Checklist of host plants of insect galls in the state of Goiás in the Midwest Region of Brazil

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Abstract

Background

Surveys of host plants of insect galls have been performed in different regions of Brazil. The knowledge of species of host plants of insect galls is fundamental to further studies of plant-galling insect interactions. However, a list of host plant species of gall-inducing insects has not yet been compiled for the flora of the Midwest Region of Brazil.

New information

We provide a compilation of the plant species reported to host insect galls in the Cerrado of the state of Goiás in the Midwest Region of Brazil. Altogether we found records for 181 species of 47 families of host plants, which hosted 365 distinct gall morphotypes.

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Keywords

Cerrado, galls, Goiás, host plants, Neotropical savannas, plant-insect interactions

Introduction

Insect galls are structures formed by the development of larvae or nymphs in the interior of plant tissues (Mani 1964, Rohfritsch 1982, Stone and Schönrogge 2003). Galls develop by hypertrophy and hyperplasia of the plant cells, which changes all of the structure of the attacked plant organ (Moura et al. 2008). Because of the intimate level of interaction between gall-inducing insects and their host plants at histological and cellular scale, these insects are considered the most specialized guild of herbivores (Stone and Schönrogge 2003, Carneiro et al. 2009, Fernandes and Santos 2014). Due to this high degree of specialization, knowledge regarding the identity of host plant species is fundamental to studies of plant-galling insect interactions.

It is already known that there exists a high diversity of insect galls in the Neotropics (Gagné 1994, Fernandes and Santos 2014), mainly in the savannas located in central Brazil (Araújo et al. 2014b). A likely explanation for this is the great diversity of plants in the region (Espírito-Santo and Fernandes 2007), since richness of host plants is an important factor in explaining the distribution patterns of insect galls (Araújo et al. 2014b). Considering that each species of plant is a potential host for gall ing, a greater local and regional diversity of plant species implies greater galling species richness (Mendonça 2007). Several studies in Brazil have produced local and regional lists of host plant species and their associated galls, especially in the South and Southeast regions (e.g. Gonçalves-Alvim and Fernandes 2001, Maia and Fernandes 2004, Mendonça 2007, Maia et al. 2008, Bregonci et al. 2010), while in other regions, such as the Midwest, surveys are still scarce (Araújo et al. 2013). In the present work, we provide a compilation of plant species that have been recorded to host insect galls in the state of Goiás in the Midwest Region of Brazil.

Material and methods

We compiled data from different surveys of plant species that are hosts of insect galls from several locations in the state of Goiás in the Midwest Region of Brazil (Fig. 1). We also included data from the Distrito Federal, which is a separate political entity, but is surrounded by the state of Goiás. All records of hosts and galls were collected between 2005 and 2013 in different types of vegetation that comprise the Cerrado biome (Table 1). We included data published in local checklists (e.g. Santos et al. 2010, Araújo et al. 2011, Araújo et al. 2014a) as well as unpublished data. The identification of the plants was made by comparison with the collections of Universidade Federal de Goiás, herbarium, literature, as well as consultation with specialists. We checked the synonymy using The Plant List
database (www.theplantlist.org). In addition to the list of host plants, we provide a short morphological characterization of gall morphotypes (plant organ, gall form and gall color) associated with each host plant species. The use of gall morphotypes is a commonly used and reliable parameter because evidence indicates that each gall morphospecies (examples in Fig. 2) is unique to a particular gall-inducing insect (Stone and Schönrogge 2003), and each galling species is specific to a particular host plant (Abrahamson et al. 1998). Insect galls can be differentiated from galls induced by other organisms, such as mites and nematodes, because they form an internal chamber where the immature insect develops (see Fig. 2f). Furthermore, insect galls are relatively large structures (in cm scale) and usually closed (internal chamber has no opening to the outside), unlike other galls induced by animals. Insect galls were collected and taken to laboratory where they were dissected to obtain the immature and adults gall-inducing insects. It was not our objective to list the species (or taxa) of the gall-inducing insects responsible for the galls observed in the plants of our survey. For details about galling insect taxa associated with each host plant species the original studies should be consulted.

Table 1.
Description of the sites and vegetation formations in which insect galls were sampled in the state of Goiás, Midwest, Brazil. 2005-2013.

| Code | Sampled site | Municipal | Vegetation type | Geocoordinate | Altitude (m) | Reference |
|------|--------------|-----------|-----------------|---------------|--------------|-----------|
| 1    | Parque Estadual da Serra dos Pireneus | Pirenópolis | Savanna, Rock Savanna, Semidecidual Forest, Riparian Forest | 15°49’S, 48°53’W | 1,156 | Araújo et al. 2011 |
| 2    | Pedreira da Prefeitura | Pirenópolis | Savanna | 15°50’S, 48°55’W | 840 | Unpublished |
| 3    | Reserva da UEG | Anápolis | Savanna | 16°22’S, 48°56’W | 1,097 | Unpublished |
| 4    | Floresta Nacional de Silvânia | Silvânia | Grassland, Savanna, Semidecidual Forest, Riparian Forest | 16°38’S, 48°39’W | 963 | Unpublished |
| 5    | Fazenda do Geraldo | Silvânia | Savanna | 16°40’S, 48°18’W | 837 | Unpublished |
| 6    | Condomínio Itanhanga | Goiânia | Savanna | 16°33’S, 49°17’W | 762 | Araújo et al. 2013 |
| 7    | Bosque Saint Hilaire | Goiânia | Semidecidual Forest | 16°36’S, 49°15’W | 795 | Santos et al. 2010 |
| 8    | Zona Rural de Senador Canedo | Senador Canedo | Savanna | 16°43’S, 49°06’W | 774 | Unpublished |
| 9    | Fazenda Bom Sucesso | Senador Canedo | Savanna | 16°42’S, 49°02’W | 749 | Unpublished |
| 10   | Banana Menina | Hidrolândia | Savanna | 16°59’S, 49°14’W | 893 | Unpublished |
| 11   | Zona Rural de Bela Vista | Bela Vista | Savanna | 15°57’S, 48°56’W | 809 | Unpublished |
|   | Site Name                  | Location               | Map Code | Literature       |
|---|---------------------------|------------------------|----------|------------------|
| 12| Condomínio Del Rey         | Caldas Novas, Savanna  | 17°42'S, 48°38'W | 702, Santos et al. 2012 |
| 13| Fazenda Caiapônia          | Caiapônia, Semidecidual Forest 16°56'S, 51°49'W | 703 | Unpublished |
| 14| Fazenda Lajeado            | Jataí, Savanna        | 17°53'S, 51°38'W | 756, Unpublished |
| 15| Estação Ecológica da UFG   | Jataí, Semidecidual Forest 17°56'S, 51°42'W | 646 | Unpublished |
| 16| Jardim Botânico Mata do Açude | Jataí, Semidecidual Forest 17°56'S, 51°43'W | 618 | Unpublished |
| 17| Parque Nacional das Emas   | Mineiros, Savanna, Grassland 17°56'S, 52°56'W | 878 | Araújo et al. 2014a |
| 18| REBIO Contagem             | Brasília, Savanna     | 15°37'S, 47°52'W | 994, Unpublished |
| 19| APA Cafuringa              | Brasília, Savanna     | 15°31'S, 47°57'W | 873, Unpublished |

Figure 1.
Localization of the sites in which insect galls were sampled in the state of Goiás, Midwest, Brazil. 2005-2013. The number of each site corresponds to code in the Table 1.
Results

We recorded a total of 181 species of 47 families of plants that host insect galls in the state of Goiás (Table 2). Seventy-three (40.3%) plant species are registered as gall hosts for the first time to Goiás. Associated with plant species were 365 gall morphotypes, of which 192...
(52.6%) had previously been recorded and 173 (47.4%) are new records. The plant families with the highest gall richness were Fabaceae, Malpighiaceae, Myrtaceae, Vochysiaceae, Sapindaceae, Erythroxylaceae, Burseraceae, Sapotaceae, Styracaceae and Asteraceae. These 10 families exhibited 58% of the insect gall morphotype richness and 52.4% of the total number of host plant species. The family Fabaceae hosted 58 gall morphotypes, while Malpighiaceae, Myrtaceae and Vochysiaceae had 29, 28 and 23 gall morphotypes, respectively.

