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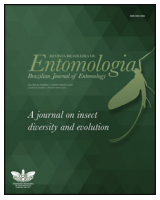

Gall-inducing insects from the Maricá Environmental Protection Area (RJ, Southeastern Brazil)

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ABSTRACT

The Maricá Environmental Protection Area (RJ, Southeastern Brazil) is predominantly occupied by the restinga ecosystem. Two broad inventories of insect galls and several contributions to the taxonomical knowledge of the local gall-inducing fauna have been done since 1992. The present study aims to compile literature data, compare them with data from recent collections and evaluate the similarity between the gall-inducing insects from this area and those from other restingas, using the Sorensen's index. Field work was carried out from April 2021 to March 2022, in a total of 14 expeditions. All voucher material was deposited in the Entomological Collection of Museu Nacional/UFRJ. According to literature compilation, the Environmental Protection Area of Maricá (MEPA) hosts 108 gall-inducing species, 83.3% were collected again. Twenty-three gall morphotypes were found for the first time in the study area as well as two host plants, *Schwartzia brasiliensis* (Marcgraviaceae) and *Lantana fucata* (Verbenaceae). All Brazilian restingas have low similarity with MEPA, which shows that this restinga is unique in the composition of the gall-inducers. MEPA includes 63 endemic species and morphospecies of cecidogenous insects. Nyctaginaceae, Boraginaceae, and Erythroxylaceae showed the greatest average of inducers by plant species. However, these taxa are not the best represented in MEPA, but they include super hosts, which explains their highest value. The family Myrtaceae shelters the greatest richness of gall-inducing insects and the greatest richness of host plant species. A new case of inquilinism was observed in galls on *Neomitranthes obscura* (Myrtaceae).

Introduction

Several inventories of insect galls have been developed in Brazil over the last 35 years, mainly in Cerrado and Atlantic forest phytogeographic domains (Araújo, 2018). Regarding all the phytophysiognomies of the Atlantic forest, restingas represent one of the most endangered. It is also the most investigated, especially in the state of Rio de Janeiro (Southeastern Brazil), where the Maricá Environmental Protection Area stands out for the largest number of studies.

This protection area is located in the municipality of Maricá between the coordinates 22°52'-22°54'S and 42°48'-42°54'W and was established in 1984 (INEA, 2023). With an area of about 970 hectares, it is predominantly occupied by the restinga ecosystem and hosts 204 plant species (Silva and Oliveira, 1989) as well as a rich fauna of gall-inducing insects (Maia, 2001a).

Two broad inventories of insect galls were performed in the Maricá Environmental Protection Area (hereafter MEPA), the first by Monteiro et al. (1994) and the second by Maia (2001a). Monteiro et al. (1994) reported 87 gall morphotypes and provided the identification of host plants and gall-inducing insects, the former in species and the latter in order (Coleoptera, Hemiptera, Hymenoptera, Lepidoptera and Thysanoptera) or family (Cecidomyiidae, Diptera). Concerning the characterization of the galls, data included only the galled organ and no illustrations. Maia (2001a), investigating gall midges (Cecidomyiidae), reported 72 gall morphotypes in MEPA. All host plants were identified in species, except one (identified in genus), while gall-inducers were identified in species, genus, and other taxonomical categories. Each gall morphotype was photographed and morphologically characterized by shape, length, color, presence/absence of trichomes, number of internal chamber, and host organ. Data on other gall dwellers (parasitoids, inquilines, and predators) were also provided. Since them, no other inventory has been performed in this area. Nevertheless, some scattered records of insect galls are found in the literature as in Maia et al. (2002) - four morphotypes, Maia (2006) - two morphotypes, and Maia and Santos 2015 - one morphotype. Several contributions to the taxonomical knowledge of the galling-insects of the MEPA have been done since 1992. In fact, this restinga is the Brazilian surveyed ecosystem with the greatest amount of identified cecidogenous species.

MEPA suffers intense anthropic action even before its establishment as an area of environmental protection, which includes the abandonment of cars, tires, ilegal removal of plants and sand, the ongoing construction

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of a resort in the restinga area, and others. These actions can have a negative impact on the gall-inducing insect fauna. However, basic information is needed to assess this impact. The present study has three main objectives: 1) to provide this basic information through the elaboration of a list of the host plants (with updated botanical names) and gall-inducing insects (with indication of the species described from this restinga, endemic species, as well as species known only from this locality); 2) compare the richness of gall-inducing insects previously recorded in literature with the current richness (obtained through new field work in the area) in order to verify what has changed over the years; 3) compare the gall richness of the MEPA with the richness of other restingas investigated in Brazil.

Material and methods

The first list of the gall-inducing insects and their host plants of MEPA was prepared by compiling data from the literature: Maia and Couri (1993); Couri and Maia (1992); Maia et al. (1992, 2002, 2005); Maia (1993a, 1993b, 1993c, 1993d, 1994, 1995a, b, 1996a, 1996b, 2001a, 2001b, 2001c, 2004, 2005, 2006, 2010, 2013, 2021, 2022a, 2022b, 2023); Monteiro et al. (1994); Vanin et al. (2000); Brown et al. (2004); Sousa and Maia (2007); Oliveira and Maia (2008); Maia and Araújo (2009); Viceconte and Maia (2009); Rodrigues and Maia (2010); Maia and Nava (2011); Maia and Santos (2011, 2015); and Evenhuis (2022). It includes all insects and plants reported in these papers regardless of their taxonomic categories. Botanical names were verified on Flora and Funga do Brasil (JBRJ, 2023) and updated whenever necessary.

This list also provides data on gall morphological characterization, type localities of the inducers, endemisms and references. Data on gall morphology are not standardized since authors provided different information. Monteiro et al. (1994) reported only the host organ and the gall-inducing insect, while the other authors provided data on shape, color, presence or absence of trichomes, number of internal chambers, galled organ and gall-inducers. In the present work, morphological characters of some galls was added. They came from personal observations made in field work. The inducers are presented in alphabetical order. The type locality of the inducers was verified in the taxonomical works with their description.

The endemism of gall-inducing insects was proposed based on the endemism of their host plants, considering the high degree of specificity of this relationship. Data on plant endemism were retrieved from Flora and Funga do Brasil (JBRJ, 2023). Information on the geographic distribution of inducers was obtained from Maia (2021). The asterisk indicates gall-inducing species known only from MEPA.

Field work was carried out from April 2021 to March 2022, in a total of 14 expeditions, with six hours each. During this period, the local vegetation was investigated for insect galls. Exsiccates of galled species were prepared. Samples of each gall morphotype were collected, photographed and transported to the laboratory. Galls were characterized by host organ, shape (according the terminology of Isaias et al., 2013), color, presence or absence of trichomes, and number of internal chamber.

Some samples of each gall morphotype were pressed, dried and preserved as voucher material. Others were dissected to obtain immature insects and the remaining was placed individually in plastic pots layered at the bottom with damp cotton and covered with fine mesh to obtain pupal exuviae and adults. All pots were checked daily for emergence. The insects were preserved in 70% alcohol. The gall midges were subsequently mounted on microscope slides following the method outlined in Gagné (1994). The insects were identified at the lowest possible taxonomic level. All material was deposited in the Entomological Collection of Museu Nacional/Universidade Federal do Rio de Janeiro (MNRJ).

The new records were added to the previous ones to update the data. The Sorensen's index (SI= 2c/a+b, where c= number of species in common; a= number o species in community 1; b = number of species in community 2) and UPGMA analysis were adopted, using the software Past 4.03, to assess the gall similarity of MEPA with all other investigated Brazilian restingas: Paulo Cesar Vinha State Park (in Guarapari, ES) (Bregonci et al., 2010), Fazenda Caruara Private Reserve of Natural Heritage (in São João da Barra, RJ) (Carvalho-Fernandes et al., 2016), Jurubatiba Restinga National Park (in RJ) (Monteiro et al., 2004), Costa do Sol State Park (in RJ) Carvalho-Fernandes et al., 2016), Restinga de Massambaba (in Arraial do Cabo, RJ) (Monteiro et al., 1994), Grumari Restinga (in Rio de Janeiro, RJ) (Oliveira and Maia, 2005), Marambaia Restinga (in Rio de Janeiro, RJ) (Maia and Silva, 2016), Marambaia Island (in Mangaratiba, RJ) (Rodrigues et al., 2014), Praia do Sul State Biological Reserve (in Ilha Grande, Angra dos Reis, RJ) (Maia and Oliveira, 2010), Bertioga Restinga de State Park (in Bertioga, SP) (Maia et al., 2008), Babitonga (in SC) (Melo Júnior et al., 2015), and Acaraí State Park (in São Francisco do Sul, SC) (Arriola and Melo Júnior, 2016). Whenever galls were reported on the same host plant species, their morphology was compared based on figures and/or gall description to quantify the number of different morphotypes.

Results

The results of the present study were divided into three topics: i) literature compilation, where general data and the list of gall-inducing insects, their host plants and galls in the Environmental Protection Area of Maricá are presented; ii) field work, where new records of galls are provided, and iii) similarity of gall richness, where MEPA is compared to other Brazilian restingas.

Literature Compilation

According to literature compilation, MEPA hosts 108 gall-inducing species on 56 plant species of 31 families; 61 the inducers (56.5%) are identified in species and 11 in genus (10.2%), the others are in suprageneric taxonomic categories (33.3%). The gallers belong mainly to Cecidomyiidae (Diptera), being responsible for 86 gall morphotypes (79.6%). Hemiptera, Lepidoptera, Hymenoptera, Thysanoptera, and Coleoptera are also reported as gall-inducers. However, they are represented by few species (Table 1). Each cecidogenous species is associated with a single host plant, except *Pacholenus pelliceus* (Coleoptera) and *Lopesia singularis* (Cecidomyiidae), each reported in two congeneric plant species.

The study area is the type locality of 48 species of gall-inducers, all belonging to Cecidomyiidae. In addition, it hosts seven species endemic to Brazil and 21 endemic to Atlantic forest, for a total of 28 endemic inducers. The former include six species of Cecidomyiidae and one species of Curculionidae, while the latter are exclusively represented by Cecidomyiidae. Furthermore, gallers which are identified in supraspecific categories totalize 27 endemic species, 15 to Brazil and 12 to Atlantic forest. The former include ten morphospecies of Cecidomyiidae, three of Hemiptera, and one of Hymenoptera and Lepidoptera, whereas the latter comprise four morphospecies of Cecidomyiidae, two of Hymenoptera, two of Lepidoptera, one of Thysanoptera, and two gallers not determined. Adding the number of endemic species and morphospecies, we obtain a total of 55, which corresponds to 50.9% of the local guild of gall-inducing insects, an expressive value. Most endemic gallers (n=21) are associated with Myrtaceae (38.2%).

Considering the geographic distribution of gall-inducing insects, six species and 12 morphospecies are known only from MEPA. They

Table 1
Richness of gall-inducing insects (based on literature compilation), number of inducers collected again from April 2021 to March 2022, new records and updated richness of species in the Environmental Protection Area of Maricá (Maricá, RJ, Southeastern Brazil).

Gall-inducers	Richness of species based on literature compilation	Number of collected species from April 2021 to March 2022	New records	Updated richness of species
Cecidomyiidae	86	74	13	99
Hemiptera	7	5	1	8
Lepidoptera	6	6	1	7
Hymenoptera	4	2	1	5
Thysanoptera	2	2	0	2
Coleoptera	1	1	1	2
Not determined	2	0	5	7
Total	**108**	**90**	**22**	**130**

are represented by 6 species and 8 morphospecies of gall midges, two morphospecies of Hymenoptera, and one morphospecies of Lepidoptera and Thysanoptera.

