Checklist of Cecidomyiidae (Diptera) in the state of Minas Gerais (Southeastern Brazil)

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ABSTRACT
The first checklist of gall midges (Diptera: Cecidomyiidae) in the state of Minas Gerais (MG) is presented based on literature review. Data on phytogeographic domains were added and the composition of the Cerrado fauna is compared to that of the Atlantic Forest. Gall midges on endemic and/or useful host plant species are pointed out. Botanical names were updated and a map of MG showing the recorded localities is presented. Forty-three gall midge species occur in the state, 42 are gall-inducers and one is a successor in galls. Cecidomyiids are associated with 35 plant species of 17 families. Among the hosts, 19 are useful and five are endemic. Asteraceae and Callophyllaceae harbor the highest number of gall midge species. Lopesia and Asphondylia are the best represented genera of Cecidomyiidae. Cerrado hosts 32 and Atlantic Forest 18 cecidomyiid species. Sorensen`s index indicates a similarity of 0.36 between these domains. The gall midge fauna of MG is compared to that of Rio de Janeiro (RJ) and Espírito Santo (ES) states, showing a similarity index of 0.30 with RJ and 0.21 with ES. As these states share other host plant species, the similarity between them can be greater than those indicated here.

Keywords: Species richness, Cerrado, Atlantic Forest, galls, host plants.

RESUMO
A primeira lista de cecidomiídeos (Diptera: Cecidomyiidae) no estado de Minas Gerais (MG) é apresentada com base em revisão da literatura. Informações sobre os domínios fitogeográficos foram acrescidas e a composição da fauna do Cerrado é comparada com a da Mata Atlântica. Cecidomiídeos em espécies de plantas hospedeiras endêmicas e/ou úteis são indicados. Nomens botânicos foram atualizados e um mapa de MG mostrando as localidades registradas é apresentado. Quarenta e três espécies de Cecidomyiidae ocorrem no estado, 42 são indutoras de galhas e uma é sucessora em galhas. Estes insetos estão associados a 35 espécies botânicas de 17 famílias. Entre os hospedeiros, 19 são úteis e cinco são endêmicos. Asteraceae e Callophyllaceae abrigam o maior número de espécies de cecidomiídeos. Lopesia e Asphondylia são os gêneros melhores representados dessa família de insetos. O Cerrado hospeda 32 espécies de Cecidomyiidae e a Mata Atlântica Forest 18. O índice de Sorensen indicat uma similaridade de 0,36 entre esses domínios. A fauna de MG é comparada com a dos estados do Rio de Janeiro (RJ) e do Espírito Santo (ES), mostrando um índice de similaridade de 0.30 com o RJ e de 21 com o ES. Como esses estados compartilham outras espécies de plantas hospedeiras, a similaridade de cecidomiídeos entre os mesmos pode ser maior do que a indicada aqui.
Palavras-chave: Riqueza de espécies, Cerrado, Mata Atlântica, galhas, plantas hospedeiras.

1 INTRODUCTION

Cecidomyiidae (Diptera) (Fig. 1) are the most diverse gall-inducing insects in the world (Gagné & Jaschhof 2017). Due to this habit, they are commonly known as “gall midges”. Although most cecidomyiids are gall-inducers, the family includes also fungivorous, predaceous, free-living phytophagous, and species that live obligatorily in galls induces by other insects (Gagné 1994).

In Brazil, Cecidomyiidae are represented by 261 species (Maia in print a). The faunas of Rio de Janeiro and Minas Gerais are the most investigated, concentrating the highest number of insect gall inventories and described cecidomyiids. In the former, 104 species were reported (Maia & Barros 2009), while the number of species in the later is still unknown.

Minas Gerais (MG) is the fourth largest Brazilian state in territorial extension, with 586,522.12 Km2 and three phytogeographic domains: Cerrado, Atlantic Forest, and Caatinga. The first covers about 54%, the second 40%, and the third 8% of the state territory (IEF 2020).

This paper aims to present the first checklist of gall midge species of Minas Gerais, show their distribution in the state, point out endemisms and indicate their association with plants, highlighting useful host species.

2 MATERIAL AND METHODS

A literature review was performed on the database “Web of Science”, using “Cecidomyiidae” and “Minas Gerais” as keywords. All insect galls Brazilian inventories published from 1988 to 2020 were examined, as well as taxonomical papers and the catalog of Gagné & Jaschhof, 2017. Collecting localities were retrieved from original papers. Phytogeographic domains were stablished using maps of vegetation of IBGE 2004.

Information about host plant species (correct spelling, author, synonyms, origin, endemism, distribution in Brazilian domains and categories of the conservational status) was obtained from Flora do Brasil 2020. Plant uses were verified in the Useful Tropical Plants 2014 website.

