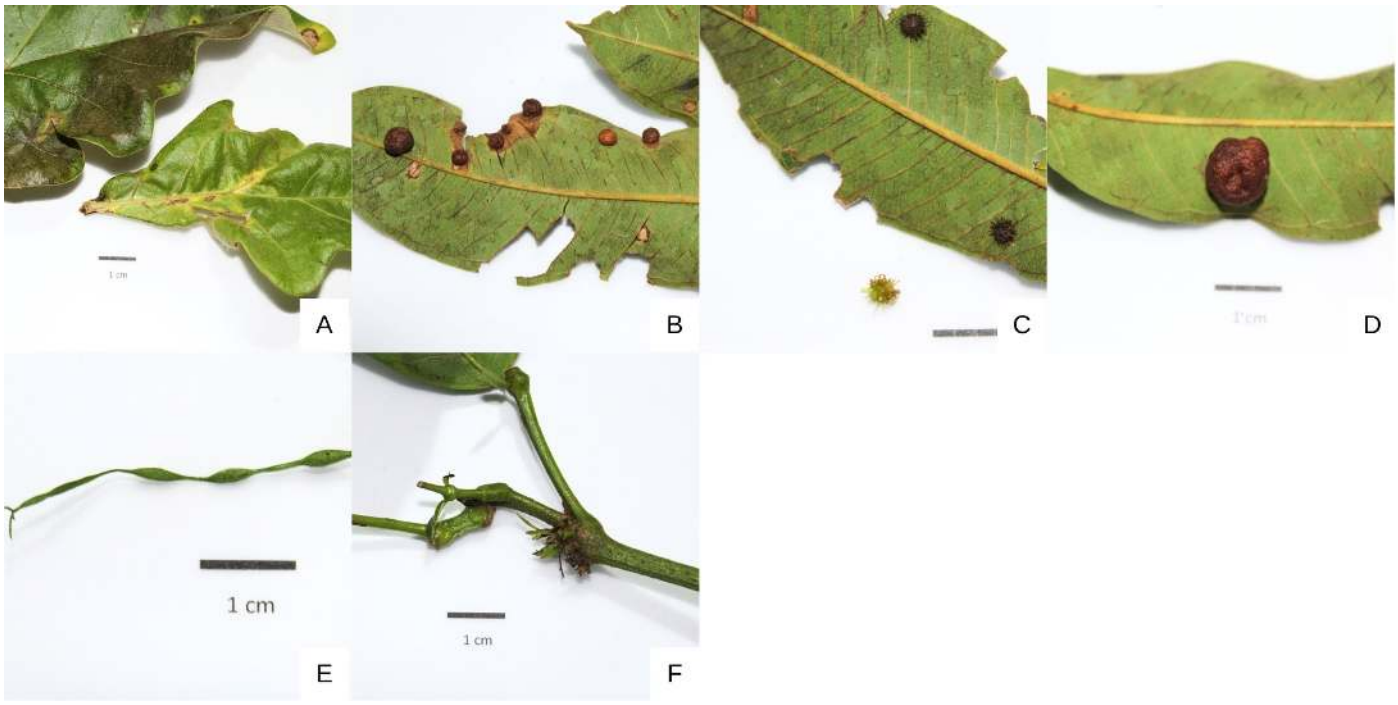



**Figure 7.** Solanaceae. a. *Solanum lycocarpum* A.St.-Hil. Vochysiaceae. b-d. *Qualea parviflora* Mart. e. Unidentified sp1, f. Unidentified sp2.

the host plant. Viable galls were kept in plastic containers for the rearing of inducers. All insects obtained from the rearing were stored in absolute alcohol, sorted and identified taxonomically at least to the family and guild to which they belonged. After identification of the host plants by Dr. Giselda Durigan (IPA/SP), the exsiccates were deposited in the SORO herbarium of the Federal University of São Carlos (UFSCar), Sorocaba campus. Vouchers of inducing insects and associated fauna are deposited in the scientific collection of the Diptera Systematics Laboratory (LSDiptera Collection) of UFSCar, Sorocaba Campus.

## Results and discussion

In this study, a hundred and three gall morphotypes were recorded on 46 plant species, distributed in 21 families (Table 2, Figs. 2-7). The morphotypes of galls found in ES Jatai in the 2012 and 2024 surveys were compared. This analysis included plant and morphotype data to group the data from both surveys, providing an overview of the total composition of morphotypes and host plants in the sampled area.

