Are gall midge species (Diptera, Cecidomyiidae) host-plant specialists?

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ABSTRACT. Are gall midge species (Diptera, Cecidomyiidae) host plant specialists? Despite the speciose fauna of gall-inducing insects in the Neotropical region, little is known about their taxonomy. On the other hand, gall morphotypes associated with host species have been extensively used as a surrogate of the inducer species worldwide. This study reviewed the described gall midges and their galls to test the generalization on the use of gall morphotypes as surrogates of gall midge species in the Brazilian fauna. We compiled taxonomic and biological data for 196 gall midge species recorded on 128 host plant species. Ninety two percent of those species were monophagous, inducing galls on a single host plant species, whereas only 5.6% species were oligophagous, inducing galls on more than one congeneric host plant species. Only four species induced galls on more than one host plant genus. We conclude that gall morphotypes associated with information on the host plant species and attacked organs are reliable surrogates of the gall-inducing species.

KEYWORDS. Biodiversity; cecidomyiids; herbivory; insect galls; species richness.

RESUMO. Espécies de moscas galhadoras (Diptera, Cecidomyiidae) são especialistas em plantas hospedeiras? Apesar do elevado número de espécies da fauna de insetos indutores de galhas na região Neotropical, muito pouco espécies foram descritas. Por outro lado, o morfotipo da galha associado com a espécie da planta hospedeira é em todo o mundo amplamente utilizado como um indicador da espécie de inseto indutor. Este estudo revê as espécies de cecidommídeos descritos e suas galhas para verificar a generalização do uso da morfologia da galha como indicador da espécie de cecidomíideo na fauna brasileira. Nós compilamos dados biológicos e taxonômicos de 196 espécies de cecidomiídeos em 128 espécies de plantas no Brasil. Noventa e dois porcento destas espécies foram monófagas, induzindo galhas em uma única espécie de planta hospedeira, enquanto somente 5,6% das espécies foram oligófagas, induzindo galhas em mais de uma espécie de planta do mesmo gênero. Somente quatro espécies induzem galhas em espécies de plantas de gêneros diferentes. Nós concluímos que o morfo-tipo da galha associado com a espécie da planta hospedeira e com o órgão atacado são indicadores confiáveis da espécie de insetos indutores de galhas.

PALAVRAS-CHAVE. Biodiversidade; cecidomíideos; herbivoria; insetos galhadores; riqueza em espécies.

Galling insects are amongst the most specialized and fascinating herbivores because of their ability to control and redirect plant development (Shorthouse *et al.* 2005). Galling insects are a type of herbivores that, in order to complete their life cycle, obligatorily induce galls on the host plant. Plant galls are cells, tissues or organs of abnormal growth formed due to an increase in cell volume (hypertrophy) and/or cell number (hyperplasia) in response to feeding or other stimuli by foreign organisms (Rohfritsch & Shorthouse 1982; Dreger-Jauffret & Shorthouse 1992; Raman *et al.* 2005). A new definition of galls was coined by Raman (2007) excluding plant growth induced by bacteria and fungi, which form amorphous growths that are called tumors. Insect induced galls on the other hand, result in mostly symmetrical growth forms. From an evolutionary point of view, galls can be seen as extended phenotypes of insects or adaptations that allow inducers to feed on high quality tissues, and protect themselves from natural enemies and/or harsh environments (Price *et al.* 1986, 1987; Weis *et al.* 1988; Nyman & Julkunen-Tiitto 2000; Stone & Schönrogge 2003).

Gall-inducers are speciose in the Neotropical region, but despite their richness, little is known about their taxonomy (e.g. Fernandes & Price 1988; Fernandes *et al.* 1996, 2001; Gonçalves-Alvim & Fernandes 2001; Julião *et al.* 2004). The gall midges (Diptera, Cecidomyiidae) represent the largest taxon of gall-inducing insects in the Neotropical region (Fernandes *et al.* 1996; Lara & Fernandes 1996) with nearly 500 described species classified into 170 genera (Gagné 1994, 2004). However, the richness of gall midges is highly underestimated. A recent study estimated the global richness of galling insects to be approximately 120,000 species (Espírito-Santo & Fernandes 2007), making the knowledge of this guild essential for ecological studies.

It is widely accepted that most gall-inducing insects are highly specific to their host plants and organs, that is, they induce galls on a single or closely related species (Dreger-

Jauffret & Shorthouse 1992; Floate *et al.* 1996). Therefore, several authors have used gall morphotypes as a surrogate of the insect species (Fernandes & Price 1988; Floate *et al.* 1996; Price *et al.* 1998; Hanson & Gómez-Laurito 2005) due to their high host plant and plant organ specificity (Dreger-Jauffret & Shorthouse 1992; Shorthouse *et al.* 2005). As a result of this high specificity, gall morphotypes have been also used as tools in plant systematics (Raman 1996; Abrahamson *et al.*1998). For instance, galling species were used to distinguish between two *Chrysothamnus nauseosus* (Pall. ex Pursh) Britton subspecies (Floate *et al.* 1996). Other studies have also demonstrated the same intimate relationship between galling insects and their host plants. Hybrids of *Quercus* L., *Populus* L., and *Salix* L. were discriminated from parental host plants by their respective gall inducers (Aguilar & Boecklen 1992; Fritz *et al.* 1994; Floate & Whitham 1995).

In tropical areas, where the taxonomic knowledge of gall midges is scarce, the use of gall morphotypes associated with host species as a surrogate of the inducer species is widespread in ecological studies (e.g., Fernandes & Price 1988; Fernandes *et al.* 1996, 2001; Araújo *et al.* 2003; Dalbem & Mendonça. 2006; Urso-Guimarães & Scareli-Santos 2006). These studies assumed that galls differing in morphology and host species are induced by different species. The specificity of gall-inducing insects to particular gall morphologies has not been tested in southern latitudes in the tropics, as they have been in northern latitudes. The purpose of this study was to examine whether the use of gall morphotype associated with host plant species might be a surrogate of insect species in the Brazilian fauna. If this is correct, then the described galling insect species for which we have data on the galls would be specialists on host plant species and organs, with each galling species inducing morphologically similar galls on a single organ of the given host plant. The analyses were restricted to the family Cecidomyiidae, as this family represents the most common galling insect taxon in the region and, consequently, most patterns of gall-inducing species in Brazil may be strongly dependent upon the responses of cecidomyiid species. In addition, taxonomic knowledge of non-cecidomyiid galling insects is still incipient (e.g., Maia 2006), impairing a more detailed attempt to correlate gall morphology and host species to the gall inducer in these other taxa.

MATERIAL AND METHODS

The gall midges and host plant species database was compiled from taxonomic reviews of the gall midges of the Neotropical Region (e.g., Gagné 1994, 2004; Maia 2005a, and references therein) and from subsequent published papers (Maia 2005b, 2007; Maia & Fernandes 2005ab, 2006, 2007; Oliveira & Maia 2005). The undescribed species used in the data base were separated on the basis of gall midge morphology by V.C. Maia. Galls vary enormously in shape, host organ, epidermal cover and host plant species attacked (Stone & Schönrogge 2003). We used these variables to describe and categorize them. The terms fusiform and elliptical, globulous and globular, spheroid and spherical were used as synonymous throughout the analyses, but were kept separate in the table to maintain the original description.

