Checklist of the gall midges (Diptera, Cecidomyiidae) in the state of Bahia (Northeastern Brazil)

Lista dos Cecidomyiidae (Diptera) no estado da Bahia (Nordeste do Brasil)

ABSTRACT
Forty-four gall midge species (Cecidomyiidae, Diptera) of 28 genera have been recorded in Bahia in association with 17 plant families. Fabaceae stands out for hosting the greatest number of gall midge species, followed by Burseraceae, Calophyllaceae, Myrtaceae, and Nyctaginaceae. Lopesia Rübsaamen 1908, Dasineura Rondani, 1840 and Bruggmannia Tavares, 1906 were the best represented gall midge genera. Six species, Costadiplosis maricaensis Viceconte & Maia, 2001, Dasineura couepiae Maia, 2001a, D. globosa Maia, 1996, D. marginalis Maia, 2005, Lopesia andirae Garcia, Lima, Caldo e Urso-Guimarães, 2017, and L. marginalis Maia, 2001a induce galls in endemic plants. Nine host plants are useful and together host 19 gall midge species (43% of the total). Concerning the geographic distribution in Bahia, each cecidomyiid species was recorded in a single phytogeographic domain. Atlantic Forest totaled 32 species, Cerrado five and Caatinga three. As the municipalities of occurrence of Cleitodiplosis graminis (Tavares, 1916), Dasineura braziliensis (Tavares, 1922), and Haplusia plumipes Karsch 1877 were not stated, their domains could not be established. Bahia shares 19 cecidomyiid species with the state of Rio de Janeiro, 13 with Espírito Santo, and 10 with Minas Gerais, corresponding to 0.25, 0.34 and 0.24 of fauna similarity, respectively. Nineteen species are only known from Bahia, eighteen of them were described between 1877 and 1922, and have never been recollected. Most species have been recorded on the coast of Bahia and most of the state area remains uninvestigated.

Keywords: Plant-insect interaction, geographic distribution, endemisms, fauna composition, useful plants.
RESUMO
Quarenta e quatro espécies de Cecidomyiidae (Diptera) de 28 gêneros são registradas na Bahia em associação com 17 famílias botânicas. As Fabaceae se destacam por hospedar o maior número de espécies de Cecidomyiidae, seguidas por Burseraceae, Calophyllaceae, Myrtaceae e Nyctaginaceae. Lopesia Rübsaamen, 1908, Dasineura Rondani, 1840 e Bruggmannia Tavares, 1906 são os gêneros mais bem representados da família Cecidomyiidae. Seis espécies, Costadiplosis maricaensis Viceconte & Maia, 2001, Dasineura couepiae Maia, 2001a, D. globosa Maia, 1996, D. marginalis Maia, 2005, Lopesia andirae Garcia, Lima, Caldo e Urso-Guimarães, 2017 e L. marginalis Maia, 2001a induzem galhas em plantas endêmicas. Nove plantas hospedeiras são úteis e juntas hospedam 19 cecidomiídeos (43% do total). Em relação à distribuição geográfica na Bahia, cada espécie de Cecidomyiidae foi registrada em um único domínio fitogeográfico. A Mata Atlântica totalizou 32 espécies, o Cerrado cinco e a Caatinga três. Os municípios de ocorrência de Cleitodiplosis graminis (Tavares, 1916), Dasineura braziliensis (Tavares, 1922) e Haplusia plumipes Karsch 1877 não foram informados, por isso seus domínios não puderam ser estabelecidos. A Bahia compartilha 19 espécies de Cecidomyiidae com o estado do Rio de Janeiro, 13 com o Espírito Santo e 10 com Minas Gerais, correspondendo respectivamente a 0,25; 0,34 e 0,24 de similaridade faunística. Dezenove espécies são conhecidas apenas da Bahia, 18 delas foram descritas entre 1877 e 1922, e nunca foram coletadas novamente. A maioria das espécies foi registrada na costa da Bahia, e a maior parte da área do estado permanece não investigada.

Palavras-chave: Interação inseto-planta, distribuição geográfica, endemismps, composição da fauna, plantas úteis.

1 INTRODUCTION
Cecidomyiidae (Fig. 1) is a very diverse family of Diptera, with more than 6,500 species, most of them are gall-inducers (Gagné & Jaschhof 2017). The family comprises species of economic importance, as for example Iatrophobia brasiliensis (Rübsaamen, 1915), an agricultural pest of Manihot utilissima (Euphorbiaceae), commonly known as “cassava”. Others prey whiteflies and scale insects, as all species of Diadiplosis Felt, 1911.

In Brazil, only about 250 species of cecidomyiids are known, most recorded in Atlantic Forest areas of the state of Rio de Janeiro. In the beginning of the 20th century, J. S. Tavares, a Portuguese priest, described several species from Bahia (Tavares 1906, 1915, 1916, 1917, 1918a,b, 1920a-c, 1921, 1922). After this period, no new data was added to the fauna knowledge until 2014, when Maia reported four cecidomyiid species in Porto Seguro and Trancoso (Maia, 2014). Later, other species were reported in several municipalities of the state (Maia, 2020a-c). This new amount of information led to the elaboration of the first checklist of the gall midges in Bahia.

Bahia (BA) is the fifth largest Brazilian state in territorial extension, with 564.760,427 Km² and three phytogeographic domains: Caatinga, Cerrado and Atlantic Forest. The first covers about 54% of the state area, the second 27%, and the third 19% (IBGE 2020). The number of cecidomyiid species in Bahia is unknown, as well as their distribution in the state. Furthermore, a list of host plant...
species has not yet been provided. This paper aims to fill these information gaps and contribute to the knowledge of the Cecidomyiidae fauna in Bahia.