Concerning botanical taxa, 56 species of 31 families host gall-inducing insects (Table 2). Among them, Nyctaginaceae showed the greatest average of gall-inducing species by plant species (8) and Sapotaceae the lowest (0.8). In spite of being the plant family with the highest number of galled species (n=9) and gall-inducers (n=28), Myrtaceae occupied the third position, being surpassed by Nyctaginaceae, Boraginaceae, and Erythroxylaceae (Table 2).

List of gall-inducing insects, their host plants and galls in the Environmental Protection Area of Maricá (RJ, Southeastern Brazil):

Cecidomyiidae (Diptera)

1. *Alycaulus* sp. on *Mikania hoehnei* Robinson (Asteraceae). Gall: Stem swelling, ovoid, 1.0-1.8 cm long, 0.5-0.8 cm wide, glabrous, brown, one-chambered. Ref.: Maia (2001a). Not endemic.

2. *Arrabidaeamyia serrata* Maia, 2001 on *Fridericia conjugata* (Vell.) Mart (Bignoniaceae). Gall: on leaf, conical, extralaminar, 0.8-1.4 cm long, 0.5 cm wide (at the base), green, glabrous, one-chambered. Ref.: Maia (2001b) - host plant as *Arrabidaea conjugata* (Vell.) Mart. Type locality: MEPA, RJ. Not endemic.

3. *Asphondylia borreriae* Rübsaamen, 1905 on *Borreria verticillata* (L.) Meyer (Rubiaceae). Gall: on inflorescence, fusiform, 1.0 cm long, 0.3 cm wide (at the base), green glabrous, one-chambered. Refs: Rübsaamen (1905), Maia et al. (1992), Maia (2001a). Type locality: Rio de Janeiro, RJ. Not endemic.

4. *Asphondylia communis* Maia & Couri, 1993 on *Ximenia americana* L. var. *americana* (Olacaceae). Gall: on stem, ovoid, 0.9-1.1 cm long; 0.5-0 .6 cm wide, brown, glabrous, one-chambered. Refs.: Maia et al., 1992, Maia (2001a). Type locality: MEPA, RJ. Not endemic.

5. *Asphondylia fluminensis* Maia, 2023 on *Erythroxylum ovalifolium* Peyr (Erythroxylaceae). Gall: on closed flower, ovoid, 0.2 cm long, 0.1 cm wide, greenish, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Asphondylia* sp., Maia (2023). Type localities: MEPA, Arraial do Cabo, and Carapebus, RJ. Endemic to Atlantic forest.

6. *Asphondylia peploniae* Maia, 2001 on *Peplonia asteria* (Vell.) Fontella & E. A. Schwartz (Apocynaceae). Gall: on closed flower, 0.6 cm long, 0.4 cm wide, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Asphondylia* sp., plant family as Asclepiadaceae; Maia (2001b) - plant family as Asclepiadaceae. Type locality: Carapebus, RJ. Endemic to Atlantic forest.

7. *Asphondylia sennae* Maia & Couri, 1992 on *Senna bicapsularis* (L.) Roxb (Fabaceae). Gall: on ovary, spherical, yellow, glabrous, one-chambered. Ref.: Maia et al. (1992). Type locality: MEPA, RJ. Not endemic*.

8. *Asphondylia varroniae* Maia, 2023 on *Varronia curassavica* (Boraginaceae Gall: on closed flower, ovoid, 0.5 cm long, 0.2 cm wide, green or yellow, with trichomes, multichambered. Refs.: Maia (2001a) - gall-inducer as *Asphondylia cordiae* Möhn, 1975 – misidentification, host plant as *Cordia verbenacea* DC.; Maia (2023). Type localities: Bertioga, SP; MEPA and Carapebus, RJ. Not endemic.

9. Asphondyliina on *Phytolacca* cfr. *esculenta* Van Houtte (Phytolaccaceae). Gall: rosette bud gall, green. Ref.: Maia et al. (2002). Not endemic*.

10. *Bruggmannia acaudata* Maia, 2004 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on leaf, conical, intralaminar, 0.6 cm long, 0.4 cm wide (at the base), green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Bruggmannia* sp., Maia (2004). Type localities: Itaipuaçu (Maricá) and MEPA, RJ. Not endemic.

11. *Bruggmannia elongata* Maia & Couri, 1993 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on leaf, lenticular, intralaminar, 0.3 cm in diameter, green, glabrous, multichambered. Refs.: Maia and Couri (1993), Maia (2001a). Type locality: MEPA, RJ. Not endemic.

12. *Bruggmannia monteiroi* Maia & Couri, 1993 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on stem and leaf, extralaminar, spherical, purple, with trichomes, one-chambered. Refs.: Maia and Couri (1993), Maia (2001a). Type locality: MEPA, RJ. Not endemic*.

13. *Bruggmannia robusta* Maia & Couri, 1993 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on leaf, spherical, extralaminar, 0.2 cm in diameter, red or yellow, with trichomes, multichambered. Refs.: Maia and Couri (1993), Maia (2001a). Type locality: MEPA, RJ. Not endemic.

14. *Bruggmanniella byrsonimae* (Maia & Couri, 1992) on *Byrsonima sericea* DC. (Malpighiaceae). Gall: on closed flower, ovoid, 1.2- 1.5 cm long, 0.5-0.6 cm wide, green or brown, glabrous, multichambered. Refs.: Maia et al. (1992), Maia (2001a) - gall-inducer as *Asphondylia byrsonimae*, Maia (2001b). Type locality: MEPA, RJ. Not endemic.

15. *Bruggmanniella maricensis* (Maia & Couri, 1992) on *Struthanthus taubatensis* Eichler (Loranthaceae). Gall: on midvein, ovoid, complex, 1.0-1.5 cm long, 0.6 cm wide, green, glabrous, multichambered. Refs.: Maia et al. (1992) - gall-inducer as *Asphondylia maricensis*, host plant as *Struthanthus maricensis* Rizz.; Maia (2022a). Type locality: MEPA, RJ. Endemic to Brazil*.

16. *Bruggmanniella maytenuse* (Maia & Couri, 1992) on *Monteverdia obtusifolia* (Mart.) Biral (Celastraceae). Gall: on fruit, ovoid, 0.8-0.9 cm long, 0.7 cm wide, red, glabrous, multichambered. Refs.: Maia et al. (1992), Maia (2001a) - gall-inducer as *Asphondylia maytenuse*, host plant as *Maytenus obtusifolia* var. *obovata* Mart. Type locality: MEPA, RJ. Endemic to Brazil.

17. Cecidomyiidae on *Byrsonima sericea* DC. (Malpighiaceae). Gall: on stem, ovoid, 1.5 cm long, 0.8 cm wide, brown, glabrous, one or multichambered. Ref.: Maia (2001a). Not endemic.

Table 2
Richness of gall-inducing insects by plant family and species based on literature compilation in the Environmental Protection Area of Maricá (Maricá, RJ, Southeastern Brazil).

Plant family (n=31)	Richness of host species (n=56)	Richness of gall-inducing Insects (n=108)	Average of gall-inducing insects by family
Anacardiaceae	2	2 (Hemiptera)	1
Apocynaceae	2	1 (Cecidomyiidae)	1
		1 (Hemiptera)	
		Total: 2	
Asteraceae	1	2 (Cecidomyiidae)	2
Bignoniaceae	1	3 (Cecidomyiidae)	3
Boraginaceae	1	3 (Cecidomyiidae)	4
		1 (Hemiptera)	
		Total: 4	
Burseraceae	2	2 (Cecidomyiidae)	1.5
		1 (Hemiptera)	
		Total: 3	
Cactaceae	1	1 (Cecidomyiidae)	1
Celastraceae	1	2 (Cecidomyiidae)	2
Chysobalanaceae	1	2 (Cecidomyiidae)	2
Clusiaceae	2	2 (Cecidomyiidae)	2
		2 (Lepidoptera)	
		Total: 4	
Convolvulaceae	1	1 (Cecidomyiidae)	1
Erythroxylaceae	1	4 (Cecidomyiidae)	4
Euphorbiaceae	1	3 (Cecidomyiidae)	3
Fabaceae	5	6 (Cecidomyiidae)	1.2
Lamiaceae	1	1 (Cecidomyiidae)	1
Lauraceae	1	1 (Cecidomyiidae)	2
		1 (Hemiptera)	
		Total: 2	
Loranthaceae	2	2 (Cecidomyiidae)	1
Malpighiaceae	3	4 (Cecidomyiidae)	2
		2 (Lepidoptera)	
		Total: 6	
Myrtaceae	9	20 (Cecidomyiidae)	3.1
		1 (Coleoptera)	
		3 (Hymenoptera)	
		2 (Thysanoptera)	
		2 (not determined)	
		Total: 28	
Nyctaginaceae	1	7 (Cecidomyiidae)	8
		1 (Hymenoptera)	
		Total: 8	
Ochnaceae	1	1 (Cecidomyiidae)	1
Olacaceae	1	1 (Cecidomyiidae)	1
Phytolaccaceae	1	1 (Cecidomyiidae)	1
Polypodiaceae	1	1 (Cecidomyiidae)	2
		1 (Lepidoptera)	
		Total: 2	
Primulaceae	1	1 (Cecidomyiidae)	2
		1 (Lepidoptera)	
		Total: 2	
Santalacaeae	1	1 (Cecidomyiidae)	1
Sapindaceae	1	2 (Cecidomyiidae)	2
Sapotaceae	7	6 (Cecidomyiidae)	0.8
Smilacaceae	1	2 (Cecidomyiidae)	3
		1 (Hemiptera)	
		Total: 3	
Rubiaceae	1	1 (Cecidomyiidae)	1
Verbenaceae	1	1 (Cecidomyiidae)	1

18. Cecidomyiidae on *Eugenia punicifolia* (Kunth) DC. (Myrtaceae). Gall: on fruit. Ref.: Monteiro et al. (1994) - host plant as *Eugenia ovalifolia* Cambess. Endemic to Brazil.

19. Cecidomyiidae on *Manilkara subsericea* (Mart.) Dubard (Sapotaceae). Gall: on leaf, lenticular, intralaminar, 0.7-0.4 cm long, 0.4-0.2 cm wide, green, glabrous, multichambered. Refs.: Monteiro et al. (1994), Maia (2001a). Endemic to Brazil.

20. Cecidomyiidae on *Myrciaria floribunda* (West ex Willdenow) Berg. (Myrtaceae). Gall: on leaf, stellate, extralaminar, 0.4 cm in diameter, with a small cylinder in the middle, green or yellow, glabrous, multichambered. Ref.: Maia (2001a). Not endemic.

21. Cecidomyiidae on *Myrsine parvifolia* (A.DC.) Mez. (Primulaceae). Gall: on leaf, lenticular, intralaminar, 0.4 cm in diameter, green, glabrous, multichambered. Ref.: Maia (2001a) - host plant as *Rapanea parvifolia* (A. DC) Mez.; plant family as Myrsinaceae. Not endemic.

22. Cecidomyiidae on *Phoradendron piperoides* (H. B. & K.) (Santalaceae). Gall: on leaf, lenticular, intralaminar, green, glabrous, one-chambered. Refs.: Monteiro et al. (1994), Maia (2013). Not endemic*.

