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LISTS OF SPECIES

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List of angiosperm species in an Atlantic Forest fragment reveals collection gaps in Espírito Santo state, Brazil

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Abstract: This study presents a list of angiosperm species in an Atlantic Forest fragment in the southern portion of Espírito Santo state, Brazil, a region that represents a collection gap within the Atlantic Forest. The studied site is a relatively small fragment of 144 ha located within a conservation unit, the Mata das Flores State Park. The site belongs to a conservation priority area for the Atlantic Forest in Espírito Santo, and is under strong anthropic pressure. Of the 239 species listed here, 21 are new records for the state, eight are endemic, and 20 figure either in the country's or the state's Red Lists of endangered species. Rubiaceae and Piperaceae were the families with the highest number of species. We show that small fragments that were never inventoried before can reveal a relatively large number of threatened species and that collection gaps need to be filled in order to refine our understanding about conservation priorities within the Atlantic Forest Biome.

Key words: checklist; collection gaps; conservation status; new records

INTRODUCTION

Collection gaps affect the knowledge about species conservation statuses and endemism levels, and hamper effective management planning for conservation areas (Grand et al. 2007; Joppa et al. 2011). This is of great concern considering the high endemism levels of Southeast Brazil and that most known species have small distribution ranges (Pimm et al. 2014). Fragments with less than 100 ha correspond to 30–40% of all remnants in the biome (Ribeiro et al. 2009), which has high levels of floristic richness, endangered species, and endemism (e.g., Mori et al. 1981; Peixoto 1992). Most of this knowledge is based on floristic studies and local floras, which can also lead to the description of new species and new occurrences (Baitello 2001; Deble 2005; Deble et al. 2006; Oliveira and Deble 2006; Coelho 2010; Brotto and Baitello 2012). The description and identification of new species are important topics for biodiversity research agendas (see Joly et al. 2014). Moreover, this biome has the highest number of endangered species in Brazil and the southeast portion of the biome houses the majority of these species (Martinelli et al. 2013).

The number of endemic species of an area is directly affected by collection effort (see Murray-Smith et al. 2009; Werneck et al. 2011). It is noteworthy that from the 8,630 endemic species of the Atlantic Forest, 1,104 (12.8 %) are indigenous from Rio de Janeiro state, whereas the neighboring state of Espírito Santo, with nearly the same total area of Rio de Janeiro, have almost half (551) of this value (List of Species of the Brazilian Flora 2014). Despite the increased knowledge about

the Atlantic Forest flora (Stehmann et al. 2009; Forzza et al. 2010), some regions of this biome remain poorly known. Studies about centers of endemism have shown a geographical bias of sampling effort in the central and northern portions of the Espírito Santo state (Murray-Smith et al. 2009; Werneck et al. 2011), while the southern portion have insufficient data of species occurrences. Nevertheless, the floristic composition of the remnants will reflect their history, making each remnant unique (Santos and Kinoshita 2003).

Floristic studies are crucial in order to fill these collection gaps. Field surveys are often viewed as the obvious, though expensive, way to do this. In the absence of information about the species richness, alternative approaches, such as mapping of vegetation cover (Ribeiro et al. 2009), landscape structure (Metzger 2000), or predictive models (Bini et al. 2006) can be used as surrogates for the expensive and time consuming field surveys, in order to subsidize conservation strategies. Such approaches have the advantages of covering larger spatial extents and providing faster solutions. However, systematic field surveys are the obvious and best available solution to increase the knowledge about biodiversity (Margules and Pressey 2000). This is because most of these models are based on local inventories, and they suffer with collection gaps and lack of knowledge about the number of new, endemic or endangered species in a given site. Therefore, even though systematic field surveys have several operational shortcomings, they are the definitive solution to reveal how many species a site holds. Here we report the results of an intensive field survey on a 144 ha of an Atlantic Forest remnant within a collection gap in the southern portion of the Espírito Santo state, Brazil.