Table 2.
Host plants (families and species) and insect galls (occurrence organ, form and color) recorded in the state of Goiás, Central-western Brazil. 2005-2013. References: A = Santos et al. 2010; B = Araújo et al. 2011; C = Santos et al. 2012; D = Araújo et al. 2014a; * = new record.

| Host family        | Host species                                           | Plant organ | Gall form | Gall color | Reference |
|--------------------|--------------------------------------------------------|-------------|-----------|------------|-----------|
| Anacardiaceae      | Anacardium humile A.St.-Hil.                          | Leaf        | Conical   | Green      | B         |
| Anacardiaceae      | Anacardium occidentale L.                             | Leaf        | Discoid   | Green      |           |
| Anacardiaceae      | Anacardium occidentale L.                             | Leaf        | Globose   | Brown      |           |
| Anacardiaceae      | Astronium graveolens Jacq.                            | Leaf        | Globose   | Red        |           |
| Anacardiaceae      | Astronium graveolens Jacq.                            | Stem/Leaf   | Globose   | Yellow     |           |
| Anacardiaceae      | Litharea molleoides (Vell.) Engl.                     | Leaf        | Discoid   | Green      |           |
| Annonaceae         | Annona coriacea Mart.                                 | Leaf        | Discoid   | Yellow     | B; D      |
| Annonaceae         | Annona coriacea Mart.                                 | Leaf        | Globose   | Green      | B; D      |
| Annonaceae         | Annona coriacea Mart.                                 | Midvein     | Ellipsoid | Brown      | B; D      |
| Annonaceae         | Bocageopsis mattogrossensis (R.E.Fr.) R.E.Fr.         | Leaf        | Discoid   | Yellow     | D         |
| Annonaceae         | Duguettia furfuracea (A. St.-Hil.) Saff.              | Leaf        | Globose   | Green      |           |
| Annonaceae         | Xylopia aromatica (Lam.) Mart.                       | Leaf        | Discoid   | Brown      |           |
| Apocynaceae        | Aspidosperma macrocarpon Mart.                       | Leaf        | Discoid   | Yellow     | D         |
| Apocynaceae        | Aspidosperma macrocarpon Mart.                       | Leaf        | Conical   | Green      | D         |
| Apocynaceae        | Aspidosperma nobile Müll.Arg.                        | Leaf        | Discoid   | Green      | D         |
| Apocynaceae        | Aspidosperma tomentosum Müll.Arg.                    | Leaf        | Discoid   | Yellow     | B         |
| Araliaceae         | Schefflera macrocarpa (Seem) D.C. Frodin             | Leaf        | Discoid   | Bege       |           |
| Araliaceae         | Schefflera macrocarpa (Seem) D.C. Frodin             | Leaf        | Globose   | Yellow     |           |
| Family          | Genus                | Scientific Name                          | Part       | Shape      | Color  | Code |
|-----------------|----------------------|-----------------------------------------|------------|------------|--------|------|
| Araliaceae      | Schefflera           | *morototoni* Aubl.                      | Leaf       | Ellipsoid  | Green  | A    |
| Araliaceae      | *Schefflera*         | vinosa (Cham. & Schltdl.) *Frodin* & *Fiaschi* | Midvein    | Ellipsoid  | Brown  | D    |
| Araliaceae      | *Schefflera*         | vinosa (Cham. & Schltdl.) *Frodin* & *Fiaschi* | Petiole    | Ellipsoid  | Brown  | D    |
| Asteraceae      | Eremanthus           | erythropappus (DC.) *MacLeish*          | Leaf       | Globoid    | Green  | D    |
| Asteraceae      | Eremanthus           | goyazensis (Gardner) *Sch. Bip.*       | Stem       | Ellipsoid  | Rust   |    |
| Asteraceae      | Eremanthus           | sp.                                     | Midvein    | Globose    | Brown  |    |
| Asteraceae      | Heterocondylus       | alatus (Vell.) *King* & H. *Rob.*      | Leaf       | Ellipsoid  | Green  |    |
| Asteraceae      | Piptocarpha          | rotundifolia (Less.) *Baker*           | Leaf       | Discoid    | Green  | D    |
| Asteraceae      | Piptocarpha          | rotundifolia (Less.) *Baker*           | Leaf       | Globose    | Bege   |    |
| Asteraceae      | Piptocarpha          | rotundifolia (Less.) *Baker*           | Midvein    | Ellipsoid  | Green  | D    |
| Asteraceae      | Piptocarpha          | rotundifolia (Less.) *Baker*           | Stem       | Globose    | Brown  |    |
| Asteraceae      | Vernonia             | polysphaera *Baker*                    | Leaf       | Discoid    | Yellow |    |
| Bignoniaceae    | Arrabidaea           | sp.                                     | Leaf/Stem  | Globose    | Yellow | A    |
| Bignoniaceae    | Arrabidaea           | sp.                                     | Stem       | Ellipsoid  | Green  | A; B |
| Bignoniaceae    | Handroanthus         | ochraceus (Cham.) *Mattos*             | Leaf       | Conical    | Brown  | D    |
| Bignoniaceae    | Handroanthus         | ochraceus (Cham.) *Mattos*             | Stem       | Globose    | Green  |    |
| Bignoniaceae    | Macfadyna           | sp.                                     | Stem       | Ellipsoid  | Green  |    |
| Bignoniaceae    | Tabebuia            | aurea (Manso) *Benth.* & Hook. f. ex S. *Moore* | Leaf       | Ellipsoid  | Green  |    |
| Bignoniaceae    | Tabebuia            | aurea (Manso) *Benth.* & Hook. f. ex S. *Moore* | Leaf       | Globose    | Yellow |    |
| Bignoniaceae    | Tabebuia            | sp.                                     | Leaf       | Conical    | Green  | C    |
| Boraginaceae    | Cordia              | sellowiana Cham.                       | Leaf       | Globose    | Brown  |    |
| Burseraceae     | Protium              | heptaphyllum *March.*                  | Leaf       | Marginal roll | Green  |    |
| Burseraceae     | Protium              | heptaphyllum *March.*                  | Leaf       | Cylindrical | Green  |    |
| Burseraceae     | Protium              | heptaphyllum *March.*                  | Leaf       | Conical    | Green  | B    |
| Burseraceae     | Protium              | heptaphyllum *March.*                  | Leaf       | Discoid    | Green  |    |
| Burseraceae     | Protium              | heptaphyllum *March.*                  | Leaf       | Globose    | Brown  |    |
| Family                  | Genus and Species                             | Part                     | Shape     | Color      | Comment |
|------------------------|-----------------------------------------------|--------------------------|-----------|------------|---------|
| Burseraceae            | *Protium heptaphyllum* March.                 | Midvein                  | Ellipsoid | Brown      | A       |