To quantify the similarity between Cerrado X Atlantic Forest, MG X Rio de Janeiro, and MG X Espírito Santo faunas, the Sorensen’s Index was adopted:

\[ SI = \frac{2c}{a+b} \]

\( c = \) number of species in common
\( a = \) number of species in community 1
b = number of species in community 2

3 RESULTS

Forty-three species of gall midges have been recorded in MG, 42 of them are gall-inducer and one is successor in cecidomyiid galls. These species are distributed in 22 genera, being *Lopesia* Rübsaamen, 1908 (ten spp.) and *Asphondylia* Loew, 1859 (seven spp.) the best represented genera. The others included one to three species (Table 1).

Cecidomyiids are associated with 17 plant families. Among them, Asteraceae harbor the highest number of gall midge species (ten), followed by Calophyllaceae (five). The other plant families host one to four gall midge species (Table 2). Cecidomyiids are distributed in 35 plant species, 19 (about 54%) being useful (Table 3). Most (17) (about 49%) have medicinal uses, five are edible, four have agroforestry uses, three are used in carpentry, three in construction, and two have insecticide activity. Other uses include making perfume, incense, varnish, and cosmetic industry.

Thirty-two cecidomyiid species have been recorded in the Cerrado and 18 in the Atlantic Forest, nine of them occur in both. No gall midge has been reported in Caatinga areas. The domain of two species were not determined, since municipalities were unstated. Sorensen’s Index reveals a similarity of 0.36 between Cerrado and Atlantic Forest faunas.

Three gall midge species, *Asphondylia cipo* Urso-Guimarães, 2018, *Lopesia tibouchinae* Maia, 2004, and *Myrciamyia pterandrace* Maia & Flor, 2018 induce galls on plants endemic to Cerrado; and two, *Baccharomyia magna* Maia, 2012 and *Lopesia simplex* Maia, 2002 on plants endemic to Atlantic Forest.

Fourteen gall midge species have been recorded exclusively in MG: *Asphondylia canastreae* Urso-Guimarães & Amorim, 2002, *Asphondylia cipo* Urso-Guimarães, 2018, *Asphondylia gochnatiae* Maia, 2008, *Asphondylia micropillata* Maia, 2005a, *Baccharomyia magna* Maia, 2012, *Brethesiamyia retorta* Maia, 2010aa, *Bruggmanniella miconiae* Carvalho-Fernandes, Maia & Rodrigues, 2020, *Clinodiplosis agerati* Maia, 2016, *Clinodiplosis quartelensis* Maia & Oliveira, 2019, *Lopesia bilobata* Maia, 2004, *Meunieriella spinosa* Urso-Guimarães, 2019, *Myrciamyia pterandrace* Maia & Flor, 2018, *Myriariamyia fernandesii* Maia, 2004a, and *Parametasphondylia piperis* Maia & Santos, 2007.

Rio de Janeiro and Minas Gerais share 22 species, namely: *Asphondylia cordiae* Möhn, 1959, *Asphondylia glomeratae* Gagné, 2001, *Asphondylia serrata* Maia, 2004, *Asteromyia modesta* (Felt, 1907c), *Bruggmannia depressa* (Kieffer, 1913i), *Contarinia gemmae* Maia, 2003, *Dactylodiplosis heptaphylli* Maia, 2004, *Liodiplosis cylindrica* Gagné, 2001, *Liodiplosis spherica* Gagné, 2001,
Lopesia caulinaris Maia, 2003, Lopesia conspicua Maia, 2003, Lopesia elliptica Maia, 2003, Lopesia indaiensis Maia & Oliveira, 2018, Lopesia linearis Maia, 2003, Lopesia maricaensis Rodrigues & Maia, 2010b, Lopesia similis Maia, 2004, Lopesia simplex Maia, 2002, Lopesia tibouchinae Maia, 2004, Neolastioptera eugeniae Maia, 1993b, Pispodylia brasiliensis Couri & Maia, 1992, Schismatodiplosis lantanae (Rübsaamen, 1908), and Stephomyia epeugeniae Gagné, 1994. Sorensen’s Index reveals a similarity of 0.30 between them.

In the state of Espírito Santo (ES), there are records of 33 species of 18 genera (Maia in print b). ES and MG share eight species: Asphondylia cordiae Möhn, 1959, Asphondylia serrata Maia, 2004, Couridiplosis vena Maia, 2004, Dactylodiplosis heptaphylli Maia, 2004, Lopesia similis Maia, 2004, Lopesia simplex Maia, 2002, Neolastioptera eugeniae Maia, 1993b, and Pispodylia brasiliensis Couri & Maia, 1992. Sorensen’s Index reveals a similarity of 0.21 between them.

