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Diversity of insect galls associated with coastal shrub vegetation in Rio de Janeiro, Brazil

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ABSTRACT

Surveys in the coastal sandy plains (restingas) of Rio de Janeiro have shown a great richness of galls. We investigated the galling insects in two preserved restingas areas of Rio de Janeiro state: Parque Estadual da Costa do Sol and Reserva Particular do Patrimônio Natural Fazenda Caruara. The collections were done each two months, from June 2011 to May 2012. We investigated 38 points during 45 minutes each per collection. The galls were taken to the laboratory for rearing the insects. A total number of 151 insect galls were found in 82 plant species distributed into 34 botanic families. Most of the galls occurred on leaves and the plant families with the highest richness of galls were Myrtaceae and Fabaceae. All the six insect orders with galling species were found in this survey, where Cecidomyiidae (Diptera) was the main galler group. Hymenoptera and Thysanoptera were found as parasitoids and inquilines in 29 galls. The richness of galls in the surveyed areas reveals the importance of restinga for the composition and diversity of gall-inducing insect fauna.

Key words: galling insects, sandy coastal plain, cecidomyiid, arthropod-plant interaction.

INTRODUCTION

Galls are abnormal modifications in plant tissue induced by insects or mites (Raman 2007). Among the insects, six orders have been recorded by having gall-inducing species, Diptera, Hymenoptera, Lepidoptera, Coleoptera, Hemiptera, and Thysanoptera. The family Cecidomyiidae (Diptera) is the main taxa of galling insect within the arthropods (Gagné and Jaschhof 2014).

Brazil shows a rich fauna of galling insects, but the taxonomic knowledge of them is poorly known. Cerrado, Atlantic Forest, Amazon Forest, Caatinga,

and Pantanal are among the studied biomes and they have shown a high number of insect galls. Some studies have correlated this rich fauna to the flora of these areas, mainly the most diverse ones, such as Amazon, Atlantic Forest, and Cerrado (Maia 2001, Araújo 2013, Santos et al. 2013).

The surveys of galls in Brazil are concentrated in the southeastern region, and these contributions have been corroborating with the high diversity of insect galls in this region. Most of the records are related to surveys in sandy coastal plains, also called restinga (Maia 2001, Oliveira and Maia 2005, Maia and Oliveira 2010, Rodrigues et al. 2014).

Restinga areas were investigated in Espírito Santo, São Paulo, and Rio de Janeiro states, being

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the last one the most studied (Maia 2013, Maia et al. 2014). The Atlantic forest, biome where the restinga vegetation is inserted, is known by the high plant diversity and endemism level. Considering the high specificity degree of this guild to their host plants, we expect a high diversity of these insects even in areas where there are some available data.

To the present contribution we investigated the galling insects associated with coastal shrub vegetation in two preserved areas of Rio de Janeiro state.

MATERIAL AND METHODS

Surveys were conducted in two preserved areas: Parque Estadual da Costa do Sol (PECS) and Reserva Particular do Patrimônio Natural Fazenda Caruara (RPPNFC). The PECS was created in 2011 and has about 9,800 ha, being the surveys done in the municipalities of Saquarema, Araruama, Arraial do Cabo, and Cabo Frio. The RPPNFC has 3,800 ha of area and is a private reserve located in the municipality of São João da Barra.

The collections were made each two months, from June 2011 to May 2012. 38 points were chosen

and distributed along the restinga vegetation from each Municipality, proportionally to the restinga area (Fig. 1). In each point we investigated the plants during 45 minutes. All the galls were photographed and separated in morphotypes following the classification proposed by Isaias et al. (2013), where the authors standardized the most common galls shapes found in Brazil. The host plants were pressed, dried and sent for identification to botanist of Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ). The plant species names were updated using the Flora do Brasil website (Flora do Brasil 2015).

The galls were taken to the Diptera laboratory of Museu Nacional, for rearing the insects and obtain the adults for identification. Each gall morphotype was kept individually in plastic pots layered at the bottom with damp cotton and covered by fine screening. The pots were checked daily for adult emergence (gallers, parasitoids, inquilines and predators). Immature insects were obtained by dissecting some galls. All specimens were preserved in 70% ethanol. The Cecidomyiidae specimens were mounted in slides following Gagné

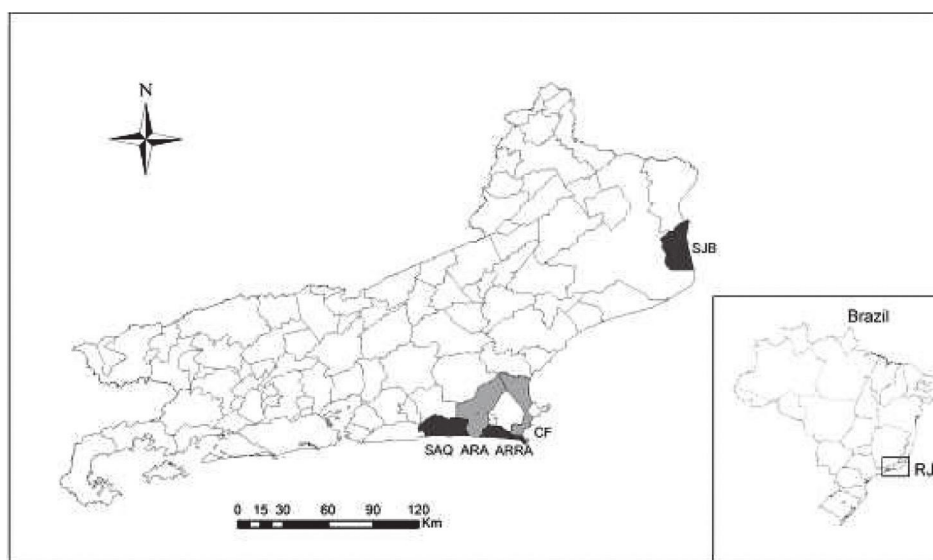


Figure 1 - Location of sites of collection in restinga vegetation from Rio de Janeiro state, Brazil. Abbreviations: ARA: Araruama, ARRA: Arraial do Cabo, CF: Cabo Frio, SAQ: Saquarema, SJB: São João da Barra, RJ: Rio de Janeiro state.