23. Cecidomyiidae on *Sideroxylon obtusifolium* (Roem. Ex Schultz.) (Sapotaceae). Gall: on leaf. Ref.: Monteiro et al. (1994) - host plant as *Bumelia obtusifolia* Roem. & Schult. Not endemic*.

24. Cecidomyiidae on *Smilax rufescens* Griseb (Smilacaceae). Gall: on midvein, fusiform, 0.7 cm long, 0.4 cm wide, green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Brazil.

25. Cecidomyiidae on *Smilax rufescens* Griseb (Smilacaceae). Gall: on leaf, lenticular, intralaminar, 0.3 cm in diameter, green or yellow, glabrous, one-chambered. Ref.: Maia (2001a) - gall-inducer as *Smilasioptera candelariae* Mohn, 1975 (Cecidomyiidae) – misidentification. Endemic to Brazil.

26. Cecidomyiidae on *Solanum affine* Sendth (Solanaceae). Gall: on leaf, globular, extralaminar, 0.4 cm in diameter, yellow, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Brazil.

27. Cecidomyiidae on *Solanum* aff. *cordifolium* Dunal (Solanaceae). Gall: on leaf. Ref.: Monteiro et al. (1994) - host plant as *Solanum* aff. *subscandens* Vell. Endemic to Brazil.

28. Cecidomyiidi on *Protium brasiliense* (Spr.) Engl. (Burseraceae). Gall: on leaf, conical, extralaminar, 0.6-1.0 cm long, 0.1-0.3 cm wide (at the base), green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Brazil.

29. Cecidomyiidi on *Ocotea notata* (Ness) Mez. (Lauraceae). Gall: on bud, ovoid, with an apical spine-like projection, 0.7 cm long (including the apical projection), 0.4 cm wide, green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Brazil.

30. Cecidomyiinae on *Fridericia conjugata* (Vell.) Mart (Bignoniaceae). Gall: on ovary, spherical, 1.2 cm in diameter, purple, glabrous, one-chambered. Ref.: Maia (2001a) - host plant as *Arrabidaea conjugata* (Vell.) Mart. Not endemic*.

31. Cecidomyiinae on *Eugenia uniflora* L. (Myrtaceae). Gall: on fruit, conical, 0.3 cm long, 0.2 cm wide (at the base), glabrous, multichambered. Ref.: Maia (2001a). Not endemic.

32. Cecidomyiinae on *Neomitranthes obscura* (DC.) N. J. E. Silveira (Myrtaceae). Gall: on leaf, triangular, 0.2 cm long, 0.3 mm wide (at the base), red or green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Atlantic forest.

33. *Cerciplanus maricaensis* Maia, 2022 on *Ouratea cuspidata* (St. Hil.) Engl. (Ochnaceae). Gall: on leaf, barrel-like with a pointed projection at the apex, extralaminar, 0.5 cm long, 0.3 cm wide (at the base), brown, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Contarinia* sp. - misidentification, Maia (2022b). Type localities: Grumari (Rio de Janeiro) and MEPA, RJ. Endemic to Brazil.

34. *Clinodiplosis conica* Oliveira & Maia, 2008 on *Microstachys corniculata* (Vahl) Griseb. (Euphorbiaceae). Gall: on bud, conical, 0.5-0.8 cm long, 0.1-0.2 cm wide (at the base), red, glabrous, multichambered. Refs.: Oliveira and Maia (2008), Maia (2001a) - gall-inducer as Cecidomyiinae, host plant as *Sebastiania glandulosa* (Mart.) Pax. Type locality: MEPA, RJ. Not endemic.

35. *Clinodiplosis costai* Maia, 2005 on *Paullinia weinmanniifolia* Mart. (Sapindaceae). Gall: rolled young leaf, 0.7 cm long, 0.1-0.2 cm wide, green or yellow, glabrous, multichambered. Refs: Maia (2001a) - gall-inducer as *Clinodiplosis* sp., Maia (2005). Type localities: Carapebus and MEPA, RJ. Endemic to Atlantic forest.

36. *Clinodiplosis melissae* Maia, 1993 on *Melissa officinalis* L. (Lamiaceae). Gall: on leaf, spherical, extralaminar, green, with tricomes, one-chambered. Ref.: Maia (1993a) - plant family as Labiatae. Type locality: MEPA, RJ. Not endemic*.

37. *Clinodiplosis profusa* Maia, 2001 on *Eugenia uniflora* L. (Myrtaceae). Gall: on leaf, conical, extralaminar, 0.6 cm long, 0.2 cm wide, green or red, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Clinodiplosis* sp., Maia (2001b). Type locality: MEPA, RJ. Not endemic.

38. *Clinodiplosis* sp. on *Erythroxylum ovalifolium* Peyr. (Erythroxylaceae). Gall: rolled young leaf, 0.8-1.0 cm long, 0.2-0.3 cm wide, green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Atlantic forest.

39. *Clinodiplosis* sp. on *Mikania hoehnei* Robinson (Asteraceae). Gall: Leaf roll, 1.0 cm long, 0.3 cm wide, green, glabrous, one-chambered. Ref.: Maia (2001a). Endemic to Brazil*.

40. *Clusiamyia nitida* Maia, 1996 on *Clusia lanceolata* Camb. (Clusiaceae). Gall: on leaf, globoid, intralaminar, 0.6-1.1 cm in diameter, green or red, glabrous, monothalamous. Refs.: Maia (1996a, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest.

41. *Cordiamyia globosa* Maia, 1996 on *Varronia curassavica* (Boraginaceae). Gall: on leaf, globular, extralaminar, 0.5 cm in diameter, green, with trichomes, multichambered. Refs.: Maia (1996b, 2001a) - host plant as *Cordia verbenacea* D.C.. Type locality: MEPA, RJ. Not endemic.

42. *Costadiplosis maricaensis* Viceconte & Maia, 2009 on *Psittacanthus dichrous* (Mart.) Mart. (Loranthaceae). Gall: on leaf, lenticular, intralaminar, 0.4 cm in diameter, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Clinodiplosiini, Viceconte and Maia (2009). Type locality: MEPA, RJ. Endemic to Brazil.

43. *Dasineura byrsonimae* Maia, 2010 on *Byrsonima sericea* DC. (Malpighiaceae). Gall: on leaf, lenticular, intralaminar, 0.3 cm in diameter, green on adaxial surface and brown on abaxial surface glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Oligotrophini, Maia (2010). Type locality: Carapebus and MEPA, RJ. Not endemic.

44. *Dasineura couepiae* Maia, 2001 on *Couepia ovalifolia* (Schott) Benth. (Chrysobalanaceae). Gall: on leaf, globoid, intralaminar, 0.4 cm in diameter, green, glabrous, multichambered. Ref.: Maia (2001a) - gall-inducer as *Dasineura* sp., Maia (2001b). Type locality: MEPA, RJ. Endemic to Atlantic forest.

45. *Dasineura globosa* Maia, 1995 on *Eugenia astringens* Cambess. (Myrtaceae). Gall: on leaf, globoid, intralaminar, 0.6 cm in diameter, yellow, glabrous, multichambered. Refs.: Maia (1995a, 2001a) - host plant as *Eugenia rotundifolia* Casar. Type locality: MEPA, RJ. Endemic to Atlantic forest.

46. *Dasineura marginalis* Maia, 2005 on *Eugenia astringens* Cambess. (Myrtaceae). Gall: marginal leaf roll, 2.0-2.5 cm long, 0.2 cm wide, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Cecidomyiidi, host plant as *Eugenia rotundifolia* Casar, Maia et al. (2005) - host plant as *E. rotundifolia*. Type localities: Macaé and Arraial do Cabo, RJ. Endemic to Atlantic forest.

47. *Dasineura myrciariae* Maia, 1995 on *Myrciaria floribunda* (West ex Willdenow) Berg. (Myrtaceae). Gall: marginal leaf roll, 0.6 cm long, 0.1 cm wide, green, glabrous, multichambered. Refs.: Maia (1995a, 2001a). Type locality: MEPA, RJ. Not endemic.

48. *Dasineura ovalifoliae* Maia & Fernandes, 2011 on *Erythroxylum ovalifolium* Peyr. (Erythroxylaceae). Gall: on leaf, triangular, 0.2 cm long, 0.1 cm wide (at the base), greenish, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Lasiopteridi, Maia and Fernandes (2011). Type locality: MEPA, RJ. Endemic to Atlantic forest.

49. *Dasineura tavaresi* Maia, 1995 on *Neomitranthes obscura* (DC.) N. Silveira (Myrtaceae). Gall: marginal leaf roll, 1.0 cm long, 0.5 cm wide, green, glabrous, multichambered. Refs.: Maia (1995a, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest.

50. *Dasineura* sp. on *Microstachys corniculata* (Vahl) Griseb. (Euphorbiaceae). Gall: marginal leaf roll, 0.6-0.7 cm long, 0.1 cm wide, green, glabrous, multichambered. Ref.: Maia (2001a) - host plant as *Sebastiania glandulosa* (Mart.) Pax. Not endemic.

51. *Dasineura* sp. on *Myrcia ovata* Cambess. (Myrtaceae). Gall: on leaf, globular, 0.1 cm in diameter, yellow, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Atlantic forest*.

52. *Dasineura* sp. on *Myrcia ovata* Cambess. (Myrtaceae). Gall: on flower peduncle, ovoid; 1.3 cm long, 0.2cm wide, glabrous, green, monothalamous. Ref.: Maia 2001a. Endemic to Atlantic forest*.

53. *Jorgenseniella eugeniae* Maia, 2005 on *Eugenia astringens* Cambess. (Myrtaceae). Gall: on leaf, lenticular, intralaminar, green, glabrous, one-chambered. Ref.: Maia et al. (2005) - host plant as *Eugenia rotundifolia* Casar and *E. umbelliflora* Berg. Type localities: Macaé and Arraial do Cabo, RJ. Endemic to Atlantic forest.

54. *Lopesia erythroxyli* Rodrigues & Maia, 2010 on *Erythroxylum ovalifolium* Peyr. (Erythroxylaceae). Gall: on bud, conical, 0.9-1.1 cm long, 0.1-0.3 cm wide, almost entirely green, except by the brown apex, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Cecidomyiinae, Rodrigues and Maia (2010). Type localities: Grumari (Rio de Janeiro), Carapebus and MEPA, RJ. Endemic to Atlantic forest.

55. *Lopesia grandis* Maia, 2001 on *Dalbergia ecastophylla* L. Taub. (Fabaceae). Gall: on leaf, discoid, extralaminar, 0.4 cm in diameter, green, glabrous, multichambered. Refs.: Maia (2001b, 2021). Type locality: Carapebus, RJ. Not endemic.

56. *Lopesia marginalis* Maia, 2001 on *Couepia ovalifolia* (Schott) Benth. (Chrysobalanaceae). Gall: marginal leaf roll, 0.8-1.5 cm long, 0.1-0.3 cm wide, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Lopesiini, Maia (2001b). Type locality: MEPA, RJ. Endemic to Atlantic forest.

57. *Lopesia maricaensis* Rodrigues & Maia, 2010 on *Protium brasiliense* (Spr.) Engl. (Burseraceae). Gall: marginal leaf roll, 1.0-1.7 cm long, 0.1-0.2 cm wide, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Cecidomyiinae, Rodrigues and Maia (2010). Type locality: MEPA, RJ. Endemic to Brazil.

58. *Lopesia singularis* Maia, 2001 on *Pouteria venosa* (Mart.) Baehni and *Pouteria psammophila* (Mart.) Radlk. (Sapotaceae). Gall: on leaf, globoid, intralaminar, 0.4-0.5 cm in diameter, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Lopesiini, Maia (2001b). Type localities: Itaipuaçu (Maricá) and MEPA, RJ. Not endemic.