| Burseraceae            | *Protium heptaphyllum* March.                 | Stem                     | Globose   | Green      | *       |
| Burseraceae            | *Protium* sp.                                | Leaf                     | Ellipsoid | Green      | *       |
| Burseraceae            | *Protium* sp.                                | Leaf/Stem                | Ellipsoid | Green      | *       |
| Burseraceae            | *Protium* sp.                                | Stem                     | Ellipsoid | Green      | *       |
| Calophyllaceae         | *Kielmeyera coriacea* Mart. & Zucc.          | Leaf                     | Globoid   | Brown      | D       |
| Calophyllaceae         | *Kielmeyera coriacea* Mart. & Zucc.          | Ellipsoid                | Brown     | *          |         |
| Calophyllaceae         | *Kielmeyera coriacea* Mart. & Zucc.          | Midvein                  | Ellipsoid | Brown      | D       |
| Calophyllaceae         | *Kielmeyera coriacea* Mart. & Zucc.          | Midvein                  | Amorphous | Brown      | D       |
| Calophyllaceae         | *Kielmeyera grandiflora* (Wawra) Saddi       | Leaf                     | Discoid   | Brown      | D       |
| Calophyllaceae         | *Kielmeyera rubriflora* Camb.                | Leaf                     | Discoid   | Brown      | *       |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Leaf                     | Discoid   | Brown      | *       |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Leaf                     | Ellipsoid | Yellow     | *       |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Leaf                     | Globose   | Yellow     | B; D    |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Leaf                     | Globoid   | Yellow     | B; C; D |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Petiole                  | Globoid   | Brown      | *       |
| Caryocaraceae          | *Caryocar brasiliense* Cambess.              | Stem                     | Amorphous | Brown      | C       |
| Caryocaraceae          | *Caryocar glabrum* (Aubl.) Pers.             | Leaf                     | Globose   | Green      | *       |
| Celastraceae           | *Cheiloclinium cognatum* (Miers) A.C. Sm.    | Midvein                  | Globose   | Brown      | *       |
| Celastraceae           | *Maytenus* sp.                               | Leaf                     | Discoid   | Green      | *       |
| Celastraceae           | *Maytenus* sp.                               | Stem                     | Ellipsoid | Brown      | *       |
| Celastraceae           | *Plencchia popuinea* Reissek                 | Leaf                     | Discoid   | Brown      | *       |
| Chrysobalanaceae       | *Couepia grandiflora* (Mart. and Zucc.) Benth. and Hook. | Leaf | Discoid | Yellow | * |
| Chrysobalanaceae       | *Hirtella glandulosa* Spreng.                | Leaf                     | Globose   | Yellow     | *       |
| Chrysobalanaceae       | *Hirtella* sp.                               | Leaf                     | Globose   | Brown      | *       |
| Family                  | Genus                        | Morphology | Color       | Note  |
|------------------------|------------------------------|------------|-------------|-------|
| Chrysobalanaceae       | *Licania humilis* Cham. & Schltld. | Leaf       | Marginal roll | Green * |
| Chrysobalanaceae       | *Licania humilis* Cham. & Schltld. | Leaf       | Globose     | Brown * |
| Chrysobalanaceae       | *Licania tomentosa* Benth.    | Leaf       | Discoid     | Green A |
| Clusiaceae             | *Calophyllum brasiliensis* Camb. | Leaf       | Globose     | Green B |
| Clusiaceae             | *Clusia* sp.                 | Leaf       | Amorphous   | Red B  |
| Combretaceae           | *Terminalia argentea* Mart. and Zucc. | Leaf       | Discoid     | Green C |
| Combretaceae           | *Terminalia argentea* Mart. and Zucc. | Leaf       | Globose     | Brown B |
| Connaraceae            | *Connarus suberosus* Planch.  | Leaf       | Discoid     | Green D |
| Connaraceae            | *Connarus suberosus* Planch.  | Leaf       | Globose     | Brown C |
| Connaraceae            | *Connarus suberosus* Planch.  | Midvein    | Ellipsoid   | Brown D |
| Connaraceae            | *Rourea induta* Planch.       | Leaf       | Discoid     | Green D |
| Connaraceae            | *Rourea induta* Planch.       | Leaf       | Discoid     | Red *  |
| Connaraceae            | *Rourea induta* Planch.       | Leaf       | Discoid     | Green D |
| Dilleniaceae           | *Davilla elliptica* A.St.-Hil. | Leaf       | Discoid     | Brown B; C; D |
| Dilleniaceae           | *Davilla elliptica* A.St.-Hil. | Leaf       | Ellipsoid   | Green B; C |
| Dilleniaceae           | *Davilla elliptica* A.St.-Hil. | Leaf       | Discoid     | Green D |
| Ebenaceae              | *Diospyros burchellii* Hern.  | Leaf       | Amorphous   | Green B |
| Ebenaceae              | *Diospyros hispida* A.DC.     | Leaf       | Globose     | Yellow C |
| Ebenaceae              | *Diospyros hispida* A.DC.     | Leaf       | Discoid     | Yellow D |
| Ebenaceae              | *Diospyros hispida* A.DC.     | Leaf       | Globoid     | Yellow D |
| Ebenaceae              | *Diospyros hispida* A.DC.     | Stem       | Globose     | Green C |
| Erythroxylaceae        | *Erythroxylum campestre* A. St.-Hil. | Leaf       | Discoid     | Green * |
| Erythroxylaceae        | *Erythroxylum deciduum* A. St.-Hil. | Leaf       | Discoid     | Green * |
| Erythroxylaceae        | *Erythroxylum deciduum* A. St.-Hil. | Terminal bud | Globose     | Brown C |
| Erythroxylaceae        | *Erythroxylum engleri* O.E.Schulz | Leaf       | Discoid     | Yellow D |
| Erythroxylaceae        | *Erythroxylum sp.*            | Leaf       | Ellipsoid   | Yellow * |
| Erythroxylaceae        | *Erythroxylum sp.*            | Stem       | Globose     | Brown * |
| Erythroxylaceae        | *Erythroxylum suberosum* A.St.-Hil. | Leaf       | Amorphous   | Red B; C |
| Family          | Genus                  | Species                        | Part     | Shape         | Color | Notes |
|-----------------|------------------------|--------------------------------|----------|---------------|-------|-------|
| Erythroxylaceae | *Erythroxylum* suberosum | A.St.-Hil.                    | Leaf     | Discoid       | Green | *     |
| Erythroxylaceae | *Erythroxylum* suberosum | A.St.-Hil.                    | Leaf     | Marginal roll | Green | C     |
| Erythroxylaceae | *Erythroxylum* suberosum | A.St.-Hil.                    | Leaf     | Globose       | Red   | *     |
| Erythroxylaceae | *Erythroxylum* suberosum | A.St.-Hil.                    | Leaf     | Marginal leaf roll | Green | D     |
| Erythroxylaceae | *Erythroxylum tortuosum* Mart. |                         | Leaf     | Discoid       | Brown | *     |