2 MATERIAL AND METHODS

A literature review was performed on the database “Web of Science”, using “Cecidomyiidae” and “Bahia” as keywords. Brazilian inventories of insect galls and taxonomical papers were examined, as well as the most recent catalog of Cecidomyiidae of the world (see references). Collecting localities were retrieved from original papers, and their phytogeographic domains were established based on maps of vegetation of IBGE 2004.

We used the Flora do Brasil 2020 website to obtain the following data on host plants: correct spelling, authorship of species, synonyms, origin, endemism, distribution in Brazilian phytogeographic domains, and categories of the conservational status. Plant uses were verified in Santos et al. 2009 and on The Useful Tropical Plants 2014 website.

We adopted the Sorensen’s Index to quantify the similarity between Bahia X Rio de Janeiro, Bahia X Espírito Santo and Bahia x Minas Gerais faunas. These states were chosen because they are the only Brazilian states whose richness of gall midge species is known.

A political map of Bahia was retrieved from IBGE 2020 and municipalities with records of Cecidomyiidae were colored using Paint.

3 RESULTS

Forty-four gall midge species of 28 genera have been recorded in Bahia (Table 1). Most are gall-inducers (n=39) (88.6%). They are associated with 17 plant families and among these, Fabaceae stands out for hosting the greatest number of gall midge species (seven), followed by Burseraceae, Calophyllaceae, Myrtaceae, and Nyctaginaceae, each with four cecidomyiid species. However, most plant families (n=7) (41.2%) hosted a single gall midge species (Table 2). The number of host plant genera was not established due to nine records in family level: three in Fabaceae, three in Rubiaceae, one in Asteraceae, one in Malvaceae, and one in Myrtaceae. Nevertheless, 17 genera were determined. The records in Asteraceae and Malvaceae represent other two genera, as in each family a single record was reported. So the minimum number of host genera is 19, while the maximum number is 26 (if each record corresponds to a genus). *Protium* Burm. f. (Burseraceae), *Calophyllum* L. (Calophyllaceae) and *Eugenia* L. (Myrtaceae) were the plant genera that hosted the greatest number of gall midge species (four). Similarly, the number of plant species was not established due to six records in genus level: one in *Andira* Lam. (Fabaceae), one in *Ficus* L. (Moraceae), two in *Lantana*
L. (Verbenaceae), and two in Styrax L. (Styracaceae). Nevertheless, 14 species were identified. The minimum number of host species is 17 if we consider the records in Ficus, Lantana and Styrax individually as one, while the maximum number is 20 if we consider that each record correspond to a different species. Calophyllum brasilienis Cambess., Protium heptaphyllum (Aubl.) Marchand and Guapira opposita (Vell.) Reitz were the plant species that hosted the greatest richness of gall midge species (four).

Lopesia Rübsaamen 1908, Dasineura Rondani, 1840 and Bruggmannia Tavares, 1906 were the best represented gall midge genera with seven, five and three species, respectively. Most genera (n=19) (67.8%) were represented by a single species (Table 1). Six gall midge species, Costadiplosis maricaensis Viceconte & Maia, 2009, Dasineura couepiae Maia, 2001a, Lopesia marginalis Maia, 2001a, Dasineura globosa Maia, 1996, Dasineura marginalis Maia, 2005, and Lopesia andira Garcia et al., 2017 induce galls in four endemic plants, the first in Psittacanthus dichroos (Loranthaceae), the second and third in Couepia ovalifolia (Schott) Benth. ex Hook.f. (Chrysobalanaceae), the fourth and fifth in Eugenia astringens Cambess. (Myrtaceae), and the last in Andira humilis Mart ex. Benth (Fabaceae). Couepia ovalifolia and Eugenia astringens are restricted to the Atlantic Forest.

Regarding the categories of conservation, 12 plant species were not evaluated (they together hosted 23 gall midge species). Protium heptaphyllum (Aubl.) Marchand (Burseraceae), a data deficient plant, hosted four gall midge species, while Myrciaria floribunda (H. West. ex Willd) O. Berg. (Myrtaceae), a less concerning plant, hosted a single gall midge species.

Nine host plant species are useful, most with several uses (Table 3). Six are medicinal, six are used in carpentry and/or cabinet making, five in general construction and five are ornamental. Others are edible (four species), used in agroforestry (four species) or as firewood or charcoal and fuel (two species), dye on textiles (two species), incense, varnishes or glaze (one species), insecticide (one species), source of tannins (one species), glues (one species) and toothbrushes (one species). These useful plants hosted 19 gall midge species (43% of the total).

Most cecidomyiid species (n=39) (88.6%) have been recorded in the Atlantic Forest, 29 of them exclusively (65.9%); 11 (25%) in the Cerrado, three (6.8%) exclusively; and seven (15.9%) in the Caatinga, two (4.6%) exclusively. Nine species have been reported in two or more Brazilian phytogeographic domains. Concerning the geographic distribution in Bahia, all cecidomyiid species have been recorded in a single domain: Atlantic Forest (32 species), Cerrado (five) and Caatinga (three). As the municipalities of occurrence of Cleitodiplosis graminis (Tavares, 1916), Dasineura braziliensis (Tavares, 1922), and Haplusia plumipes Karsch, 1877 were not stated, their domains could not be established. Until the present moment, Bahia shares 19 cecidomyiid species with Rio de
Janeiro, 13 with Espírito Santo, and 10 with Minas Gerais, corresponding to 0.25, 0.34 and 0.24 of fauna similarity, respectively (Table 4). Nineteen species are only known from Bahia, their type-locality. Eighteen of them were described between 1877 and 1922, and have never been recollected, 16 are gall-inducer, one is an inquiline and one is fungivorous. Only two host plants of these phytophagous gall midges were identified in species, six were identified in genus and eight in family. The hosts of two gall-inducers are still undetermined. Only one Cecidomyiidae species, *Schizomyia barreirensis* Santos, Maia & Calado, 2019, was recently described.