The list of gall midge species in the state of Minas Gerais is presented below in alphabetical order. Data on host plant (species, family, origin, and occurrence in Brazilian phytogeographic domains) are provided too. All localities of MG (and their respective domains) with records of cecidomyiid species are indicated, followed by references.

1) Anisodiplosis waltheriae Maia, 2005b. Host plant: Waltheria indica L. (Sterculiaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, Atlantic Forest, and Pantanal). MG: Aimorés (Atlantic Forest). Ref. Maia 2005b.

2) Asphondylia canastra Urso-Guimarães & Amorim, 2002. Host plant: Hyptis sp. (Lamiaceae). MG: Delfinópolis (Cerrado). Ref. Urso-Guimarães & Amorim 2002.

3) Asphondylia cipo Urso-Guimarães, 2018. Host plant: Lessingianthus warmingianus (Baker) H. Rob. (Asteraceae) (endemic to Cerrado). MG: Santana do Riacho (Cerrado). Ref. Urso-Guimarães 2018.

4) Asphondylia cordiae Möhn, 1959. Host plant: Varronia curassavica Jacq. (= Cordia verbenacea DC. = Cordia curassavica (Jacq.) Roem. & Schult.) (Boraginaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, Atlantic Forest, and Pampa). MG: Lagoa Santa (Cerrado). Ref.: Möhn 1959, Maia & Flor 2020.

5) Asphondylia glomeratae Gagné, 2001. Host plant: Mikania glomerata Spreng. (Asteraceae) (native to Brazil) (Cerrado and Atlantic Forest). MG: Viçosa (Atlantic Forest). Ref. Gagné 2001, Maia & Proença 2016.

6) Asphondylia gochnatiae Maia, 2008. Host plant: Moquiniastrum polymorphum (Less.) G. Sancho (=Gochnattia polymorpha (Less.) Cabrera) (Asteraceae) (native to Brazil) (Cerrado and Atlantic Forest). MG: Luz (Cerrado). Ref. Maia 2008.
7) *Asphondylia micropillata* Maia, 2005a. Host plant: *Bauhinia brevipes* Vogel (Fabaceae) (native to Brazil) (Amazon Forest, Cerrado, and Atlantic Forest). MG: Três Marias (Cerrado). Ref. Maia 2005a.

8) *Asphondylia serrata* Maia, 2004. Host plant: *Eremanthus erythropappus* (DC.) MacLeish (= *Vanillosmopsis erythropappa* (DC.) Sch. Bip.) (Asteraceae) (endemic to Brazil) (Cerrado and Atlantic Forest). MG: Serra do Ibitipoca (Atlantic Forest), Serra Azul de Minas (Cerrado), Serra do Cabral (Cerrado), São Tomé das Letras (Atlantic Forest and Cerrado), Serra do Caparaó (Atlantic Forest), Serra de São José: Tiradentes (Cerrado). Refs.: Maia 2004, Maia & Proença 2016, Maia 2013, Maia & Flor 2020.

9) *Asteromyia modesta* (Felt, 1907). Host plant: *Conyza canadensis* (L.) Cronquist (native to Brazil) (Amazon Forest, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal). MG: unstated municipality. Ref. Felt 1907, Gagné 1994.

10) *Baccharomyia magna* Maia, 2012. Host plant: *Baccharis pseudomyriocephala* Malag. (Asteraceae) (endemic to Atlantic Forest). MG: State Park Itacolomi (Atlantic Forest). Ref. Maia 2012.

11) *Brethesiamyia retorta* Maia, 2010a. Host plant: *Myrcia retorta* Cambess (Myrtaceae) (endemic to Brazil) (Cerrado and Atlantic Forest). MG: Três Marias (Cerrado). Refs. Maia 2009, 2010a.

12) *Bruggmannia depressa* (Kieffer, 1913i). Host plant: *Neea* sp. (Nyctaginaceae). MG: unstated municipality. Ref. Gagné 1994.

13) *Bruggmanniella doliocarpi* Maia, 2010b. Host plant: *Doliocarpus dentatus* (Aubl.) Standl. (Dilleniaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, Atlantic Forest, and Pantanal). MG: Dores do Indaiá (Cerrado). Ref. Maia 2010b.

14) *Bruggmanniella miconiae* Carvalho-Fernandes, Maia & Rodrigues, 2020. Host plant: *Miconia theaezans* (Bonpl.) Cogn. (Melastomataceae) (native to Brazil) (Cerrado and Atlantic Forest). MG: Dores do Indaiá (Cerrado). Ref. Carvalho-Fernandes, Maia & Rodrigues 2020.

15) *Clinodiplosis agerati* Maia, 2016. Host plant: *Ageratum conyzoides* L. (Asteraceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal). MG: Dores do Indaiá (Cerrado). Ref. Maia 2016.