RESULTS AND DISCUSSION

We recorded 196 species of gall midges on 128 host plant species belonging to 89 genera and 42 botanical families in Brazil (Tables I and II). *Asphondylia* Loew 1850 and *Clinodiplosis* Kieffer 1894 were the dominant genera, represented by 20 and 18 species each, respectively. Amongst those 196 species, 92.4% (181 species) were monophagous, inducing galls on a single host species (Table I). Only 11 (5.6%) species were oligophagous, inducing galls on more than one congeneric host plant species (Table II). There were only four (2.0%) reports of polyphagy: *Asphondylia borreriae* Rübsaamen, 1905, which induces flower galls on undetermined species on two plant genera, *Borreria* G. Mey. 1818 and *Diodia* L. 1753 (Rubiaceae); *Asphondylia corbulae* Möhn, 1960, which induces fruit (achene) galls on *Chromolaena odorata* (L.) R.M. King & H. Rob., 1970 and *Fleischmannia microstemon* (Cass.) R.M. King & H. Rob.; *Perasphondylia reticulata* Möhn, 1960, which induces bud galls on *Chromolaena odorata*, *C. ivifolia* (L.) R.M. King & H. Rob. and *Eupatorium* sp.; and *Clinodiplosis eupatorii* Felt, 1911, which induces leaf galls on *Chromolaena odorata*, *C. ivifolia* and *Eupatorium* sp. (Asteraceae) (Table II). Gall shape was undetermined for 11 gall midge species. Most galls were induced on leaves (113 galls), followed by flowers (29) and stems (26 galls). All cecidomyiid species induced galls on a single host organ, except for 18 species, which induced morphologically similar galls on more than one host plant organ (Table I and II): (*Anadiplosis procera* Tavares, 1920; *Anisodiplosis waltheriae* Maia, 2005; *Bruggmannia monteiroi* Maia & Couri, 1993; *Stephomyia rotundifoliorum* Maia, 1995; *Contodiplosis friburgensis* (Tavares, 1915), *Liodiplosis conica* Gagné, 2001; *Liodiplosis cylindrica* Gagné, 2001; *Liodiplosis spherica* Gagné, 2001; *Mikaniadiplosis annulipes* Gagné, 2001; *Zalepidota ituensis* Tavares, 1917; *Myrciamyia maricaensis* Maia, 1995; *Myrciariamyia bivalva* Maia, 1995; *Myrciariamyia fernandesi* Maia, 2004; *Neomitranthella robusta* Maia, 1995, *Rhoasphondylia friburgensis* Tavares, 1917; *Neolasioptera* sp. 1, *Neolasioptera* sp. 2, *Clinodiplosis* sp.).

The data clearly show that gall midges are mostly restricted to a single host plant species, hence supporting the statement that cecidomyiids are highly host-specific. Therefore, the gall morphotypes can be used as a reliable surrogate of the inducing species. Galling insects have evolved a unique and fine sintony with their host plants and each galling species exhibits a unique oviposition site (Raman 2007), although some exceptions have been recorded (Gagné 1989, 1994, 2004; Abrahamson *et al.* 1998; Nyman *et al.* 2000; Stone & Schönrogge 2003). In our review only two gall midges were classified as polyphagous.

Gall midges were mostly monophagous or oligophagous species inducing galls on one or a few host species in a single genus, respectively. Otherwise, recent studies by Yukawa and colleagues (Uechi *et al.* 2003, 2004; Tokuda *et al.* 2005) have reported on polymorphic galls induced by a single species of a galling cecidomyiid on one or more host species. For example, two Japanese species of Asteraceae, *Artemisia montana* (Nakai) Pamp. 1930 and *Artemisia princeps* Pamp. 1930 supported polymorphic axillary bud galls induced by *Rhopalomyia longitubifex* (Shinji, 1939) (Ganaha *et al.* 2004, 2007). Although the failure to identify polymorphic galls could lead to miss identification of the gall inducer, this phenomenon seems to be mostly rare. In Japan, less than ten galling cecidomyiids induce polymorphic galls (Uechi *et al.* 2003, 2004; Tokuda *et al.* 2005; Ganaha *et al.* 2004, 2007; Mishima & Yukawa 2007) from a total of 628 described species so far (Yukawa & Rohfritsch 2005), meaning that less than 1% induces polymorphic galls. In our study we found eight cecidomyiids that possibly induce polymorphic galls on the same or on different host species (see Tables I, II). Detailed molecular studies on galling insects would shed light on this question (see discussion on the evolutionary significance of dimorphic galls bellow).

Although reports on polymorphic galls are at best rare, gall dimorphism may be vital to understand the role and origin of gall shape diversification and gall midges speciation (Mishima & Yukawa 2007). The species of gall midges that induce morphologically similar galls on host plant congeners or on new sites (organs) on the same host plant species may represent the early stages of a host shift and formation of gall midge host races (see Ganaha *et al.* 2004, 2007; Joy & Crespi 2007). The colonization and radiation into new species and organs may promote the spatial and temporal isolation that favor reproductive isolation for gall midges.

The identity of the host plant species is crucially important for the recognition of the inducer in the field, as morphologically similar galls induced on different host plant species do not mean that they were induced by the same galling insect species (McLeish *et al.* 2006). Species of *Baccharis* L. 1753, for instance, are each host to a distinct galling species community, which induces similar leaf gall morph types. Burckhardt *et al*. (2004) described three species of *Baccharopelma* Burckhardt 2004 (Psyllidae) restricted to particular host species: *Baccharopelma dracunculifoliae* Burckhardt 2004 on *Baccharis dracunculifolia* DC., 1836, *Baccharopelma concinnae* Burckhardt 2004 on *Baccharis concinna* Barroso, 1976, *Baccharopelma brasiliensis* (Burckhardt, 1987) on *Baccharis ramosissima* Gardner, 1848, and *Baccharopelma baccharidis* (Burckhardt, 1987), on *Baccharis linearis* (Ruiz & Pav.) Pers. 1807. Therefore, using only gall morph types as a surrogate of inducer identity could lead to misidentifications.

Insect galls represent an extended phenotype of the gall inducing organism as their larvae have the ability to control gall development and morphology (Weis *et al.* 1988). The galling insect control of gall morphological is suggested by the fact that many galls with very different galler-specific morphologies may grow on the same plant host at the same time (Stone & Schönrogge 2003). In the rupestrian fields for example, 13 gall morphotypes were found on *Baccharis concinna* Barroso 1976 (Asteraceae) and a single individual plant supported 11 species simultaneously (Carneiro *et al.* 2005). Many other studies reported the same observation (e.g., Waring & Price 1989; Stone *et al.* 2002). In salt marsh vegetation, *Eugenia umbelliflora* O. Berg 1857 (Myrtaceae) and *Guapira opposita* (Vell.) Reitz 1970 (Nyctaginaceae) each support six galling species at the same time (Maia 2001b; Monteiro *et al.* 2004; Oliveira & Maia 2005).

Indeed, many studies have now shown that gall morphology is dependent on the stimuli provided by the galler (see Raman *et al.* 2005). In the temperate region, gall midges of the *Asphondylia auripila* group include 15 sympatric species which induce morphologically different galls on several organs of creosote bush, *Larrea tridentata* (Sessé & Moc. ex DC.) Coville, 1983 (Waring & Price 1989; Gagné & Waring 1990). *Asphondylia* species diversification on a host plant follows ecological shifts (= ability to induce a gall on a particular organ) and changes with timing adult emergence (Joy & Crespi 2007). Sympatric shifts on host plant organs or plant species may be responses to a combination of mistakes in oviposition site and in the developmental schedules of different tissue in plants parts (Joy & Crespi 2007). Therefore, the high species- and organ- specificity of galling insects provides further evidence of the identity of the gall inducing species.