(1994), except by using butyl acetate instead of creosote oil. These specimens were identified using taxonomic keys (Gagné 1994) and comparisons with original descriptions. All insect and plant specimens were deposited in the Entomological collection and Herbarium of Museu Nacional, Rio de Janeiro (MNRJ), respectively.

RESULTS

A total number of 151 insect galls were found in 82 plant species distributed into 34 botanic families (Table SI, Figs. 2-121). Galls were recorded in seven plant organs, most of them occurred on leaves (64%, $n = 97$), but also on buds (9%, $n = 14$), stems (21%, $n = 32$), flowers (3%, $n = 4$), fruits (2%, $n = 3$), and tendril (1%, $n = 1$).

The galls also presented varied shapes, most of them were fusiform (27%, $n = 41$), followed by globoid (20%, $n = 31$), lenticular (18%, $n = 28$), conical (9%, $n = 14$), and marginal roll (10%, $n = 16$). Other shapes as cylindrical, clavate, leaf fold, and rosette galls corresponded, each one, to less than 5% of the amount.

The super host families were Myrtaceae with 36 gall morphotypes on 11 species followed by Fabaceae with 14 galls on 11 species and Rubiaceae with nine galls on seven species. *Eugenia* L. (Myrtaceae) was the super host genera, with a total number of 21 gall morphotypes, which corresponded to 60% of the galls found on Myrtaceae.

Eugenia copacabanensis Kiaersk (Myrtaceae) was the species with the highest gall richness, with nine gall morphotypes.

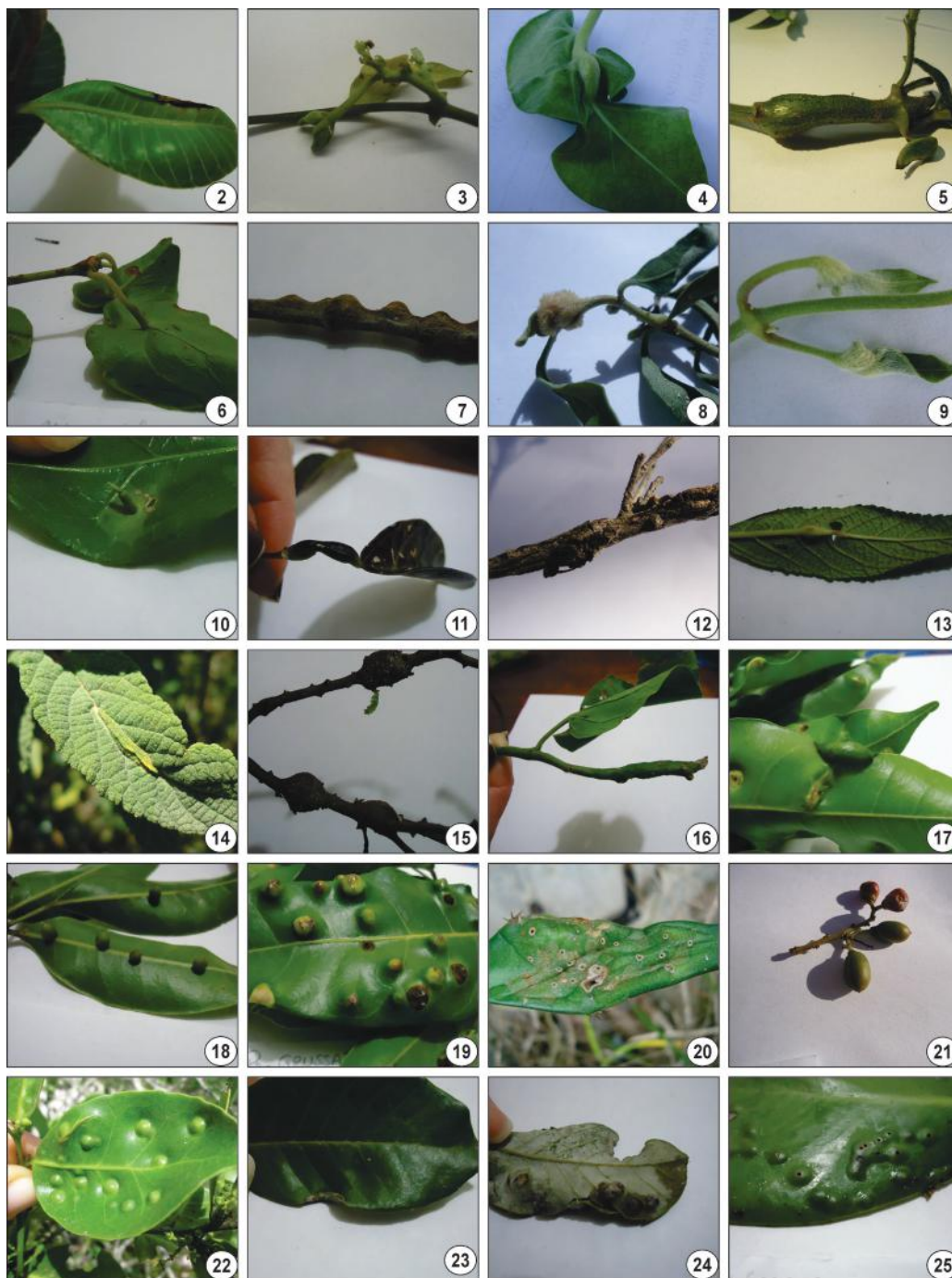
The restinga area with the richest galling species was Arraial do Cabo with 88 species, followed by São João da Barra ($n = 66$), Araruama ($n = 64$), Cabo Frio ($n = 57$), and Saquarema ($n = 49$).