16) *Clinodiplosis quartelensis* Maia & Oliveira, 2019. Host plant: *Banisteriopsis membranifolia* (A. Juss.) B. Gates (Malpighiaceae) (endemic to Brazil) (Amazon and Atlantic Forests). Ref. Quartel São João (Cerrado). Ref. Maia & Oliveira 2019.

17) *Contarinia gemmae* Maia, 2003. Host plant: *Calophyllum brasiliense* Cambess. (Calophyllaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Januária (Atlantic
18) Couridiplosis vena Maia, 2004. Host plant: Croton floribundus Spreng (Euphorbiaceae) (native) (Atlantic Forest). MG: Serra de São José: Tiradentes (Cerrado). Ref.: Maia 2004.

19) Dactylodiplosis heptaphylli Maia, 2004. Host plant: Protium heptaphyllum (Aubl.) Marchand (Burseraceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: São Tomé das Letras (Atlantic Forest and Cerrado), Serra de São José: Tiradentes (Cerrado). Refs.: Maia 2004, 2013.

20) Liodiplosis cylindrica Gagné, 2001. Host plant: Mikania glomerata Spreng. (Asteraceae) (native to Brazil) (Cerrado and Atlantic Forest). MG: Viçosa (Atlantic Forest). Refs. Gagné 2001, Maia & Proença 2016.

21) Liodiplosis spherica Gagné, 2001. Host plant: Mikania glomerata Spreng. (Asteraceae) (native to Brazil) (Cerrado and Atlantic Forest). MG: Viçosa (Atlantic Forest). Refs. Gagné 2001, Maia & Proença 2016.

22) Lopesia bilobata Maia, 2004. Host plant: Guapira sp. (Nyctaginaceae). MG: Serra de São José: Tiradentes (Cerrado). Ref.: Maia 2004.

23) Lopesia caulinaris Maia, 2003. Host plant: Calophyllum brasiliense Cambess. (Calophyllaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Brumadinho (Atlantic Forest), Januária (Atlantic Forest, Cerrado), São Tomé das Letras (Atlantic Forest, Cerrado), Serra de São José, Tiradentes (Cerrado). Refs. Maia 2003, Maia et al. 2014a, Arriola et al. 2015.

24) Lopesia conspicua Maia, 2003. Host plant: Calophyllum brasiliense Cambess. (Calophyllaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Minas Gerais: São Tomé das Letras (Atlantic Forest, Cerrado); Januária (Atlantic Forest, Cerrado). Ref. Maia 2013, Arriola et al. 2015.

25) Lopesia elliptica Maia, 2003. Host plant: Calophyllum brasiliense Cambess. (Calophyllaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Brumadinho (Atlantic Forest), São Tomé das Letras (Atlantic Forest, Cerrado), Serra de São José: Tiradentes (Cerrado). Refs. Maia 2003, 2013, Maia et al. 2014a.

26) Lopesia indaiensis Maia & Oliveira, 2018. Host plant: Andira fraxinifolia Benth (Fabaceae) (endemic to Brazil) (Caatinga, Cerrado, and Atlantic Forest). MG: Dores do Indaiá (Cerrado). Ref. Maia & Oliveira 2018.

27) Lopesia linearis Maia, 2003. Host plant: Calophyllum brasiliense Cambess. (Calophyllaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Brumadinho...
Lopesia maricaensis Rodrigues & Maia, 2010. Host plant: Protium brasiliense (Spreng.) Engl. (Burseraceae) (endemic to Brazil) (Cerrado and Atlantic Forest). Minas Gerais: Diamantina, Lagoa Santa, Serra do Cipó, Santana do Riacho, Jaboticatubas (Cerrado). Refs.: Maia 2001, Rodrigues & Maia 2010, Maia in print c.

29) Lopesia similis Maia, 2004. Host plant: Protium heptaphyllum (Aubl.) Marchand (Burseraceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Perdizes (Cerrado), Itamonte (Atlantic Forest), São Tomé das Letras (Atlantic Forest, Cerrado), Serra de São José: Tiradentes (Cerrado). Refs. Maia 2004, 2013, 2014, 2020, Maia et al. 2014a.

30) Lopesia simplex Maia, 2002. Host plant: Protium icicariba (DC.) Marchand (Burseraceae) (endemic to Atlantic Forest). Minas Gerais: Belo Horizonte (Atlantic Forest), Ouro Preto (Atlantic Forest). Refs. Maia 2002, in print.