The high specificity of host plant species shown by the cecidomyiids is also expected for all Neotropical gall forming insects. Additional support for high specificity with respect to host plants and organs is provided by recent phylogenetic studies in other taxa. Related galling insect species usually induce morphologically similar galls on phylogenetically related host plants (Nyman *et al.* 2000). Phylogenetic evidence also suggests that gall morphology of aphids (Stern 1995; Inbar *et al.* 2004), thrips (Crespi & Worobey 1998; Morris *et al.* 2002; McLeish *et al.* 2006), sawflies (Nyman *et al.* 2000) and gall wasps (Stone & Cook 1998; Stone *et al.* 2002; Cook *et al.* 2002) is controlled by the gall inducing organism.

Moreover, recent studies have now shown that insect taxa previously described as polyphagous may be groups of cryptic species. Nematine sawflies (Hymenoptera, Tenthredinidae) have been divided into three genera based on gall morphology: *Phyllocolpa* Benson, 1960 species induce leaf folds or rolls, *Pontania* L. 1758 species induce various leaf galls, and *Euura* L. 1758 species induce midrib, petiole, bud, and stem galls (Smith 1970; Price 2003, 2005). Most nematine gallers are highly host specific, except *E. mucronata* Hartig 1837 which induces galls on over 30 willow species in the Holarctic region (Price 2003). However, recent studies have shown that '*E. mucronata*' is not a single polyphagous species, but a complex consisting of several monophagous and oligophagous sibling species or host races (Nyman 2002).

Table I. Monophagous gall midges inducing galls on a single host plant at Brazil. [1] = glabrous, [2] = hairy

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Lasiopteridi					
Tribe Alycaulini					
Alycaulus globulus Gagné, 2001	*Mikania glomerata*	leaf/ petiole	ovoid	green[1]	Rübsaamen 1916; Gagné *et al.* 2001: 112, fig. 1; Gagné 2004.
Alycaulus mikaniae Rübsaamen, 1916	*Mikania* sp.	leaf	fusiform	unknownn[1]	Rübsaamen 1916; Gagné 1994, 2004: 479, fig. 60.
Alycaulus sp.	*Mikania hoehnei*	stem	ovoid	brown[1]	Maia 2001b: 593, fig. 7.
Baccharomyia ramosina Tavares, 1917	*Baccharis trimera*	stem	globular or fusiform	green[1]	Tavares 1917b; Houard 1933: 407, figs. 928, 929; Gagné 1994, 2004.
Geraldesia eupatorii Tavares, 1917	*Eupatorium* sp.	leaf	globular	green[1]	Tavares 1917b; Gagné 1994, 2004;
Neolasioptera cerei Rübsaamen, 1905	*Selenicereus setaceus*	stem	swelling	green[1]	no fig. Rübsaamen 1905; Gagné 1994, 2004; Maia 1999, 2001b: 599, fig. 21.
Neolasioptera cupheae Gagné, 1998	*Cuphea carthagenensis*	stem	ovoid	unknownn[2]	Gagné *et al*. 1998: 523, fig. 2; Gagné 2004.
Neolasioptera eugeniae Maia, 1993	*Eugenia uniflora*	leaf	discoid	green/red[1]	Maia 1993d; 2001b: 611, fig. 63; Gagné 2004.
Neolasioptera fariae Tavares, 1922	host unknownn	leaf	double convex	green[1]	Houard 1933: 444, figs.1026-1027; Tavares 1922; Gagné 1994, 2004.
Neolasioptera lantanae Tavares, 1922	*Lantana* sp.	stem	fusiform	unknown[1]	Houard 1933: 347, fig. 804; Gagné 1994, 2004.
Neolasioptera ramicola Maia, 2009	*Physalis angulata*	stem	fusiform	green	Maia *et al.* 2009a
Neolasioptera urvilleae Tavares, 1909	*Urvillea uniloba*	stem	swelling	brown[1]	Tavares 1909; Gagné 1994: 289, fig. 336; Gagné 2004.
Neolasioptera sp. 1	*Arrabidaea conjugata*	stem/ tendril/ midvein	fusiform	green[1]	Maia 2001b: 593, fig. 10.
Neolasioptera sp. 2	*Inga maritima*	stem/ tendril/ midvein	fusiform	green[1]	Maia 2001b: 605, fig. 40.
Smilasioptera candelariae Möhn, 1975	*Smilax mexicana*	leaf	blister	green[1]	Möhn 1975; Maia 2001b: 623, fig. 93.
Tribe Camptoneuromyiini					
Meunieriella dalechampiae Rübsaamen, 1905	*Dalechampia ficifolia*	stem	swelling	yellowish[2]	Rübsaamen 1905; Gagné 1994, 2004; no fig.
Tribe Dasineurini					
Dasineura braziliensis Tavares, 1922	*Protium heptaphyllum*	leaf	globulous	green[1]	Tavares 1922; Gagné 1994: 244, fig. 296; Gagné 2004.
Dasineura copabanensis Maia, 1993	*Eugenia copacabanensis*	bud	ovoid	green[1]	Gagné 2004; Maia 1993d: 719, fig. 7.
Dasineura couepiae Maia, 2001	*Couepia ovalifolia*	leaf	spherical	green[1]	Maia 2001a, b: 599, fig. 24; Gagné 2004.
Dasineura eugeniae Felt, 1912	*Eugenia buxifolia*	fruit	subglobular	green	Felt 1912; Gagné 1994, 2004; no fig.
Dasineura gigantea Angelo & Maia, 1999	*Psidium cattleianum*	bud	rosette	green[1]	Angelo & Maia 1999: 193, fig. 12; Gagné 2004.
Dasineura globosa Maia, 1995	*Eugenia rotundifolia*	leaf	globulous	yellowish[1]	Maia 1995a, 2001b: 611, fig. 59; Gagné 2004.
Dasineura myrciariae Maia, 1995	*Myrciaria floribunda*	leaf	marginal rolled leaf	green[1]	Maia 1995a, b; Maia 2001b: 611, fig. 69; Gagné 2004;
Dasineura tavaresi Maia, 1995	*Neomitranthes obscura*	leaf	marginal rolled leaf	green[1]	Maia 1995a, c; Maia 2001a: 611, fig. 72; Gagné 2004.
Cecidomyiidi					
Tribe Anadiplosini					
Alexomyia ciliata Felt, 1921	undet. host plant	unknown	unknown	unknown[1]	Felt 1921; Gagné 1994, 2004; no fig.
Anadiplosis caetetensis Tavares, 1920	undert. Fabaceae	leaf	spherical	brown[1]	Tavares 1920a; Houard 1933: 154, fig. 278,; Gagné 1994, 2004.
Anadiplosis procera Tavares, 1920	undert. Fabaceae	stem/leaf	globular	green[2]	Tavares 1920a: fig.112; Gagné 1994, 2004.
Anadiplosis pulchra Tavares, 1916	*Machaerium* sp.	leaf	subcylindrical ovoid/ globular	green[2]	Tavares 1916a, b, 1920a; Gagné 1994, 2004; no fig.
Anadiplosis venusta Tavares, 1916	*Machaerium* sp.	leaf	spherical	pale brown[2]	Tavares 1916b, 1917b; Houard 1933: 139, figs. 233-235; Gagné 1994, 2004.