59. Lopesiini on *Varronia curassavica* (Boraginaceae). Gall: on leaf petiole or midvein, ovoid, 0.3-0.4 cm long, 0.3 cm wide (at the base), green, glabrous, multichambered. Ref.: Maia (2001a) - gall-inducer as *Clinodiplosis* sp. – misidentification, host plant as *Cordia verbenacea* D.C. Not endemic.

60. *Maiamyia triangularis* (Maia & Nava, 2011) on *Eugenia uniflora* L. (Myrtaceae). Gall: on leaf, conical, intralaminar, green or red, glabrous, one-chambered. Refs.: Maia and Nava (2011) - gall-inducer as *Eugeniamyia triangularis*, Evenhuis (2022). Type locality: MEPA, RJ. Not endemic*.

61. *Mayteniella distincta* Maia, 2001a on *Monteverdia obtusifolia* (Mart.) Biral (Celastraceae). Gall: on leaf, globoid, intralaminar, 0.6-0.7 cm in diameter, green or yellow, glabrous, multichambered, remarkable due to its hard walls. Refs.: Maia (2001a) - gall-inducer as Oligotrophini; host plant as *Maytenus obtusifolia* var. *obovata* Mart., Maia (2001b). Type localities: Itaipuaçu (Maricá) and MEPA, RJ. Endemic to Atlantic forest.

62. *Meunieriella* sp. on *Andira fraxinifolia* Benth. (Fabaceae). Gall: on leaf, globose, extralaminar, yellow, glabrous, one-chambered. Ref.: Maia et al. (2002). Endemic to Brazil.

63. *Meunieriella* sp. on *Inga laurina* (Sw.) Willd (Fabaceae). Gall: on leaf, cylindrical, extralaminar, green, glabrous, one-chambered. Ref.: Maia et al. (2002). Not endemic.

64. *Myrciamyia maricaensis* Maia, 1995 on *Myrcia ovata* Cambess. (Myrtaceae). Gall: on bud, ovoid with longitudinal ridges extending from base to apex, 1.0 cm long, 0.2-0.3 cm wide, yellow, glabrous, multichambered. Refs.: Maia (1995b, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest. Ferraz and Monteiro (2003) reported the host plant as *Myrcia lundiana* Kiaersk.

65. *Myrciariamyia bivalva* Maia, 1994 (Cecidomyiidae) on *Myrciaria floribunda* (West ex Willdenow) Berg. (Myrtaceae). Gall: on bud, bivalve, ovoid, 0.7cm long, 0.5 cm wide, green or yellow, glabrous, multichambered. Refs.: Maia (1994, 2001a). Type locality: MEPA, RJ. Not endemic.

66. *Neolasioptera cerei* Rübsaamen, 1905 on *Hylocereus setaceus* (Salm-Dyck) R.Bauer (Cactaceae). Gall: on stem, ovoid; 2.5-3 0 cm long, 2.5 cm wide, green, glabrous, multichambered. Refs.: Rübsaamen (1905), Maia (2001a) - host plant as *Selenicereus setaceus* (SO) Berg. Type locality: Cabo Frio, RJ. Not endemic.

67. *Neolasioptera eugeniae* Maia, 1993 on *Eugenia uniflora* L. (Myrtaceae). Gall: on leaf, lenticular, 0.25 cm in diameter, green or red, glabrous, multichambered. Refs.: Maia (1993b, 2001a). Type locality: MEPA, RJ. Not endemic.

68. *Neolasioptera* sp. on *Fridericia conjugata* (Vell.) Mart. (Bignoniaceae). Gall: on stem, tendril or midvein, fusiform, 0.5-0.7 cm long, 0.2-0.3 cm wide, green, glabrous, one-chambered. Ref.: Maia (2001a) - host plant as as *Arrabidaea conjugata* (Vell.) Mart. Not endemic.

69. *Neolasioptera* sp. on *Inga laurina* (Sw.) Willd (Fabaceae). Gall: on midvein, fusiform, green, glabrous, one-chambered. Ref.: Maia et al. (2002). Not endemic.

70. *Neolasioptera* sp. on *Inga maritima* Benth. (Fabaceae). Gall: on stem, leaf vein and petiole, 0.7 cm long, 0.1 cm wide, green, glabrous, multichambered. Ref.: Maia (2001a). Endemic to Brazil*.

71. *Neomitranthella robusta* Maia, 1995 on *Neomitranthes obscura* (DC.) N. J. E. Silveira (Myrtaceae). Gall: on bud, pine-like, 2.5 cm long, 0.8cm wide (at the base), green, glabrous, without internal chamber. Refs.: Maia (1995b, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest.

72. *Parazalepidota clusiae* Maia 2001 on *Clusia fluminensis* Tr. & Pl. (Clusiaceae). Gall: on leaf, globoid, intralaminar, 0.5 cm in diameter, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Asphondyliini, near *Zalepidota* Rübsaamen, 1907; Maia (2001b). Type localities: Niterói and MEPA, RJ. Endemic to Atlantic forest.

73. *Paulliniamyia ampla* Maia, 2001 on *Paullinia weinmanniifolia* Mart. (Sapindaceae). Gall: on leaf, conical, etralaminar, 0.6 cm long, 0.2 cm wide, green or yellow, glabrous, multichambered. Refs: Maia (2001a) - gall-inducer as Oligotrophini, near

Ficiomyia Felt, 1922; Maia (2001b). Type localities: Arraial do Cabo, Carapebus and MEPA, RJ. Endemic to Atlantic forest.

74. *Pisphondylia braziliensis* Couri & Maia, 1992 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on bud, rosette of leaves with tubular galls in the base, tube length: 0.4cm; tube width: 0.1 cm, green, glabrous, multichambered. Refs.: Couri and Maia (1992), Maia (2001a). Type locality: MEPA, RJ. Not endemic.

75. *Primadiplosis microgrammae* Maia, 2011 on *Microgramma vacciniifolia* (Langsd. & Fisch.) Copel. (Polypodiaceae). Gall: on bud, ovoid, 4.4–8.8 mm long, 4.1–5.9 mm wide, green, one-chambered, with scattered scales that become imbricate at the apices of the gall. Ref: Maia and Santos (2011). Type locality: MEPA, RJ. Not endemic*.

76. *Proasphondylia formosa* Maia, 1993 (Cecidomyiidae) on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on bud, spherical, red, with trichomes, one- or multichambered. Ref.: Maia (1993c). Type locality: MEPA, RJ. Not endemic.

77. *Proasphondylia guapirae* Maia, 1993 on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on stem, ovoid, 0.8 cm long, 0.4 cm wide, brown, multichambered. Refs.: Maia (1993c, 2001a). Type locality: Arraial do Cabo, RJ. Not endemic.

78. *Schismatodiplosis lantanae* (Rübsaamen, 1908) on *Lantana camara* L. (Verbenaceae). Gall: on leaf, globoid, extralaminar, green, with trichomes, one-chambered. Refs.: Rübsaamen (1908, 1915), Maia (2001a). Type localities: Cabo Frio, RJ and Tubarão, SC. Not endemic.

79. *Schizomyia maricaensis* Sousa & Maia, 2007 on *Tetrapteris phlomoides* (Spr.) Nied. (Malpighiaceae). Gall: on bud, rosette of leaves with small cylinders at the bottom, cylinder length: 0.4 cm; cylinder width: 0.1 cm, green, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as Asphondyliini, Sousa and Maia (2007). Type locality: MEPA, RJ. Not endemic.

80. *Schizomyia santosi* Maia & Araújo, 2009 on *Jacquemontia holosericea* (Weinm) O`Donell (Convolvulaceae). Gall: on bud flower, 1.0 cm long, 0.4 cm wide, green. Refs.: Maia (2001a) - gall-inducer as *Schizomyia* sp., Maia and Araújo (2009). Type localities: Itaipuaçu (Maricá) and MEPA, RJ. Not endemic.

81. *Schizomyia spherica* Maia & Oliveira, 2007 on *Microstachys corniculata* (Vahl) Griseb. (Euphorbiaceae). Gall: on bud, spherical, 0.5 cm in diameter, green or yellow, glabrous, multichambered. Refs.: Maia (2001a) - gall-inducer as *Schizomyia* sp., host plant as *Sebastiania glandulosa* (Mart.) Pax; Maia and Oliveira (2007) - host plant as *S. glandulosa*. Type locality: MEPA, RJ. Not endemic.

82. *Stephomyia espiralis* Maia, 1993 on *Eugenia copacabanensis* Kiaersk. (Myrtaceae). Gall: on leaf, spiral, extralaminar, 0.4 cm long, 0.2 cm wide, green or red, glabrous, multichambered. Refs.: Maia (1993d, 2001a). Type localities: Arraial do Cabo and MEPA, RJ. Endemic to Atlantic forest.

83. *Stephomyia mina* Maia, 1993 on *Neomitranthes obscura* (DC.) N. J. E. Silveira (Myrtaceae). Gall: on leaf, conical, extralaminar, 0.8 cm long, 0.1-0.2 cm wide, green or red, glabrous, multichambered. Refs.: Maia (1993d, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest.

84. *Stephomyia rotundifoliorum* Maia, 1993 on *Eugenia astringens* Cambess. (Myrtaceae). Gall: usually on stem and rarely on leaf, cylindrical, 1.5- 1.8 cm long, 0.4-0.5 cm wide, brown, glabrous, one-chambered. Refs.: Maia (1993d, 2001a) -host plant as *Eugenia rotundifolia* Casar. Type locality: MEPA, RJ. Endemic to Atlantic forest.

85. *Stephomyia tetralobae* Maia, 1993 on *Eugenia copacabanensis* Kiaersk. (Myrtaceae). Gall: on leaf, fusiform, extralaminar, 0.9 cm long, 0.2 cm wide, green or red, glabrous, multichambered. Refs.: Maia (1993d, 2001a). Type locality: MEPA, RJ. Endemic to Atlantic forest.

86. *Youngomyia pouteriae* Maia, 2001 on *Pouteria caimito* (R. & P.) Radlk. var. *laurifolia* (Gomes) Baehni (Sapotaceae). Gall: on leaf, cylindrical, extralaminar, green, 0.5-0.3 cm long, 0.1-0.2 cm wide, green, glabrous, except apically. Refs.: Maia (2001a) - gall-inducer as Cecidomyidi, Maia (2001c). Type locality: MEPA, RJ. Not endemic.

Coleoptera

87. *Pacholenus pelliceus* Boheman, 1836 (Curculionidae) on *Myrcia ilheosensis* Kiaersk and *Myrcia brasiliensis* Kiaersk (Myrtaceae). Gall: on stem, fusiform, brown, glabrous, one-chambered (personal observation). Refs.: Monteiro et al. (1994) - gall-inducer as Coleoptera, host plants as *Gomidesia martiniana* Berg and *G. fenzliana* Berg.), Vanin et al. (2000) - host plants as *G. martiniana* Berg and *G. fenzliana* Berg. Type locality: unknown (according to Vanin and Reichardt 1976). Endemic to Brazil.

Hemiptera

88. *Calophya terebinthifolii* Burckhardt & Basset, 2000 on *Schinus terebinthifolia* Raddi (Anacardiaceae). Gall: concavity on leaf, green, glabrous, one-chambered (personal observation). Refs.: Monteiro et al. (1994) - gall-inducer as Homoptera, Burckhardt and Basset (2000), Maia (2013). Type locality: Mauá, SP. Not endemic.