Most cecidomyiid species (n=35) (79.5%) have been recorded only in the coast of Bahia, while eight (18.2%) exclusively in the interior. A single species, *Dasineura myrciariae* is known from both the coast and the interior. Gall midge records totaled 24 municipalities in the state, one in the far west (Barreiras), two in the south center (Sebastião Laranjeiras and Caetité), two in the north center (Morro do Chapéu and Campo Formoso), one in the northeast, and 18 along the coast (75%) in three mesoregions: south (10 municipalities, from Valença to Nova Viçosa), Metropolitan of Salvador (five municipalities, from Mata de São João to Itaparica), and northeast (three municipalities, from Jandaíra to Esplanada) (Fig. 2).

The list of cecidomyiid species is presented below in alphabetical order. Their habits are mentioned in brackets. Records in Bahia (municipalities and phytogeographic domains), Brazilian states and other countries are provided, followed by references. Data on plant species (geographic distribution in Brazil, origin and category of conservation) are added, but only once to avoid repetition. The following acronyms were adopted: NE – not evaluated, LC – less concerning, and DD – data deficiente (for the conservation categories); AC – Acre, AL – Alagoas, AM – Amazonas, AP – Amapá, BA – Bahia, CE – Ceará, DF – Distrito Federal, ES – Espírito Santo, GO – Goiás, MA – Maranhão, MG – Minas Gerais, MS – Mato Grosso do Sul, MT – Mato Grosso, PA – Pará, PB – Paraíba, PE – Pernambuco, PI – Piauí, PR – Paraná, RJ – Rio de Janeiro, RN – Rio Grande do Norte, RO – Rondônia, RR – Roraima RS – Rio Grande do Sul, SC – Santa Catarina, SE – Sergipe, SP – São Paulo, TO – Tocantins (for Brazilian states).

List of Cecidomyiidae (Diptera) in Bahia

1) *Anadiplosis caetetensis* Tavares, 1920a (gall-inducer). Records in Bahia: Caetité (Caatinga). Other records: unknown. Refs.: Tavares 1920a, Gagné & Jaschhof, 2017. Host plant: undetermined Fabaceae.
2) *Anadiplosis procera* Tavares, 1920a (gall-inducer). Records in Bahia: Salvador, Itaparica (Atlantic Forest). Other records: unknown. Refs.: Tavares 1920a, Gagné & Jaschhof, 2017. Host plant: undetermined Fabaceae.

3) *Andirodiplosis bahiensis* Tavares, 1920b (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1920b, Gagné & Jaschhof, 2017. Host plant: *Andira* sp. (Fabaceae).

4) *Asphondylia bahiensis* Tavares, 1917 (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1917, Gagné & Jaschhof, 2017. Host plant: undetermined Rubiaceae.

5) *Asphondylia parva* Tavares, 1917 (gall-inducer). Records in Bahia: Madre de Deus (Atlantic Forest). Other records: unknown. Refs.: Tavares 1917, Gagné & Jaschhof, 2017. Host plant: undetermined Rubiaceae.

6) *Autodiplosis parva* Tavares, 1916 (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1916, Gagné & Jaschhof, 2017. Host plant: undetermined Fabaceae.

7) *Bruggmannia acaudata* Maia, 2004 (gall-inducer). Records in Bahia: Porto Seguro-Trancoso (Atlantic Forest). Other records: ES and RJ (Atlantic Forest). Refs.: Maia, 2004, 2014, Gagné & Jaschhof, 2017. Host plant: *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Plant distribution: North (AM, AP, PA, TO), Northeast (AL, BA, CE, MA, PB, PE), Central-West (DF, GO, MS), Southeast (ES, MG, RJ, SP), South (PR, RS, SC). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado. Origin: native. Conservation category: NE.

8) *Bruggmannia elongata* Maia & Couri, 1993 (gall-inducer). Records in Bahia: Porto Seguro-Trancoso (Atlantic Forest). Other records: ES, RJ, SP, SC, and RS (Atlantic Forest). Refs.: Maia & Couri 1993, Monteiro et al. 1994. Maia 2001b, 2014, Maia et al. 2008, Maia & Oliveira 2010, Maia & Souza 2013, Rodrigues et al. 2014, Arriola et al. 2015, Carvalho-Fernandes et al. 2016, Maia & Carvalho-Fernandes 2016, Maia & Silva 2016, Goetz et al. 2018, Melo-Júnior et al. 2018, Maia 2020a. Host plant: *Guapira opposita* (Vell.) Reitz (Nyctaginaceae).

9) *Bruggmannia robusta* Maia & Couri, 1993 (gall-inducer). Records in Bahia: Porto Seguro-Trancoso (Atlantic Forest). Other records: ES, RJ, SP, and RS (Atlantic Forest). Refs.: Maia & Couri 1993, Monteiro et al. 1994, Maia 2001b, 2014, Maia et al. 2008, Maia & Oliveira 2010, Maia et al. 2014, Rodrigues et al. 2014, Maia & Carvalho-Fernandes 2016, Carvalho-Fernandes et al. 2016, Gagné & Jaschhof 2017, Goetz et al. 2018, Maia & Siqueira 2020, Maia 2020a. Host plant: *Guapira opposita* (Vell.) Reitz (Nyctaginaceae).
10) *Bruggmanniella byrsonimae* (Maia & Couri, 1992) (gall-inducer). Records in Bahia: Nova Viçosa (Atlantic Forest). Other records: ES and RJ (Atlantic Forest). Refs.: Maia & Couri 1992, Maia 2001b, Rodrigues et al. 2014, Carvalho-Fernandes et al. 2016, Maia & Silva 2016, Gagné & Jaschhof 2017, Maia & Flor 2020. Host plant: *Byrsonima sericea* DC. (Malpighiaceae). Plant distribution: North (PA, TO), Northeast (AL, CE, MA, PB, PE, PI, RN, SE, BA), Central-West (GO, MT), Southeast (ES, MG, RJ, SP). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, and Cerrado. Origin: native. Conservation category: NE.  