All the insect orders known for comprising gall inducers were found in the investigated restingas. Diptera was represented by three

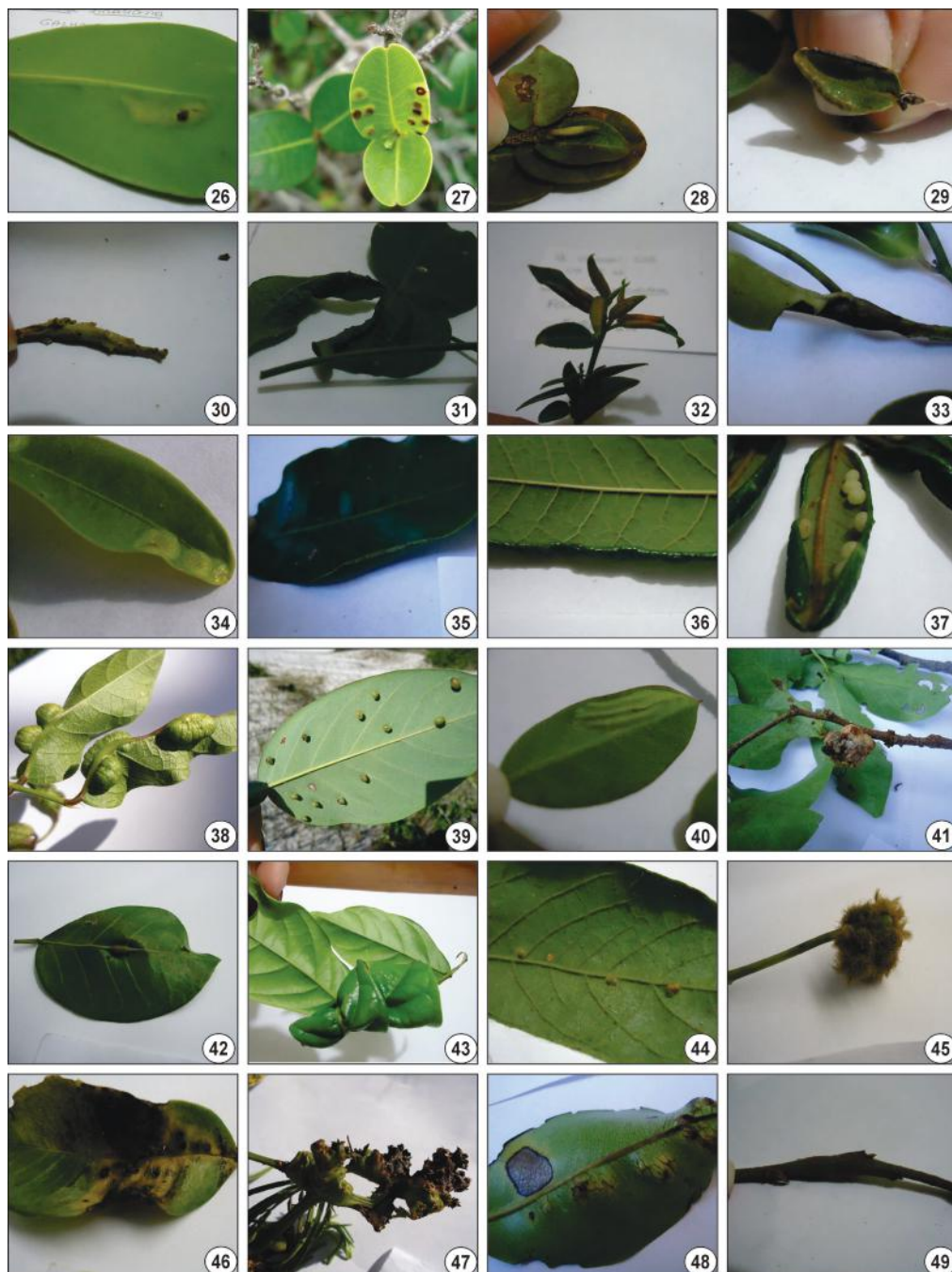
families, Agromyzidae (*Japanagromyza inferna* Spencer, 1973, $n=1$), Cecidomyiidae ($n=95$), and Tephritidae (*Procecidocchaes* sp., $n=1$). Among the Hemiptera galls ($n=9$), one species was identified, *Calophya terebinthifolii* Burckhardt & Basset, 2000 (Psyllidae) inducing lenticular galls on leaves of *Schinus terebinthifolius* Raddi (Anacardiaceae). Lepidoptera ($n=7$), Coleoptera (Curculionidae, $n=1$), Thysanoptera ($n=4$), and Hymenoptera ($n=1$) totalled less than 10% of the galls.

Forty five Cecidomyiidae were determined at species level, and they are distributed into 22 genera. The remaining specimens were identified at genus level or higher categories, totalizing 29 genera, because the material collected was insufficient for a more accurate identification. The most representative genera were *Dasineura* Rondani, 1840 with seven species, *Lopesia* Rübsaamen, 1908 with six species, *Stephomyia* Tavares, 1916, with four species, *Asphondylia* Loew, 1850, *Bruggmannia* Tavares, 1906, *Clinodiplosis* Kieffer, 1894 (each with three species). 70% of the remaining genera were represented only by one species ($n=19$).