89. Psyllidae on *Aspidosperma pyricollum* Muell. Arg. (Apocynaceae). Gall: concavity on leaf, green, glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994) - gall-inducer as Homoptera. Endemic to Brazil.

90. Psyllidae on *Protium heptaphyllum* (Aublet.) March (Burseraceae). Gall: on leaf. Ref.: Monteiro et al. (1994). Not endemic.

91. Hemiptera on *Astronium* sp. (Anacardiaceae). Gall: on leaf, globoid, intralaminar, red or green, with rough surface, glabrous, one-chambered. Ref.: Maia (2001a)* - host plant as *Atronium* sp. – misspelling.

92. Hemiptera on *Varronia curassavica* Jacq.(Boraginaceae). Gall: on leaf. Ref.: Monteiro et al. (1994) - gall-inducer as Homoptera. Not endemic.

93. Hemiptera on *Ocotea notata* (Ness) Mez. (Lauraceae). Gall: concavity on leaf, green, glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994) - gall-inducer as Homoptera. Endemic to Brazil.

94. Hemiptera on *Smilax rufescens* Griseb (Smilacaceae). Gall: on leaf, conical, extralaminar, green glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994). Endemic to Brazil.

Hymenoptera

95. Hymenoptera on *Eugenia copacabanensis* Kiaersk. (Myrtaceae). Gall: on midvein, fusiform, green, glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994). Endemic to Atlantic forest.

96. Hymenoptera on *Eugenia punicifolia* (Kunth) DC. (Myrtaceae). Gall: on stem. Ref.: Monteiro et al. (1994) - host plant as *Eugenia ovalifolia* Cambess. Endemic to Brazil.

97. Hymenoptera on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae). Gall: on stem. Ref.: Monteiro et al. (1994). Not endemic.

98. Hymenoptera on *Neomitranthes obscura* DC.) N. J. E. Silveira (Myrtaceae). Gall: stem. Ref.: Monteiro et al. (1994). Endemic to Atlantic forest*.

Lepidoptera

99. *Tortrimosaica polypodivora* (Brown et al., 2004) on *Microgramma vacciniifolia* (Langsd. & Fisch.) Copel. (Polypodiaceae). Gall: on apical bud, ellipsoid, reddish, with trichomes, one-chambered. Refs.: Brown et al. (2004), Maia and Santos (2015). Type locality: São Paulo, SP. Not endemic.

100. Lepidoptera on *Byrsonima sericea* DC. (Malpighiaceae). Gall: on bud flower. Ref.: Monteiro et al. (1994). Not endemic.

101. Lepidoptera on *Clusia fluminensis* Tr. & Pl. (Clusiaceae). Gall: on leaf, ellipsoid, intralaminar, green, glabrous, one-chambered (personal observation). Endemic to Atlantic forest*.

102. Lepidoptera on *Clusia lanceolata* Camb. (Clusiaceae). Gall: on leaf, ellipsoid, intralaminar, green, glabrous, one-chambered. Ref.: Maia (2013). Endemic to Atlantic forest.

103. Lepidoptera on *Stigmaphyllon paralias* A. Juss. (Malpighiaceae). Gall: on stem, fusiform, brown, glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994). Endemic to Brazil.

104. Lepidoptera on *Myrsine parvifolia* (A.DC.) Mez. (Primulaceae). Gall: on stem, fusiform, brown, glabrous, one-chambered (personal observation). Ref.: Monteiro et al. (1994) - host plant as *Rapanea parvifolia* (A. DC) Mez.). Not endemic.

Thysanoptera

105. Thysanoptera on *Myrciaria floribunda* (West ex Willdenow) Berg. (Myrtaceae). Gall: rolled leaf, green, many brownish perforations, glabrous, one-chambered. Refs.: Monteiro et al. (1994), Maia 2006. Not endemic*.

106. Thysanoptera on *Neomitranthes obscura* (DC.) N. J. E. Silveira (Myrtaceae). Gall: rolled leaf, green, many reddish perforations, glabrous, one-chambered. Ref.: Monteiro et al. (1994), Maia (2006). Endemic to Atlantic forest.

Gall-inducing insect not determined

107. Gall-inducer not determined on *Eugenia copacabanensis* Kiaersk. (Myrtaceae). The only information about this gall morphotype is the host organ – leaf. Ref.: Monteiro et al. (1994). Endemic to Atlantic forest.

108. Gall-inducer not determined on *Eugenia copacabanensis* Kiaersk. (Myrtaceae). The only information about this gall morphotype is the host organ – stem. Ref.: Monteiro et al. (1994). Endemic to Atlantic forest.

Despite the little information provided about these galls, Monteiro et al. (1994) recorded them as being different from each other. This position was maintained in the present study, since most cecidogenous insects are specific in relation to the host organ (Fernandes & Price 1988).

Field work

Of the 108 gall-inducing species previously recorded in the MEPA, 90 were collected again (83.3%) (galls and/or inducers) (Table 1).

Nevertheless, three species (*Asphondylia sennae*, *Clinodiplosis melissae*, and *Maiamyia triangularis*) and nine morphospecies of Cecidomyiidae (Asphondyliina on *Phytolacca* cfr. *esculenta* - bud gall, Cecidomyiidae on *E.punicifolia* - fruit gall, Cecidomyiidae on *Sideroxylon obtusifolium* - leaf gall, Cecidomyiidae on *Solanum* aff. *cordifolium* - leaf gall, Cecidomyiidi on *Ocotea notata* - bud gall, Cecidomyiinae on *Eugenia uniflora* – fruit gall, Cecidomyiinae on *Fridericia conjugata* - ovary gall, *Meunieriella* sp. on *Inga laurina* - leaf gall, and *Neolasioptera* sp. on *Inga laurina* – midvein gall were not found again. Regarding the Hymenoptera and Hemiptera, two morphospecies induced by each order were not collected: the former on *Eugenia punicifolia* and *Guapira opposita,* the latter on *Protium heptaphyllum* and *Varronia curassavica*. Furthermore, two gall morphotypes on *Eugenia copacabanensis* whose the inducers are unknown were not found.

On the other hand, 22 gall morphotypes were found for the first time in this restinga. They are associated with 17 plant species. Among them, *Schwartzia brasiliensis* (Choisy) Bedell ex Gir.-Cañas (Marcgraviaceae) and *Marcetia taxifolia* (A.St.-Hil.) DC. (Melastomataceae) were added as host plants in MEPA. Twelve gall morphotypes are new on nine plant species already reported as hosts in Brazil: on *Coccoloba* sp. (n=1), *Protium brasiliense* (n=1), *Andira fraxinifolia* (n=2), *Ocotea notata* (n=2), *Struthanthus taubatensis* (n=1), *Byrsonima sericea* (n=2), *Myrsine parvifolia* (n=1), *Eugenia copacabanensis* (n=1), and *Neomitranthes obscura* (n=1) (Table 3, Figs. 1-4). The new records of cecidogenous insects include Cecidomyiidae with 13 morphospecies, and Lepidoptera, Coleoptera, Hymenoptera and Hemiptera, each represented by a single morphospecies. The inducers of five gall morphotypes were not determined. The new data increased the richness of gall-inducing insects of the studied area from 108 to 130 (Table 1), the number of endemic gallers from 55 to 63, of each 23 are associated with Myrtaceae (36.5%).

The average of gall-inducing insects by host family increased in 14 families and decreased in a single one. However, Nyctaginaceae remained the family with the greatest gall richness (Table 4).

A new case of inquilinism was observed in galls of *Stephomyia mina* on *Neomitranthes obscura* (Myrtaceae). It is characterized by changes in the gall shape and color caused by a phytopagous species of Hymenoptera. The originally conical and green gall becomes spherical and orange (Fig. 5a).

Other results included the description of the larva and male of *Bruggmannia monteiroi* and the pupa of *Asphondylia maricensis*, already published. Due to morphological characters of the pupa, *Asphondylia maricensis* was transferred to the genus *Bruggmanniella* (Maia 2022a).

Fauna similarity

The gall-inducing fauna of MEPA is more similar to the fauna of Costa do Sol State Park than to the fauna of any other restinga investigated in Brazil. It is also notable that the fauna similarity between MEPA and other restingas of the state of Rio de Janeiro is higher than the fauna similarity between MEPA and restingas of the Espírito Santo and Southern Brazil (Fig. 6).

Discussion

Among all surveyed restingas in Brazil, MEPA is the third richest in number of gall morphotypes, being surpassed only by the Bertioga Restinga State Park (BRSP) situated in the state of São Paulo and Marambaia Island (MI) situated in the state of Rio de Janeiro (Table 5). However, the average of gall morphotypes per host plant species is higher in MEPA than in these two localities. It is important to highlight that the total area of MEPA is the shortest one. Therefore, MEPA has the greatest richness of gall-inducing species per area compared to them.

The gall-inducing fauna of MEPA is more similar to the faunas of Jurubatiba Restinga National Park and Costa do Sol State Park than to the fauna of any other restinga investigated in Brazil. It is also notable that the fauna similarity between MEPA and other restingas of the state of Rio de Janeiro is higher than the fauna similarity between MEPA and restingas of the Espírito Santo and Southern Brazil (Fig. 6). It is important to highlight that different collection efforts were done in these investigations. However, the present results are consistent with

Table 3
New records of insect galls in the Environmental Protection Area of Maricá (Maricá, RJ, Southeastern Brazil).

Host Plant Host organ/shape/ color/trichomes/		Gall morphotype: number of internal chamber	Gall-inducing insect
Family	Species		
Bignoniaceae	Bignoniaceae sp.1	Leaf/lenticular, green/without trichomes/one-chambered (Fig. 1a)	Cecidomyiidae
Boraginaceae	*Varronia curassavica* Jacq. (not endemic)	Leaf/linear/green/ with micro trichomes/ one-chambered (Fig. 1b)	Cecidomyiidae
Burseraceae	*Protium brasiliense* (Spr.) Engl. (endemic to Brazil)	Leaf/lenticular/ green/ without trichomes/one-chambered (Fig. 1c)	Hemiptera
Fabaceae	*Andira fraxinifolia* Benth. (endemic to Brazil)	Leaf/globoid/green/ with trichomes/ one-chambered (Fig. 1d)	Cecidomyiidae
		Leaf/marginal roll/ green, without trichomes/one-chambered (Fig. 1e)	Cecidomyiidae
Lauraceae	*Ocotea notata* (Ness) Mez. (endemic to Brazil)	Fruit/conical/green/ without trichomes/one-chambered (Fig. 1f)	Cecidomyiidae
		Fruit/conical/green/ without trichomes/one-chambered	Lepidoptera
Loranthaceae	*Struthanthus taubatensis* Eichler (endemic to Brazil)	Stem/fusiform/ brown/ without trichomes/ one-chambered (Fig. 2a)	Not determined
Malpighiaceae	*Byrsonima sericea* DC. (not endemic)	Closed flower/ cylindrical/ green/ without trichomes/ one-chambered (Fig. 2b)	Cecidomyiidae
		Closed flower/ ovoid/ green/ without trichomes/ one-chambered (Fig. 2c)	Cecidomyiidae
Marcgraviaceae	*Schwartzia brasiliensis* (Choisy) Bedell ex Gir.-Cañas (not endemic)	Leaf/lenticular/ green/ without trichomes/one-chambered (Fig. 2d)	Hymenoptera
Melastomataceae	*Marcetia taxifolia* (A.St.-Hil.) DC. (not endemic)	Bud/conical/ green/ with trichomes/ one-chambered (Fig. 2e)	Cecidomyiidae
Primulaceae	*Myrsine parvifolia* (not endemic)	Bud/conical/brown/ without trichomes/ one-chambered (Fig. 2f)	Chrysomelidae (Coleoptera)
Myrtaceae	*Eugenia copacabanensis* Kiaersk. (endemic to Atlantic forest)	Leaf/lenticular/green/ without trichomes/ one-chambered (Fig. 3a)	Not determined
	Neomitranthes obscura (DC.) N. J. E. Silveira (endemic to Atlantic forest)	Flower bud/conical/reddish/ without trichomes/one-chambered (Fig. 3b)	Cecidomyiidae
	Myrtaceae sp.1	Leaf/marginal roll/ green, without trichomes/one-chambered (Fig. 3c)	Not determined
		Leaf/lenticular/ green/ without trichomes/one-chambered (Fig. 3d)	Not determined
Nyctaginaceae	*Guapira opposita* (Vell.) Reitz (not endemic)	Bud/globoid/without trichomes/one-chambered (Fig. 3e)	Cecidomyiidae
Polygonaceae	*Coccoloba* sp.	Fruit/globoid/ without trichomes/ one-chambered (Fig. 3f)	Cecidomyiidae
Smilacaceae	*Smilax rufescens* Griseb (endemic to Brazil)	Stem/fusiform/brown/ without trichomes/ multichambered (Fig. 4a)	Not determined
Verbenaceae	*Lantana fucata* Lindl. (not endemic)	Leaf/cylindrical/ green/without trichomes/one-chambered (Fig. 4b)	*Asphondylia* sp. (Cecidomyiidae)
		Leaf/globoid/green/ with trichomes/ one-chambered (Fig. 4c)	Cecidomyiidae