Table I. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Machaeriobia machaerii (Kieffer, 1913)	*Machaerium* sp.	leaf	spherical	unknown[2]	Kieffer 1913; Rübsaamen 1916; Gagné 1994, 2004; no fig.
Uleella dalbergiae Rübsaaamen, 1907	*Dalbergia* sp.	leaf/ petiole	spherical	redish/ brownish	Rübsaamen 1907; Gagné 1994: 257, fig. 310; Gagné 2004.
Tribe Asphondyliini					
Anasphondylia myrtaceae Tavares, 1920	undet. Myrtaceae	leaf	hemisphe-rical	green-reddish[1]	Tavares 1920b; Houard, 1933: 276, fig. 638-640; Gagné 1994, 2004.
Asphondylia bahiensis Tavares, 1917	undert. Rubiaceae	flower	subovoid/ spherical	green[1]	Tavares 1917b; Houard 1933: 390, fig. 886; Gagné 1994, 2004.
Asphondylia canastrae Urso-Guimarães & Amorim, 2002	*Hyptis* sp.	flower	spherical	unknown	Urso-Guimarães & Amorim 2002: 569, fig. 12; Gagné 2004.
Asphondylia communis Maia & Couri, 1992	*Ximenia americana var. americana*	stem	ovoid	brown[1]	Maia *et al.* 1992; Maia 2001b: 617, fig. 81; Gagné 2004.
Asphondylia fructicola Maia, 2009	*Solanum* sp.	fruit	spherical	green	Maia *et al.* 2009b
Asphondylia glomeratae Gagné, 2001	*Mikania glomerata*	leaf vein/ petiole	fusiform	green[1]	Gagné *et al.* 2001: 112, fig. 2; Gagné 2004.
Asphondylia maricensis Maia & Couri, 1992	*Struthanthus maricensis*	leaf	swelling	green[1]	Maia *et al.* 1992; Gagné 2004; no fig.
Asphondylia microcapillata Maia, 2005	*Bahuinia brevipes*	leaf	spheroid	green[2]	Maia & Fernandes 2005b: 33, fig. 15.
Asphondylia parva Tavares, 1917	undert. Rubiaceae	flower	subovoid/ elliptical	green[1]	Tavares 1917b; Gagné 1994, 2004; no fig.
Asphondylia peploniae Maia, 2001	*Peplonia asteria*	flower	ovoid	green[1]	Maia 2001b: 593, fig. 5; Gagné 2004.
Asphondylia rochae Tavares, 1918	*Jussiaea* sp.	stem	elliptical	unknown	Tavares 1918b; Houard 1933: 308, fig. 887; Gagné 1994, 2004.
Asphondylia sanctipetri Urso-Guimarães & Amorim, 2002	*Didymopanax morototoni*	leaf vein/ petiole	swollen	green[1]	Urso-Guimarães & Amorim 2002: 569, fig. 24; Gagné 2004.
Asphondylia sennae Maia & Couri, 1992	*Senna bicapsularis*	flower	spherical	yellow[1]	Maia *et al.* 1992; no fig.; Gagné 2004
Asphondylia serrata Maia, 2004	*Vanilosmopsis erythropappa*	leaf	ovoid	yellowish	Maia 2004; Maia & Fernandes 2004: 434, fig. 13.
Asphondylia struthanthi Rübsaamen, 1916	*Struthanthus* sp.	fruit	globular	unknown	Rübsaamen 1916; Gagné 1994, 2004; no fig.
Asphondylia sulphurea Tavares, 1909	*Smilax* sp.	leaf	elliptical	green[1]	Gagné 1994, 2004; Tavares 1909: figs. 6-7, tab.V
Asphondylia ulei Rübsaamen, 1907	*Mikania* sp.	leaf	spherical	unknown[2]	Rübsaamen 1907; Gagné 1994, 2004; no fig.
Asphondylia sp. 1	*Vernonia rufogrisea*	bud	spherical	yellowish[2]	Maia 2001b: 593, fig. 8.
Asphondylia sp. 2	*Erythroxylum ovalifolium*	flower	ovoid	greenish	Maia 2001b: 559, fig. 31.
Asphondylia sp. 3	*Porophyllum ruderale*	unknown	unknown	unknown	Pamplona *et al.* 2000; no fig.
Bruggmannia acaudata Maia, 2004	*Guapira opposita*	leaf	cylindrical	green[1]	Maia 2001b: 617, fig. 78; Maia 2004.
Bruggmannia braziliensis Tavares, 1906	*Myrsine* sp.	leaf	spherical	brown[2]	Tavares 1906; 1909: fig. 10, pl VII; Gagné 1994, 2004.
Bruggmannia depressa Kieffer, 1913	*Neea* sp.	leaf	globular	unknownn	Rübsaamen 1908; Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmannia elongata Maia & Couri, 1993	*Guapira opposita*	leaf	circular	green[1]	Maia & Couri 1993; Maia 2001b: 617, fig. 75; Gagné 1994, 2004.
Bruggmannia globulifex Kieffer, 1913	*Neea* sp.	leaf	subspheroid	yellowish/ reddish[2]	Rübsaamen 1908; Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmannia lignicola Kieffer, 1913	*Neea* sp.	stem	conical	unknownn[2]	Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmannia longicauda Kieffer, 1913	*Neea* sp.	leaf	subspherical	yellowish[1]	Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmannia longiseta Kieffer, 1913	*Neea* sp.	petiole	spheroid	yellowish[1]	Kieffer 1913; Gagné 1994, 2004.
Bruggmannia monteiroi Maia & Couri, 1993	*Guapira opposita*	leaf/stem	spherical		Maia & Couri 1993; Gagné 2004; no fig.
Bruggmannia neeana Kieffer, 1913	*Neea* sp.		spheroid	purple[2]	Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmannia robusta Maia & Couri, 1993	*Guapira opposita*	leaf	globular	red/yellow[2]	Maia & Couri 1993; Maia 2001b: 617, fig.79; Gagné 2004.