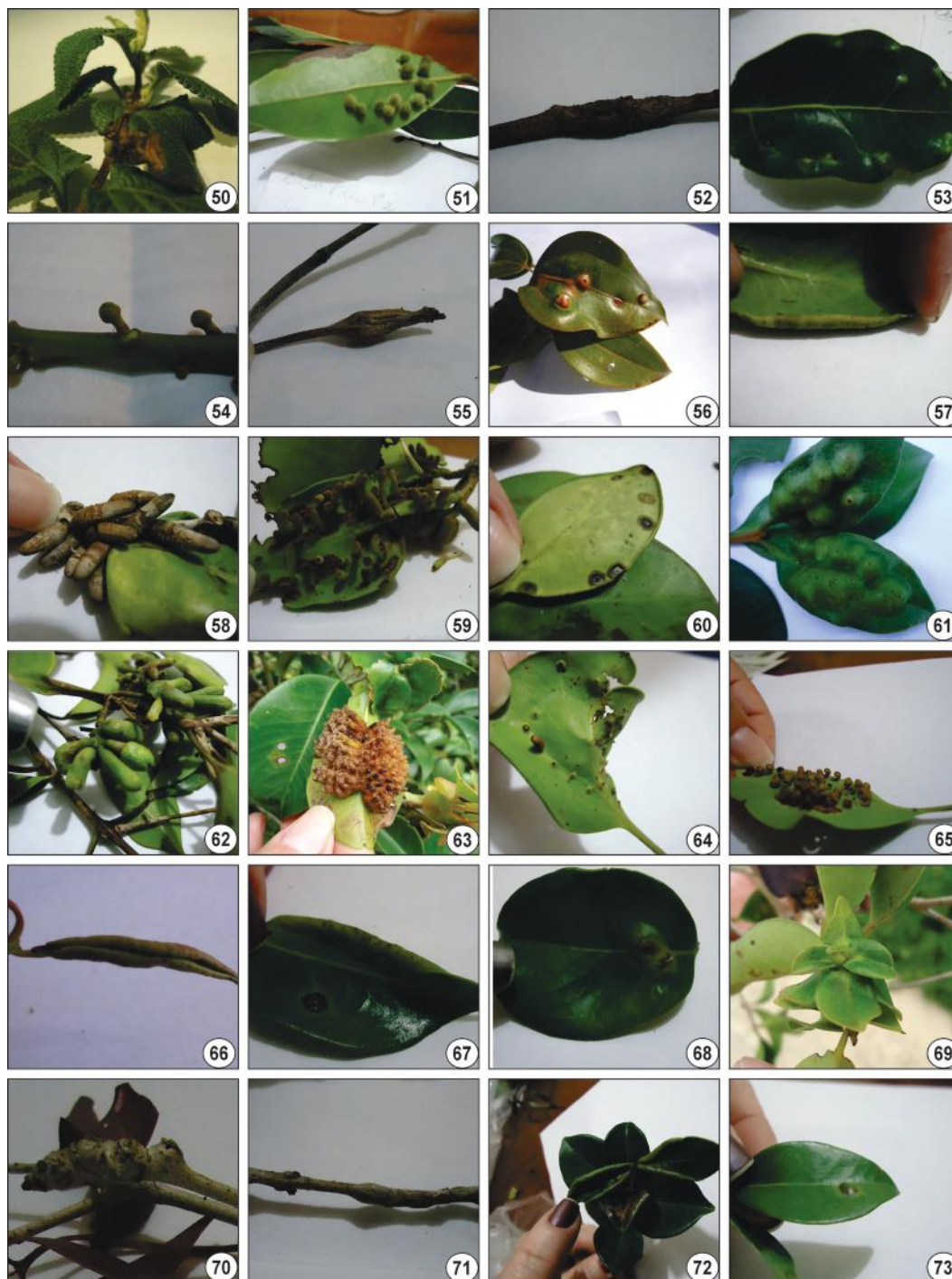
Sixteen Cecidomyiidae species were found in all investigated areas: *Asphondylia cordiae* Möhn, 1975, *Bruggmannia robusta* Maia & Couri, 1992, *B. elongata* Maia & Couri, 1992, *Clinodiplosis profusa* Maia, 2001, *Dasineura byrsonimae* Maia, 2011, *D. globosa* Maia, 1995, *D. copacabanensis* Maia, 1993, *Lopesia erythroxyli* Rodrigues & Maia, 2010, *L. singularis* Maia, 2001, *Maytenella distincta* Maia, 2001, *Neolasioptera eugeni-ae* Maia, 1993, *Paulliniamyia ampla* Maia, 2001, *Schismatodiplosis lantanae* Rübsaamen, 1907, *Smilasioptera candelariae* Möhn, 1975, *Stephomyia rotundifoliorum* Maia, 1993, and *Youngomyia pouteriae* Maia, 2001. Some species were recorded only in one area, as *Dactylodiplosis heptaphylli* Maia, 2004, *Lopesia similis* Maia, 2004, *Neolasioptera cerei* Rübsaamen, 1905, *Bruggmanniella*