31) Lopesia spinosa Maia, 2004. Host plant: Croton floribundus Spreng (Euphorbiaceae) (native to Brazil) (Atlantic Forest). MG: Delfinópolis (Cerrado), Serra de São José: Tiradentes (Cerrado). Ref.: Maia 2004, Urso-Guimarães 2019

32) Lopesia tibouchinae Maia, 2004. Host plant: Pleroma candolleanaum (Mart ex DC.) Triana (=Tibouchina candolleana Mart ex DC) (Melastomataceae) (endemic to Cerrado). MG: Serra de São José: Tiradentes (Cerrado), Patrocínio (Cerrado). Ref.: Maia 2004, in print c.

33) Meunieriella spinosa Urso-Guimarães, 2019. Host plant: Inga edulis Mart. (Fabaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Delfinópolis (Cerrado). Ref. Urso-Guimarães 2019.

34) Myrciariamyia admirabilis Maia, 2007. Host plant: Erythroxylum suberosum A. St.-Hil. (Erythroxylaceae) (native to Brazil) (Amazon Forest and Cerrado). MG: São Tomé das Letras (Cerrado), Serra de São José: Tiradentes (Cerrado), Serra do Lenheiro: São João del Rey (Cerrado). Refs. Maia & Fernandes 2004, Maia 2007, 2013, Maia et al. 2014a.

35) Myrciariamyia fernandesii Maia, 2004a. Host plant: Myrciaria tenella (DC.) O.Berg (Myrtaceae) (native to Brazil) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Serra de São José: Tiradentes (Cerrado). Ref. Maia 2004.

36) Myrciamyia pterandrae Maia & Flor, 2018. Host plant: Pterandra pyroidea A. Juss. (Malpighiaceae) (endemic to Cerrado). MG: Quartel de São João (Cerrado). Ref. Maia & Flor 2018.
37) *Neolasioptera borreriae* Möhn, 1964. Host plant: *Borreria cf. brachystemonoides* Cham & Schltldl (Rubiaceae) (native to Brazil) (Atlantic Forest, Cerrado, and Pampa). MG (unstated municipality) (Atlantic Forest). Refs. Möhn, 1964, Rodrigues & Maia 2020

38) *Neolasioptera eugeniae* Maia, 1993. Host plant: *Eugenia uniflora* L. (Myrtaceae) (native to Brazil) (Cerrado, Atlantic Forest, and Pampa). MG: Itamonte (Atlantic Forest). Ref. Maia 1993, 2014.

39) *Parametsasphondylia piperis* Maia & Santos, 2007. Host plant: *Piper* sp. (Piperaceae). MG: Serra de São José: Tiradentes (Cerrado). Ref. Maia & Santos 2007

40) *Pisphondylia brasiliensis* Couri & Maia, 1992. Host plant: *Guapira opposita* (Vell.) Reitz. (Nyctaginaceae) (native to Brazil) (Amazon, Atlantic Forest, Caatinga, and Cerrado). MG: Brumadinho (Atlantic Forest). Refs. Couri & Maia 1992, Maia et al. 2010.

41) *Schismatodiplosis lantanae* (Rübsaamen, 1915). Host plant: *Lantana camara* L. (Verbenaceae) (naturalized) (Amazon Forest, Caatinga, Cerrado, and Atlantic Forest). MG: Aimorés (Atlantic Forest), Antônio Dias (Vale do Rio Doce) (Atlantic Forest and Cerrado). Refs. Rübsaamen 1915, Fernandes et al. 2001, Fernandes & Negreiros 2006.

42) *Schizomyia macropillata* Maia, 2005a. *Bauhinia brevipes* Spreng. (Fabaceae) (native to Brazil) (Amazon Forest, Cerrado, and Atlantic Forest). MG: Três Marias (Cerrado). Ref. Maia 2005a.

43) *Stephomyia epeugeniae* Gagné, 1994. Host plant: *Eugenia* sp. and *Eugenia punicifolia* (Kunth.) DC. (= *Eugenia ovalifolia* Cambess.) (Myrtaceae) (endemic to Brazil) (Amazon Forest, Atlantic Forest, Caatinga, and Cerrado). Minas Gerais: Belo Horizonte (Cerrado). Ref.: Gagné 1994.

Additionally, *Termitomastus leptoproctus* Silvestri, 1901 was previously reported in Minas Gerais (Gagné & Jaschhof 2017), but the collecting locality is Cuiabá in Mato Grosso, so this species was not included in the present list. Minas Gerais was cited due to an error in the acronym of Mato Grosso (published as MG instead of MT).