| Erythroxylaceae | *Erythroxylum tortuosum* Mart. |                         | Leaf     | Globose       | Red   | *     |
| Euphorbiaceae   | *Manihot* sp.           |                                | Leaf     | Conical       | Red   | A     |
| Euphorbiaceae   | *Manihot tripartita* (Spreng.) Müll. Arg. |                         | Leaf     | Conical       | Green | C     |
| Euphorbiaceae   | *Maprounea guianensis* Aubl. |                                | Stem     | Ellipsoid     | Green | *     |
| Fabaceae        | *Acosmium dasycarpum* (Vogel) Yakovlev |                         | Leaf     | Discoid       | Yellow | C   |
| Fabaceae        | *Acosmium dasycarpum* (Vogel) Yakovlev |                         | Leaf     | Discoid       | Green | B     |
| Fabaceae        | *Anadenanthera falcata* (Benth.) Spreng. |                         | Leaf     | Globose       | Red   | D     |
| Fabaceae        | *Anadenanthera peregrina* (L.) Spreng. |                         | Leaf     | Conical       | Yellow | *   |
| Fabaceae        | *Anadenanthera peregrina* (L.) Spreng. |                         | Leaf     | Globose       | Red   | B     |
| Fabaceae        | *Andira cujabensis* Benth. |                                | Leaf     | Discoid       | Green | D     |
| Fabaceae        | *Andira cujabensis* Benth. |                                | Leaf     | Conical       | Green | D     |
| Fabaceae        | *Andira cujabensis* Benth. |                                | Midvein  | Ellipsoid     | Brown | D     |
| Fabaceae        | *Andira cujabensis* Benth. |                                | Petiole  | Globoid       | Brown | D     |
| Fabaceae        | *Andira paniculata* Benth. |                                | Leaf     | Amorphous     | Green | B     |
| Fabaceae        | *Andira paniculata* Benth. |                                | Leaf     | Discoid       | Brown | B     |
| Fabaceae        | *Andira paniculata* Benth. |                                | Leaf     | Ellipsoid     | Green | B     |
| Fabaceae        | *Andira sp.*            |                                | Leaf     | Discoid       | Green | *     |
| Fabaceae        | *Andira sp.*            |                                | Leaf     | Ellipsoid     | Green | *     |
| Fabaceae        | *Andira sp.*            |                                | Leaf     | Globose       | Green | C     |
| Fabaceae        | *Bauhinia curvula* Benth. |                                | Leaf     | Globose       | Yellow | *   |
| Fabaceae        | *Bauhinia curvula* Benth. |                                | Leaf     | Globose       | Brown | *     |
| Fabaceae        | *Bauhinia curvula* Benth. |                                | Leaf     | Globose       | Green | *     |
| Fabaceae        | *Bauhinia curvula* Benth. |                                | Stem     | Ellipsoid     | Brown | *     |
| Fabaceae        | *Bauhinia sp.1*         |                                | Leaf     | Globose       | Red   | *     |
| Fabaceae        | *Bauhinia sp.1*         |                                | Stem     | Ellipsoid     | Brown | A     |
| Fabaceae        | *Bauhinia sp.1*         |                                | Stem     | Globose       | Brown | *     |
| Family         | Genus                             | Part    | Shape    | Color    | Location |
|---------------|-----------------------------------|---------|----------|----------|----------|
| Fabaceae      | Bauhinia sp.2                     | Leaf    | Globose  | Brown    | C        |
| Fabaceae      | Bauhinia sp.3                     | Leaf    | Globose  | Branca   | *        |
| Fabaceae      | Bauhinia sp.3                     | Leaf    | Globose  | Green    | C        |
| Fabaceae      | Bauhinia sp.4                     | Leaf    | Globose  | Green    | *        |
| Fabaceae      | Bauhinia ungulata L.              | Leaf    | Discoid  | Green    | A        |
| Fabaceae      | Bauhinia ungulata L.              | Midvein | Globose  | Red      | B        |
| Fabaceae      | Bowdichia virgilioides Kunth      | Leaf    | Discoid  | Green    | D        |
| Fabaceae      | Bowdichia virgilioides Kunth      | Midvein | Ellipsoid| Green    | D        |
| Fabaceae      | Copaifera langsdorffii Desf.      | Leaf    | Bilobed  | Brown    | C        |
| Fabaceae      | Copaifera langsdorffii Desf.      | Leaf    | Discoid  | Yellow   | *        |
| Fabaceae      | Copaifera langsdorffii Desf.      | Leaf    | Globose  | Yellow   | *        |
| Fabaceae      | Copaifera langsdorffii Desf.      | Leaf    | Globose  | Brown    | *        |
| Fabaceae      | Copaifera langsdorffii Desf.      | Stem    | Ellipsoid| Brown    | *        |
| Fabaceae      | Dalbergia miscolobium Benth.      | Leaf    | Discoid  | Yellow   | *        |
| Fabaceae      | Dimorphandra mollis Benth.        | Leaf    | Discoid  | Yellow   | *        |
| Fabaceae      | Hymenaea stigonocarpa Mart. ex Hayne | Leaf   | Discoid  | Brown    | B        |
| Fabaceae      | Hymenaea stigonocarpa Mart. ex Hayne | Leaf   | Discoid  | Yellow   | A; D     |
| Fabaceae      | Inga cylindrica (Vell.) Mart.     | Leaf    | Cylindrical | Green  | A        |
| Fabaceae      | Inga cylindrica (Vell.) Mart.     | Leaf    | Globose  | Green    | A        |
| Fabaceae      | Inga cylindrica (Vell.) Mart.     | Midvein | Globose  | Green    | A        |
| Fabaceae      | Inga marginata Wild.              | Leaf    | Discoid  | Green    | *        |
| Fabaceae      | Inga sp.                          | Leaf    | Globose  | Brown    | *        |
| Fabaceae      | Inga sp.                          | Stem    | Ellipsoid| Brown    | *        |
| Fabaceae      | Inga uruguensis Hooker et Arnott  | Leaf    | Globose  | Green    | A        |
| Fabaceae      | Leotolobium dasycarpum Vogel      | Leaf    | Discoid  | Green    | D        |
| Fabaceae      | Leotolobium dasycarpum Vogel      | Midvein | Ellipsoid| Green    | D        |
| Fabaceae      | Machaerium opacum Vog.            | Leaf    | Discoid  | Brown    | *        |
| Fabaceae      | Machaerium opacum Vog.            | Leaf    | Discoid  | Green    | *        |
| Fabaceae      | Piptadenia sp.                    | Leaf    | Discoid  | Yellow   | A        |
| Fabaceae      | Piptadenia sp.                    | Stem    | Ellipsoid| Grey     | *        |
| Fabaceae      | Sclerolobium paniculatum Vog.     | Leaf    | Discoid  | Green    | *        |
| Fabaceae      | Stryphnodendron adstringens (Mart.) Coville | Leaf | Discoid  | Brown    | *        |
| Family         | Species                                      | Morphology  | Color   | Position |
|---------------|----------------------------------------------|-------------|---------|----------|
| Fabaceae      | Stryphnodendron adstringens (Mart.) Coville  | Leaf        | Discoid | Yellow   |
| Fabaceae      | Stryphnodendron adstringens (Mart.) Coville  | Midvein     | Ellipsoid | Brown   |