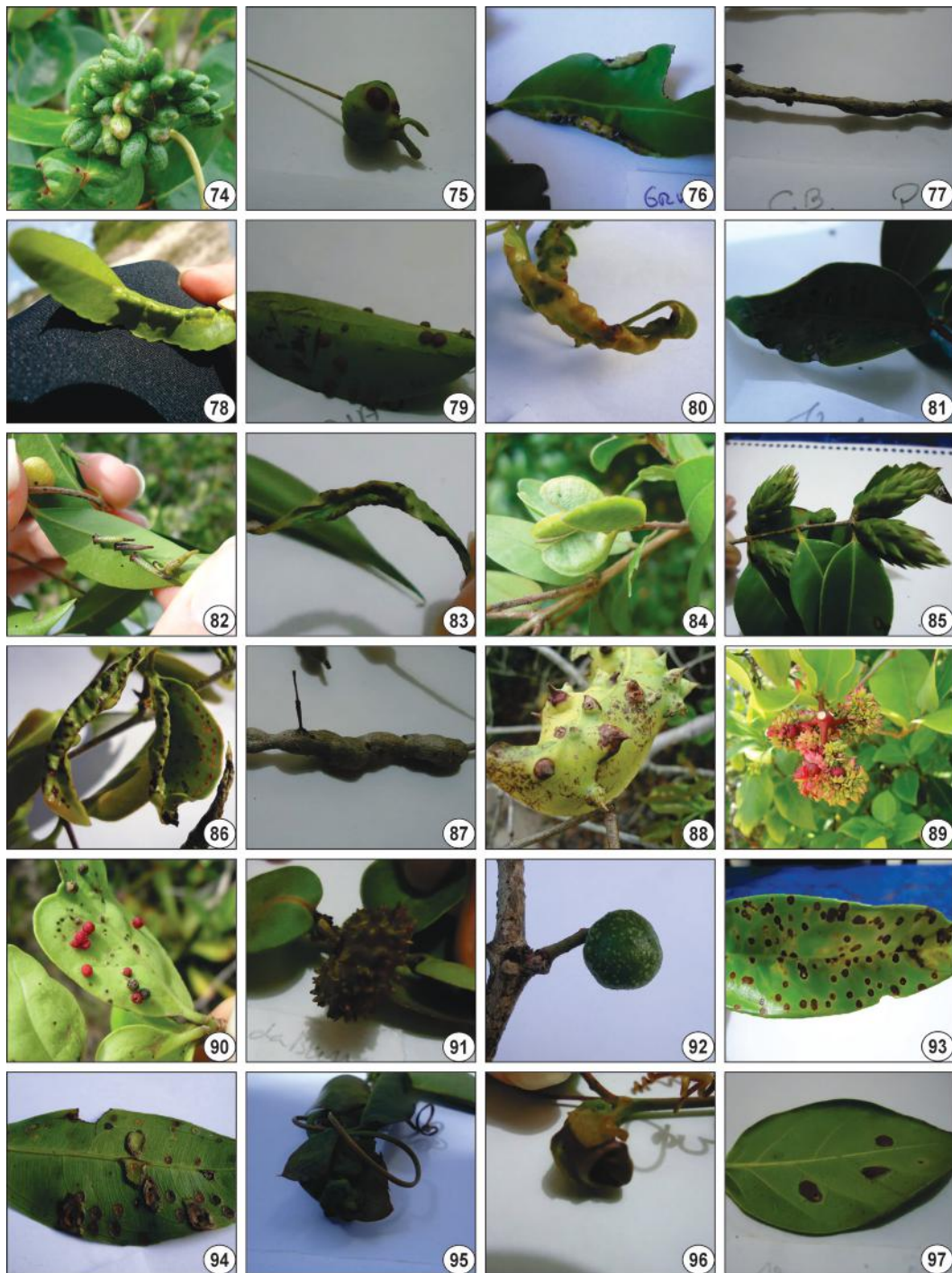
Figures 2-25 - Galling insects from Parque Estadual da Costa do Sol and RPPN Fazenda Caruara (RJ, Brazil). 2, *Lithraea brasiliensis*, marginal roll. 3-4, 3, *Oxypetalum banksii*, globoid bud gall, 4, fusiform leaf vein. 5, *Eupatorium punctulatum*, fusiform stem gall. 6, *Mikania hoehnei*, stem fusiform gall. 7-8, *Vernonia rufogrisea*, 7, stem gall, 8, petiole gall. 9, Asteraceae sp., globoid leaf gall. 10-11, *Fridericia conjugata*, 10, conical leaf gall, 11, fusiform gall. 12, *Euploca polyphylla*, stem gall. 13-15, *Varronia curassavica*, 13, leaf vein gall, 14, lenticular leaf vein gall, 15, stem gall. 16, *Tournefortia villosa*, stem gall. 17-19, *Protium heptaphyllum*, 17, marginal roll, 18, globoid leaf gall, 19, lenticular gall. 20, *Hylocereus setaceus*, stem gall. 21-22, *Maytenus obtusifolia*, 21, fruit gall, 22, lenticular leaf gall. 23-24, *Couepia ovalifolia*, 23, marginal roll, 24, globoid leaf gall. 25, *Clusia fluminensis*, lenticular leaf gall.