The Fabaceae family is the most species-rich in the Cerrado biome (JBRJ, 2025), the richest host plant species in entomogenous gall morphotypes in all Brazilian biomes (Araújo, 2018; Araújo et al., 2019; Urso-Guimarães et al., 2024) and exhibiting the richest number of species in the woody composition in ESJataí (Toppa et al., 2005). Despite this, in the survey conducted by Saito and Urso-Guimarães (2012) at ESJataí, Fabaceae was revealed to be the fourth richest family of host plants, exhibiting only six morphotypes. In the present study, Fabaceae was recorded as the richest family with 33 gall morphotypes, followed by Annonaceae, and Bignoniaceae (Fig. 8), both with 11 morphotypes. The variation in family richness between studies can be attributed to various factors, such as differences in sampling effort (new areas were sampled), seasonal variations, changes in vegetation composition over time and the presence of super-host. Thus, our data still corroborates Southwood's (1960, 1961) hypothesis that the richer plant families in number of species will predominate as hosts for gall inducers.

The species *Copaifera langsdorffii* Desf. and *Diptychandra aurantiaca* Tul. were found to have 15 and 6 morphotypes of galls, respectively, in our study, instead of *Byrsonima* cf *intermedia* A. Juss. (Malpighiaceae) (N=6) in the previous survey (Saito and Urso-Guimarães, 2012). *Duguetia furfuracea* (A. St.-Hil.) Saff. (Annonaceae) was found to be a super-host species in both surveys (N=5 in 2012 and N=9 in this survey). Both species are known in the literature as super-host plants, which are the host plant species with two or more gall morphotypes (Veldtman and McGeoch 2003; Santos-Silva and Araújo 2020).

The elevated level of morphotype diversity observed in *C. langsdorffii* (14) surpasses the total number of morphotypes identified in the second most prevalent family in this study, the Bignoniaceae (11 morphotypes), underscoring the substantial impact of super-host species on the observed diversity patterns. This phenomenon is particularly evident in the case of *C. langsdorffii*, for which up to 23 gall morphotypes have been documented so far (Fagundes et al., 2020; Carvalho-Sposito et al., 2022).

Although the number of host plant species found in both surveys (2012; 2024) is very similar (41; 46), the number of morphotypes found in each work shows a considerable divergence (69; 103). Consequently, the average number of morphotypes per host plant is 2.24 in this study, compared to 1.68 in the 2012 survey. This difference can be partly attributed to the presence and variation in abundance of super-host species between the studies, such as *Copaifera langsdorffii*, since superhost species are known to influence gall morphotype richness by including a large number of morphotypes within a single species (Veldtman and McGeoch 2003; Grandez-Rios et al., 2020).

The plant organ most affected by gall formation was the leaf (n=85, 82,5%), the most common shapes were globoid (n= 28, 27%) and fusiform (n=27, 26%); the predominant color was green (n=69, 67%), most of the galls had a glabrous surface (n=82, 80%) and each had gall one chamber. All these aspects corroborate patterns observed in other studies conducted in Brazil (Fernandes and Price, 1988; Saito and Urso-Guimarães 2012; Urso-Guimarães et al., 2024), although for papers published before 2013, there was no consistent pattern for naming gall morphotypes, standardized only in Isaias et al. (2013).

**Table 2**
Characterization of insect galls recorded in Ecological Station of Jataí, State of São Paulo, Brazil, by host plant. Figures refer to the photos of the gall morphotype.