11) *Cleitodiplosis graminis* (Tavares, 1916) (gall-inducer). Records in Bahia: unstated municipality. Other records: Rio de Janeiro (Atlantic Forest). Refs.: Tavares 1916, 1921, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Paspalum conjugatum* Berg. (Poaceae). Plant distribution: North (AC, AM, AP, PA, RO, RR, TO), Northeast (AL, BA, CE, MA, PB, PE, PI, RN, SE), Central-west (DF, GO, MS, MT), Southeast (ES, MG, RJ, SP), South (PR, SC, RS). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado, Pampa, Pantanal. Origin: native. Conservation category: NE.  

12) *Clinodiplosis bahiensis* (Tavares, 1917) (gall-inducer). Records in Bahia: Salvador, Madre de Deus (Atlantic Forest). Other records: unknown. Refs.: Tavares 1917, Gagné 2004, Gagné & Jaschhof 2017. Host plant: undetermined Asteraceae.  

13) *Clinodiplosis pulchra* (Tavares, 1917) (gall-inducer). Records in Bahia: Salvador, Madre de Deus (Atlantic Forest). Other records: unknown. Refs.: Tavares 1917, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Lantana* sp. (Verbenaceae).  

14) *Compsodiplosis itaparicana* Tavares, 1922 (gall-inducer). Records in Bahia: Salvador, Itaparica (Atlantic Forest). Other records: unknown. Refs.: Tavares 1922, Gagné 1994, Gagné & Jaschhof 2017. Host plant: undetermined.  

15) *Contarinia gemmae* Maia, 2003 (gall-inducer). Records in Bahia: Sebastião Laranjeiras (Cerrado). Other records: AM (Amazon), GO (Cerrado), MG (Cerrado and Atlantic Forest), RJ and SP (Atlantic Forest). Refs.: Madeira et al. 2003, Maia et al. 2008, Arriola et al. 2015, Proença & Maia 2015, Gagné & Jaschhof 2017, Maia 2019, Maia, in print. Host plant: *Calophyllum brasiliense* Cambess. (Calophyllaceae). Plant distribution: North (AC, AM, AP, PA, RO, RR, TO), Northeast (BA, MA), Central-West (DF, GO, MS, MT), Southeast (ES, MG, RJ, SP), South (PR, SC). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado. Origin: native. Conservation category: NE.  

16) *Costadiplosis maricaensis* Viceconte & Maia, 2009 (gall-inducer). Records in Bahia: Porto Seguro (Atlantic Forest). Other records: Rio de Janeiro (Atlantic Forest). Refs.: Maia 2001b,
Viceconte & Maia 2009, Gagné & Jaschhof 2017, Maia, 2020 c. Host plant: *Psittacanthus dichroos* (Mart.) Mart. (Loranthaceae). Plant distribution: Northeast (AL, BA, PB, PE, RN, SE), Central-West (GO), Southeast (ES, MG, RJ, SP), South (PR, SC). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado. Origin: native (endemic). Conservation category: NE.

17) *Couridiplosis vena* Maia, 2004 (gall-inducer). Records in Bahia: Ilhéus (Atlantic Forest). Other records: MG (Cerrado), ES, SP, and PR (Atlantic Forest). Refs.: Maia 2004, Maia & Fernandes 2004, Gagné & Jaschhof 2017, Maia 2020c. Host plant: *Croton floribundus* Spreng (Euphorbiaceae). Plant distribution: Northeast (AL, BA, CE, PB, PE), Central-West (DF, MS, MT), Southeast (ES, MG, RJ, SP), South (PR). Phytogeographic domain: Atlantic Forest. Origin: native. Conservation category: NE.

18) *Dactylodiplosis heptaphylli* Maia, 2004 (gall-inducer). Records in Bahia: Conde, Caravelas (Atlantic Forest). Other records: MG, ES and RJ (Atlantic Forest). Refs.: Narahara et al. 2004, Maia 2001b, 2013, Carvalho-Fernandes et al. 2016, Maia & Carvalho-Fernandes 2016, Gagné & Jaschhof 2017, Maia 2020c. Host plant: *Protium heptaphyllum* (Aubl.) Marchand (Burseraceae). Plant distribution: North (AC, AM, AP, PA, RO, RR, TO), Northeast (AL, BA, CE, MA, PE, RN, SE), Central-West (DF, MS, MT), Southeast (ES, MG, RJ, SP). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado. Origin: native. Conservation category: DD.

19) *Dasineura braziliensis* (Tavares, 1922) (gall-inducer). Records in Bahia: unstated municipality. Other records: MT, PI, and MG (Cerrado). Refs.: Tavares 1922, Gagné 1994, Gagné & Jaschhof 2017, Maia in print. Host plant: *Protium heptaphyllum* (Aubl.) Marchand (Burseraceae).