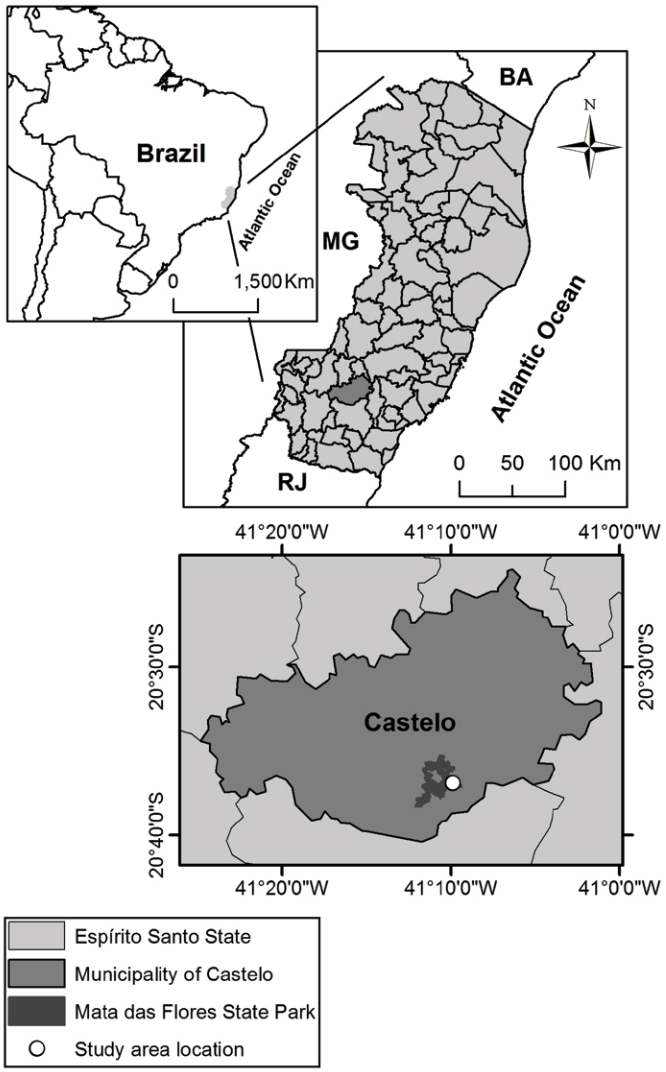

Figure 1. Location of the studied fragment. Top left, location of Espírito Santo state in Brazil. Top right, location of Castelo Municipality within Espírito Santo. Bottom, location of the fragment within Mata das Flores State Park (800 ha. of total area) in Castelo.

MATERIALS AND METHODS

Study site

The study was conducted in a 144 ha forest fragment (Figure 1) located in in the Mata das Flores State Park (MFSP; 20°35′54″ S, 041°10′53″ W), Municipality of Castelo, Espírito Santo state (ES). The area comprises a Lowland Ombrophilous Forest, with mean annual precipitation of 1,200 mm (Oliveira-Filho et al. 2005), and elevation ranging between 100 m and 800 m. The park is adjacent to the urban area of Castelo and is surrounded by cattle farms and coffee crops (IEMA 2012). There are evidences of past selective logging within the Park. Nonetheless, the MFSP is an important corridor connected to two other state parks located at higher altitudes, Forno Grande and Pedra Azul.

Floristic study

Plant samples were collected on a weekly basis from August 2012 to June 2014 through expeditious walks on the studied fragment. Fertile specimens were collected and dried following usual procedures in plant collection (Peixoto and Maia 2013), and identified using specialized literature, consults to specialists (see Acknowledgements) and to the collections of RB, VIES (acronyms follow Thiers 2015), as well as the virtual herbarium REFLORA (http://reflora.jbrj.gov.br/jabot/PrincipalUC/PrincipalUC.do). The samples were deposited at VIES, with duplicates sent to RB.