| Plant Family | Plant Species | Phytophysiognomy | Plant Organ | Morphotype | Gall color | Trichomes | Trichome color | Figure |
|---|---|---|---|---|---|---|---|---|
| Anacardiaceae | Anacardiaceae sp. | Campo cerrado | leaf, petiole | globoid | brown | absent | - | 2a |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Campo cerrado | leaf | globoid | green/brown | present | cream | 2b |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Campo cerrado | leaf | globoid | green/brown | absent | - | 2c |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Campo cerrado | leaf | globoid | green/brown | absent | - | 2d |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Campo Sujo | leaf | globoid | green | absent | - | 2e |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Campo Sujo | leaf | cylindrical | green/brown | absent | - | 2f |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Cerrado sensu stricto | leaf | leaf fold | green | absent | - | 2g |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Cerrado sensu stricto | leaf | globoid | brown | absent | - | - |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Cerrado sensu stricto | leaf | globoid | pink | absent | - | 2h |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. | Cerradão | leaf | globoid | green | absent | - | 2i |
| Annonaceae | *Xylopia sericea* A.St.-Hil. | Campo Sujo, Cerrado sensu stricto | leaf | lenticular | green/brown | absent | - | 2j-k |
| Annonaceae | *Xylopia sericea* A.St.-Hil. | Campo Sujo, Cerrado sensu stricto | leaf vein | fusiform | green | absent | - | 2l-m |
| Apocynaceae | *Forsteronia glabrescens* Müll.Arg. | Campo cerrado | leaf | amorphous | green | absent | - | 2n |
| Asteraceae | *Chromolaena squalida* (DC.) R.M.King & H.Rob. | Campo cerrado | stem | fusiform | green/brown | present | cream | 2o |
| Asteraceae | *Moquiniastrum pulchrum* (Cabrera) G.Sancho | Cerradão | leaf, petiole | globoid | cream | present | cream | 2p-q |
| Asteraceae | *Moquiniastrum pulchrum* (Cabrera) G.Sancho | Cerradão | leaf | amorphous | cream | present | cream | 2r |
| Asteraceae | Moquiniastrum sp 1 | Cerradão | petiole | amorphous | cream/brown | absent | - | 2s |
| Bignoniaceae | *Adenocalymma peregrinum* (Miers) L.G.Lohmann | Cerrado sensu stricto | leaf | fusiform | green/brown | present | cream | 2t |
| Bignoniaceae | *Adenocalymma peregrinum* (Miers) L.G.Lohmann | Cerrado sensu stricto | petiole, main leaf vein | fusiform | green | absent | - | 3a |
| Bignoniaceae | *Amphilophium magnoliifolium* (Kunth) L.G.Lohmann | Cerradão | petiole | fusiform | green/brown | present | cream | 3b |
| Bignoniaceae | *Amphilophium elongatum* (Vahl) L.G.Lohmann | Campo Sujo | tendril | fusiform | green | absent | - | 3c |
| Bignoniaceae | *Amphilophium elongatum* (Vahl) L.G.Lohmann | Cerradão | tendril | fusiform | green | absent | - | 3d |
| Bignoniaceae | *Amphilophium elongatum* (Vahl) L.G.Lohmann | Cerradão | leaf | lenticular | brown | absent | - | 3e |
| Bignoniaceae | *Handroanthus ochraceus (*Cham.) Mattos | Campo sujo | leaf bud | amorphous | cream | present | cream | 3f |
| Bignoniaceae | Bignoniaceae sp 2 | Cerradão | stem | fusiform | cream/green | present | cream | 3g |
| Bignoniaceae | Bignoniaceae sp 2 | Cerradão | petiole | fusiform | green | absent | - | 3h |
| Bignoniaceae | Bignoniaceae sp 3 | Floresta estacional semidecidual | tendril | fusiform | cream/green | absent | - | 3i |
| Bignoniaceae | Bignoniaceae sp 3 | Floresta estacional semidecidual | leaf | marginal roll | green | absent | - | 3j |
| Burseraceae | *Protium heptaphyllum* (Aubl.) Marchand | Campo cerrado, Cerrado sensu stricto | leaf | conical | green | absent | - | 3k |
| Caryocaraceae | *Caryocar brasiliense* Cambess. | Campo cerrado | leaf | globoid | cream/ brown | present | cream | 3l |
| Chrysobalanaceae | *Couepia grandiflora* (Mart. & Zucc.) Benth | Campo cerrado | leaf | lenticular | brown | present | brown | 3m |
| Chrysobalanaceae | *Licania sp.* | Campo cerrado | leaf | lenticular | green | absent | - | 3n |
| Connaraceae | *Rourea induta* Planch. | Campo Sujo | leaf bud | amorphous | brown | absent | - | 3o |
| Erythroxylaceae | *Erythroxylum suberosum* A.St.-Hil. | Cerradão | leaf | amorphous | brown | present | brown | 3p |
| Fabaceae | *Anadenanthera colubrina* (Vell.) Brenan | Campo cerrado | petiole | globoid | green/brown | absent | - | 3q |
| Fabaceae | *Anadenanthera colubrina* (Vell.) Brenan | Cerrado sensu stricto | petiole | globoid | brown | absent | - | 3r |
| Fabaceae | *Andira humilis* Mart. ex Benth. | Campo cerrado | leaf | lenticular | brown | absent | - | 3s |
| Fabaceae | *Andira humilis* Mart. ex Benth. | Campo cerrado | leaf | fusiform | brown | absent | - | 3t |
| Fabaceae | *Andira humilis* Mart. ex Benth. | Campo sujo, Cerrado sensu stricto | leaf | globoid | green | absent | - | 4a |
| Fabaceae | *Bauhinia holophylla* (Bong.) Steud. | Campo Cerrado, Campo Sujo | leaf | globoid | brown | present | brown | 4b |
| Fabaceae | *Bauhinia holophylla* (Bong.) Steud. | Campo cerrado | leaf bud | fusiform | green | present | cream | 4c |
| Fabaceae | *Bauhinia holophylla* (Bong.) Steud. | Cerradão | leaf | globoid | cream | present | brown | - |
| Fabaceae | *Bauhinia holophylla* (Bong.) Steud | Campo Cerrado | leaf vein | lenticular | green | absent | - | 4d |
| Fabaceae | Bauhinia sp. | Floresta estacional semidecidual | leaf | leaf fold | green | present | brown | 4e |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | lenticular | green/brown | absent | - | 4f |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | globoid | green/brown | absent | - | 4g |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | leaf fold | green/red | absent | - | 4h |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | lenticular | green/brown | absent | - | 4i |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf, petiole | amorphous | brown | absent | - | 4j |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado, Floresta estacional semidecidual | leaf | fusiform | green/red | absent | - | 4k |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado, Floresta estacional semidecidual | leaf | fusiform | red | absent | - | 4l |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf vein | fusiform | cream/ green/red/ brown | absent | - | 4m |