| Fabaceae      | Tachigali aurea Tul.                         | Leaf        | Ellipsoid | Brown   |
| Fabaceae      | Tachigali vulgaris L.G.Silva & H.C.Lima      | Leaf        | Globoid | Yellow   |
| Lauraceae     | Nectandra cuspidata Nees                    | Leaf        | Discoid | Green   |
| Loganiaceae   | Strychnos pseudoquina A. St.-Hil.            | Leaf        | Discoid | Green   |
| Loganiaceae   | Strychnos pseudoquina A. St.-Hil.            | Leaf        | Globose | Green   |
| Loranthaceae  | Struthanthus sp.                             | Leaf        | Discoid | Brown   |
| Malpighiaceae | Banisteriopsis argyrophylla (A. Juss.) B. Gates | Leaf        | Globose | Green   |
| Malpighiaceae | Banisteriopsis megaphylla (A. Juss.) B. Gates | Leaf        | Globose | Green   |
| Malpighiaceae | Byrsonima basiloba A. Juss.                  | Leaf        | Globose | Brown   |
| Malpighiaceae | Byrsonima coccolobifolia Kunth               | Leaf        | Conical | Green   |
| Malpighiaceae | Byrsonima coccolobifolia Kunth               | Leaf        | Discoid | Yellow   |
| Malpighiaceae | Byrsonima coccolobifolia Kunth               | Leaf        | Discoid | Brown   |
| Malpighiaceae | Byrsonima guileminiana Brad. and Mark.       | Leaf        | Discoid | Yellow   |
| Malpighiaceae | Byrsonima laxiflora Griseb.                  | Leaf        | Conical | Yellow   |
| Malpighiaceae | Byrsonima laxiflora Griseb.                  | Stem        | Ellipsoid | Brown   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Conical | Yellow   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Discoid | Brown   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Ellipsoid | Brown   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Virgula | Yellow   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Conical | Brown   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Leaf        | Discoid | Green   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Stem        | Ellipsoid | Brown   |
| Malpighiaceae | Byrsonima pachyphylla A. Juss.               | Stem        | Globose | Brown   |
| Family            | Genus                  | Part       | Shape     | Color  | Notes |
|-------------------|------------------------|------------|-----------|--------|-------|
| Malpighiaceae     | Byrsonima sp.1         | Leaf       | Conical   | Green  | *     |
| Malpighiaceae     | Byrsonima sp.2         | Leaf       | Discoid   | Green  | *     |
| Malpighiaceae     | Byrsonima sp.3         | Leaf       | Conical   | Yellow | B     |
| Malpighiaceae     | Byrsonima sp.3         | Midvein    | Ellipsoid | Green  | *     |
| Malpighiaceae     | Byrsonima verbascifolia (L.) DC. | Leaf | Discoid   | Green  | D     |
| Malpighiaceae     | Byrsonima verbascifolia (L.) DC. | Leaf | Conical   | Yellow | *     |
| Malpighiaceae     | Byrsonima verbascifolia (L.) DC. | Leaf | Globose   | Purple | *     |
| Malpighiaceae     | Diplopterys pubipetala (A. Juss.,) W. R. Anderson and C. Cav. Davis | Leaf | Discoid   | Green  | *     |
| Malpighiaceae     | Heteropterys byrsonimifolia A. Juss. | Leaf | Discoid   | Brown  | *     |
| Malpighiaceae     | Heteropterys byrsonimifolia A. Juss. | Stem | Ellipsoid | Brown  | *     |
| Malpighiaceae     | Peixotoa sp.           | Leaf       | Globose   | Green  | C     |
| Malpighiaceae     | Pterandra pyroidea A. Juss. | Leaf | Globose   | Yellow | B     |
| Malvaceae         | Eriotheca gracilipes (K.Schum.) A.Robyns | Leaf | Discoid   | Yellow | *     |
| Malvaceae         | Eriotheca gracilipes (K.Schum.) A.Robyns | Leaf | Discoid   | Green  | D     |
| Malvaceae         | Eriotheca gracilipes (K.Schum.) A.Robyns | Midvein | Ellipsoid | Green  | D     |
| Malvaceae         | Eriotheca gracilipes (K.Schum.) A.Robyns | Midvein | Globoid   | Brown  | D     |
| Malvaceae         | Eriotheca pubescens (Mart. & Zucc.) Schott & Endl. | Leaf | Globoid   | Brown  | C     |
| Malvaceae         | Eriotheca pubescens (Mart. & Zucc.) Schott & Endl. | Leaf | Discoid   | Brown  | *     |
| Malvaceae         | Eriotheca pubescens (Mart. & Zucc.) Schott & Endl. | Leaf | Discoid   | Green  | *     |
| Malvaceae         | Pseudobombax longiflorum (Mart. and Zucc.) A. Robyns | Leaf | Conical   | Red     | B; C  |
| Malvaceae         | Sida micrantha A.St.-Hil | Leaf/Stem | Globose | Yellow | B     |
| Melastomataceae   | Macairea radula (Bonpl.) DC. | Leaf/Stem | Globose | Yellow | B     |
| Melastomataceae   | Miconia albicans (Sw.) Triana | Leaf | Globoid   | Brown  | B; C; D |
| Melastomataceae   | Miconia albicans (Sw.) Triana | Leaf | Discoid   | Brown  | D     |
| Melastomataceae   | Miconia albicans (Sw.) Triana | Leaf | Discoid   | Bege    | *     |
| Melastomataceae   | Miconia albicans (Sw.) Triana | Leaf | Globose   | Brown  | *     |
| Melastomataceae   | Miconia sp.1           | Stem       | Globose   | Green  | *     |
| Family            | Genus                        | Part            | Shape         | Color         | Notes          |
|-------------------|------------------------------|-----------------|---------------|---------------|----------------|
| Melastomataceae   | *Miconia* sp.2               | Leaf            | Amorphous     | Brown         | *              |
| Melastomataceae   | *Miconia* sp.2               | Stem            | Ellipsoid     | Brown         | *              |
| Melastomataceae   | *Miconia* sp.3               | Inflorescence   | Globose       | Brown         | *              |
| Meliaceae         | *Guarea* sp.                 | Stem            | Globose       | Brown         | *              |
| Myristicaceae     | *Virola sebifera* Aubl.      | Leaf            | Globose       | Green         | *              |
| Myrsinaceae       | *Rapanea guianensis* Aubl.   | Stem            | Ellipsoid     | Brown         | *              |
| Myrtaceae         | *Campomanesia adamantium* (Cambess.) O.Berg | Leaf          | Discoid       | Brown         | D              |
| Myrtaceae         | *Eugenia aurata* O.Berg      | Leaf            | Discoid       | Black         | D              |
| Myrtaceae         | *Eugenia punicifolia* (Kunth) DC. | Leaf          | Ellipsoid     | Green         | B              |
| Myrtaceae         | *Eugenia sp.*                | Leaf            | Discoid       | Green         | *              |
| Myrtaceae         | *Eugenia ternatifolia* Cambess. | Leaf          | Globose       | Green         | D              |
| Myrtaceae         | *Myrcia bella* Cambess.      | Leaf            | Discoid       | Brown         | D              |
| Myrtaceae         | *Myrcia bella* Cambess.      | Midvein         | Ellipsoid     | Green         | D              |
| Myrtaceae         | *Myrcia camapuanensis* N.Silveira | Midvein       | Globose       | Brown         | D              |