20) *Dasineura couepiae* Maia, 2001a (gall-inducer). Records in Bahia: Caravelas, Conde, Porto Seguro (Atlantic Forest). Other records: RJ and ES (Atlantic Forest). Refs.: Monteiro et al. 1994, Maia 2001a, b, Bregonci et al. 2010, Carvalho-Fernandes et al. 2016, Gagné & Jaschhof 2017, Maia & Cruz, 2020. Host plant: *Couepia ovalifolia* (Schott) Benth. ex Hook. f. (Chrysobalanaceae). Plant distribution: Northeast (BA), Southeast (ES, MG, RJ). Phytogeographic domain: Atlantic Forest. Origin: native (endemic). Conservation category: NE.

21) *Dasineura globosa* Maia, 1996 (gall-inducer). Records in Bahia: Conde, Mata de São João (Atlantic Forest). Other records: ES, RJ (Atlantic Forest). Refs.: Maia 1996, 2001b, Oliveira & Maia 2005, Rodrigues et al. 2014, Carvalho-Fernandes et al. 2016, Maia & Silva 2016, Gagné & Jaschhof 2017, Maia & Cruz in print. Host plant: *Eugenia astringens* Cambess. (= *Eugenia umbelliflora* O. Berg., *E. rotundifolia* Casar (Myrtaceae). Plant distribution: Northeast (BA), Southeast (ES, RJ, SP), South (PR, SC). Origin: native (endemic). Phytogeographic domain: Atlantic Forest.
22) **Dasineura marginalis** Maia, 2005 (gall-inducer). Records in Bahia: Conde, Jandaíra, Salvador (Atlantic Forest). Other records: ES and RJ (Atlantic Forest). Refs.: Maia 2001b, Maia et al. 2005, Rodrigues et al. 2014, Carvalho-Fernandes et al. 2016, Gagné & Jaschhof 2017, Maia & Cruz in print. Host plant: *Eugenia astringens* Cambess (= *Eugenia umbelliflora* O. Berg., *E. rotundifolia* Casar) (Myrtaceae).

23) **Dasineura myrciariae** Maia, 1996 (gall-inducer). Records in Bahia: Campo Formoso, Caetité, Morro do Chapéu, and Tucano (Caatinga), Conde, Esplanada, and Salvador (Atlantic Forest). Other records: British Guiana and Brazil: AC and PA (Amazon Forest), MT (Amazon Forest, Cerrado), GO (Cerrado), PE (Caatinga), MG (Cerrado, Atlantic Forest), AL, SE, ES, RJ, PR and SC (Atlantic Forest), SP (Cerrado-Atlantic Forest transition, Atlantic Forest). Refs: Maia 1996, Maia 2001b, Bregonci et al. 2010, Maia et al. 2014, Maia & Carvalho-Fernandes 2016, Maia & Silva 2016, Gagné & Jaschhof 2017, Maia 2019, Maia & Cruz in print. Host plant: *Myrciaria floribunda* (H. West ex Willd.) O. Berg (LC). Plant distribution: North (AC, AM, PA, RO, RR), Northeast (AL, BA, PE), Central-West (GO, MS, MT), Southeast (ES, MG, RJ, SP), South (PR, SC, RS). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado. Origin: native. Conservation category: LC.

24) **Dialeria styracis** Tavares, 1918a (inquiline). Records in Bahia: Caetité (Caatinga). Other records: unknown. Refs.: Tavares 1918a, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Styrax* sp. (Styracaceae).

25) **Dichodiplosis triangularis** (Felt, 1908) (fungivorous). Records in Bahia: Salvador (Atlantic Forest). Other records: USA (widespread) and Costa Rica. Refs.: Felt 1908, Gagné & Jaschhof 2017.

26) **Gnesiodiplosis itaparicae** Tavares, 1917 (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares, 1917, Gagné 1994, Gagné & Jaschhof 2017. Host plant: undetermined Rubiaceae.

27) **Haplusia plumipes** Karsch 1877 (fungivorous). Records in Bahia: unstated municipality. Other records: unknown. Refs.: Karsch 1877, Gagné 1994, Gagné & Jaschhof 2017.

28) **Lopesia andirae** Garcia, Lima, Calado & Urso-Guimarães, 2017 (gall-inducer). Records in Bahia: Barreiras (Cerrado). Other records: MT and SP (Cerrado). Refs.: Garcia et al. 2017, Lima & Calado 2018. Host plant: *Andira humilis* Mart. ex Benth. (Fabaceae). Plant distribution: North (PA, RO), Northeast (BA, MA, PE, RN), Central-West (DF, MS, MT), Southeast (MG, SP), South (PR). Phytogeographic domains: Amazon Forest, Caatinga, Cerrado. Origin: native (endemic). Conservation status: NE.
29) *Lopesia caulinaris* Maia, 2003 (gall-inducer). Records in Bahia: São Sebastião do Passé (Atlantic Forest). Other records: AM (Amazon Forest), RJ, SP, and SC (Atlantic Forest), MG (Atlantic Forest, Cerrado), GO (Cerrado). Refs.: Madeira et al. 2003, Maia 2013, Maia et al. 2008, Arriola et al. 2015, Proença & Maia 2015, Gagné & Jaschhof 2017, Melo-Júnior et al. 2018, Maia 2019. Host plant: *Calophyllum brasiliense* Cambess. (Calophyllaceae).

30) *Lopesia conspicua* Maia, 2003 (gall-inducer). Records in Bahia: Sebastião Laranjeiras (Cerrado). Other records: AM and AP (Amazon Forest), GO (Cerrado), MG (Atlantic Forest, Cerrado), RN, RJ, SP, SC and PR (Atlantic Forest). Refs.: Madeira et al. 2003, Maia 2013, Arriola et al. 2015, Proença & Maia 2015, Gagné & Jaschhof 2017. Host plant: *Calophyllum brasiliense* Cambess. (Calophyllaceae).