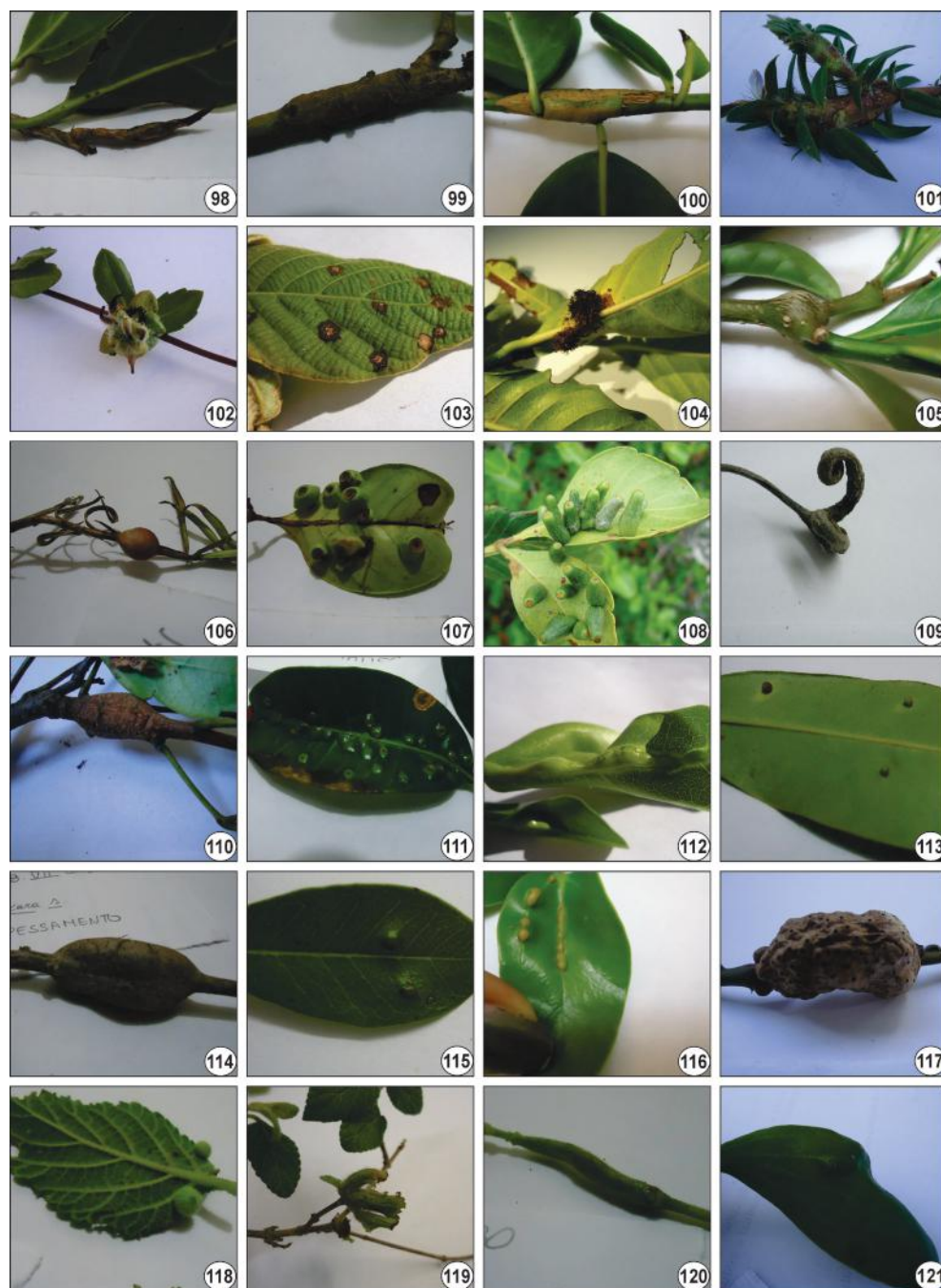
Figures 26-49 - Gallling insects from Parque Estadual da Costa do Sol and RPPN Fazenda Caruara (RJ, Brazil). 26, *Clusia hilariana*, lenticular leaf gall. 27-29, *Erythroxylum ovalifolium*, 27, lenticular leaf gall, 28, conical bud gall, 29, marginal roll. 30, *Croton compressus*, stem gall. 31, *Dalechampia micromeria*, marginal roll. 32, *Microstachys corniculata*, marginal roll. 33-35, *Pera glabrata*, 33, stem gall, 34, lenticular leaf gall, 35, marginal roll. 36, *Andira legalis*, marginal roll. 37, *Andira* sp., globoid leaf gall. 38, *Centrosema virginianum*, leaf vein gall. 39, *Dalbergia ecastaphyllum*, globoid leaf gall. 40, *Indigofera sabulicola*, lenticular leaf gall. 41-42, *Inga laurina*, 41, globoid bud gall, 42, leaf vein gall. 43-44, *Inga maritima*, 43, leaf vein gall, 44, globoid leaf gall. 45-46, *Machaerium lanceolatum*, 45, globoid bud gall, 46, lenticular leaf gall. 47, *Senegalia lacerans*, bud gall. 48, *Swartzia apetala*, lenticular leaf gall. 49, *Humiria balsamifera*, stem gall.



Figs. 50-73 - Gallling insects from Parque Estadual da Costa do Sol and RPPN Fazenda Caruara (RJ, Brazil). 50, *Hyptis* sp., leaf vein gall. 51, *Ocotea pulchella*, globose leaf gall. 52-53, *Ocotea notata*, 52, stem gall, 53, lenticular leaf gall. 54, Malpighiaceae sp., fruit gall. 55, *Stigmaphyllon paralias*, stem gall. 56, *Miconia cinnamomifolia*, leaf vein gall. 57-61, *Eugenia astringens*, 57, marginal roll, 58, conical leaf gall, 59, clavate gall, 60, lenticular leaf gall, 61, globose leaf gall. 62-70, *Eugenia copacabanensis*, 62, bud gall, 63, conical leaf gall, 64, conical gall, 65, spiral leaf gall, 66, leaf fold, 67, marginal roll, 68, leaf vein gall, 69, rosette gall, 70, stem gall. 71, *Eugenia puniceifolia*, stem gall. 72, *Eugenia selloi*, marginal roll. 73, *Eugenia uniflora*, lenticular leaf gall.



Figs. 74-97 - Galling insects from Parque Estadual da Costa do Sol and RPPN Fazenda Caruara (RJ, Brazil). 74-75, *Eugenia uniflora*, 74, conical leaf gall, 75, fruit gall. 76-77, *Eugenia* sp., 76, marginal roll, 77, stem gall. 78-81, *Myrcia ovata*, 78, conical leaf gall, 79, globooid leaf gall, 80, marginal roll, 81, lenticular leaf gall. 82-83, *Myrciaria floribunda*, 82, cylindrical leaf gall, 83, marginal roll. 84, *Myrciaria tenella*, young leaf fold. 85-87, *Neomitranthes obscura*, 85, pine-like gall, 86, leaf fold, 87, stem gall. 88, *Psidium cattleianum*, conical leaf gall. 89-92, *Guapira opposita*, 89, rosette gall, 90, globooid leaf gall, 91-92, bud gall. 93, *Ouratea cuspidata*, lenticular leaf gall. 94, *Ouratea* sp., lenticular leaf gall. 95, *Passiflora alliaceae*, bud gall. 96, *Passiflora mucronata*, leaf fold gall. 97, *Cocoloba rigida*, lenticular leaf gall.



Figs. 98-121 - Galling insects from Parque Estadual da Costa do Sol and RPPN Fazenda Caruara (RJ, Brazil). 98, *Coccoloba rigida*, stem gall. 99, *Myrsine parvifolia*, stem gall. 100, *Scutia arenicola*, stem gall. 101, *Diodella apiculata*, stem gall. 102, *Enhydra sessilis*, bud gall. 103, *Ladenbergia hexandra*, lenticular leaf gall. 104-105, *Psychotria carthagenensis*, 104, globoid leaf gall, 105, stem gall. 106, *Spermacocae verticilata*, stem gall. 107, *Paullinia racemosa*, conical leaf gall. 108-110, *Paullinia weinmanniaefolia*, 108, conical leaf gall, 109, tendril gall, 110, stem gall. 111-112, *Chrysophyllum lucentifolium*, 111, lenticular leaf gall, 112, leaf vein gall. 113-114, *Manilkara subsericea*, 113, globoid leaf gall, 114, stem gall. 115, *Sideroxylum obtusifolium*, lenticular leaf gall. 116-117, *Smilax rufescens*, 116, leaf vein gall, 117, stem gall. 118-120, *Lantana fucata*, 118, globoid leaf gall, 119, cylindrical leaf gall, 120, stem gall. 121, *Phoradendron quadrangulare*, globoid leaf gall.