The state of Minas Gerais is divided in twelve mesoregions, nine of them with records of Cecidomyiidae: 1) North Mesoregion (in Januária municipality), 2) Jequitinhonha (in Diamantina municipality), 3) Triângulo Mineiro e Alto Parnaíba (in Patrocínio and Perdizes municipalities), 4) Central Mineira (Três Marias, Serra do Cabral, Dores do Ímdia, Luz, and Quartel Geral), 5) Metropolitan Mesoregion de Belo Horizonte (Jaboticatubas, Serra Azul de Minas, Santana do Riacho, Belo Horizonte, Brumadinho, Lagoa Santa, Ouro Preto, and Conceição do Mato de Dentro), 6) Vale do Rio Doce (in Antônio Dias and Aimorés), 7) South and Southeast of Minas (in Delfinópolis, Itamonte, São Tomé das Letras), 8) Campo das Vertentes (in São João del Rei and, Tiradentes), and 9) Zona da Mata (Alto Caparaó, Viçosa, and Serra do Ibitipoca). Among them, the Metropolitan Mesoregion of Belo Horizonte includes about 30% of the reported localities. In Vale do...
Mucuri, Northwest of Minas, and West of Minas mesoregions, no cecidomyiids have been recorded so far.

4 DISCUSSION

Forty-three species of gall midges have been recorded in MG, which corresponds to about 16% of the number of species in Brazil. This value is low when compared to the Rio de Janeiro state (RJ), with about 40% of the Brazilian diversity. Since the territorial extension of MG is about 13.5 times bigger than that of RJ and MG is occupied by three phytogeographic domains, while RJ is covered only by the Atlantic Forest, we could expect a more diversified fauna in MG then in RJ. Both states are the best surveyed in Brazil, but in MG most published data have an ecological approach, while in RJ the main approach is taxonomical. This can explain the lower richness of gall midges in MG.

Asteraceae host the highest number of gall midge species. This plant family is one of the most diverse in Brazil (Ferreira & Forzza 2009) and has great importance in the floristic composition of MG (Almeida et al. 2005). Asteraceae have been cited in several Brazilian inventories of insect gall as an important host family, mainly in Cerrado, as in Jequitinhonha (Fernandes et al. 1997), Serra do Espinhaço (Carneiro et al. 2009), Ingaí (Malves & Freire-Costa 2012), Serra do Cipó (Coelho et al. 2009), Serra de São José (Maia & Fernandes 2004), Serra do Cabral (Coelho et al. 2013), Três Marias (Gonçalves-Alvim & Fernandes 2001), Belo Horizonte (Fernandes et al. 1988) (Minas Gerais), Silvânia (Bergamini et al. 2017) (Goiás), and Caetité (Silva et al. 2018) (Bahia), but also in Atlantic Forest as in Itamonte (Maia 2014), São Tomé das Letras (Maia 2013), Vale do Rio Doce (Fernandes et al. 2001), Serra da Mantiqueira (Coelho et al. 2013) (Minas Gerais), Santa Teresa (Maia et al. 2014b) (Espírito Santo), Reserva Biológica União (Maia & Siqueira 2020), Parque Nacional do Itatiaia (Maia & Mascarenhas 2017), Ilha do Cabo Frio (Maia & Souza 2013), Angra dos Reis (Maia & Oliveira 2010) (RJ), Bertioga (Maia et al. 2004) (São Paulo), Telêmaco (Santos & Ribeiro 2015) (Paraná), Babitonga (Melo-Júnior et al. 2018), São Francisco do Sul (Arriola et al. 2015) (Santa Catarina), Canela, Santa Tereza (Goetz et al. 2018), and São Francisco de Paula (Toma & Mendonça-Júnior 2013) (Rio Grande do Sul). No inventories in Amazon, Caatinga, and Pantanal areas have been pointed out Asteraceae as an important host family. Most part of MG is covered by Cerrado and Atlantic Forest. The great diversity of Asteraceae in the state can explain the great diversity of cecidomyiids on this plant family. Calophyllaceae were the second richest family in number of gall midge species, but with a single host plant, Calophyllum brasiliense, and 50% less diverse than Asteraceae.
Nineteen host species (about 54%) are useful. They host 27 gall midge species, whose impact on plants should be evaluated since they can be harmful to their hosts, affecting negatively flower, fruit, seed and biomass production (Fernandes et al. 2007).

Most gall midge species (74%) have been reported in the Cerrado. However, the Atlantic Forest harbors a higher plant diversity than the Cerrado, about 20,000 and 11,600 species, respectively (Myers et al. 2000, MMA 2020). So, we could expect a higher diversity of gall midges in the Atlantic Forest, as predict the hypothesis of plant richness (Southwood 1960, 1961). But it was not observed, probably because the Cerrado is the most investigated domain in MG. Sorensen’s Index reveals a similarity of 0.36 between the gall midge fauna of the Cerrado and that of the Atlantic Forest. Three gall midge species induce galls on plants endemic to Cerrado and two on plants endemic to Atlantic Forest. Since these inducers are monophagous, they can be considered as endemic too.