the floristic results presented by Araújo and Henriques (1984). These authors showed that geographically closer restingas have greater plant similarity to each other than to more distant ones. Since gall-inducing insects are very specific in relation to their host plants, it is expected that restingas with similar plant composition are also similar in relation to the gall-inducing fauna. All the Brazilian restingas already investigated have low similarity with MEPA, which shows that MEPA is unique in the composition of the gall-inducers. Therefore, the preservation of this peculiar fauna depends on the preservation of MEPA.

Regarding the taxonomic knowledge of the gall-inducing insects, MEPA stands out as the restinga with the largest number of inducers identified in species (n=61), followed by Jurubatiba Restinga National Park (n=37) (Table 6). In fact, MEPA is the restinga area that has been studied for the longest time. Therefore, a greater number of specimens has been obtained, which allows several taxonomic studies. Such studies have resulted in the description and identification of a large number of gall-inducers, and made MEPA the type locality for several gall-inducing species. However, there is a high number of undetermined species (n=69), which shows the need to continue taxonomic studies in this area.

MEPA comprises gall-inducers of six insect orders: Diptera, Hemiptera, Lepidoptera, Coleoptera, Hymenoptera, and Thysanoptera. Comparing this guild composition between different restingas, we can observe that only one other restinga, Costa do Sol State Park, includes gall-inducers of the six aforementioned insect orders. In all these localities, Cecidomyiidae were the most frequent gall-inducers (Table 7). Additionally, Cecidomyiidae and Hemiptera were the only taxa represented in all Brazilian restingas already investigated, with Hemiptera being the second most frequent gall-inducers in several

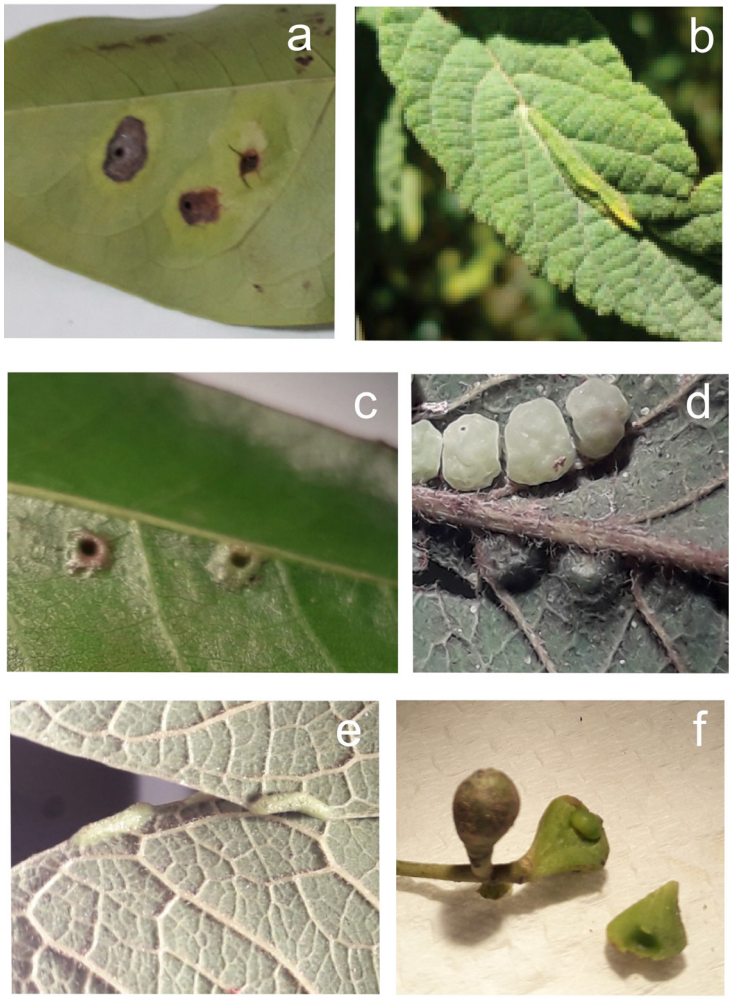

Figure 1 Insect galls from the Maricá Environmental Protected Area (Maricá, RJ): a) Lenticular leaf gall on Bignoniaceae sp.1, b) Linear leaf gall on *Varronia curassavica* Jacq. (Boraginaceae), c) Lenticular leaf gall on *Protium brasiliense* (Spr.) Engl. (Burseraceae), d-e) Galls on *Andira fraxinifolia* Benth. (Fabaceae): d) globoid, hairy leaf gall, e) Fusiform leaf vein gall, f) Fruit gall induced by Cecidomyiidae on *Ocotea notata* (Ness) Mez. (Lauraceae).

Table 4
Updated gall richness and average of gall-inducing species per plant family in the Environmental Protection Area of Maricá (Maricá, RJ, Southeastern Brazil).

Host plant family	Data from literature compilation		Updated data	
	Richness of gall-inducers	Average of gall-inducing insects by family	Richness of gall-inducers	Average of gall-inducing insects by family
Bignoniaceae	3	3	4	2
Boraginaceae	4	4	5	5
Burseraceae	3	1.5	4	2
Fabaceae	6	1	8	1.6
Lauraceae	2	1	4	4
Loranthaceae	2	1	3	1.5
Malpighiaceae	6	2	8	2.6
Marcgraviaceae	0	0	1	1
Melastomataceae	0	0	1	1
Myrtaceae	28	3.1	32	3.2
Nyctaginaceae	8	8	9	9
Polygonaceae	0	0	1	1
Primulaceae	2	2	3	3
Smilacaceae	3	3	4	4
Verbenaceae	1	1	3	1.5

localities. Hymenoptera and Thysanoptera were recorded in a few restingas and always as the least frequent gall-inducing orders, while Coleoptera and Lepidoptera occupied an intermediate position (Table 7). Since Houard (1933), Cecidomyiidae and Hemiptera have been cited as the two most frequent gall-inducing insects in South America, although with a large predominance of the former.

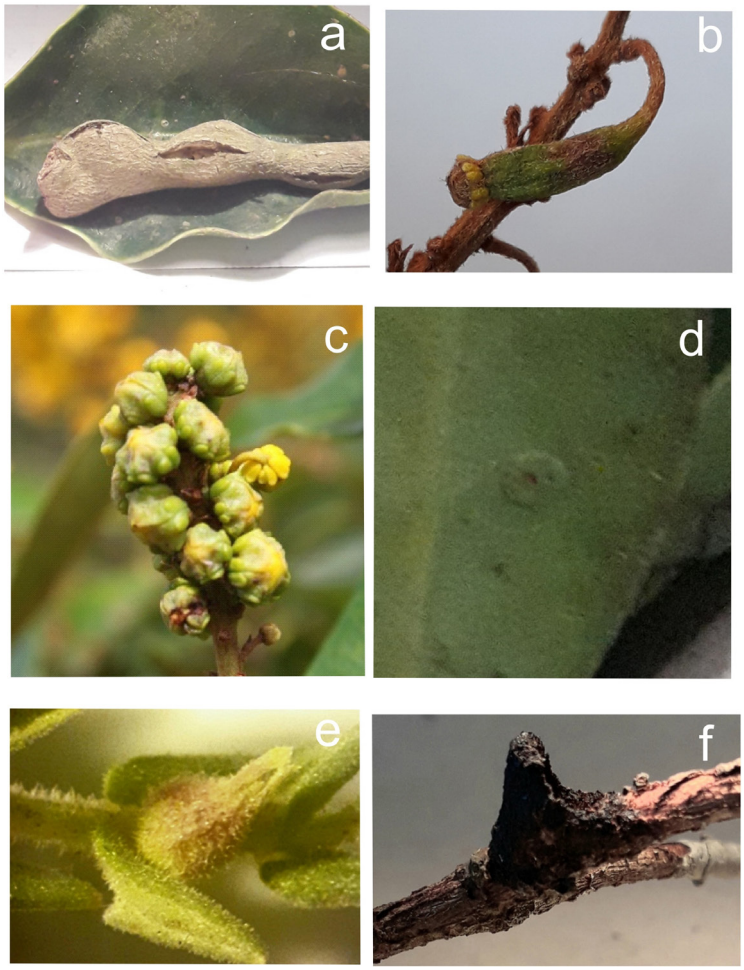

Figure 2 Insect galls from the Maricá Environmental Protected Area (Maricá, RJ): a) Fusiform stem gall on *Struthanthus taubatensis* Eichler (Loranthaceae), b-c) Flower bud galls on *Byrsonima sericea* DC. (Malpighiaceae): b) Ovoid, c) Cylindrical, d) Lenticular leaf gall on *Schwartzia brasiliensis* (Choisy) Bedell ex Gir.-Cañas (Marcgraviaceae), e) Globoid leaf gall on *Marcetia taxifolia* (A.St.-Hil.) DC. (Melastomataceae), f) Conical bud gall on *Myrsine parvifolia* (A.DC.) Mez. (Primulaceae).

Table 5
Richness of insect galls and host plant species in Brazilian restingas.