Family and genera were listed in alphabetical order following APG III (2009), including only indigenous species. Endemic species were marked with a circle (●) and new records for ES with a diamond (◊). Identifications made by specialists based on non-fertile specimens were included in the list and marked with an asterisk (*), without designation of a collector number. The currently accepted names were verified in the List of Species of the Brazilian Flora (LSBF; http://floradobrasil.jbrj.gov.br/). Conservation status was attributed following the

Red Book of the Brazilian Flora (RBBF; Martinelli et al. 2013) and the Endangered Species Flora of the Espírito Santo State (ESFES; Fraga et al. 2007).

The LSBF and SL (CRIA, http://splink.cria.org.br/) websites were used as sources to assign a species as a new occurrence to ES. We considered that a species has a new occurrence in ES when it was not listed in LSBF, and a voucher specimen identified by a specialist was not located in herbaria collections using SL. The LSBF was also used to establish a comparison between the species richness of the families in MFSP and ES. The SL was also used to check how many specimens for a particular species are included in herbaria collections. Both databases were consulted after the last updating of the LSBF (between 14 August and 17 August 2015).

RESULTS

The inventory resulted in 61 families, 159 genera and 239 species (Table 1). The families with the highest number of species were Rubiaceae (25 spp.), Piperaceae (19 spp.), Myrtaceae (13 spp.), Moraceae (10 spp.) and Fabaceae (9 spp.). These families comprised about 31% of all identified

Table 1. List of angiosperms from Mata das Flores State Park, ES, Brazil. ◊ New records for ES ● Endemic species of ES; * Species identified based on non-fertile specimens. Red List (IUCN 2013) Status in Brazil: LC = least concern, VU = vulnerable, EN = endangered, CR = critically endangered. RBBF - Red Book of the Brazilian Flora; ESFES - Endangered Species of the Espírito Santo state Flora.