Table I. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Bruggmannia ruebsaameni Kieffer, 1913	*Neea* sp.	petiole	globular	unknown[2]	Rübsaamen 1905, 1907; Kieffer 1913; Gagné 1994, 2004; no fig.
Bruggmanniella annonae Urso Guimarães & Amorim	*Duguetia furfuracea*	stem	fusiform	brown[1]	Urso-Guimarães & Scareli-Santos 2006.
Bruggmanniella braziliensis Tavares, 1909	*Sorocea ilicifolia*	stem	pyriforme	brown[1]	Tavares 1909; Houard 1933: 43, figs.30-31; Gagné 1994, 2004.
Bruggmanniella byrsonimae (Maia & Couri, 1992)	*Byrsonima seriacea*	inflores-cence	ovoid	brown[1]	Maia & Couri 1993; Maia 2001b: 606, fig. 43; Gagné 2004.
Bruggmanniella maytenuse Maia & Couri, 1992	*Maytenus obtusifolia var. obovata*	fruit	ovoid	red[1]	Maia & Couri 1993; Maia 2001b: 598, fig. 23; Gagné 2004.
Bruggmanniella oblita Tavares, 1920	*Schinnus* sp.	stem	swelling	brown	Tavares 1920a; Houard 1933: 214, fig.500; Gagné 1994, 2004.
Macroporpa peruviana Rübsaamen, 1916	undet. Malphighiaceae	leaf	globular	unknown	Rübsaamen 1916: 440, figs.7-8; Houard 1933: 157, fig. 301; Gagné 1994, 2004.
Macroporpa ulei Rübsaamen, 1916	undet. Lauraceae	leaf	ovoid	unknown	Rübsaamen 1916: 444, fig.12; Houard 1933: 86, fig.111; Gagné 1994, 2004.
Metasphondylia squamosa Tavares, 1918	undert. Malvaceae	stem	ovoid	green[2]	Tavares 1918a; Houard, 1933: 234, figs. 545-546; Gagné 1994, 2004.
Parazalepidota clusiae Maia, 2001	*Clusia fluminensis*	leaf	spherical	green[1]	Maia 2001a, b: 599, fig. 26; Gagné 2004.
Perasphondylia mikaniae Gagné, 2001	*Mikania glomerata*	bud	rosette	green[1]	Gagné *et al.* 2001: 112, fig. 8.; Gagné 2004.
Pisphondylia brasiliensis Couri & Maia, 1992	*Guapira opposita*	bud	rosette	green[1]	Maia 2001b: 617, fig. 76; Couri & Maia 1992; Gagné 2004.
Proasphondylia brasiliensis Felt, 1915	undet. Host plant	unknown	unkonw	unknown	Felt 1915; Gagné 1994, 2004; no fig.
Proasphondylia formosa Maia, 1993	*Guapira opposita*	stem	spherical	reddish[1]	Maia 1993a; Gagné 2004; no fig.
Proasphondylia guapirae Maia, 1993	*Guapira opposita*	stem	ovoid	brown/ reddish[1]	Maia 1993a; 2001b: 617, fig.77; Gagné 2004.
Schizomyia spherica Maia & Oliveira, 2007	*Sebastiania glandulosa*	apical bud	spherical	green/ yellow[1]	Maia 2001b: 605, fig. 36; Maia & Oliveira 2007.
Schizomyia manihoti Tavares, 1925	*Manihot utilissima*	leaf	globulous	purple[1]	Tavares 1925: fig. 3, Tab. II; Gagné 1994, 2004.
Schizomyia macrocapillata Maia, 2005	*Bauhinia brevipes*	leaf	spherical	reddish-orange[2]	Maia & Fernandes 2005b: fig. 32, p.39
Schizomyia maricaensis Souza & Maia, 2007	*Tetrapterys phlomoides* (Spr.) Nied.	bud	rosette	grreen[1]	Maia 2001a: 605, fig. 47; Sousa & Maia 2007.
Schizomyia santosi Maia & Araújo, 2009	*Jacquemontia holosericea*	flower	ovoid	green/ reddish[2]	Maia 2001b: 599, fig. 29; Maia & Araújo 2009
Schizomyia tuiuiu Urso-Guimarães & Amorim, 2002	*Bauhinia rufa*	leaf	spherical	reddish/ brownish[2]	Urso-Guimarães & Amorim, 2002: 569, fig. 34; Gagné 2004.
Schizomyia sp. 3	*Stachytarpheta* sp.	unknown	unknown	unknown	Maia 2005a; no fig.
Schizomyia sp. 4.	*Psittacanthus robustus*	flower	unknown	unknown	Gagné 1994; no fig.
Stephomyia clavata Tavares, 1921	undert. Myrtaceae	leaf	claviform	green with a brown ring[1]	Tavares 1921; Gagné 1994: 275, fig. 323; Gagné 2004.
Stephomyia epeugeniae Gagné, 1994	*Eugenia* sp.	leaf	ellipsoidal	green[1]	Tavares 1916ab, 1921; Gagné 1994, 2004; no fig.
Stephomyia espiralis Maia, 1995	*Eugenia copacabanensis*	leaf	espiral	red[1]	Maia 1995b, 2001b: 605, fig. 50; Gagné 2004.
Stephomyia mina Maia, 1995	*Neomitranthes obscura*	leaf	conical	red/Green[1]	Maia 1995b, 2001b: 617, fig. 74; Gagné 2004.
Stephomyia rotundifoliorum Maia, 1995	*Eugenia rotundifolia*	leaf/stem	cylindrical	brown[1]	Maia 1993b, 1995b, 2001: 611, fig. 60; Gagné 2004.
Stephomyia tetralobae Maia, 1995	*Eugenia copacabanensis*	leaf	elliptical	red[1]	Maia 1995b, 2001b: 605, fig. 51; Gagné 2004.
Stephomyia sp.	*Eugenia multiflora*	stem	cylindrical	brown[1]	Maia 2001b: 605, fig. 52.
Tavaresomyia mimosae (Tavares, 1925)	*Mimosa caesalpinifolia*	fruit	unknown	unknown	Tavares 1925; Möhn 1961; Gagné 1994, 2004.