31) *Lopesia elliptica* Maia, 2003 (gall-inducer). Records in Bahia: Sebastião Laranjeiras (Cerrado). Other records: Mexico, Guatemala, Costa Rica, Dominican Republic, Cuba, Bolivia, Guyana, Peru, and Brazil: AM, AP, PA, RO and MA (Amazon Forest), GO, TO, MG, PE (Cerrado), RN, RJ, SP, SC and PR (Atlantic Forest), MG (Atlantic Forest, Cerrado). Refs.: Madeira et al. 2003, Maia et al. 2008, Maia 2013, Arriola et al. 2015, Proença & Maia 2015, Gagné & Jaschhof 2017, Melo-Júnior et al. 2018. Host plant: *Calophyllum brasiliense* Cambess. (Calophyllaceae).

32) *Lopesia grandis* Maia 2001 (gall-inducer). Records in Bahia: Camamu, Porto Seguro-Trancoso, Santa Cruz de Cabrália, Itacaré, Nova Viçosa, Una, Ilhéus, Valença, Belmonte (Atlantic Forest). Other records: PB, ES, RJ, and SP (Atlantic Forest). Refs.: Maia 2001a, b, 2015, Maia et al. 2008, Maia & Oliveira 2010, Rodrigues et al. 2014, Carvalho-Fernandes et al. 2016, Maia & Silva 2016, Gagné & Jaschhof 2017, Melo-Júnior et al. 2018, Maia 2020a, b. Host plant: *Dalbergia ecastaphyllum* (L.) Taub. Plant distribution: North (AP, PA), Northeast (AL, BA, CE, MA, PB, PE, RN, SE), Southeast (ES, RJ, SP), South (PR, SC, RS). Phytogeographic domains: Amazon Forest, Atlantic Forest. Origin: native. Conservation category: NE.

33) *Lopesia marginalis* Maia, 2001a (gall-inducer). Records in Bahia: Caravelas, Conde (Atlantic Forest). Other records: ES and RJ (Atlantic Forest). Refs.: Monteiro et al. 1994, Maia 2001a, b, Gagné & Jaschhof 2017, Maia & Cruz 2020, Maia 2020b. Host plant: *Couepia ovalifolia* (Schott) Benth. ex Hook.f. (Chrysobalanaceae).

34) *Lopesia similis* Maia, 2004 (gall-inducer). Records in Bahia: Conde, Porto Seguro (Atlantic Forest). Other records: PA (Amazon Forest), PB, AL, SE, ES, and RJ (Atlantic Forest), DF, MT and MS (Cerrado), MG (Cerrado, Atlantic Forest). Refs.: Narahara et al. 2004, Maia 2013, Maia & Souza 2013, Maia 2014, Carvalho-Fernandes et al. 2016, Gagné & Jaschhof 2017, Maia 2020a, b, Maia in print. Host plant: *Protium heptaphyllum* (Aubl.) Marchand (Burseraceae).
35) *Metasphondylia squamosa* Tavares, 1918b (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1918b, Gagné 1994, Gagné & Jaschhof 2017. Host plant: undetermined Malvaceae.

36) *Meunieriella insignis* (Tavares, 1922) (inquiline). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1922, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Protium heptaphyllum* (Aubl.) Marchand (Burseraceae)

37) *Neolasioptera fariae* (Tavares, 1922) (inquiline). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1922, Gagné 1994, Gagné & Jaschhof 2017. Host plant: undetermined.

38) *Neolasioptera lantanae* (Tavares, 1922) (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1922, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Lantana* sp. (Verbenaceae).

39) *Novocalmonia fici* Ozdikmen, 2009 (gall-inducer). Records in Bahia: Itaparica and Salvador (Atlantic Forest). Other records: unknown. Refs.: Tavares 1917, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Ficus* sp. (Moraceae).

40) *Pisphondylia brasiliensis* Couri & Maia, 1992 (gall-inducer). Records in Bahia: Porto Seguro-Trancoso (Atlantic Forest). Other records: MG, ES, RJ, SP, SC, and RS (Atlantic Forest). Refs.: Couri & Maia 1992, Maia 2001b, 2014, Maia et al. 2008, Maia et al. 2010, Maia & Souza 2013, Arriola et al. 2015, Carvalho-Fernandes et al. 2016, Gagné & Jaschhof 2017, Melo-Júnior et al. 2018. Host plant: *Guapira opposita* (Vell.) Reitz. (Nyctaginaceae)

41) *Procontarinia mangiferae* (Felt, 1911) (gall-inducer). Records in Bahia: Salvador (Atlantic Forest). Other records: India, China, Reunion, Iran, Guadeloupe, St. Vincent, Trinidad. Refs.: Felt 1911, Gagné & Jaschhof 2017. Host plant: *Mangifera indica* L. (Anacardiaceae). Plant distribution: North (AC, AM, PA, RO, RR, TO), Northeast (AL, BA. CE, MA, PB, PE, PI, RN, SE), Central-West (DF. GP, MS, MT), Southeast (ES, MG, RJ, SP), South (PR, SC, RS). Phytogeographic domains: Amazon Forest, Atlantic Forest, Caatinga, Cerrado, Pampa, Pantanal. Origin: cultivated. Conservation category: NE.

42) *Schizomyia barreirensis* Santos, Maia & Calado, 2019 (gall-inducer). Records in Bahia: Barreiras (Cerrado). Other records: unknown. Ref.: Santos et al. 2019. Host plant: *Bauhinia cupulata* Benth. (Fabaceae). Plant distribution: North (PA, TO), Northeast (MA, PI, BA), Central-West (GO, MT); Phytogeographic domains: Amazon Forest, Caatinga, Cerrado. Origin: native. Conservation category: NE.
43) *Stephomyia clavata* (Tavares, 1920c) (gall-inducer). Records in Bahia: Madre de Deus (Atlantic Forest). Other records: unknown. Refs.: Tavares 1920c, Gagné 1994, Gagné & Jaschhof 2017. Host plant: undetermined Myrtaceae.