**Table 2**
Continued...

| Plant Family | Plant Species | Phytophysiognomy | Plant Organ | Morphotype | Gall color | Trichomes | Trichome color | Figure |
|---|---|---|---|---|---|---|---|---|
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | cylindrical | green/pink | absent | - | 4n |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | amorphous | green | absent | - | 4o |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | globoid | brown | absent | - | 4p |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | lenticular | brown | absent | - | 4q |
| Fabaceae | *Copaifera langsdorffii* Desf. | Floresta estacional semidecidual | leaf | cylindrical | green/brown | absent | - | 4r |
| Fabaceae | *Copaifera langsdorffii* Desf. | Floresta estacional semidecidual | leaf | globoid | brown | absent | - | 4s |
| Fabaceae | *Copaifera langsdorffii* Desf. | Campo cerrado | leaf | globoid | green/brown | absent | - | 4t |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | leaf | globoid | cream/ green/red | absent | - | 5a |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | stem, petiole | fusiform | green/brown | absent | - | 5b-c |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | leaf | globoid | cream/brown | absent | - | 5d |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | leaf | marginal roll | green | absent | - | 5e |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | leaf | conical | green | absent | - | 5f |
| Fabaceae | *Diptychandra aurantiaca* Tul. | Campo cerrado | leaf | lenticular | green | absent | - | 5g |
| Fabaceae | *Hymenaea stigonocarpa* Mart. ex Hayne | Campo Cerrado | petiole | lenticular | brown | absent | - | 5h |
| Fabaceae | *Periandra mediterranea* (Vell.) Taub. | Cerradão | leaf | amorphous | brown | present | cream | 5i |
| Malpighiaceae | *Banisteriopsis adenopoda* (A.Juss.) B.Gates | Cerradão | leaf | conical | green | absent | - | 5j |
| Malpighiaceae | *Banisteriopsis adenopoda* (A.Juss.) B.Gates | Cerradão | leaf bud | amorphous | green | absent | - | 5k |
| Malpighiaceae | *Banisteriopsis adenopoda* (A.Juss.) B.Gates | Cerradão | leaf | lenticular | green | absent | - | 5l |
| Malpighiaceae | *Banisteriopsis adenopoda* (A.Juss.) B.Gates | Cerradão | leaf vein | fusiform | green/brown | absent | - | 5m |
| Malpighiaceae | Banisteriopsis sp. | Campo cerrado | leaf | lenticular | green/ yellow/ brown | present | cream | 5n |
| Malpighiaceae | Banisteriopsis sp. | Campo cerrado | leaf | globoid | green | absent | - | 5o |
| Malpighiaceae | *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis | Cerradão | petiole | fusiform | green | absent | - | 5p |
| Malpighiaceae | *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis | Cerradão | leaf | lenticular | green | absent | - | 5q |
| Malpighiaceae | *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis | Cerradão | leaf | conical | green | absent | - | 5r |
| Malpighiaceae | *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis | Cerradão | leaf bud | amorphous | green | absent | - | 5s |
| Melastomataceae | *Miconia albicans* (Sw.) Steud | Cerradão | leaf | amorphous | brown | absent | - | 5t |