| Myrtaceae         | *Myrcia guianensis* (Aubl.) DC. | Leaf          | Globose       | Green         | D              |
| Myrtaceae         | *Myrcia guianensis* (Aubl.) DC. | Leaf          | Discoid       | Green         | D              |
| Myrtaceae         | *Myrcia guianensis* (Aubl.) DC. | Midvein        | Globose       | Brown         | D              |
| Myrtaceae         | *Myrcia guianensis* (Aubl.) DC. | Midvein        | Conical       | Green         | D              |
| Myrtaceae         | *Myrcia multiflor* (Lam.) DC. | Leaf            | Globose       | Green         | D              |
| Myrtaceae         | *Myrcia rostrata* DC         | Leaf            | Discoid       | Green         | A              |
| Myrtaceae         | *Myrcia sp.1*                | Leaf            | Globose       | Green         | B              |
| Myrtaceae         | *Myrcia sp.1*                | Stem            | Ellipsoid     | Brown         | *              |
| Myrtaceae         | *Myrcia sp.1*                | Stem            | Globose       | Green         | *              |
| Myrtaceae         | *Myrcia sp.2*                | Leaf            | Globose       | Green         | A              |
| Myrtaceae         | *Myrcia sp.2*                | Stem            | Ellipsoid     | Brown         | *              |
| Myrtaceae         | *Myrcia sp.3*                | Axillary bud    | Ellipsoid     | Brown         | *              |
| Myrtaceae         | *Myrcia variabilis* DC.      | Leaf            | Discoid       | Brown         | *              |
| Myrtaceae         | *Myrcia vestita* DC.         | Leaf            | Discoid       | Yellow        | D              |
| Myrtaceae         | *Psidium larotteanum* Cambess. | Leaf          | Globose       | Brown         | D              |
| Myrtaceae         | *Psidium larotteanum* Cambess. | Leaf          | Discoid       | Brown         | D              |
| Myrtaceae         | *Psidium larotteanum* Cambess. | Leaf          | Marginal leaf roll | Green        | D              |
| Myrtaceae         | *Psidium myrtoides* O.Berg   | Leaf            | Discoid       | Yellow        | *              |
| Myrtaceae         | *Psidium myrtoides* O.Berg   | Stem            | Ellipsoid     | Brown         | *              |
| Family      | Genus                     | Species Details                   | Part     | Shape     | Color       | Comments |
|-------------|---------------------------|-----------------------------------|----------|-----------|-------------|----------|
| Myrtaceae   | *Psidium salutare var. pohliamum* (O.Berg) Landrum | Leaf Globose | Green | B         |             |          |
| Nyctaginaceae | *Guapira gracilifolia* (Vell.) Reitz | Leaf Discoid | Brown * |             |             |          |
| Nyctaginaceae | *Guapira noxia* (Netto) Lundell | Leaf Discoid | Brown D |             |             |          |
| Nyctaginaceae | *Guapira noxia* (Netto) Lundell | Midvein Ellipsoid | Brown D |             |             |          |
| Nyctaginaceae | *Guapira noxia* (Netto) Lundell | Midvein Globoid | Brown D |             |             |          |
| Nyctaginaceae | *Guapira sp.* | Leaf Discoid | Yellow * |             |             |          |
| Nyctaginaceae | *Guapira sp.* | Leaf Globose | Green * |             |             |          |
| Nyctaginaceae | *Guapira sp.* | Midvein Ellipsoid | Green * |             |             |          |
| Nyctaginaceae | *Guapira sp.* | Stem Ellipsoid | Brown * |             |             |          |
| Nyctaginaceae | *Neea theifera* Oerst. | Leaf Discoid | Green C |             |             |          |
| Ochnaceae   | *Ouratea hexasperma* (A.St.-Hil.) Baill. | Leaf Discoid | Green B; C; D |             |             |          |
| Ochnaceae   | *Ouratea hexasperma* (A.St.-Hil.) Baill. | Stem Globose | Brown * |             |             |          |
| Ochnaceae   | *Ouratea spectabilis* (Mart.) Engl. | Leaf Conical | Brown D |             |             |          |
| Ochnaceae   | *Ouratea spectabilis* (Mart.) Engl. | Leaf Discoid | Green D |             |             |          |
| Piperaceae  | *Piper arboreum* Aubl. | Leaf Discoid | Green A |             |             |          |
| Piperaceae  | *Piper arboreum* Aubl. | Stem Ellipsoid | Marron A |             |             |          |
| Piperaceae  | *Piper arboreum* Aubl. | Stem Globose | Green B |             |             |          |
| Piperaceae  | *Piper sp.* | Leaf Globose | Green * |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Leaf Discoid | Green B; C; D |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Leaf Ellipsoid | Brown * |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Leaf Ellipsoid | Green * |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Midvein Ellipsoid | Green D |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Petiole Ellipsoid | Red D |             |             |          |
| Proteaceae  | *Roupala montana* Aubl. | Stem Ellipsoid | Brown * |             |             |          |
| Ramnaceae   | *Rhamnidioum elaeocarpum* Reissek | Stem Globose | Brown * |             |             |          |
| Rubiaceae   | *Alibertia edulis* (Rich.) A. Rich. Ex DC. | Leaf Discoid | Yellow * |             |             |          |
| Rubiaceae   | *Alibertia sp.1* | Leaf Discoid | Green * |             |             |          |
| Rubiaceae   | *Alibertia sp.2* | Leaf Discoid | Orange * |             |             |          |
| Rubiaceae   | *Coussarea sp.* | Leaf Globose | Yellow * |             |             |          |
| Rubiaceae   | *Coussarea sp.* | Stem Globose | Green * |             |             |          |
| Rubiaceae   | *Palicourea rigida* Kunth | Leaf Globoid | Brown D |             |             |          |
| Family       | Species                          | Part      | Shape      | Color      | Notes |
|--------------|----------------------------------|-----------|------------|------------|-------|
| Rubiaceae    | *Palicourea rigida* Kunth       | Leaf      | Amorphous  | Bege       | *     |
| Rubiaceae    | *Palicourea rigida* Kunth       | Leaf      | Globose    | Yellow     | B     |
| Rubiaceae    | *Palicourea sp.*                | Stem      | Ellipsoid  | Brown      | *     |
| Salicaceae   | *Casearia sylvestris* Sw.       | Leaf      | Discoid    | Brown      | D     |
| Salicaceae   | *Casearia sylvestris* Sw.       | Leaf      | Globose    | Green      | *     |
| Sapindaceae  | *Cupania sp.*                   | Stem      | Ellipsoid  | Green      | *     |
| Sapindaceae  | *Matayba guianensis* Aubl.      | Leaf      | Globose    | Green      | *     |
| Sapindaceae  | *Matayba sp.*                   | Leaf      | Conical    | Green      | *     |
| Sapindaceae  | *Serjania leethis* A. St.-Hil.  | Midvein   | Globose    | Green      | *     |