Family/Species	RBBF list	ESFES list	Voucher
Acanthaceae			
Aphelandra blanchetiana (Nees) Hook.			T.T.Carrijo 1717
Aphelandra longiflora (Lindl.) Profice			T.T.Carrijo 1777
Aphelandra maximiliana (Nees) Benth. ●	EN	EN	T.T.Carrijo 1689
Justicia genuflexa Nees & Mart.	VU	VU	T.T.Carrijo 1712
Justicia parahyba P.L.R.Moraes			T.T.Carrijo 1876
Justicia wasshauseniana Profice		VU	T.T.Carrijo 1851
Ruellia solitaria Vell.			T.T.Carrijo 2046
Schaueria lachnostachya Nees			T.T.Carrijo 1540
Achariaceae			
Carpotroche brasiliensis (Raddi) A. Gray			T.T.Carrijo 1945
Amaranthaceae			
Chamissoa acuminata Mart.◊			T.T.Carrijo 1891
Chamissoa altissima (Jacq.) Kunth			T.T.Carrijo 1656
Apocynaceae			
Asclepias curassavica L.			T.T.Carrijo 2215
Oxypetalum banksii R.Br. ex Schult.			T.T.Carrijo 1705
Rauvolfia capixabae I.Koch & Kin.-Gouv.			T.T.Carrijo 1568
Tabernaemontana hystrix Steud.			T.T.Carrijo 1796
Araceae			
Monstera adansonii Schott			T.T.Carrijo 1757
Philodendron loefgrenii Engl.			T.T.Carrijo 1908
Syngonium vellozianum Schott			T.T.Carrijo 2160
Arecaceae			
Astrocaryum aculeatissimum (Schott) Burret			T.T.Carrijo 1622
Desmoncus polyacanthos Mart.			T.T.Carrijo 1809
Geonoma elegans Mart.			T.T.Carrijo 1581
Aristolochiaceae			
Aristolochia cymbifera Mart. & Zucc.			J. Freitas 203
Asparagaceae			
Herreria glaziovii Lecomte			T.T.Carrijo 2077
Asteraceae			
Ageratum conyzoides L.			T.T.Carrijo 1813
Baccharis trinervis Pers.			T.T.Carrijo 1860
Chromolaena maximilianii (Schrad. ex DC.) R.M.King & H.Rob.			T.T.Carrijo 1750
Cyathula prostrata Blume			T.T.Carrijo 1742
Emilia fosbergii Nicolson			T.T.Carrijo 1812
Piptocarpha cf. *axillaris* (Less.) Baker ◊			T.T.Carrijo 1797
Synedrella nodiflora (L.) Gaertn.			T.T.Carrijo 1814
Vernonanthura ferruginea (Less.) H.Rob. ◊			T.T.Carrijo 1803
Balanophoraceae			
Langsdorffia hypogaea Mart.			T.T.Carrijo 1415
Begoniaceae			
Begonia fischeri Schrank			T.T.Carrijo 1809
Begonia hirtella Link		EN	T.T.Carrijo 1911
Bignoniaceae			
Adenocalymma trifoliatum (Vell.) R.C.Laroche			T.T.Carrijo 1691
Bignonia aequinoctialis L.			T.T.Carrijo 1653
Bignonia campanulata Cham.			T.T.Carrijo 1571
Tanaecium selloi (Spreng.) L.G.Lohmann			T.T.Carrijo 1643
Boraginaceae			
Cordia taguahyensis Vell.			T.T.Carrijo 2056
Heliotropium angiospermum Murray ◊			T.T.Carrijo 1584
Myriopus paniculatus (Cham.) Feuillet			T.T.Carrijo 1886
Bromeliaceae			
Aechmea ramosa Mart. ex Schult. & Schult.f.			T.T.Carrijo 2231
Billbergia cf. *horrida* Regel			T.T.Carrijo 1806
Tillandsia usneoides (L.) L.			T.T.Carrijo 1785
Tillandsia loliacea Mart. ex Schult. & Schult.f.			T.T.Carrijo 1774
Vriesea carinata Wawra			T.T.Carrijo 1935
Vriesea ensiformis (Vell.) Beer			T.T.Carrijo 1701
Cactaceae			
Pereskia aculeata Mill.			T.T.Carrijo 1719
Calophyllaceae			
Calophyllum brasiliense Cambess.			T.T.Carrijo 1948
Cannabaceae			
Trema micrantha (L.) Blume			T.T.Carrijo 1680
Celastraceae			
Cheiloclinium cognatum (Miers) A.C.Sm.			T.T.Carrijo 1951
Hippocratea volubilis L.			T.T.Carrijo 1410
Commelinaceae			
Commelina obliqua Vahl			T.T.Carrijo 1496
Dichorisandra incurva Mart. ex Schult.f.			T.T.Carrijo 1599
Dichorisandra thyrsiflora J.C.Mikan			T.T.Carrijo 1635
Dichorisandra nutabilis Aona & M.C.E.Amaral ●			T.T.Carrijo 2181
Tripogandra diuretica (Mart.) Handlos			T.T.Carrijo 2057
Tripogandra warmingiana (Seub.) Handlos			T.T.Carrijo 1805
Tradescantia zebrina Heynh. ex Bosse			T.T.Carrijo 1636
Costaceae			
Costus spiralis (J.A.Christq.) Roscoe			T.T.Carrijo 1616
Cucurbitaceae			
Gurania bignoniaceae (Poepp. & Endl.) C.Jeffrey			T.T.Carrijo 2150
Wilbrandia verticillata (Vell.) Cogn.			T.T.Carrijo 1940