| Myrtaceae | *Campomanesia adamantium* (Cambess.) O.Berg | Campo cerrado, Cerrado sensu stricto | leaf | globoid | green/red | absent | - | 6a |
| Myrtaceae | *Campomanesia adamantium* (Cambess.) O.Berg | Campo cerrado | leaf vein | fusiform | green/brown | present | brown | 6b |
| Myrtaceae | *Campomanesia adamantium* (Cambess.) O.Berg | Campo cerrado | leaf | lenticular | green/orange | absent | - | 6c |
| Myrtaceae | *Eugenia aurata* O.Berg | Cerradão | leaf | lenticular | brown | absent | - | 6d |
| Myrtaceae | *Eugenia bimarginata* DC. | Cerradão | leaf | cylindrical | green/brown | absent | - | 6e |
| Myrtaceae | *Eugenia punicifolia* (Kunth) DC. | Campo Sujo | petiole | fusiform | brown | absent | - | 6f |
| Myrtaceae | *Eugenia punicifolia* (Kunth) DC. | Campo Sujo | leaf | lenticular | brown | absent | - | 6g |
| Myrtaceae | *Eugenia punicifolia* (Kunth) DC. | Cerradão | leaf | globoid | brown | absent | - | 6h |
| Ochnaceae | *Ouratea spectabilis* (Mart.) Engl. | Campo cerrado | leaf | lenticular | green/brown | absent | - | 6i |
| Ochnaceae | *Ouratea spectabilis* (Mart.) Engl. | Campo cerrado | leaf vein | fusiform | green/brown | absent | - | 6j-k |
| Sapindaceae | *Serjania lethalis* A.St.-Hil. | Campo Sujo, Cerradão, Cerrado sensu stricto, Floresta estacional semidecidual | leaf | lenticular | green/brown | absent | - | 6l |
| Sapindaceae | Sapindaceae sp 1 | Cerradão | leaf | globoid | green | present | cream | 6m |
| Sapindaceae | Sapindaceae sp 1 | Cerradão | tendril | fusiform | green | absent | - | 6n |
| Sapindaceae | *Talisia angustifolia* Radlk. | Campo cerrado | leaf | lenticular | green | absent | - | 6o |
| Sapotaceae | *Pouteria ramiflora* (Mart.) Radlk. | Campo cerrado | leaf | lenticular | brown | absent | - | 6p |
| Sapotaceae | *Pouteria torta* (Mart.) Radlk | Cerradão, Cerrado sensu stricto | leaf | cylindrical | green | present | cream | 6q |
| Smilacaceae | Smilax sp. | Campo cerrado, Floresta estacional semidecidual | main leaf vein | fusiform | green | absent | - | 6r |
| Smilacaceae | Smilax sp. | Floresta estacional semidecidual | tendril | fusiform | green | absent | - | 6s |
| Smilacaceae | Smilax sp. | Floresta estacional semidecidual | leaf, leaf vein | fusiform | green | absent | - | 6t |
| Solanaceae | *Solanum lycocarpum* A.St.-Hil. | Cerrado sensu stricto | main leaf vein | fusiform | cream | absent | - | 7a |
| Vochysiaceae | *Qualea parviflora* Mart. | Campo sujo | leaf | globoid | brown | absent | - | 7b |
| Vochysiaceae | *Qualea parviflora* Mart. | Campo sujo | leaf | globoid | green/brown | present | cream | 7c |
| Vochysiaceae | *Qualea parviflora* Mart. | Campo sujo | leaf | globoid | brown | absent | - | 7d |
| Unidentified | Unidentified sp1 | Cerradão | tendril | fusiform | green | absent | - | 7e |
| Unidentified | Unidentified sp2 | Cerrado sensu stricto | petiole | amorphous | green | absent | - | 7f |

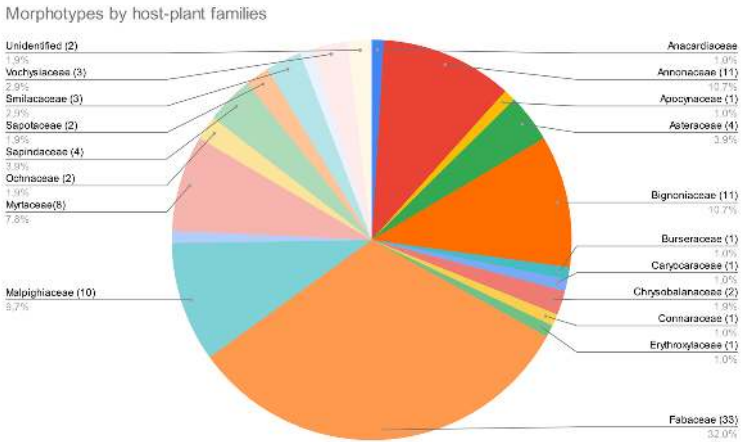



**Figure 8.** Diagram showing the percentage of richness of gall morphotypes in the host plant families found at the Jataí Ecological Station, Luiz Antonio, State of São Paulo, Brazil.