| Sapindaceae  | *Serjania obtusidentata* Radlk. | Leaf      | Discoid    | Green      | *     |
| Sapindaceae  | *Serjania obtusidentata* Radlk. | Leaf/Stem | Ellipsoid  | Green      | A     |
| Sapindaceae  | *Serjania sp.*                  | Leaf      | Discoid    | Green      | *     |
| Sapindaceae  | *Serjania sp.*                  | Leaf      | Ellipsoid  | Green      | *     |
| Sapindaceae  | *Serjania sp.*                  | Leaf      | Globose    | Brown      | *     |
| Sapindaceae  | *Serjania sp.*                  | Midvein   | Ellipsoid  | Brown      | B     |
| Sapindaceae  | *Serjania sp.*                  | Stem      | Conical    | Brown      | *     |
| Sapindaceae  | *Serjania sp.*                  | Stem      | Ellipsoid  | Brown      | *     |
| Sapotaceae   | *Chrysophyllum marginatum* (Hook. and Arn.) Radlk. | Leaf | Globose    | Green      | *     |
| Sapotaceae   | *Micropholis sp.*               | Leaf      | Globose    | Green      | B     |
| Sapotaceae   | *Micropholis sp.*               | Stem      | Globose    | Brown      | B     |
| Sapotaceae   | *Pouteria ramiflora* (Mart.) Radlk. | Leaf | Discoid    | Brown      | D     |
| Sapotaceae   | *Pouteria ramiflora* (Mart.) Radlk. | Leaf | Globose    | Green      | *     |
| Sapotaceae   | *Pouteria ramiflora* (Mart.) Radlk. | Stem | Ellipsoid  | Brown      | B     |
| Sapotaceae   | *Pouteria sp.*                  | Leaf      | Discoid    | Red        | *     |
| Sapotaceae   | *Pouteria torta* (Mart.) Radlk. | Leaf      | Conical    | Green      | D     |
| Sapotaceae   | *Pouteria torta* (Mart.) Radlk. | Leaf      | Discoid    | Yellow     | D     |
| Sapotaceae   | *Pouteria torta* (Mart.) Radlk. | Leaf      | Conical    | Brown      | D     |
| Sapotaceae   | *Pouteria torta* (Mart.) Radlk. | Leaf      | Discoid    | Brown      | C     |
| Siparunaceae | *Siparuna guianensis* Aubl.     | Leaf      | Cylindrical| Green      | *     |
| Siparunaceae | *Siparuna guianensis* Aubl.     | Leaf      | Ellipsoid  | Yellow     | *     |
| Siparunaceae | *Siparuna guianensis* Aubl.     | Leaf      | Ellipsoid  | Brown      | *     |
| Siparunaceae | *Siparuna guianensis* Aubl.     | Stem      | Ellipsoid  | Green      | *     |
| Siparunaceae | *Siparuna guianensis* Aubl.     | Stem      | Globose    | Brown      | *     |
| Family             | Genus                     | Part       | Shape        | Color       | Notes       |
|--------------------|---------------------------|------------|--------------|-------------|-------------|
| Siparunaceae       | Siparuna guianensis Aubl. | Stem       | Globose      | Green       | A           |
| Siparunaceae       | Siparuna sp.              | Midvein    | Ellipsoid    | Yellow      | *           |
| Smilacaceae        | Smilax fluminensis Steud. | Leaf       | Discoid     | Yellow      | *           |
| Smilacaceae        | Smilax fluminensis Steud. | Leaf       | Globose     | Green       | *           |
| Smilacaceae        | Smilax sp.                | Leaf       | Globose     | Green       | B           |
| Solanaceae         | Solanum sp.               | Stem       | Ellipsoid   | Brown       | *           |
| Styracaceae        | Styrax acuminatus Pohl.   | Leaf       | Discoid     | Brown       | *           |
| Styracaceae        | Styrax acuminatus Pohl.   | Stem       | Ellipsoid   | Brown       | *           |
| Styracaceae        | Styrax ferrugineus Nees and Mart. | Leaf       | Discoid     | Green       | *           |
| Styracaceae        | Styrax ferrugineus Nees and Mart. | Stem       | Ellipsoid   | Brown       | C           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Conicile    | Green       | *           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Globose     | Brown       | A           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Globose     | Green       | B           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Erythrocyte | Brown       | A           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Globose     | Brown       | A           |
| Styracaceae        | Styrax pohlii A.DC.       | Leaf       | Discoid     | Brown       | B           |
| Styracaceae        | Styrax pohlii A.DC.       | Stem       | Fusiform    | Brown       | A; B        |
| Styracaceae        | Styrax pohlii A.DC.       | Stem       | Globose     | Brown       | A; B        |
| Styracaceae        | Styrax sp.                | Leaf       | Globose     | Green       | B           |
| Ulmaceae           | Celtis iguanaea (Jacq.) Sarg. | Leaf       | Discoid     | Yellow      | A           |
| Ulmaceae           | Celtis iguanaea (Jacq.) Sarg. | Leaf/Stem  | Conical     | Green       | *           |
| Ulmaceae           | Trema micrantha (L.) Blume | Leaf       | Ellipsoid   | White       | A           |
| Ulmaceae           | Trema micrantha (L.) Blume | Leaf       | Globose     | Green       | A           |
| Ulmaceae           | Trema micrantha (L.) Blume | Stem       | Globose     | Brown       | A           |
| Verbenaceae        | Aegiphyla sp.             | Leaf       | Globose     | Green       | *           |
| Vochysiaceae       | Qualea grandiflora Mart.  | Leaf       | Discoid     | Green       | B; C        |
| Vochysiaceae       | Qualea grandiflora Mart.  | Leaf       | Globose     | Green       | D           |
| Vochysiaceae       | Qualea grandiflora Mart.  | Leaf       | Conical     | Green       | D           |
| Vochysiaceae       | Qualea grandiflora Mart.  | Leaf       | Discoid     | Brown       | C           |
| Vochysiaceae       | Qualea grandiflora Mart.  | Leaf       | Globose     | Brown       | *           |
| Vochysiaceae       | Qualea grandiflora Mart.  | Stem       | Globose     | Brown       | C           |
| Vochysiaceae       | Qualea multiflora Mart.   | Leaf       | Discoid     | Green       | D           |
| Vochysiaceae       | Qualea multiflora Mart.   | Leaf       | Discoid     | Brown       | *           |
| Vochysiaceae       | Qualea multiflora Mart.   | Leaf       | Star        | Green       | C           |
| Vochysiaceae       | Qualea multiflora Mart.   | Leaf       | Globose     | Brown       | C           |
The genera *Byrsonima* (Malpighiaceae), *Qualea* (Vochysiaceae) and *Myrcia* (Myrtaceae) were the richest in gall morphotypes, with 22, 21 and 17 morphotypes, respectively. *Byrsonima pachyphylla* A. Juss. (Malpighiaceae), *Protium heptaphyllum* March. (Burseraceae), *Qualea parviflora* Mart. (Vochysiaceae), and *Styrax pohlii* A.DC. (Styracaceae) were the host species with the most diverse gall morphotypes. Other important host species were: *Caryocar brasiliense* Cambess. (Caryocaraceae) (7), *Qualea multiflora* Mart. (Vochysiaceae) (7), *Roupala montana* Aubl. (Proteaceae) (7), *Qualea grandiflora* Mart. (Vochysiaceae) (6) and *Siparuna guianensis* Aubl. (Siparunaceae) (6).