Table I. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Zalepidota ituensis Tavares, 1917	*Porophyllum* sp.	stem/ flower	elliptical	purple[1]	Tavares 1917b: fig. 1-2, pl. VI; Gagné 1994, 2004.
Zalepidota piperis Rübsaamen, 1907	*Piper* sp.	stem	swelling	green[1]	Rübsaamen 1907; Tavares 1925; Gagné 1994, 2004.
Zalepidota tavaresi Kieffer, 1913	*Piper* sp.	stem	swelling	unknown	Tavares 1909: figs. 24-26, pl. IV; figs. 10-13, pl.V; Kieffer 1913; Gagné 1994, 2004.
Tribe Cecidomyiini					
Contarinia sp. 1	*Ouratea cuspidata*	leaf	barrel-like	brown[1]	Maia 2001b: 617, fig. 80.
Contarinia sp. 2	*Heteropteris* sp.	flower	swelling		Gagné 1994; no fig.
Procontarinia mangiferae (Felt, 1911)	*Mangifera indica*	flower	elliptical	unknown	Tavares 1918a; Gagné 2004; no fig.
Sphaerodiplosis dubia Rübsaamen, 1916	undet. Host plant	unknown	unknown	unknown	Rübsaamen 1916; Gagné 2004; no fig.
Tribe Clinodiplosini					
Autodiplosis parva Tavares, 1920	undet. Fabaceae	leaf	elliptical	green[1]	Tavares 1920a; Houard 1933: 148, fig. 272; Gagné 2004.
Cleitodiplosis graminis Tavares, 1916	*Paspalum conjugatum*	apical bud	conical	white[2]	Tavares 1916a, 1921; Houard 1933: 22, figs.6-7; Gagné 2004.
Clinodiplosis bahiensis Tavares, 1917	undet. Asteraceae	stem	globular	unknown[2]	Tavares 1917b; Houard 1933: 435, figs. 994-995; Gagné 2004.
Clinodiplosis cearensis Tavares, 1917b	undert. Asteraceae	unknown	unknown	unknown	Tavares 1917b; Gagné 1994, 2004;
Clinodiplosis chlorophorae Rübsaamen, 1905	*Chlorophora tinctoria*	flower	swollen	unknown	no fig. Rübsaamen 1905; Gagné 1994, 2004; no fig.
Clinodiplosis conica Oliveira & Maia, 2008	*Sebastiania glandulosa*	bud	conical	reddish or green	Maia 2001b: 605, fig. 35; Oliveira & Maia 2008
Clinodiplosis costai Maia, 2005	*Paullinia weinmanniaefolia*	leaf	rolled young leaf	green[1]	Maia 2001b: 617, fig. 85; Maia 2005b.
Clinodiplosis diodiae Maia, 2001	*Diodia gymnocephala*	flower	elliptical	green[1]	Maia 2001a, b: 617, fig. 84; Gagné 2004.
Clinodiplosis floricola Novo-Guedes & Maia, 2008	*Heteropteris nitida*	flower	ovoid	yellow[1]	Maia 2001b: 605, fig. 46; Novo-Guedes & Maia 2008.
Clinodiplosis iheringi Tavares, 1925	*Aegiphila arborescens*	leaf	elliptical/ ovoid	unknown	Tavares 1925; Gagné 1994, 2004.
Clinodiplosis marcetia Tavares, 1917	*Marcetia* sp.	bud	rosette	green[2]	Tavares 1917a; Houard, 1933: 292, fig. 671; Gagné 1994, 2004.
Clinodiplosis melissae Maia, 1993	*Melissa officinalis*	leaf	spherical	green[1]	Maia 1993c: 697, fig. 12; Gagné 2004.
Clinodiplosis profusa Maia, 2001	*Eugenia uniflora*	leaf	cylindrical	green/red[1]	Maia 2001a, b: 611, fig. 62; Gagné 2004.
Clinodiplosis pulchra Tavares, 1917	*Lantana* sp.	flower	ovoid	pink	Tavares 1917b, 1918a; Houard, 1933: 347, fig. 800; Gagné 1994, 2004.
Clinodiplosis rubia Tavares, 1918	*Rubia* sp.	bud	swollen	green/ pinkish[1]	Tavares 1918b; Gagné 1994, 2004; no fig.
Clinodiplosis sp. 1	*Peplonia asteria*	leaf	leaf roll	green/red[1]	Maia 2001b: 593, fig. 4.
Clinodiplosis sp. 2	*Mikania hoehnei*	leaf	leaf roll	green[1]	Maia 2001b: 593, fig. 6.
Clinodiplosis sp. 3	*Erythroxyllum ovalifolium*	leaf	rolled young leaf	green[1]	Maia 2001b: 599, fig. 32.
Clinodiplosis sp. 4	*Neomitranthes obscura*	leaf	marginal leaf roll	green[1]	Maia 2001b: 611, fig. 72.
Clinodiplosis sp. 5	*Passiflora mucronata*	leaf	rolled young leaf	green[1]	Maia 2001b: 617, fig. 82.
Costadiplosis maricaensis Viceconte & Maia, prelo	*Psittacanthus dichrous*	leaf	spherical	green	Maia 2001b: 605, fig. 42; Viceconte & Maia prelo
Houardodiplosis rochae Tavares, 1925	*Combretum leprosum*	apical bud/ stem	elliptica[1]	white-yellowish	Tavares 1925; Houard 1933: 280, fig. 641; Gagné 1994, 2004.
Liodiplosis conica Gagné, 2001	*Mikania glomerata*	leaf/ petiole/ branch	conical	green[1]	Gagné *et al.* 2001: 112, fig. 6; Gagné 2004.

Table I. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Liodiplosis cylindrica Gagné, 2001	*Mikania glomerata*	leaf/ petiole/ branch	cylindrical	green/red[1]	Gagné *et al*. 2001: 112, fig. 5; Gagné 2004.
Liodiplosis spherica Gagné, 2001	*Mikania glomerata*	leaf/ petiole/ branch	spherical	green[1]	Gagné *et al*. 2001: 112, fig. 7; Gagné 2004.
Tribe Lopesiini					
Cordiamyia globosa Maia, 1996	*Cordia verbenacea*	leaf	globulous	green[2]	Maia 1996a; 2001b: 593, fig. 11; Gagné 2004.
Lopesia brasiliensis Rübsaamen, 1908	*Ossaea* sp.	leaf/ petiole	subspherical	reddish/ brown[2]	Rübsaamen 1908; Gagné 1994, 2004; no fig.
Lopesia bilobata Maia, 2004	*Guapira* sp.	leaf	circular	yellowish	Maia 2004; Maia & Fernandes 2004: 436, fig. 40.
Lopesia caulinaris Maia, 2002	*Calophyllum brasiliense*	stem	ovoid	brown[1]	Madeira *et al.* 2002: 35, fig. 17a-b; Gagné 2004.
Lopesia conspicua Maia, 2002	*Calophyllum brasiliense*	leaf	spheroid	green[1]	Madeira *et al.* 2002: 38, fig. 34a-b; Gagné 2004.
Lopesia elliptica Maia, 2002	*Calophyllum brasiliense*	leaf	elliptical	green[1]	Madeira *et al.* 2002: 41, fig. 51a-b; Gagné 2004.
Lopesia grandis Maia, 2001	*Dalbergia ecastophylla*	leaf	discoid	green[1]	Maia 2001a, b: 605, fig. 39; Gagné 2004.
Lopesia linearis Maia, 2002	*Calophyllum brasiliense*	leaf	linear	green[1]	Madeira *et al.* 2002: 43, fig. 67a-b; Gagné 2004.
Lopesia marginalis Maia, 2001	*Couepia ovalifolia*	leaf	marginal leaf roll	green[1]	Maia 2001a, b: 599, fig. 25; Gagné 2004.
Lopesia similis Maia, 2004	*Protium heptaphyllum*	leaf	marginal rolled leaf	green[1]	Narahara *et al*. 2004: 490, figs. 32-34.
Lopesia simplex Maia, 2002	*Protium icicariba*	leaf	rolled leaf margin	green[1]	Maia *et al*. 2002: 177, figs. 24-26; Gagné 2004.
Lopesia singularis Maia, 2001	*Pouteria venosa*	leaf	circular	green[1]	Maia 2001a, b: 623, fig. 92; Gagné 2004.
Lopesia spinosa	*Croton floribundus*	leaf	ovoid	yellowish	Maia 2004; Maia & Fernandes 2004: 436, fig. 35.
Lopesia tibouchinae	*Tibouchina candolleana*	leaf	swelling	green	Maia 2004; Maia & Fernandes 2004, no fig.
Myrciamyia maricaensis Maia, 1995	*Myrcia ovata*	apical bud/ stem	ovoid	yellowish[1]	Maia 1995b, c; 2001b: 611, fig. 66; Gagné 2004.
Myrciariamyia admirabilis Maia, 2007	*Erythroxylum suberosum*	leaf	unknown	reddish[2]	Maia & Fernandes 2007: 46, figs. 18-19.
Myrciariamyia bivalva Maia, 1995	*Myrciaria floribunda*	apical/ axial bud	bivalve	yellowish[1]	Maia 1994, 1995b; 2001b: 611, fig. 70. Gagné 2004.
Myrciariamyia fernandesi Maia, 2004	*Myrciaria tenella*	apical/ axial bud	bivalve	yellowish[1]	Maia 2004; Maia & Fernandes 2005a, b: no fig.
Rochadiplosis tibouchinae Tavares, 1917	*Tibouchina* sp.	leaf	spherical	green[2]	Tavares 1917a; Houard 1933: 288, fig. 670; Gagné 2004
Unplaced Lasioperidi					
Calmonia fici Gagné, 1994	*Ficus* sp.	leaf	conical with tubular projection	unknown	Tavares 1917b; Houard 1933: 46, figs. 35-37; Gagné 1994, 2004.
Calmonia urostigmatis Tavares, 1917	*Ficus* sp.	leaf	subspherical with projection	unknown	Tavares 1917b; Houard 1933: 46, fig. 39-43; Gagné 1994, 2004.
Couridiplosis vena Maia, 2004	*Croton floribundus*	leaf vein	swelling	green	Maia 2004; Maia & Fernandes 2004: 436, fig. 37.
Eugeniamyia dispar Maia, 1996	*Eugenia uniflora*	leaf	spherical	white[1]	Maia *et al.* 1996: 1089, fig. 11; Gagné 2004.