44) *Styraxdiplosis caetitensis* Tavares, 1915 (gall-inducer). Records in Bahia: Caetité (Atlantic Forest, Caatinga). Other records: unknown. Refs.: Tavares 1915, Gagné 1994, Gagné & Jaschhof 2017. Host plant: *Styrax* sp. (Styracaceae).

**4 DISCUSSION**

Forty-four gall midge species of 28 genera have been recorded in BA, these numbers correspond to about 17% and 30% of the species and genera of the Brazilian fauna, respectively. Most recorded cecidomyiids are gall-inducers, the predominant habit of the family. Fabaceae stands out for hosting the greatest number of gall midge species as in several inventories in Amazon Forest (e.g. Araújo et al. 2012, Almada & Fernandes, 2011), Caatinga (e.g. Santos et al. 2012, Carvalho-Fernandes et al. 2012), Cerrado (e.g. Costa & Araújo 2019, Ribeiro et al. 2019, Silva et al. 2018), Atlantic Forest (e.g. Maia & Carvalho-Fernandes 2016, Ansaloni et al. 2018) and Pantanal (e.g. Ascendino et al. 2018).

*Lopesia*, *Dasineura* and *Bruggmannia* were the best represented gall midge genera. The first genus is also the best represented in MG, but the other two are not. *Lopesia* is the second best represented genus in RJ, followed by *Bruggmannia* and *Dasineura*. In ES, these genera are also the best represented, but with fewer species.

Six gall midge species induce galls in endemic plants in BA, while in MG this number is greater: 10. The number of cecidomyiids in endemic plant in ES and RJ has not yet been established. No gall midges are associated with endangered plant species in BA. Similar data are unknown for ES, RJ and MG. As most Cecidomyiidae are monophagous, they can be considered endemic when associated exclusively with endemic hosts. This is the case of these six species.

Nine host plant species are useful. Together, they host 19 gall midge species in BA. In MG, 19 plant species are useful and they totaled 27 cecidomyiid species. Data for ES and RJ are unknown. As gall-inducers affect negatively their host plants, it is important to know their identity to recognize potential pests.

Although the Atlantic Forest is the phytogeographic domain with the smallest territorial area in Bahia, it comprehends most of the gall midge species recorded in the state, whereas the widest domain, Caatinga, comprises the lowest number of cecidomyiid species. This result can be attributed
to the greater number of studies of coastal fauna and also to the greater flora diversity of the Atlantic Forest compared to the Cerrado and Caatinga.

All cecidomyiid species have been reported in a single phytogeographic domain in Bahia. However, their host plants are distributed in other Brazilian domains. Only six species among the host plants of Bahia do not occur in Atlantic Forest + Caatinga + Cerrado, namely: *Croton floribundus*, *Couepia ovalifolia* and *Eugenia astringens* (restricted to the Atlantic Forest), *Andira humilis* and *Bauhinia cupulata* (with occurrence in the Amazon Forest, Caatinga and Cerrado), and *Dalbergia ecastophyllum* (restricted to Amazon Forest and Atlantic Forest). Therefore, the lack of records of the same species in different domains in Bahia can be attributed to the lack of collection, considering that the presence of the host plant is the primary condition for the occurrence of the gall.

The number of shared cecidomyiid species among Bahia, Rio de Janeiro, Espírito Santo, and Minas Gerais is low if we consider the distribution of the plant species. Of the 14 host species recorded in Bahia, only four do not also occur in Rio de Janeiro, Espírito Santo, and Minas Gerais. So, we can attribute this result to the lack of field work again.

The temporal gap in the taxonomy works draws attention as well the number of species never recollected. Furthermore, most gall midge species have been collected only in the coast of Bahia. These facts indicate a scenario of lack of studies in the region and point to the need to investigate the composition and geographic distribution of this family in Bahia.

5 CONCLUSIONS

Bahia comprises about 17% of the Brazilian diversity of gall midges. The status of superhost family was confirmed for Fabaceae. *Lopesia*, *Dasineura* and *Bruggmannia* were indicated as the best represented gall midge genera in the state, as well as in RJ and ES. Six gall midge species induce galls in endemic plants and were proposed as endemic too. No gall midges are associated with endangered plant species. Nineteen gall midge species induce gall in useful host plants and can be considered as potential pest.

Atlantic Forest comprehends most of the gall midge due to the greater number of studies of coastal fauna and also to the greater flora diversity of the Atlantic Forest compared to the Cerrado and Caatinga.

All cecidomyiid species have been reported in a single phytogeographic domain in Bahia. However, the distribution of the host plants suggest that most gall midges can have a wider distribution.
The number of shared cecidomyiid species among Bahia, Rio de Janeiro, Espírito Santo, and Minas Gerais is low; however this result can reflect the lack of field work.

The temporal gap in the taxonomy works, the number of gall midge species never recollected and the number of species collected only in the coast of Bahia indicate the lack of studies and the need to investigate the composition and geographic distribution of Cecidomyiidae in Bahia.