TABLE I
Hymenoptera families associated with Cecidomyiidae galls in restingas of the Parque Estadual da Costa do Sol (Saquarema, Araruama, Arraial do Cabo and Cabo Frio) and Reserva Particular do Patrimônio Natural Fazenda Caruara (São João da Barra) Rio de Janeiro state, Brazil.

Family	Plantspecies	Gall	Galler	Hymenoptera
Boraginaceae	<i>Varronia curassavica</i>	inflorescence	<i>Asphondylia cordiae</i>	Eulophidae Elasmidae
Erythroxylaceae	<i>Erythroxylum ovalifolium</i>	lenticular	<i>Dasineura ovalifoliae</i>	Eulophidae
Fabaceae	<i>Andira fraxinifolia</i>	lenticular	<i>Meureriella</i> sp.	Eulophidae Aphelinidae
Lauraceae	<i>Ocotea pulchella</i>	globoid	Schizomyiina	Hymenoptera
Malpighiaceae	<i>Byrsonima sericeae</i>	stem	Cecidomyiidae	Eulophidae
Myrtaceae	<i>Eugenia astringens</i>	clavate	<i>Stephomyia</i> sp.	Hymenoptera
	<i>Eugenia copacabanensis</i>	fusiform	<i>Stephomyia tetralobae</i>	Hymenoptera
		conical	<i>Bruggmannia</i> sp.	Eulophidae Eurytomidae
		rosette	unknown	Torymidae
	<i>Eugenia astringens</i>	marginal roll	<i>Dasineura marginalis</i>	Eulophidae
		conical	<i>Stephomyia rotundifoliorum</i>	Eulophidae Scelionidae
		clavate	<i>Stephomyia</i> sp.	Eulophidae Eurytomidae
	<i>Eugenia uniflora</i>	fruit	Cecidomyiidae	Hymenoptera
	<i>Myrcia ovata</i>	globoid	Cecidomyiidae	Hymenoptera
Nyctaginaceae	<i>Guapira opposita</i>	rosette	<i>Pisphondylia braziliensis</i>	Eulophidae
		lenticular	<i>Bruggmannia elongata</i>	Braconidae, Eulophidae, Eurytomidae
		globoid	<i>Bruggmannia robusta</i>	Hymenoptera
		budgall	unknown	Eulophidae
Rubiaceae	<i>Diodia</i> sp.	fusiform	<i>Neolasioptera</i> sp.	Eulophidae, Torymidae
	<i>Enhydra sessilis</i>	budgall	Cecidomyiidae	Hymenoptera
	<i>Psychotria carthagenensis</i>	globoid	<i>Apodiplosis</i> sp.	Hymenoptera
Sapindaceae	<i>Paullinia weinmanniaefolia</i>	conical	<i>Paulliniamyia ampla</i>	Torymidae, Eurytomidae, Eulophidae
Sapotaceae	<i>Manilkara subsericea</i>	cylindrical	Cecidomyiidae	Eurytomidae
		fusiform	unknown	Eulophidae
	<i>Pouteria venosa</i>	lenticular	<i>Lopesia singularis</i>	Eulophidae, Eupelmidae
Smilacaceae	<i>Smilax rufescens</i>	fusiform	Cecidomyiidae	Eulophidae
Smilacaceae	<i>Smilax rufescens</i>	lenticular	<i>Smilasioptera candelariae</i>	Eulophidae

maytenuse Maia & Couri, 1992, *Pisphondylia braziliensis* Couri & Maia, 1992, *Asphondylia communis* Maia & Couri, 1992, in São João da Barra; *Clusiamyia granulosa* Maia, 2001, *Stephomyia tetralobae* Maia, 1993, *Clinodiplosis costai* Maia, 2005, in Arraial do Cabo; *Myrciamyia maricaensis* Maia, 1995 in Cabo Frio.

The associated fauna was composed by parasitoids and inquilines. Parasitoids were represented by six Hymenoptera families found in 27 gall morphotypes: Braconidae, Elasmidae, Eulophidae, Eupelmidae, Eurytomidae, and Torymidae (Table I). *Dimeromicrus cecidomyiae* Ashmead, 1887 (Torymidae) was found in galls of *Paulliniamyia*

ampla on *Paullinia weinmanniaefolia* Mart. (Sapindaceae). The inquilines were represented by Thysanoptera and were found in globoid galls on buds of *Senegalia lacerans* (Benth.) Seigler & Ebinger (Fabaceae), and marginal roll on *Eugenia astringens* Cambess (Myrtaceae).

All the gall records in Saquarema, Araruama and São João da Barra are new to these municipalities. The new galls recorded from Rio de Janeiro state are: marginal roll on *Lithraea brasiliensis* Marchand, stem gall on *Eupatorium punctulatum* DC., stem gall on *Euploca polyphylla* (Lehm.) J.I.M.Melo & Semir DC., galls on stem of *Tournefortia villosa* Salzm. Ex DC., marginal roll on *Dalechampia micromeria* Baill., lenticular on leaves of *Andira fraxinifolia* Benth., bud galls on *Inga laurina* Willd., lenticular leaf galls on *Indigofera sabulicola* Benth., leaf gall on *Machaerium lanceolatum* (Vell.) J.F. Macbr., bud gall on *S. lacerans*, leaf gall on *Swartzia apetala* Raddi, stem gall on *Humiria balsamifera* (Aubl.) J.St.-Hill., leaf gall on *Ocotea pulchella* (Nees & Mart.) Mez; leaf vein gall on *Miconia cinnamomifolia* (DC.) Naudim, conical leaf gall and rosette gall on *Eugenia copacabanensis* Kiaersk, marginal roll on *Eugenia selloi* B. D. Jacks., conical leaf vein gall and marginal roll on *Myrcia ovata* Cambess., cylindrical gall on *Myrciaria floribunda* (H. West ex Willd.) O. Berg., young leaf fold on *Myrciaria tenella* (DC.) O. Berg, bud gall on *Guapira opposita* (Vell.) Reitz., bud gall on *Passiflora alliaceae* Barb. Rodr., stem and leaf galls on *Coccoloba rigida* Meisn., stem gall on *Diodella apiculata* (Willd. ex Roem. & Schult.) Delprete; bud gall on *Enhydra sessilis* (Sw.) DC., lenticular leaf gall on *Ladenbergia hexandra* (Pohl) Klotzsch, leaf gall on *Psychotria carthagenensis* Jacq., stem and flower galls on *Spermacocae verticilata* L., leaf gall on *Paullinia racemosa* Wawra, leaf and leaf vein galls on *Chrysophyllum lucentifolium* Cronquist, globoid and cylindrical gall on *Lantana*