Table I. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Haplopalpus serjaneae Rübsaamen, 1916	*Serjania* sp.	leaf	cylindrical	unknown[2]	Rübsaamen 1916; Houard 1933: 220, figs. 513-514; Gagné 1994, 2004.
Guarephila albida Tavares, 1909	*Guarea trichilioides*	leaf	globulous	unknown[2]	Tavares 1909; Houard 1933: 177, fig. 401; Gagné 2004.
Guareamyia purpura Maia, 2007	*Guarea macrophylla*	leaf	globulous	purple[1]	Maia 2007: 451, fig. 2.
Mayteniella distincta Maia, 2001	*Maytenus obtusifolia* var. *obovata*	leaf	spherical	green/ yellow[1]	Maia 2001a, b: 599, fig. 22; Gagné 2004.
Neomitranthella robusta Maia, 1995	*Neomitranthes obscura*	apical/ axial bud	cylindrical	green[1]	Maia 1995b, c, 2001b: 617, fig. 73; Gagné 2004.
Paulliniamyia ampla Maia, 2001	*Paullinia weinmanniaefolia*	leaf	cylindrical	green/ yellow[1]	Maia 2001a, b: 617, fig. 86a; Gagné 2004.
Sphaeromyia flava Maia, 2007	*Guarea macrophylla*	leaf	globulous	yellow[1]	Maia 2007: 451, fig. 3.
Uleia clusiae Rübsaamen, 1905	*Clusia* sp.	bud	pointed fusiform	unknown	Rübsaamen 1905; Gagné 1994, 2004; no fig.
Unplaced Cecidomyiidi					
Andirodiplosis bahiensis Tavares, 1920	*Andira* sp.	leaf	swelling	green[1]	Tavares 1920a; Houard 1933: 143, figs. 258-260; Gagné 2004.
Anisodiplosis waltheriae Maia, 2005	*Waltheria indica*	leaf/ inflorescence	spherical	yellow/ brown[2]	Maia & Fernandes 2005a: 36, fig. 18-19; Almeida *et al*. 2006.
Apodiplosis praecox Tavares, 1922	*Psychotria* sp.	leaf	spherical	green[1]	Tavares 1922; Houard 1933: 385, figs. 881-882; Gagné 1994, 2004.
Arrabidaeamyia serrata Maia, 2001	*Arrabidaea conjugata*	leaf	cylindrical	green[1]	Maia 2001a, b: 593, fig. 9; Gagné 2004.
Clusiamyia granulosa Maia, 2001	*Clusia hilariana*	leaf	spherical	green[1]	Maia 2001a, b: 599, fig. 27; Gagné 2004.
Clusiamyia nitida Maia, 1996	*Clusia lanceolata*	leaf	rounded	green/red[1]	Maia 1996b, 2001a, b: 599, fig. 28; Gagné 2004.
Compsodiplosis itaparicana Tavares, 1922	unkwon	leaf	discoid	green[1]	Tavares 1922; Gagné 2004; no fig.
Contodiplosis friburgensis (Tavares, 1915)	*Styrax* sp.	leaf/ stem	spheroid	green-reddish[2]	Houard, 1933: 327, figs. 759-760; Gagné 1994, 2004.
Contodiplosis humilis (Tavares, 1915)	*Styrax* sp.	leaf	lenticular	green-reddish[1]	Tavares 1915; Houard 1933: 327, fig. 763-765; Gagné 2004.
Contodiplosis tristis (Tavares, 1915)	*Styrax* sp.	leaf	spherical	white[2]	Tavares 1915; Houard 1933: 327, figs. 754-755; Gagné 2004.
Dactylodiplosis heptaphylli Maia, 2004	*Protium heptaphyllum*	leaf	ovoid	green[1]	Narahara *et al*. 2004: 488, figs. 16-18.
Dactylodiplosis histeriae Rübsaamen, 1916	*Heisteria cyanocarpa*	leaf vein	globular	unknown[2]	Rübsaamen 1916: 456, fig. 29; 457, fig. 30; Gagné 2004.
Dactylodiplosis icicaribae Maia, 2002	*Protium icicariba*	leaf	conical	green[1]	Maia *et al*. 2002: 174, figs.11-13; Gagné 2004.
Epihormomyia miconiae Maia, 2001	*Miconia cinnamomifolia*	bud	ovoid	green/[1]	Maia 2001a, b: 605, fig. 48; Gagné 2004.
Frauenfeldiella coussapoae Rübsaamen, 1905	*Coussapoa sp*.	aerial root	spherical	unknown[1]	Rübsaamen 1905; Gagné 2004; no fig.
Gnesiodiplosis itaparicae Tavares, 1917	undet. Rubiaceae	axial bud	ovoid	green[1]	Tavares 1917b; Houard 1933: 390, figs. 888-889; Gagné 1994, 2004.
Karshomyia sp.	undet. Host plant	unknown	unknown	unknown	Felt 1908; no fig.
Manilkaramyia notabilis Maia, 2001	*Manilkara subsericea*	bud	ovoid	green[1]	Maia 2001a, b: 623, fig. 89; Gagné 2004.
Megaulus sterculiae Rübsaamen, 1916	*Sterculia* sp.	leaf vein	spheroid	unknown	Rübsaamen 1916; Gagné 2004; no fig.
Mikaniadiplosis annulipes Gagné, 2001	*Mikania glomerata*	leaf vein/ petiole/ branch	fusiform	green[1]	Gagné *et al.* 2001: 112, fig. 4; Gagné 2004.
Ouradiplosis aurata Felt, 1915	undet. Host plant	unknown	unknown	unknown	Felt 1915; Gagné 2004; no fig.
Parkiamyia paraensis Maia, 2006	*Parkia pendula*	leaf	pea	green[1]	Maia & Fernandes 2006: 2, fig. 1a.
Styraxdiplosis caetitensis Tavares, 1915	*Styrax* sp.	leaf	elliptical	green[2]	Tavares 1915; Houard 1933: 327, figs. 757-758; Gagné 1994, 2004.
Styraxdiplosis cearensis Tavares, 1925	*Croton hemiargyreus*	leaf	eliptical/ ovoid	green[2]	Tavares 1915, 1925; Houard 1933: 188, fig.440; Gagné 1994, 2004.
Youngomyia pouteriae Maia, 2001	*Pouteria caimito var. laurifolia*	leaf	cylindrical	green[1]	Maia 2001b: 623, fig. 91; Maia 2001c; Gagné 2004.