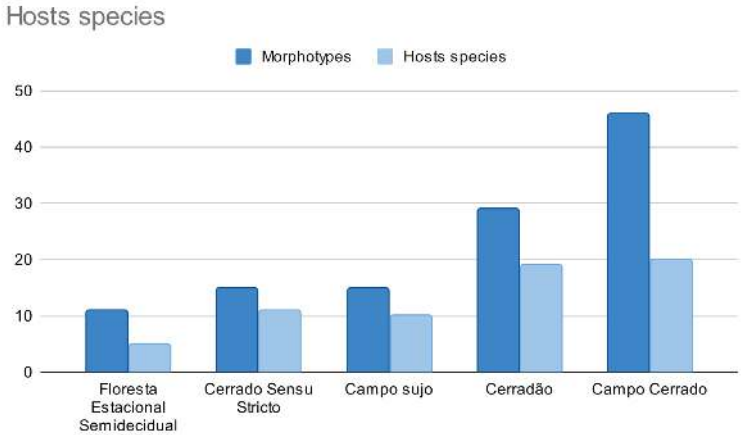



**Figure 9.** Relationship between the number of host plants and the morphotypes found in each phytophysiognomy.

Of the host plant species found in this study, ten are common to those found in Saito and Urso-Guimarães (2012), namely: *Duguetia furfuracea* (A.St.-Hil.) Saff. (Annonaceae), *Moquiniastrum pulchrum* (Cabrera) G.Sancho (Asteraceae, [=*Gochnatia pulchrum* Cabrera]), *Couepia grandiflora* (Mart. and Zucc.) Benth (Chrysobalanaceae), *Erythroxylum suberosum* A.St.-Hil. (Erythroxylaceae), *Miconia albicans* (Sw.) Steud (Melastomataceae), *Eugenia aurata* O.Berg, *E. bimarginata* DC., *E. punicifolia* (Kunth) DC. (Myrtaceae), *Ouratea spectabilis* (Mart.) Engl. (Ochnaceae), and *Pouteria torta* (Mart.) Radlk (Sapotaceae). The other 36 host plant species are new records for the study area (Table 2).

The campo cerrado phytophysiognomy had the highest morphotype richness (n=46), while the seasonal semideciduous forest had the lowest (n=11) (Fig. 9). Both areas were sampled for the first time. The remaining phytophysiognomies had an average of eight families and ten genera each. This difference in gall richness between phytophysiognomies can be attributed to various factors such as floristic composition, vegetation structure, seasonality, microclimatic conditions and availability of resources for gall-forming insects (Araújo et al., 2014b). Galls were recorded on *Xylopia sericea* A.St.-Hil, *Amphilophium magnoliifolium* (Kunth) L.G.Lohmann, and *Banisteriopsis adenopoda* (A. Juss.) representing the first documented occurrence of these plants within the ESJataí and the municipality of Luis Antonio.

The comparison among localities (Table 3) indicates that gall morphotype richness is not solely determined by sampling effort. For example, the Altinópolis area, despite a markedly low sampling effort of 7.5 hours, yielded a highly concentrated richness of 1.95 morphotypes per host plant species, a value comparable to the intensively sampled Sorocaba site (48 hours, 2.1 morphotypes per host plant). These disparities suggest that ecological local factors, such as vegetation composition (more species richness equals to more potential host plants) and crucially, the abundance of super-host plants (such as *Copaifera langsdorffii*), play a more decisive role in determining local diversity patterns than sampling duration, although increased sampling effort remains essential for maximizing the detection of morphotypes (Araújo et al., 2013; Araújo et al., 2014a).

The associated fauna is composed of four guilds, which were characterized according to Luz and Mendonça-Júnior (2019) as inducers (N=17), parasitoids (N=25), inquilines (N=4), and successors (N=17), according to Luz and Mendonça-Filho, inquilines may or may not stimulate the formation of new tissues in the gall and may or may not cause the death of the inducer. Most of the gall-inducing insects belonged to the Cecidomyiidae family (Diptera) (N=17), with *Clinodiplosis bellum* Urso-Guimarães and Carmo-Neto, 2015, *Alycaulus hexadentatus* Urso-Guimarães, 2018, and *Lopesia curupirae* Urso-Guimarães, Garcia and Ospina, 2024 reported for the first time in this area, confirming the importance of this group as the main inducer of entomogenous galls in all ecosystems (Table 4). As for the fauna associated with galls, the parasitoids mostly belong to the order Hymenoptera, superfamily Chalcidoidea, a group known to parasitize various insects, including the larvae of gall-forming insects (Rizzo and Askew 2008, Gómez and Nieves-Aldrey, 2012). The successional fauna, in turn, was dominated by hemipterans of the superfamily Coccoidea (mealybugs) (N=3) and acari of the Parasitiformes Order (N=12).