Investigated restinga	Insect gall richness	Host plant species richness	Average of galls by plant species	Reference
Bertioga Restinga de State Park (SP)	233	123	1.89	Maia et al. (2008)
Marambaia Island (RJ)	147	70	2.10	Rodrigues et al. (2014)
Maricá Environmental Protection Area	130	58	2.24	Present work
Costa do Sol State Park (RJ)	123	67	1.83	Carvalho-Fernandes et al. (2016)
Jurubatiba Restinga National Park (RJ)	98	40	2.45	Monteiro et al. (2004)
Babitonga (SC)	86	43	2.00	Melo Júnior et al. (2015)
São João da Barra (RJ)	66	38	1.74	Carvalho-Fernandes et al. (2016)
Acaraí State Park (SC)	56	31	1.81	Arriola and Melo Júnior (2016)
Grumari Restinga (RJ)	43	25	1.72	Oliveira and Maia (2005)
Arraial do Cabo (RJ)	41	27	1.52	Monteiro et al. (1994)
Paulo Cesar Vinha State Park (ES)	38	21	1.81	Bregonci et al. (2010)
Praia do Sul State Biological Reserve (RJ)	36	22	1.64	Maia and Oliveira (2010)
Marambaia Restinga (RJ)	31	24	1.29	Maia and Silva (2016)

All gall-inducing species are associated with a single host plant, except *Pacholenus pelliceus* (Coleoptera) and *Lopesia singularis* (Cecidomyiidae). The high specificity of the gall-inducers was already mentioned by several authors (Mani, 1964; Abrahamson and Weiss, 1997; Stone and Schönrogge, 2003). Concerning Brazilian species, 92% are species-specific (Carneiro et al., 2009a). These data show how gall-inducers are dependent on their host plants, and the preservation of the former depends on the preservation of the latter.

The gall-inducing guild of MEPA includes 63 endemic species and morphospecies. This large number of endemic gallers is associated with the large number of endemic plants. Most endemic gallers are found on Myrtaceae (36.5%), the woody family with most endemism

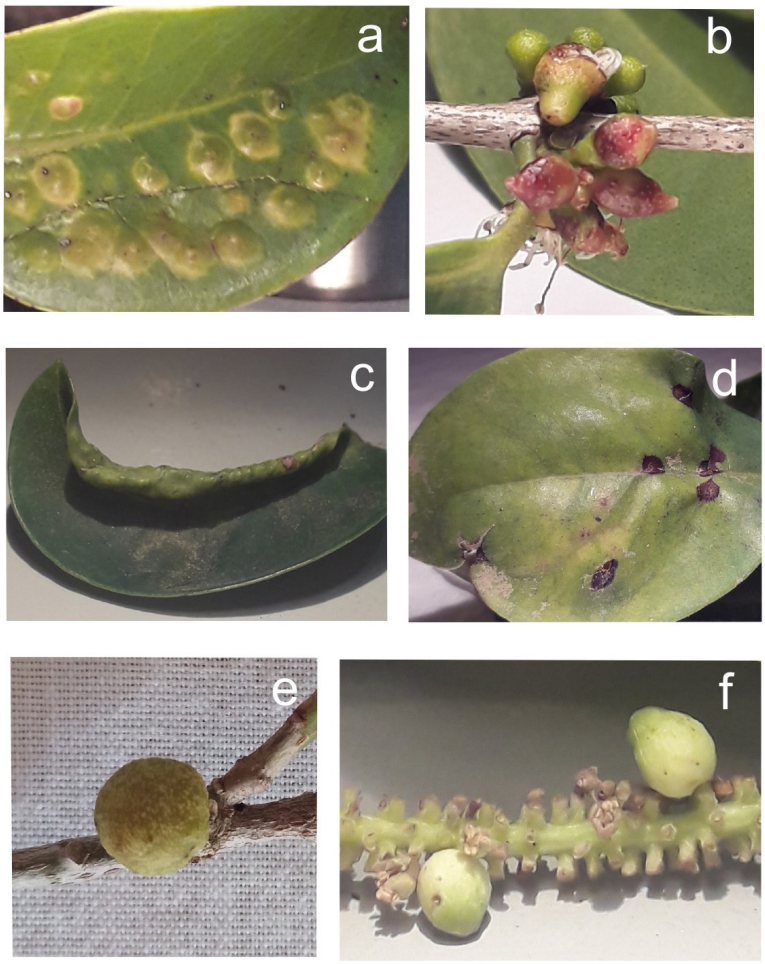

Figure 3 Insect galls from the Maricá Environmental Protected Area (Maricá, RJ): a) Lenticular leaf gall on *Eugenia copacabanensis* Kiaersk. (Myrtaceae), b) Flower bud gall on *Neomitranthes obscura* (DC.) N. J. E. Silveira (Myrtaceae), c-d) Leaf galls on Myrtaceae sp.1: c) Marginal roll, d) lenticular, e) Globoid, glabrous leaf gall on *Guapira opposita* (Vell.) Reitz (Nyctaginaceae), f) Fruit gall on *Coccoloba* sp. (Polygonaceae).

Table 6
Number and percentage of gall-inducing insects identified in species by Brazilian restingas.

Restinga	Number of gall-inducers identified in species	Reference
Marambaia Restinga (RJ)	19 (61.3%)	Maia and Silva (2016)
Maricá Environmental Protection Area	61 (46.9%)	Present work
São João da Barra (RJ)	29 (43.9%)	Carvalho-Fernandes et al. (2016)
Jurubatiba Restinga National Park (RJ)	37 (37.7%)	Monteiro et al. (2004)
Praia do Sul State Biological Reserve (RJ)	11 (30.5%)	Maia and Oliveira (2010)
Grumari Restinga (RJ)	11 (25.6%)	Oliveira and Maia (2005)
Costa do Sol State Park (RJ)	31 (25.2%)	Carvalho-Fernandes et al. (2016)
Acaraí State Park (SC)	14 (25.0%)	Arriola and Melo Júnior (2016)
Babitonga (SC)	17 (19.8%)	Melo Júnior et al. (2015)
Marambaia Island (RJ)	27 (18.4%)	Rodrigues et al. (2014)
Paulo Cesar Vinha State Park (ES)	6 (15.8%)	Bregonci et al. (2010)
Bertioga Restinga State Park (SP)	27 (11.6%)	Maia et al. (2008)
Arraial do Cabo (RJ)	0 (0%)	Monteiro et al. (1994)

in the Atlantic Forest. The high rate of endemic gallers increases the importance of MEPA in conserving the Brazilian biodiversity.

Nyctaginaceae, Boraginaceae, and Erythroxylaceae showed the greatest average of gall-inducing species by plant species. However, these families are not the best represented in MEPA in terms of species richness, which contradicts the taxon size hypothesis. Nyctaginaceae are represented by four species, Boraginaceae by three and Erythroxylaceae by four (Silva and Oliveira, 1989). All of them include a single galled plant species, but these species are super hosts, which explains their highest value. Nevertheless, the family Myrtaceae shelters the greatest richness of gall-inducing insects and the greatest richness of host plant species in MEPA. In several other insect galls inventories in restingas,

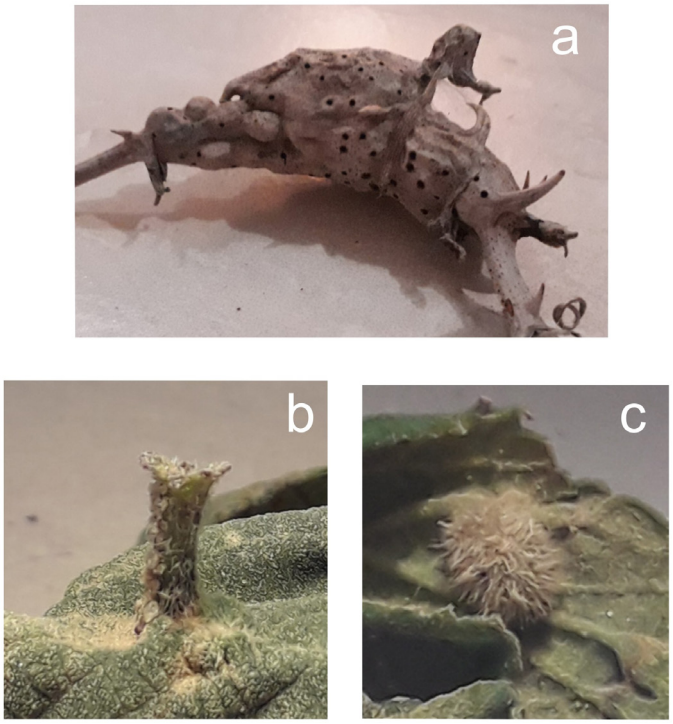

Figure 4 Insect galls from the Maricá Environmental Protected Area (Maricá, RJ): a) Fusiform stem gall on *Smilax rufescens* Griseb (Smilacaceae), b-c) Leaf galls on *Lantana fucata* Lindl. (Verbenaceae): b) Globoid, c) Cylindrical.

Table 7
Richness of gall-inducing insect orders in Brazilian restingas.

Restinga	Diptera	Hemiptera	Coleoptera	Lepidoptera	Hymenoptera	Thysanoptera
MR	C: 25 (80.6%)	1 (3.2%)	0	2 (6.4%)	0	0
MEPA	C: 99 (76.1%)	8 (6.1%)	2 (1.5%)	7 (5.4%)	4 (3.0%)	2 (1.5%)
SJB	C: 47(71.2%)	6 (9.1%)	1 (1.5%)	4 (6.1%)	0	0
	A: 1 (1.5%)					
JRNP	C: 76 (77.5%)	2 (2.0%)	0	1 (1.0%)	0	0
PSSBR	C: 27 (75.0%)	4 (11.1%)	0	1 (2.8%)	0	0
GR	C: 39 (90.8%)	1 (2.3%)	1 (2.3%)	1 (2.3%)	0	0
CSSP	C:80 (65.0%)	5 (4.1%)	1 (0.81%)	4 (3.2%)	1 (0.81%)	4 (3.2%)
	A:1 (0.81%)					
	T:1 (0.81%)					
ASP	C: 27 (48.2%)	4 (7.1%)	1 (1.8%)	2 (3.6%)	0	0
BAB	C:35 (40.7%)	4 (4.6%)	2 (2.3%)	3 (3.5%)	0	0
MI	C: 80 (54.4%)	3 (2.0%)	4 (2.7%)	4 (2.7%)	0	1 (0.68%)
	T: 1 (0.68%)					
	M: 1 (0.68%)					
PCVSP	C: 32 (84.0%)	6 (16.0%)	0	0	0	0
BRSP	C: 134 (57.5%)	3 (1.9%)	5 (3.2%)	11 (7.1%)	0	2 (1.3%)
	T:1 (0.43%)					
AC	C:30 (73.2%)	4 (9.5%)	0	2 (4.9%)	2 (4.9%)	1 (2.4%)

AC – Arraial do Cabo, ASP – Acaraí State Park, BAB – Babitonga, BRSP – Bertioga Restinga State Park, CSSP – Costa do Sol State Park, GR – Grumari Restinga, JRNP – Jurubatiba Restinga National Park, MEPA – Maricá Environmental Protection Area, MI – Marambaia Island, MR – Marambaia Restinga, PCVSP – Paulo César Vinha State Park, PSSBR – Praia do Sul State Reserve. A – Agromyziidae, C – Cecidomyidae, M – Muscomorpha, T – Tephritidae.

Myrtaceae were also indicated as superhost (Maia, 2019). In fact, this botanical family is one of the most species-rich woody plant families in Brazilian restingas (Souza and Morin, 2008; Lourenço and Barbosa, 2012).

Ninety gall morphotypes (83.3%) were found again in MEPA. This is a very satisfactory result, considering that the precise location of eight host plant species was not reported in the literature: *Eugenia punicifolia*, *Inga laurina*, *Melissa officinalis*, *Phytolacca* cfr. *esculenta*, *Protium heptaphyllum*, *Senna bicapsularis*, *Sideroxylon obtusifolium*, and *Solanum* aff. *cordifolium*. Similarly, the precision location of two gall morphotypes was not reported too, one on *Eugenia uniflora* induced by *Maiamyia triangularis* and the other on *Fridericia conjugata* induced by Cecidomyiinae. Furthermore, the incomplete morphological characterization of four morphotypes (on *Eugenia copacabanensis Myrciaria floribunda*, *Guapira opposita,* and *Varronia curassavica* each) did not allow their recognition.