Table II. Oligophagous and polyphagous gall midges inducing galls on several host species in a single genus at Brazil. [1] = glabrous, [2] = hairy.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Lasiopteridi					
Tribe Alycaulini					
Neolasioptera cruttwellae Gagné, 1977	*Chromolaena odorata* *C. ivaefolia*	stem	fusiform	unknown	Gagné 1977.
Tribe Dasineurini					
Arcivena kielmeyera Gagné, 1984	*Kielmeyera coriaceae*	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. rosea	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. petiolaris	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. variata	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. speciosa	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. rubifolia	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
	K. corymbosa	flower bud	swollen	unknown[1]	Gagné 1984, 2004.
Dasineura marginalis Maia, 2005	*Eugenia umbelliflora*	leaf	roll leaf	green[1]	Maia *et al.* 2005
	Eugenia rotundifolia	leaf	roll leaf	green[1]	Maia 2001b: 611, fig. 58; Maia *et al.* 2005: 349, figs. 12-13.
Jorgenseniella eugeniae Maia, 2005	*Eugenia umbelliflora*	leaf leaf	discoid	green/ yellowish[1]	Maia *et al.* 2005: 352, figs. 26-28.
	Eugenia rotundifolia		discoid	green/ yellowish[1]	Maia 2001b: 611, fig. 59; Maia *et al.* 2005.
Cecidomyiidi					
Tribe Asphondyliini					
Asphondylia borreriae Rübsaamen, 1905	*Borreria* sp.	flower	swollen	unknown[1]	Rübsaamen 1905; Gagné 1994, 2004.
	Diodia sp.	flower	swollen	unknown[1]	Rübsaamen 1905; Gagné 1994, 2004.
	Borreria verticillata	inflorescence	fusiform	green[1]	Rübsaamen 1905; Maia *et al.* 1992.
Asphondylia corbulae Möhn, 1960	*Chromolaena odorata* *Fleischmannia microstemon*	achene	swelling	uknown	Möhn 1960; Gagné 1977.
Asphondylia cordiae Möhn, 1959	*Cordia alba*	flower	swollen	unknown[1]	Möhn 1959; Gagné 1994, 2004.
	Cordia dentata	flower	swollen	unknown[1]	Möhn 1959; Gagné 1994, 2004.
	Cordia verbenacea	flower	ovoid	green[2]	Maia 2001b: 593, fig. 12.
Asphondylia moehnei Skuhravá, 1989	*Mikania glomerata*	stem	ovoid	green/ yellow-brown[1]	Skuhravá 1989; Gagné *et al.* 2001: 122, fig. 3.
	Mikania guaco	stem	elliptical	und.[1]	Tavares 1909; Houard 1933: 401, fig. 908; Gagné 1994, 2004.
Asphondylia tournefortiae Rübsaamen, 1916	*Tournefortia angustiflora*	fruit	elongate sheroid	unknown[1]	Rübsaamen 1916; Houard 1933; Möhn 1960; Gagné 1994, 2004; no fig.
	Tournefortia volubilis	fruit	elongate sheroid	unknown[1]	Rübsaamen 1916; Houard 1933; Möhn 1960; Gagné 1994, 2004; no fig.
Perasphondylia reticulata Möhn, 1960	*Chromolaena odorata* *C. ivifolia* *Eupatorium* sp.	bud	swollen	unknown	Möhn 1960; Gagné 1977.
Rhoasphondylia friburgensis Tavares, 1917	*Baccharis schultzii*	leaf/stem	spherical	unknown[1]	Tavares 1917b; Möhn 1960; Gagné 1994, 2004.
	Baccharis dracunculifolia	leaf/stem	spherical	unknown[1]	Tavares 1917b; Möhn 1960;Gagné 1994: 215, fig. 288; Gagné 2004.
	Baccharis trinervis	leaf/stem	spherical	unknown[1]	Tavares 1917b; Möhn 1960; Gagné 1994, 2004.
Tribe Clinodiplosini					
Clinodiplosis eupatorii Felt, 1911	*Chromolaena odorata*	leaf	conical	unknown[1]	Felt 1911; Gagné 1977, 1994: 244, fig. 295; Gagné 2004.
	Chromolaena ivifolia	leaf	conical	unknown[1]	Felt 1911; Gagné 1977, 1994: 244, fig. 295; Gagné 2004.
	Eupatorium sp.	leaf	conical	unknown[1]	Felt 1911; Gagné 1977, 1994: 244, fig. 295; Gagné 2004.
Clinodiplosis sp.	*Mikania guaco*	stem/leaf	cylindrical, spinelike	unknown[1]	Rübsaamen 1907; Gagné 1994, 2004.
	Mikania sp.	stem/leaf	cylindrical, spinelike	unknown[1]	Rübsaamen 1907; Gagné 1994, 2004.

Table II. Cont.

Galling insect	Host plant taxa	Organ	Shape	Color	Reference
Iatrophobia brasiliensis Rübsaamen, 1916	*Manihot aipi*	leaf	cylindrical	green/red[1]	Rübsaamen 1907, 1916; Gagné 1994, 2004.
	Manihot dichotoma	leaf	cylindrical	green/red[1]	Rübsaamen 1907, 1916; Gagné 1994, 2004.
	Manihot palmata	leaf	cylindrical	green/red[1]	Rübsaamen 1907, 1916; Gagné 1994, 2004.
	Manihot tripartita	leaf	cylindrical	green/red[1]	Rübsaamen 1907, 1916; Gagné 1994, 2004.
	Manihot utilissima	leaf	cylindrical	green/red[1]	Rübsaamen 1907, 1916; Houard 1933: 197, figs.453-455; Gagné 1994, 2004.
Schismatodiplosis lantanae (Rübsaamen, 1917)	*Lantana camara*	leaf	spheroid	green[2]	Rübsaamen 1907; Maia 2001b: 623, fig. 100; Gagné 1994, 2004.
	Lantana hispida	leaf	spheroid	green[2]	Rübsaamen 1907; Gagné 1994, 2004.
	Lantana urticifolia	leaf	spheroid	green[2]	Rübsaamen 1907; Gagné 1994, 2004.
	Lantana sp.	leaf	spheroid	green[2]	Rübsaamen 1907; Tavares 1909; Houard 1933: 347, figs. 881-812; 1918a; Gagné 1994, 2004.

Our review strengthens the view that gall midges are highly host-plant specific and that morphologically similar galls on several host plant species are induced by different cecidomyiid species. This is consistent with observations in north temperate latitudes, even though conventional wisdom seems to expect that species differ in responses in temperate and tropical regions. However, the evidence of this study shows that herbivores in tropical and temperate regions area very similar in patterns of specificity. Within the same host plant species gall morphology and the attacked host organ are reliable indicators of distinct cecidomyiid species. Due to an insufficient number of taxonomists working on galling insects, and large numbers of gall-inducing species in the Neotropical region (see Espírito Santo & Fernandes 2007), the use of host-plant records associated with gall morphology represents a reliable tool that will allow the development of field-based ecological studies, until taxonomic work is developed (e.g. Fernandes & Price 1988; Dalbem & Mendonça 2006; Urso-Guimarães & Scareli-Santos 2006; Espírito-Santo *et al.* 2007). Hence, the use of gall morphology as a surrogate of the gall-inducing species should not discourage the training of students in galling species systematics. By using this approach, Neotropical ecologists may incur a little (7.7%) error, but this error is small enough that it may not lead to inaccurate conclusions. We hope that this study serves to stimulate studies in other biogeographical regions and expand it to other galling taxa.

Acknowledgments. We thank T. G. Cornelissen, P. E. Hanson, P. W. Price, F. A. O. Silveira and two anonymous reviewers for suggestions on earlier versions of the manuscript. This study was supported by CNPq (309633/2007-9), and FAPERJ (Proc. E-16/171.290/2006). We gratefully acknowledge a scholarship of the CAPES/PICDT to M. A. A. Carneiro. This study was in partial fulfillment of the requirements for PhD degree to M. A. A. Carneiro at the Universidade Federal de Minas Gerais.

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Received 21/12/2007; accepted 24/06/2009