**Table 3**
Richness of gall morphotypes from localities with Cerrado phytophysiognomies in São Paulo State.

| Locality | Richness - gall morphotypes | Richness - host plant species | Average number of gall/host plant species | Total sampling effort |
|---|---|---|---|---|
| Sorocaba, SP (Ansaloni et al., 2018) | 113 | 54 | 2.1 | 48h |
| Jataí Ecological Station, Luiz Antônio, SP (this study + Saito and Urso-Guimarães, 2012) | 162 (93 + 69) | 78 (37 + 41) | 2.1 | 40h (25h + 15h) |
| Altinópolis, SP (Ribeiro et al., 2019) | 41 | 21 | 1.95 | 7.5h |
| Santa Rita do Passa Quatro, SP (Urso-Guimarães and Scareli-Santos, 2006) | 35 | 25 | 1.4 | not informed |

**Table 4**
Gall makers and associated fauna in galls of Jataí Ecological Station, São Paulo, Brazil.

| Plant Family | Plant Species/morphotype figure | Indutor | Associated fauna |
|---|---|---|---|
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. (Fig. 2b) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Annonaceae | *Duguetia furfuracea* (A.St.-Hil.) Saff. (Fig. 2h) | Diptera, Cecidomyiidae, Cecidomyiinae | not observed |
| Apocynaceae | *Forsteronia glabrescens* Müll.Arg. (Fig. 2n) | not observed | Hemiptera, Coccoidea (succssor) |
| Asteraceae | *Moquiniastrum pulchrum* (Cabrera) G.Sancho (Fig. 2 p-q) | Diptera, Cecidomyiidae | Acari, Parasitiformes (successor); Hymenoptera, Chalcidoidea (parasitoid) |
| Bignoniaceae | *Adenocalymma peregrinum* (Miers) L.G.Lohmann (Fig. 3a) | not observed | Acari, Parasitiformes (successor); Hymenoptera, Chalcidoidea (parasitoid); Diptera, Cecidomyiidae, *Meunieriella* sp. (inquiline) |
| Bignoniaceae | *Amphilophium elongatum* (Vahl) L.G.Lohmann (Fig. 3c) | Diptera, Cecidomyiidae, Cecidomyiinae | not observed |
| Bignoniaceae | *Handroanthus ochraceus* (Cham.) Mattos (Fig. 3f) | Diptera, Cecidomyiidae, *Clinodiplosis* sp. | Coleoptera, Curculionidae (successor); Hymenoptera, Chalcidoidea (parasitoid); Diptera, Sciaridae (inquiline); Lepidoptera (predator); Aranea (sucessor) |
| Bignoniaceae | Bignoniaceae sp 2 (Fig. 3h) | not observed | Hymenoptera, Chalcidoidea (parasitoid);Diptera, Cecidomyiidae, *Trotteria* sp.2 (inquiline) |
| Bignoniaceae | Bignoniaceae sp 3 (Fig. 3i) | Diptera, Cecidomyiidae, Clinodiplosini | not observed |
| Burseraceae | *Protium heptaphyllum* (Aubl.) Marchand (Fig. 3k) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Caryocaraceae | *Caryocar brasiliense* Cambess. (Fig. 3l) | not observed | Acari, Parasitiformes (successor); Hemiptera, Coccoidea (parasitoid); Hymenoptera, Chalcidoidea (parasitoid) |
| Chrysobalanaceae | *Licania* sp. (Fig. 3n) | not observed | Acari, Parasitiformes (successor) |
| Fabaceae | *Anadenanthera colubrina* (Vell.) Brenan (Fig. 3r) | Diptera, Cecidomyiidae, *Lopesia curupirae* Urso-Guimarães, Garcia and Ospina, 2024 | Hymenoptera, Chalcidoidea (parasitoid); Thysanoptera, Phlaeothripidae (successor) |
| Fabaceae | *Andira humilis* Mart. ex Benth. (Fig. 3s) | not observed | Hemiptera (successor) |
| Fabaceae | *Andira humilis* Mart. ex Benth. (Fig. 4a) | Diptera, Cecidomyiidae | not observed |
| Fabaceae | *Bauhinia* sp. (Fig. 4e) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Fabaceae | *Copaifera langsdorffii* Desf. (Fig. 4f, 4g, 4h, 4n) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Fabaceae | *Copaifera langsdorffii* Desf. (Fig. 4k) | Diptera, Cecidomyiidae | Hymenoptera, Chalcidoidea (parasitoid) |