Fourteen gall midge species have been recorded exclusively in MG. Nevertheless, the distribution of their host plant species includes other Brazilian states. Rio de Janeiro and MG share only 22 gall midge species, so there are 21 unshared species. However, among the total of host plant species in MG, only six do not occur in RJ: *Lessingianthus warmingianus* (Asteraceae), *Bauhinia brevipes* (Fabaceae), *Myrcia retorta* (Myrtaceae), *Erythroxylum suberosum* (Erythroxylaceae), *Pterandra pyroidea* (Malpighiaceae), and *Borreria cf brachystemonoides* (Rubiaceae). These plants harbor seven gall midge species. Therefore there are 14 gall midge species with records exclusively in MG whose host plants occur also in RJ. If these gallers are confirmed in RJ, the Sorensen’s index reaches 0.42.

ES and MG share only eight cecidomyiid species on seven plant species. However, both states have 21 host plant species in common. These hosts totalize 30 gall midge species. If they are confirmed in ES, the Sorensen’s index goes up to 0.79. These data indicate that the similarity of cecidomyiid fauna between MG x RJ and MG x ES can increase as the occurrence of these gall-inducers on shared plants is reported.

There are records of gall midge species in nine mesoregions of MG, most concentrated in the Metropolitan Mesoregion of Belo Horizonte. No records are known from Vale do Mucuri, Northwest of Minas, and West of Minas mesoregions (Fig. 2). So, future inventories should focus on these not investigated regions.
5 CONCLUSIONS

MG harbors only 16% of the Brazilian richness of gall midges, in spite of being the fourth state in territorial area with three phytogeographic domains and one of the most surveyed for galls. However, the number of taxonomic studies in the state is low, which can explain this low percentual.

Asteraceae host the greatest richest of gall midge species since this plant family is one of the most diverse and best represented in MG. Calophyllaceae is the second richest family in number of cecidomyiid species, which is related to the presence of a super host species, *Calophyllum brasiliense*. Most plants are useful, adding value to the gall midges associated with them.

Cerrado exhibits a higher richness of cecidomyiid species than the Atlantic Forest. The former occupies a more extensive area than the latter and is the most surveyed domain in MG. Five gall midges induce galls on endemic plants, adding importance to these hosts. Fourteen cecidomyiid species are known only from MG, but their host plants occur in other Brazilian states, so these insects can have a wider distribution. MG and RJ share 22 gall midge species, while MG and ES share eight. However, the number of shared host plants is greater, so the number of cecidomyiids in common can be greater too.

Nine mesoregions from 12 show records of gall midges. Nevertheless, data are mainly concentrated in the Metropolitan Mesoregion of Belo Horizonte, where most studies are developed. Three gaps in the gall midges distribution are pointed out, Vale do Mucuri, Northwest of Minas, and West of Minas. Field works in these areas are necessary to fulfill these gaps. Taxonomic studies are primordial to increase the knowledge of these insects in MG.

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Table 1. Species richness of Cecidomyiidae (Diptera) by genus in the world, Brazil and in Minas Gerais state (MG).

| Genus          | Number of species | Brazil | MG |
|----------------|-------------------|--------|----|
| Anisodiplosis  | 1                 | 1      | 1  |
| Asphondylia    | 299               | 23     | 7  |
| Asteromyia     | 9                 | 1      | 1  |
| Baccharomyia   | 5                 | 1      | 1  |
| Brethesiamyia  | 1                 | 1      | 1  |
| Bruggmannia    | 19                | 14     | 1  |
| Bruggmanniella | 15                | 11     | 2  |
| Clinodiplosis  | 107               | 21     | 2  |
| Contarinia     | 301               | 2      | 1  |
| Couridiplosis  | 1                 | 1      | 1  |
| Dactylodiplosis| 3                 | 3      | 1  |
| Liodiplosis    | 3                 | 3      | 2  |
| Lopesia        | 30                | 26     | 11 |
| Myrciamyia     | 2                 | 2      | 1  |
| Myrciariamyia  | 3                 | 3      | 2  |
| Meunieriella   | 21                | 4      | 1  |
| Neolasioptera  | 134               | 9      | 2  |
| Parametaspodylia| 1               | 1      | 1  |
| Pispohnydia    | 2                 | 1      | 1  |
| Schismatodiplosis| 1              | 1      | 1  |
| Schizomyia     | 56                | 8      | 1  |
| Stephomyia     | 7                 | 6      | 1  |