Continued

Table 1. *Continued.*

Family/Species	RBBF list	ESFES list	Voucher
Cyperaceae			
Cyperus surinamensis Rottb.			L.A.Silva 221
Pycreus unioloides (R.Br.) Urb. ◊			T.T.Carrijo 1609
Erythroxylaceae			
Erythroxylum macrocalyx Mart.			T.T.Carrijo 1655
Euphorbiaceae			
Acalypha cf. *communis* Müll. Arg. ◊			T.T.Carrijo 1605
Actinostemon concolor (Spreng.) Müll.Arg.			T.T.Carrijo 1895
Actinostemon verticillatus (Klotzsch) Baill.			T.T.Carrijo 1494
Mabea fistulifera Mart.			T.T.Carrijo 1417
Pachystroma longifolium (Ness) I.M. Johnst.			T.T.Carrijo 1787
Pausandra morisiana (Casar.) Radlk.			T.T.Carrijo 2164
Senefeldera verticillata (Vell.) Crozait			*
Fabaceae			
Aeschynomene americana L.			T.T.Carrijo 1806
Bauhinia forficata Link			T.T.Carrijo 2088
Desmodium subsericeum Malme			T.T.Carrijo 1721
Inga hispida Schott ex Benth.			*
Parapiptadenia pterosperma (Benth.) Brenan			*
Peltophorum dubium (Spreng.) Taub.			T.T.Carrijo 1626
Piptadenia gonoacantha (Mart.) J.F.Macbr.			L.A.Silva 404
Senna affinis (Benth.) H.S.Irwin & Barneby			T.T.Carrijo 2103
Senegalia giganticarpa (G.P.Lewis) Seigler & Ebinger			T.T.Carrijo 1795
Heliconiaceae			
Heliconia aemygdiana Burle-Marx			T.T.Carrijo 1570
Heliconia apparicioi Barreiros ◊			T.T.Carrijo 1852
Heliconia episcopalis Vell.		VU	T.T.Carrijo 2024
Heliconia farinosa Raddi			T.T.Carrijo 1617
Iridaceae			
Neomarica altivallis (Ravenna) A. Gil			T.T.Carrijo 1848
Lauraceae			
Ocotea cilata L.C.S. Assis & Mello-Silva ●			T.T.Carrijo 1652
Ocotea dispersa (Ness & Mart.) Mez			*
Ocotea sassafras (Meins.) Mez			T.T.Carrijo 1538
Urbanodendron verrucosum (Ness) Mez			*
Lecythidaceae			
Cariniana estrellensis (Raddi) Kuntze			*
Cariniana legalis (Mart.) Kuntze	EN		T.T.Carrijo 1498
Lecythis lurida (Miers) S.A.Mori			M. Ribeiro 959
Malpighiaceae			
Bunchosia macilenta Dobson	VU	VU	T.T.Carrijo 1565
Malvaceae			
Gaya pilosa K.Schum.			T.T.Carrijo 2186
Malvaviscus arboreus Cav.			T.T.Carrijo 1800
Pavonia nemoralis A.St.-Hil. ◊			T.T.Carrijo 1966
Pavonia sepium A.St.-Hil.			T.T.Carrijo 1497
Pavonia stellata (Spreng.) Spreng.			T.T.Carrijo 1499
Quararibea turbinata (Sw.) Poir.			T.T.Carrijo 2137
Urena lobata L.			T.T.Carrijo 2216
Marantaceae			
Goeppertia aemula (Körn.) Borchs. & S.Suárez		VU	T.T.Carrijo 1709
Goeppertia cylindrica (Roscoe) Borchs. & S.Suárez		VU	T.T.Carrijo 1633
Goeppertia joffilyana (J.M.A.Braga) Borchs. & S.Suárez ◊			T.T.Carrijo 1905