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Figure 2. Map of Bahia (Northeastern Brazil) showing the municipalities (colorful areas) with records of Cecidomyiidae.
Table 1. Representativeness of Cecidomyiidae genera in Brazil and Bahia (Northeastern Brazil)

| Genus of Cecidomyiidae | Number of species | Brazil | Bahia |
|------------------------|------------------|--------|-------|
| Anadiplosis            | 4                | 4      | 2     |
| Androtodiplosis        | 1                | 1      | 1     |
| Asphondylia            | 299              | 23     | 2     |
| Autodiplosis           | 1                | 1      | 1     |
| Bruggmania             | 19               | 14     | 3     |
| Bruggmaniella          | 15               | 11     | 1     |
| Cleitodiplosis         | 1                | 1      | 1     |
| Clinodiplosis          | 107              | 21     | 1     |
| Compsodiplosis         | 1                | 1      | 1     |
| Contarina              | 301              | 2      | 1     |
| Costadiplosis          | 1                | 1      | 1     |
| Couridiplosis          | 1                | 1      | 1     |
| Dactylo diplosis       | 3                | 3      | 1     |
| Dasineura              | 476              | 10     | 5     |
| Dialeria               | 1                | 1      | 1     |
| Dichodiplosis          | 3                | 1      | 1     |
| Gnesiodiplosis         | 1                | 1      | 1     |
| Haplusia               | 7                | 2      | 1     |
| Lopesia                | 30               | 26     | 7     |
| Metasphondylia         | 1                | 1      | 1     |
| Meunieriella           | 21               | 4      | 1     |
| Neolasioptera          | 134              | 9      | 2     |
| Novocalmonia           | 3                | 2      | 1     |
| Pispilpodylia          | 2                | 1      | 1     |
| Procontarinia          | 15               | 1      | 1     |
| Schizomyia             | 56               | 8      | 1     |
| Stephomyia             | 7                | 6      | 1     |
| Styraxdiplosis         | 2                | 2      | 1     |
Table 2. Number of gall midge species (Cecidomyiidae) by host plant family, genus and species in Bahia (Northeastern Brazil). Interrogation marks correspond to undetermined plants.

| Host plant families (n=17) | Number of host genus (n=19+?) | Number of host species (n=17+?) | Number of gall midge species (n=41) |
|---------------------------|-----------------------------|-------------------------------|-----------------------------------|
| Anacardiaceae             | 1                           | 1                             | 1                                 |
| Asteraceae*               | 1                           | 1                             | 1                                 |
| Burseraceae               | 1                           | 1                             | 4                                 |
| Calophyllaceae            | 1                           | 1                             | 4                                 |
| Chrysobalanaceae          | 1                           | 1                             | 2                                 |
| Euphorbiaceae             | 1                           | 1                             | 1                                 |
| Fabaceae*                 | 3+?                         | 3+?                           | 7                                 |
| Loranthaceae             | 1                           | 1                             | 1                                 |
| Malpighiaceae             | 1                           | 1                             | 1                                 |
| Malvaceae*                | 1                           | 1                             | 2                                 |
| Moraceae                  | 1                           | 1                             | 1                                 |
| Myrtaceae                 | 2+?                         | 2+?                           | 4                                 |
| Nyctaginaceae             | 1                           | 1                             | 4                                 |
| Poaceae                   | 1                           | 1                             | 1                                 |
| Rubiaceae*                | ?                           | ?                             | 3                                 |
| Styracaceae               | 1                           | ?                             | 2                                 |
| Verbenaceae               | 1                           | ?                             | 2                                 |
Table 3. Useful plant species with Cecidomyiidae galls in Bahia (Northeastern Brazil) and their uses. 1. Dye on textiles, 2. General construction, 3. Incense, varnishes or glaze, 4. Insecticide, 5. Source of tannins, 6. Toothbrushes, 7. Ornamental, and 8. Glues.

| Plant species                  | Medicinal | Edible | Agroforestry | Carpentry/cabinet making | Fuel/charcoal/Firewood | Other |
|-------------------------------|-----------|--------|--------------|--------------------------|------------------------|-------|
| *Byrsonima sericea*           |           | x      |              |                          |                        | 1, 2, 5, 7 |
| *Calophyllum brasiliense*     | x         |        | x            |                          |                        | 2, 7, 8 |
| *Croton floribundus*          | x         |        | x            |                          |                        |       |
| *Eugenia astringens*          |           |        |              |                          |                        |       |
| *Guapira opposita*            |           |        |              |                          | x                      | 2, 7   |
| *Mangifera indica*            | x         | x      |              | x                        | x                      | 1, 2, 4, 6, 7 |
| *Myrciaria floribunda*        | x         | x      |              |                          |                        |       |
| *Paspalum conjugatum*         | x         |        |              |                          |                        |       |
| *Protium heptaphyllum*        | x         | x      |              |                          |                        | 2, 3   |

Table 4. Number of gall midge species (Cecidomyiidae) in Bahia (BA), Rio de Janeiro (RJ), Espírito Santo (ES) and Minas Gerais (MG), number of shared species and Sorensen’s Index

| Number of species in Brazilian states | Number of shared species with BA | Sorensen’s Index $SI = 2c/(a+b)$ |
|--------------------------------------|---------------------------------|---------------------------------|
| Nr. gall midge species in BA         | 44                              |                                 |
| Nr. gall midge species in RJ         | 104                             | 19                              | 0.25                          |
| Nr. gall midge species in ES         | 33                              | 13                              | 0.34                          |
| Nr. gall midge species in MG         | 43                              | 10                              | 0.24                          |
List of cities: 1- Jandaíra, 2- Conde, 3- Esplanada, 4- Mata de São João, 5- São Sebastião do Passé, 6- Madre de Deus, 7- Salvador, 8- Itaparica, 9- Valença, 10- Camamu, 11- Itacaré, 12- Ilhéus, 13- Una, 14- Belmonte, 15- Santa Cruz de Cabrália, 16- Porto Seguro, 17- Caravelas, 18- Nova Viçosa, 19- Sebastião Laranjeiras, 20- Caetité, 21- Barreiras, 22- Morro do Chapéu, 23- Campo Formoso, 24- Tucano.