| Fabaceae | *Copaifera langsdorffii* Desf. (Fig. 4r) | Diptera, Cecidomyiidae | Hymenoptera, Chalcidoidea (parasitoid) |
| Fabaceae | *Diptychandra aurantiaca* Tul. (Fig. 5a) | Diptera, Cecidomyiidae | not observed |
| Fabaceae | *Diptychandra aurantiaca* Tul. (Fig. 5b-c) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Fabaceae | *Diptychandra aurantiaca* Tul. (Fig. 5d) | Diptera, Cecidomyiidae | Acari, Parasitiformes (successor) |
| Fabaceae | *Diptychandra aurantiaca* Tul. (Fig. 5e) | Diptera, Cecidomyiidae, *Lopesia* sp.1 | not observed |
| Fabaceae | *Diptychandra aurantiaca* Tul. (Fig. 5g) | not observed | Acari, Parasitiformes (successor) |
| Malpighiaceae | *Banisteriopsis adenopoda (A.Juss.) B.Gates* (Fig. 5j) | Diptera, Cecidomyiidae, Cecidomyiidi | Hymenoptera, Chalcidoidea (parasitoid) |
| Malpighiaceae | *Banisteriopsis* sp. (Fig. 5n) | not observed | Acari, Parasitiformes (successor); Hymenoptera, Chalcidoidea (parasitoid) |
| Malpighiaceae | *Banisteriopsis* sp. (Fig. 5o) | not observed | Acari, Parasitiformes (successor) |
| Malpighiaceae | *Diplopterys pubipetala* (A.Juss.) W.R.Anderson and C.C.Davis (Fig. 5r) | Diptera, Cecidomyiidae, *Clinodiplosis bellum* Urso-Guimarães and Carmo-Neto, 2018 | Acari, Parasitiformes (successor); Hymenoptera, Chalcidoidea (parasitoid) |
| Myrtaceae | *Campomanesia adamantium* (Cambess.) O.Berg (Fig. 6a) | Diptera, Cecidomyiidae, Lopesini | Hemiptera (successor); Hymenoptera, Chalcidoidea (parasitoid) |
| Myrtaceae | *Eugenia bimarginata* DC. (Fig. 6e) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Sapindaceae | *Serjania lethalis* A.St.-Hil. (Fig. 6l) | Diptera, Cecidomyiidae | Hymenoptera (parasitoid) |
| Sapindaceae | Sapindaceae sp 1 (Fig. 6m) | not observed | Acari, Parasitiformes (successor); Hemiptera, Coccoidea (successor); Hymenoptera, Chalcidoidea (parasitoid); Diptera, Cecidomyiidae, *Trotteria* sp.1 (inquiline) |
| Sapotaceae | *Pouteria torta* (Mart.) Radlk (Fig. 6q) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Smilacaceae | *Smilax* sp. (Fig. 6r) | Diptera, Cecidomyiidae, *Alycaulus hexadentatus* Urso-Guimarães, 2018 | Acari, Parasitiformes (successor); Hymenoptera, Chalcidoidea (parasitoid) |
| Smilacaceae | *Smilax* sp. (Fig. 6s, 6t) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Vochysiaceae | *Qualea parviflora* Mart. (Fig. 7b, 7d) | not observed | Hymenoptera, Chalcidoidea (parasitoid) |
| Unidentified | Unidentified sp.1 (Fig. 7e) | not observed | Collembola (successor) |

**Acknowledgements**

SMS acknowledges Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) - Brazil (Finance Code 001), SMS and MVUG acknowledge Dra Giselda Durigan (IPA/SP) by identifying plant species. Fieldwork was financed by the following FAPESP thematic projects: "Campos Naturais do Estado de São Paulo: Diagnóstico, Manejo e Conservação" (FAPESP #2020/01378-0) and "Desafios para a Conservação de Anfíbios e Répteis Escamados, com ênfase na Fauna Brasileira: de Informações Básicas às Ações de Conservação" (FAPESP #2020/12658-4).

**Conflicts of interest**

The authors declare that they have no conflict of interest related to the publication of this manuscript.

**Author contribution statement**

SS contributed to the conceptualization**,** data collection and analysis, writing – original draft, review and editing. MVU contributed to conceptualization**,** methodology, resources, data collection and analysis, writing – original draft, review and editing.

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