Goeppertia widgrenii (Körn.) Borchs. & S.Suárez	EN	VU	T.T.Carrijo 1546
Maranta leuconeura E. Morren			T.T.Carrijo 1883
Stromanthe tonckat (Aubl.) Eichler			T.T.Carrijo 2125
Meliaceae			
Guarea guidonia (L.) Sleumer			T.T.Carrijo 1748
Trichillia hirta L.			T.T.Carrijo 1773
Trichilia pseudostipularis (A.Juss.) C.DC.			T.T.Carrijo 2153
Menispermaceae			
Abuta convexa (Vell.) Diels			*
Chondrodendron platiphyllum (A.St.-Hil.) Miers			T.T.Carrijo 1894
Hyperbaena oblongifolia (Mart.) Chodat & Hassl. ◊			T.T.Carrijo 1778
Monimiaceae			
Mollinedia sphaerantha Perkins			T.T.Carrijo 2155
Mollinedia widgrenii A.DC. ◊			T.T.Carrijo 1960
Moraceae			
Brosimum guianense (Aubl.) Huber			M.C. Santos 03
Clarisia ilicifolia (Spreng.) Lanj. & Rossberg			T.T.Carrijo 1572
Dorstenia arifolia Lam.			T.T.Carrijo 1516
Dorstenia elata Hook.			T.T.Carrijo 1618
Dorstenia bonijesu Carauta & C. Valente		VU	T.T.Carrijo 1939
Dorstenia hirta Desv.			T.T.Carrijo 1556
Ficus eximia Schott.			M.C. Santos 01
Ficus obtusiuscula (Miq.) Miq.			T.T.Carrijo 2008
Naucleopsis oblongifolia (Kuhlm.) Carauta			-
Sorocea hillari Gaudich.			T.T.Carrijo 1768
Myristicaceae			
Virola bicuhyba (Schott ex Spreng.) Warb.			*
Myrtaceae			
Eugenia bahiensis DC.	LC		T.T.Carrijo 2059
Eugenia candolleana DC.			*
Eugenia excelsa O.Berg	LC		T.T.Carrijo 1764
Eugenia itapemirimensis Cambess.			*
Eugenia melanogyna (D.Legrand) Sobral			*
Eugenia neogracilis Mazine & Sobral			*
Eugenia pisiformis Cambess.	LC		T.T.Carrijo 1492
Eugenia prasina O.Berg	LC		T.T.Carrijo 1657
Marlierea silvatica (O.Berg) Kiaersk.●			*
Myrcia follii G.M.Barroso & Peixoto ●	CR	VU	T.T.Carrijo 2021
Myrcia guianensis (Aubl.) DC.	LC		*
Myrcia limae G.M.Barroso & Peixoto ●	EN	VU	T.T.Carrijo 2218
Myrcia splendes (Sw.) DC.			T.T.Carrijo 1686
Nyctaginaceae			
Bougainvillea spectabilis Willd.			T.T.Carrijo 1798
Guapira opposita (Vell.) Reitz			T.T.Carrijo 1560
Leucaster caniflorus (Mart.) Choisy			*
Ramisia brasiliensis Oliv.			T.T.Carrijo 2010
Ochnaceae			
Ouratea parviflora (A.DC.) Baill.			T.T.Carrijo 1498
Orchidaceae			
Oeceoclades maculata (Lindl.) Lindl.			T.T.Carrijo 1663
Rodriguezia venusta Rchb.f.			T.T.Carrijo 1850
Sacoila lanceolata (Aubl.) Garay			T.T.Carrijo 1411
Oxalidaceae			
Oxalis bela-vitoriae Lourteig ◊	CR		T.T.Carrijo 1559
Oxalis cytisoides Mart. ex Zucc.		VU	T.T.Carrijo 1720
Passifloraceae			
Passiflora kermesiana Link & Otto			T.T.Carrijo 1727
Phytolacaceae			
Rivina humilis L.			T.T.Carrijo 1799