Figure 5 Insect galls from the Maricá Environmental Protected Area (Maricá, RJ): a) Leaf galls on *Neomitranthes obscura* (DC.) N. Silveira (Myrtaceae) – black arrow: original galls induced by *Stephomyia mina* Maia, 1993 (Diptera, Cecidomyiidae), white arrows: galls modified by inquilines, b-c) Bud galls on *Erythroxylum ovalifolium* Peyr (Erythroxylaceae): b) Original gall induced by *Lopesia erythroxyli* Rodrigues & Maia, 2010 (Diptera, Cecidomyiidae), c) Gall modified by inquilines, d-e) Bud galls on *Eugenia astringens* Cambess. (Myrtaceae): d) Original galls induced by *Stephomyia rotundifoliorum* Maia, 1993 (Diptera, Cecidomyiidae), e) Galls modified by inquiline, f-g) Bud galls on *Myrcia ovata* Cambess. (Myrtaceae): f) Original gall induced by *Myrciamyia maricaensis* Maia, 1995 (Diptera, Cecidomyiidae), g) Gall modified by inquilines, h-j) Leaf galls on *Paullinia weinmanniifolia* Mart. (Sapindaceae): h) Original gall induced by *Paulliniamyia ampla* Maia, 2001 (Diptera, Cecidomyiidae), i) Gall modified by inquilines.

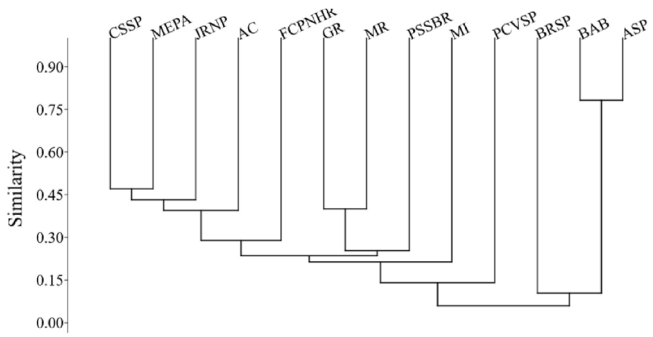

Figure 6 Grouping diagram (UPGMA) for similarity of gall-inducing insects among different Brazilian restingas. AC – Arraial do Cabo, ASP – Acaraí State Park, BAB – Babitonga, BRSP – Bertioga Restinga, State Park, CSSP – Costa do Sol State Park, FCPRNH – Fazenda Caruara Private Reserve of Natural Heritage, GR – Grumari Restinga, JRNP – Jurubatiba Restinga National Park, MEPA – Maricá Environmental Protection Area, MI – Marambaia Island, MR – Marambaia Restinga, PCVSP – Paulo César Vinha State Park, PSSBR – Praia do Sul State Biological Reserve.

On the other hand, *Schwartzia brasiliensis (*Marcgraviaceae) and *Lantana fucata* Lindl were reported as new host plants in the study area. Both species are already known as host plants from other restingas: the former from Marambaia (Rio de Janeiro, RJ), reported as *Norantea brasiliensis* Choisy by Maia and Silva (2016), and the latter from São João da Barra (RJ) reported by Carvalho-Fernandes et al. (2016).

New gall morphotypes were also reported in MEPA. Four of them were already known from other restingas: i) linear leaf gall on *Varronia curassavica* and ii) fusiform stem gall on *Smilax rufescens,* both reported in the Costa do Sol State Park (RJ) by Carvalho-Fernandes et al. (2016); iii) fusiform stem gall on *Neomitranthes obscura* reported in the Jurubatiba Restinga National Park (RJ) by Monteiro et al. (2004); and iv) globoid, glabrous, green, leaf gall on *Guapira opposita* in Bertioga (SP) and Guarapari (ES), reported by Maia et al. (2008) and Bregonci et al. (2010), respectively. Additionally, the globoid leaf gall on *Marcetia taxifolia* (A.St.-Hil.) DC. was previously reported in Cerrado areas of Serra do Espinhaço (MG) by Carneiro et al. (2009b), being its first record in an area of the Atlantic forest.

Thirteen morphotypes are new on their respective plants. On *Coccoloba* P. Browne, four other galls were previously known: i) stem gall on *C. moseni* Lindl.; ii) lenticular leaf gall on *C. warming* Meisn., both from Bertioga (SP) (Maia et al., 2008); iii) inflorescence gall on *C. alnifolia* from Mangaratiba (RJ) (Rodrigues et al., 2014); and iv) lenticular leaf gall on *Coccoloba* sp. from Jurubatiba Restinga National Park (RJ) (Monteiro et al., 2004). On *Protium brasiliense,* two other galls were already reported in MEPA (RJ): i) marginal leaf roll induced by *Lopesia maricaensis* Rodrigues and Maia, 2010 (Cecidomyiidae) and ii) conical gall induced by a not determined gall midge. On *Andira fraxinifolia*, three other galls are known: i) vermiform leaf gall induced by *Lopesia indaiensis* reported in Tamandaré (PE), Bertioga (SP), Dores do Indaiá (MG) and Mangaratiba (RJ) by Maia and Oliveira (2018); ii) lenticular gall induced by *Meunieriella* sp., reported in Araruama and Arraial do Cabo (RJ) by Carvalho-Fernandes et al. (2016); and iii) globose leaf gall induced by *Meunieriella* sp., reported by Maia et al. (2002) in the MEPA (RJ). On *Ocotea notata*, three other galls were reported: i) concavity on leaf induced by Hemiptera, reported in Arraial do Cabo, Cabo Frio and MEPA (RJ) by Carvalho-Fernandes et al. (2016) and Monteiro et al. (1994); ii) bud gall induced by Cecidomyiidae in the MEPA and Carapebus (RJ) (Maia, 2001a); and iii) fusiform stem gall induced by Curculionidae (Coleoptera) in Araruama, Arraial do Cabo and São João da Barra (RJ) (Carvalho-Fernandes et al., 2016). On *Struthanthus taubatensis*, a single morphotype was previously recorded: midvein gall induced by *Bruggmanniella maricensis*, being reported until now only in the MEPA (RJ). On *Bysonima sericea*, four other morphotypes are known: i) bud flower gall induced by Lepidoptera reported in Arraial do Cabo and MEPA (RJ) by Monteiro et al. (1994); ii) closed flower gall induced induced by *Bruggmanniella byrsonimae* in Viçosa (BA), Linhares (ES), Mangaratiba, Rio de Janeiro, MEPA, Araruama, Arraial do Cabo, Carapebus, and São João da Barra (RJ) (Maia, 2021); iii) stem gall induced by Cecidomyiidae in MEPA, Saquarema Araruama, Arraial do Cabo, Cabo Frio, Carapebus, and São João da Barra (RJ) (Monteiro et al., 1994; Maia, 2001a; Carvalho-Fernandes et al. 2016); and iv) lenticular leaf gall induced by *Dasineura byrsonimae*, all reported in Conceição da Barra (ES), Mangaratiba, Rio de Janeiro, MEPA, Saquarema, Araruama, Reserva Biológica União, Arraial do Cabo, Cabo Frio, Carapebus, and São João da Barra (RJ) (Maia, 2021). On *Myrsine parvifolia,* two other galls were previously known: i) lenticular leaf gall induced by Cecidomyiidae, recorded in the MEPA and Carapebus (RJ) by Monteiro et al. (1994) and Maia (2001a), and ii) stem gall induced by Lepidoptera in the MEPA, Saquarema, Araruama, Arraial do Cabo, and Cabo Frio (RJ) (Monteiro et al., 1994; Maia, 2006; Carvalho-Fernandes et al., 2016). On *Eugenia copacabanensis*, ten other galls are known: i) spiral leaf gall induced by *Stephomyia espiralis* reported in from MEPA, Saquarema, Araruama, Arraial do Cabo, and Cabo Frio (RJ); ii) fusiform leaf gall induced by *Stephomyia tetralobae* in MEPA and Arraial do Cabo (RJ); iii) fruit gall induced by *Dasineura copacabanensis* in MEPA, Saquarema, Araruama, Arraial do Cabo, Cabo Frio, and São João da Barra (RJ); iv) midvein gall induced by Hymenoptera in MEPA and Arraial do Cabo (RJ); v) conical leaf gall induced by *Bruggmannnia* sp. in Arraial do Cabo (RJ); vi) leaf fold induced by Thysanoptera in Arraial do Cabo (RJ); vii) rosette bud gall in Arraial do Cabo (RJ); viii) marginal leaf roll in Araruama and Cabo Frio (RJ), ix) stem gall in MEPA and Arraial do Cabo(RJ); and x) leaf gall in the MEPA (RJ). The inducers of these three last gall morphotypes were not determined (Monteiro et al., 1994; Maia, 2001a; Carvalho-Fernandes et al., 2016).On *Neomitranthes obscura*, six other galls are known: i) rolled leaf induced by Thysanoptera reported in MEPA, Araruama e Arraial do Cabo (RJ) by Monteiro et al. (1994), Maia (2006), and Carvalho-Fernandes et al. (2016); ii) conical leaf gall induced by *Stephomyia mina* in MEPA, Araruama, Arraial do Cabo, and Carapebus (RJ) (Monteiro et al., 1994; Maia, 2006; Carvalho-Fernandes et al., 2016); iii) bud gall induced by *Neomitranthella robusta* in MEPA, Saquarema, Araruama, Arraial do Cabo, Cabo Frio, and Carapebus (RJ) (Monteiro et al., 1994; Maia, 2001a; Carvalho-Fernandes et al., 2016); iv) marginal leaf roll induced by *Dasineura tavaresi* in MEPA, Saquarema, Araruama, Arraial do Cabo, Cabo Frio, and Carapebus (RJ) (Maia, 2001a; Carvalho-Fernandes et al., 2016); v) triangular leaf gall induced by Cecidomyiinae in MEPA, Arraial do Cabo and Carapebus (RJ) (Maia, 2001a); vi) stem gall in MEPA, Saquarema, Araruama, and Arraial do Cabo (RJ) (gall-inducer not determined).

Considering the small percentage of galls not collected again due to the lack of information, we can observe a small increase in the gall richness of MEPA. Therefore, this area has been fulfilling its role of preserving the fauna of gall-inducing insects, despite local anthropogenic action.

A new case of inquilinism was observed in galls of *Stephomyia mina* on *Neomitranthes obscura* (Myrtaceae) (Fig. 5a). Other four examples of gall inquilines (sensu Mani 1964) were already reported in MEPA: on *Erythroxylum ovalifolium* (Figs. 5b-c), *Eugenia astringens* (Figs. 5d-e), *Myrcia ovata* (Figs. 5f-g), and *Paullinia weinmanniifolia* (Figs. 5h-i).

Conclusions

MEPA shelters a rich and peculiar gall-inducing fauna found nowhere else. It is the Brazilian restinga with the greatest number of identified gall-inducers. Furthermore, MEPA is the type locality of 48 cecidogenous species of Cecidomyiidae and hosts 63 endemic inducers. Comparing previous data with current data, we can state that MEPA has been playing an important role in conserving the diversity of gall-inducing fauna of Brazil. Therefore it is essencial to keep this area preserved.

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Conflicts of interest

The author declares no conflicts of interest.

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