**Discussion**

We have systematically compiled the results of studies on plant species that host insect galls in the Cerrado of the state of Goiás for the first time, which resulted in new records of 73 (40.3%) plant species and 173 (47.4%) gall morphospecies. Our results corroborate previous studies that indicate Fabaceae as the plant family that hosts the greatest diversity of galling insects in the Neotropical Region (Gagné 1994, Maia and Fernandes 2004, Araújo et al. 2014b, Fernandes and Santos 2014). Local studies in different regions of Brazil found the same pattern (Gonçalves-Alvim and Fernandes 2001, Santos et al. 2010, Araújo et al. 2011, Araújo et al. 2013, Araújo et al. 2014a). Fabaceae is the most diverse plant family of the Cerrado with nearly 800 species, and so it is not surprising that it hosts the highest diversity of insect galls (Araújo et al. 2014b).

We found that *Byrsonima*, *Qualea* and *Myrcia* were the genera hosting the greatest number of gall morphotypes. These results differ from that observed in other regions of Brazil. For example, Mendonça 2007] found the genera *Mikania* (Asteraceae), *Eugenia* (Myrtaceae) and *Guapira* (Nyctaginaceae) to host the greatest diversity of galls in the state.
of Rio Grande do Sul in Southern Brazil. In the Brazilian Southeast, the genera *Myrcia* (Myrtaceae), *Ocotea* (Lauraceae) and *Paullinia* (Sapindaceae) hosted the most diversity of galls in the state of São Paulo (Maia et al. 2008), while *Baccharis* (Asteraceae) hosted the greatest richness of galls in state of Minas Gerais (Fernandes et al. 1996). With regards to host plant species, some species stand out as super-hosts of insect galls in Goiás, such as *Byrsonima pachyphylla*, *Protium heptaphyllum*, *Qualea parviflora* and *Styrax pohlii*. In a previous study, Maia and Fernandes 2004] recorded seven morphotypes of galls on *P. heptaphyllum* in Cerrado areas of Minas Gerais. Our compilation also adds new gall records for some host species. Galls on *Siparuna guianensis* were registered for the first time in the Neotropics by Santos et al. 2010] with only one gall morphotype, while in the present compilation six gall morphotypes are associated with this host plant.

Most of the studies performed in Brazil have shown a high diversity of galling insects in the Cerrado (Gonçalves-Alvim and Fernandes 2001, Maia and Fernandes 2004, Santos et al. 2010, Araújo et al. 2011), one of the most fragmented biomes of the world (Klink and Machado 2005). To maintain this high gall diversity it is essential that the remaining fragments of Cerrado are preserved and retain a high diversity of native plants (Araújo et al. 2014b). In the state of Goiás, areas of native vegetation are very small and the majority is widely fragmented (Cunha et al. 2007). Given the eminent risk of destruction of the remaining vegetation, inventories of host plants and their associated insect galls are urgently needed to provide a foundation for further understanding these interactions. We hope that this compilation can serve as an important tool for gall inventories and provide a theoretical reference for new studies in the state of Goiás and in all of Brazil.

**Author contributions**

WSA, BAR, TMS, ECS, FAGG, CSS and BBS collect data in field and help in data compilation. WSA created the map and formatted the figures. WSA and EDPJ wrote the manuscript. All authors read the manuscript and contributed with suggestions.

**References**

- Abrahamson W, Melika G, Scrafford R, Csoka G (1998) Gall-Inducing Insects Provide Insights into Plant Systematic Relationships. American Journal of Botany 85 (8): 1159. DOI: [10.2307/2446348](10.2307/2446348)
- Araújo W, Silva I, Santos B, Gomes-Klein V (2013) Host plants of entomogenous galls in areas of cerrado in the state of Goiás, Brazil. Acta Botanica Brasilica 27 (3): 537-542. DOI: [10.1590/S0102-33062013000300011](10.1590/S0102-33062013000300011)
- Araújo WSD, Santos BBd, Gomes-Klein VL (2011) Insect galls from Serra dos Pireneus, GO, Brazil. Biota Neotropica 11 (2): 357-365. DOI: [10.1590/s1676-06032011000200034](10.1590/s1676-06032011000200034)
- Araújo WSD, Sobral FL, Maracahipes L (2014a) Insect galls of the Parque Nacional das Emas (Mineiros, GO, Brazil). Check List 10 (6): 1445. DOI: [10.15560/10.6.1445](10.15560/10.6.1445)
• Araújo WSd, Santos BBd, Guilherme FAG, Scareli-Santos C (2014b) Galling Insects in the Brazilian Cerrado: Ecological Patterns and Perspectives. Neotropical Insect Galls. DOI: 10.1007/978-94-017-8783-3_15

• Bregonci JdM, Polycarpo PV, Maia VC (2010) Galhas de insetos do Parque Estadual Paulo César Vinha (Guarapari, ES, Brasil). Biota Neotropica 10 (1): 265-274. DOI: 10.1590/s1676-06032010000100023

• Carneiro M, Branco CA, Braga CD, Almada E, Costa MM, Maia V, Fernandes GW (2009) Are gall midge species (Diptera, Cecidomyiidae) host-plant specialists? Revista Brasileira de Entomologia 53 (3): 365-378. DOI: 10.1590/s0085-56262009000300010

• Cunha HF, Ferreira A, Brandão D (2007) Composição e fragmentação do Cerrado em Goiás usando Sistema de Informação Geográfica (SIG). Boletim Goiano de Geografia 27 (2): 139-152. DOI: 10.5216/bgg.v27i2.2661

• Espírito-Santo M, Fernandes G (2007) How many species of gall-inducing insects are there on Earth, and where are they? Annals of Entomological Society of America 100 (2): 95-99.

• Fernandes G, Santos J (2014) Neotropical Insect Galls. Springer, 550 pp. DOI: 10.1007/978-94-017-8783-3

• Fernandes GW, Carneiro MA, Lara AC, Allain LR, Andrade GI, Julião GR, Reis TR, Silva IM (1996) Galling insects on neotropical species of Baccharis (Asteraceae). Tropical Zoology 9 (2): 315-332. DOI: 10.1080/03946975.1996.10539315

• Gagné R (1994) The gall midges of the region neotropical. Ithaca, Comstock, USA 352: pp.

• Gonçalves-Alvim S, Fernandes GW (2001) Comunidades de insetos galhadores (Insecta) em diferentes fisionomias do cerrado em Minas Gerais, Brasil. Revista Brasileira de Zoologia 18: 289-305. DOI: 10.1590/s0101-817520010000500025

• Klink C, Machado R (2005) Conservation of the Brazilian Cerrado. Conservation Biology 19 (3): 707-713. DOI: 10.1111/j.1523-1739.2005.00702.x

• Maia VC, Fernandes GW (2004) Insect galls from Serra de São José (Tiradentes, MG, Brazil). Brazilian Journal of Biology 64: 423-445. DOI: 10.1590/s1519-69842004000300007

• Maia VC, Magenta MAG, Martins SE (2008) Ocorrência e caracterização de galhas de insetos em áreas de restinga de Bertioga (São Paulo, Brasil). Biota Neotropica 8 (1): 167-197. DOI: 10.1590/s1676-06032008000100020

• Mani MS (1964) Ecology of plant galls. The Hague, 434 pp. DOI: 10.1007/978-94-017-6230-4

• Mendonça M (2007) Plant diversity and galling arthropod diversity - searching for taxonomic patterns in an animal-plant interaction in the Neotropics. Boletin de la Sociedad Argentina de Botanica 42 (3): 347.

• Moura MZD, Soares GLG, Isalas RMDS (2008) Species-specific changes in tissue morphogenesis induced by two arthropod leaf gallers in Lantana camara L. (Verbenaceae). Australian Journal of Botany 56 (2): 153. DOI: 10.1071/bt07131

• Rohfritsch O (1982) Patterns in gall development. In: Shorthouse JD, Rohfritsch O (Eds) Biology of insect- and acarina-induced galls.

• Santos B, Ribeiro B, Silva T, Araújo W (2012) Galhas de insetos em uma área de cerrado sentido restrito na região semi-urbana de Caldas Novas (Goiás, Brasil). Revista Brasileira de Biociências 10 (4): 439-445.
• Santos BBd, Ferreira HD, Araújo WSd (2010) Ocorrência e caracterização de galhas entomógenas em uma área de floresta estacional semidecídua em Goiânia, Goiás, Brasil. Acta Botanica Brasilica 24 (1): 243-249. DOI: 10.1590/s0102-33062010000100026

• Stone G, Schönrogge K (2003) The adaptive significance of insect gall morphology. Trends in Ecology & Evolution 18 (10): 512-522. DOI: 10.1016/s0169-5347(03)00247-7