fucata Lindl., globoid leaf gall on *Phoradendron quadrangulare* (Kunt) Griseb.

DISCUSSION

In restinga areas a total number of 480 gall morphotypes in 229 plant species and 60 botanic families have been recorded in São Paulo, Espírito Santo, and Rio de Janeiro states (Maia et al. 2014). Most of the gall inducers are identified only on family level or superior categories. Cecidomyiidae is the best known family among the gall inducers in Brazil, but the gall midge taxonomy is far to reach all the species that probably may exist.

Cecidomyiidae is a family with many different feeding habits, but about 75% of the species are plant feeders. The majority are gall-inducing insects, being this family the most important taxon among this herbivore guild. About 60% of the galls occurring in restingas from Southeast of Brazil are induced by Cecidomyiidae (Maia 2013, Gagné and Jaschhof 2014, Maia et al. 2014).

Tephritidae is the second family of Diptera in importance among the galling species, being the cecidogenous represented by about 5% of all described species, most of them associated with Asteraceae (Freidberg 1998). This is the second record of Tephritidae galls in restingas from Rio de Janeiro, the other previous species was associated with another Asteraceae species, *Vernonia rufrogisea* St.-Hill. in Ilha da Marambaia (Mangaratiba, Rio de Janeiro state), and another record on *Vernonia beyrichii* Less. from Bertioga, São Paulo (Maia et al. 2008, Rodrigues et al. 2014).

Agromyzidae are mainly known as leaf miners, but so far the galling species are known from seven genera. They usually induce galls on Salicaceae, Asteraceae and Fabaceae (Spencer 1990). The gall of *Japanagromyza inferna* was previously recorded in restingas from Arraial do Cabo, Marambaia, and Saquarema (Rio de Janeiro state) associated with

the same host plant found in this work (Sousa and Couri 2014).

Galls of Lepidoptera, Coleoptera, Hemiptera, Hymenoptera and Thysanoptera were previously recorded in Brazilian restingas. They comprise about 10% of all galls found in coastal shrub vegetation, with Hemiptera and Lepidoptera the most abundant (Maia et al. 2014).

Leaves are the main affected organ by the galling insects (Mani 1964) probably because this is the most abundant organ and, in most of the case, in restingas vegetation is available during all the year, unlike other dry forests, as caatinga in Brazil, where trees lose their leaves during the dry season. Leaf galls in restingas correspond to about 60% of all galls, but as recorded in this survey, galls are also present in other organs, such as stems, buds, fruits, and flowers (Maia 2013, Maia et al. 2014).

Despite in this inventory the most common gall shape found was fusiform, globoid galls are the most common shape in the Neotropical region (Isaias et al. 2013), the same pattern is observed in various ecosystems in Brazil, such as Cerrado, Amazon forest and also in restingas (Carvalho-Fernandes et al. 2012, Santos et al. 2012, Maia 2013, Maia et al. 2014).

The two most galled plant families recorded in this study are well reported in restingas as the super host families. Myrtaceae can be considered the main host family in coastal shrub vegetation in Southeastern Brazil, due to its great representativeness in all insect galls inventories. Other families, such as Fabaceae, Asteraceae, and Nyctaginaceae are also pointed as important hosts, nonetheless they vary in their importance according to the survey, probably because the diversity of vegetation physiognomies presented in the distinct areas (Bregonci et al. 2010, Maia 2001, Maia et al. 2008, Maia and Oliveira 2010, Rodrigues et al. 2014). In other Brazilian biomes, such as Araucaria Forest, Cerrado, Amazon Forest, Caatinga, and Caatinga-Cerrado transition these families also present the

role of main gall hosts (Coelho et al. 2009, Almada and Fernandes 2011, Santos et al. 2011, Costa et al. 2014, Toma and Mendonça Jr 2013).

The identified gall midges of the present study comprise about 35% of species and 50% of genera that are known from Rio de Janeiro state. The recorded richest genera are also among the most speciose in the state (Maia and Barros 2009).

Parasitoidism is the main mortality factor affecting the survival rate of cecidomyiids. The Hymenoptera families represented in this study are frequent in galls in restingas of Rio de Janeiro, and Eulophidae and Eupelmidae are among the most common families associated with many galls in a great variety of plant families and species (Maia and Azevedo 2009).

The restingas of the State of Rio de Janeiro can be considered the most studied when we compare with other Brazilian restingas. Even so, we still have a great diversity to be discovered, as shown with the new records presented here and a high number of new species to be named in these areas.

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SUPPLEMENTARY MATERIAL

TABLE SI - host plants, galls morphology, inducers and investigated localities of Parque estadual Costa do Sol (araruama, arraial do Cabo, Cabo Frio, and Saquarema) and of RPPn Fazenda Caruara, Grussaí (São João da Barra), Rio de Janeiro, Brazil, from June 2011 to May 2012. abbreviations: aRa: araruama, aRRa: arraial do Cabo, CF: Cabo Frio, SaQ: Saquarema, SJB: São João da Barra.