Continued

Table 1. *Continued.*

Family/Species	RBBF list	ESFES list	Voucher
Picramniaceae			
Picramnia parvifolia Engl. ◊			T.T.Carrijo 1500
Piperaceae			
Piper aduncum L.			T.T.Carrijo 1583
Piper amalago L.			T.T.Carrijo 1628
Piper anisum (Spreng.) Angely			T.T.Carrijo 1654
Piper arboreum Aubl.			J.A.Christ 26
Piper bowiei Yunck.			J.A.Christ 93
Piper caldense C.DC.			T.T.Carrijo 1645
Piper cernuum Vell.			J.A.Christ 92
Piper dilatatum Rich			J.A.Christ 74
Piper gaudichaudianum Kunth			T.T.Carrijo 1612
Piper glabratum Kunth			T.T.Carrijo 1585
Piper hoffmannseggianum Roem. & Schult			T.T.Carrijo 1543
Piper macedoi Yunck.			T.T.Carrijo 1586
Piper miquelianum C.DC.			T.T.Carrijo 1802
Piper permucronatum Yunck.			T.T.Carrijo 1668
Piper piliovarium Yunck. ◊			T.T.Carrijo 1632
Piper pubisubmarginalum Yunck.			T.T.Carrijo 1688
Piper tuberculatum Jacq.			T.T.Carrijo 1666
Piper umbellatum L.			J.A.Christ 99
Piper vicosanum Yunck.		EN	J.A.Christ 76
Plumbaginaceae			
Plumbago scandens L.			T.T.Carrijo 1740
Poaceae			
Cenchrus purpureus (Schumach.) Morrone			T.T.Carrijo 1747
Primulaceae			
Clavija caloneura Mart.			T.T.Carrijo 1710
Stylogyne warmingii Mez.			T.T.Carrijo 1534
Rubiaceae			
Alseis floribunda Schott			F.T.Leite 42
Amaioua guianensis Aubl.			F.T.Leite 57
Cordiera myrciifolia (K. Schum.) C. H. Perss. & Delprete			F.T.Leite 35
Carapichea ipecacuanha (Brot.) L. Andersson	VU		F.T.Leite 43
Genipa americana L.			F.T.Leite 111
Hamelia patens Jacq.			T.T.Carrijo 1669
Faramea campanella Müll.Arg.			T.T.Carrijo 1684
Faramea coerulea (Nees & Mart.) DC.			T.T.Carrijo 1677
Faramea involucellata Müll.Arg.			T.T.Carrijo 1957
Faramea martiana Müll.Arg.			T.T.Carrijo 1525
Faramea multiflora A.Rich. ex DC.			T.T.Carrijo 1763
Faramea sellowiana Benth.			T.T.Carrijo 1704
Geophila repens (L.) I.M.Johnst.			F.T.Leite 49
Margaritopsis cephalantha (Müll.Arg.) C.M.Taylor			F.T.Leite 69
Margaritopsis chaenotricha (DC.) C.M. Taylor			F.T.Leite 62
Psychotria carthagenensis Jacq.			F.T.Leite 96
Psychotria deflexa DC.			F.T.Leite 80
Psychotria stellaris Müll.Arg.			T.T.Carrijo 1548
Psychotria rhytidocarpa Müll. Arg.			T.T.Carrijo 1547
Psychotria minutiflora Müll.Arg.			T.T.Carrijo 1936
Rudgea coronata (Vell.) Müll. Arg. subsp. *coronata*			T.T.Carrijo 1607
Rudgea coronata subsp. *ochroleuca* (Müll.Arg.)			T.T.Carrijo 1514
Rudgea coronata subsp. *saint-hilaire* (Standl.) Zappi ●	CR	CR	T.T.Carrijo 1484
Rudgea reflexa Zappi		EN	T.T.Carrijo 1579
Sabicea villosa Willd. Ex. Schult.			F.T.Leite 85
Rutaceae			
Erythrochiton brasiliensis Ness & Mart.			T.T.Carrijo 1518
Almeidea rubra A.St.-Hil.			T.T.Carrijo 1575
Rauia resinosa Nees & Mart.			T.T.Carrijo 1580
Conchocarpus macrophyllus J.C.Mikan			T.T.Carrijo 1945
Esenbeckia pilocarpoides Kunth			T.T.Carrijo 1767