Table 2. Richness of host plants and gall midge species in Minas Gerais state (Southeastern Brazil)

| Host plant families | Number of host genus | Number of host species | Number of gall midges |
|---------------------|----------------------|------------------------|-----------------------|
| Asteraceae          | 8                    | 8                      | 8                     |
| Boraginaceae        | 1                    | 1                      | 1                     |
| Burseraceae         | 1                    | 3                      | 4                     |
| Calophyllaceae      | 1                    | 1                      | 5                     |
| Dilleniaceae        | 1                    | 1                      | 1                     |
| Erythroxylaceae     | 1                    | 1                      | 1                     |
| Euphorbiaceae       | 1                    | 1                      | 2                     |
| Fabaceae            | 3                    | 3                      | 4                     |
| Lamiaceae           | 1                    | 1                      | 1                     |
| Malpighiaceae       | 2                    | 2                      | 2                     |
| Melastomataceae     | 2                    | 2                      | 2                     |
| Myrtaceae           | 3                    | 4                      | 4                     |
| Nyctaginaceae       | 2                    | 3                      | 3                     |
| Piperaceae          | 1                    | 1                      | 1                     |
| Rubiaceae           | 1                    | 1                      | 1                     |
| Sterculiaceae       | 1                    | 1                      | 1                     |
| Verbenaceae         | 1                    | 1                      | 1                     |
Table 3. Host plant species recorded in Minas Gerais state (Southeastern Brazil) and their uses.

| Host Plant Species                      | Medicinal                                                                 | Uses                                      |
|-----------------------------------------|---------------------------------------------------------------------------|-------------------------------------------|
| **Ageratum conyzoides** L. (Asteraceae) | anti-inflammatory, antiallergic, antinematocidal, anticoagulant, smooth muscle relaxant, haemostatic, analgesic, antifungal, antibacterial hypothermic activities, antidiarrhoeal | insecticidal activity                    |
| **Andira fraxinifolia** Benth (Fabaceae) | skin ulcer, anthelmintic other uses                                       | construction reforestation                |
| **Calophyllum brasiliense** Cambess. (Calophyllaceae) | analgesic activity, anti-inflammatory, against herpes, rheumatism and gastro-intestinal problems, antioxidant |                                           |
| **Conyza canadensis** (L.) Cronquist (Asteraceae) | antirheumatic, astringent, balsamic, diuretic, styptic, tonic and vermifuge | making of perfume                        |
| **Croton floribundus** Spreng (Euphorbiaceae) | Anthelmintic, purgative, antiscorbutic, carminative, treatment of ulcers, syphilis and ailments of the eyes, including trachoma | Reforestation, carpentry                  |
| **Doliocarpus dentatus** (Aubl.) Standl. (Dilleniaceae) | antimycobacterial activity, anti-inflammatory |                                           |
| **Eremanthus erythropappus** (DC.) MacLeish (Asteraceae) | antimicrobial and antioxidant | living fence carpentry                    |
| **Erythroxylum suberosum** A. St.-Hil. (Erythroxylaceae) | astringent | carpentry and source of tannins          |
| **Eugenia punicifolia** L. (Myrtaceae) | antioxidative activity |                                           |
| **Eugenia uniflora** L. (Myrtaceae) | antihypertensive, antimicrobial, antioxidant, anti-inflammatory, hypoglycemic, diuretic, to treat inflammations, rheumatic pain and fever | fruit cosmetics industry                  |
| **Euryops aristatus** (L.) Schinoni (Euphorbiaceae) | bronchodilator, expectorant, cough suppressant, to treat bronchitis, pleurisy, colds and flu, coughs and asthma |                                           |
| **Euryops carinatus** (L.) Schinoni (Euphorbiaceae) | antioxidative activity |                                           |
| **Mikania glomerata** Spreng. (Asteraceae) | antioxidant |                                           |
| **Myrciaria tenella** (DC.) O.Berg (Myrtaceae) | anti-inflammatory | fruits                                    |
| **Protium brasiliense** Spreng. Engl. (Burseraceae) | anti-inflammatory | seed oil                                  |
| **Protium heptaphyllum** (Aubl.) Marchand (Burseraceae) | to treat chest afflictions, bronchitis, asthma, gangrenous ulcers and general inflammations | pulp agroforestry use (excellent shade), incense (stem resin), varnishes, carpentry |
| **Protium icicariba** (DC.) Marchand (Burseraceae) | stringent, depurative, antirheumatic, haemostatic, stimulant antisyphilitic, to treat skin problem, soothe, toothache | fruits, seed (substitute for olives) in general construction |
| **Varronia curassavica** Jacq. (Boraginaceae) | insecticide |                                           |
| **Waltheria indica** L. (Sterculiaceae) | antisiphilitic, febrifuge, antidiarrheal, general tonic to children, antifungal, sedative, antibacterial |                                           |
Figure 1. Female of Cecidomyiidae (Diptera), *Neolasioptera* sp.

Figure 2. Map of Minas Gerais, showing the localities with records of Cecidomyiidae (Diptera).