Pilocarpus giganteus Engl.			T.T.Carrijo 1761
Neoraputia alba (Nees & Mart.) Emmerich ex Kallunki			T.T.Carrijo 1952
Salicaceae			
Casearia espiritosantensis R. Marquete & Mansano●			*
Casearia souzae R. Marquete & Mansano			T.T.Carrijo 1715
Casearia sylvestris Sw.			*
Prockia crucis P. Browne ex L.			T.T.Carrijo 1909
Sapindaceae			
Paullinia meliifolia Juss. ◊			T.T.Carrijo 2196
Cardiospermum grandiflorum Sw.			T.T.Carrijo 2212
Allophylus melanophloeus Radlk. ◊			T.T.Carrijo 1476
Serjania communis Cambess.			T.T.Carrijo 1735
Matayba guianensis Aubl.			T.T.Carrijo 1976
Sapotaceae			
Chrysophyllum gonocarpum (Mart. & Eichler ex Miq.) Engl.			L.A.Silva 403
Chrysophyllum lucentifolium Cronquist			*
Ecclinusa guianensis Eyma			T.T.Carrijo 1502
Sarcaulus brasiliensis (A.DC.) Eyma			*
Pouteria bangii (Rusby) T.D.Penn.			J.Freitas 202
Pouteria durlandii (Standl.) Baehni			J.Freitas 199
Pouteria guianensis Aubl.			*
Pouteria filipes Eyma			*
Simaroubaceae			
Picramnia crenata (Vell.) Engl. ◊			M.Zanetti 01
Smilacaceae			
Smilax spicata Vell.	EN	EN	T.T.Carrijo 1629
Solanaceae			
Physalis angulata L.			T.T.Carrijo 2213
Solanum aculeatissimum Jacq. ◊			T.T.Carrijo 1792
Solanum campaniforme Roem. & Schut.			T.T.Carrijo 2063
Solanum lacteum Vell.			T.T.Carrijo 1801
Solanum sublentum Hiern			T.T.Carrijo 2047
Stemonuraceae			
Discophora guianensis Miers			T.T.Carrijo 1569
Urticaceae			
Laportea aestuans (L.) Chew			T.T.Carrijo 1728
Pilea hyalina Fenzl			T.T.Carrijo 1808
Pourouma guianensis Aubl.			T.T.Carrijo 2168
Urera baccifera (L.) Gaudich. ex Wedd.			T.T.Carrijo 1758
Verbenaceae			
Lantana camara L.			T.T.Carrijo 1946
Stachytarpheta jamaicensis (L.) Vahl			T.T.Carrijo 2055
Violaceae			
Noisettia orchidiflora (Rudge) Ging.			T.T.Carrijo 1613

species. Twenty-two families were represented by only one species each, totalizing about 9% of all identified species. Considering the criteria previously explained, 21 species are new records for ES, eight are endemic to this state, and 20 are listed as vulnerable, endangered or critically endangered in the RBBF (Martinelli et al. 2013) or in the ESFES (Fraga et al. 2007).

Amongst Rubiaceae, *Rudgea coronata* subsp. *saint-hilaire* (Standl.) Zappi (Figure 2a, b) is endemic of the ES, and is indicated as critically endangered (CR) in both RBBF and ESFES lists. This taxon is relatively common in the park, occurring strictly within the forest, and their individuals aggregate in relatively small populations. The occurrence of *Rudgea coronata* subsp. *saint-hilaire* in the ES was attested by only two collections, both from the Linhares municipality, northern Espírito Santo. Thus, the collections of MFSP expanded the geographic distribution of this species to the southwards of the state. Another species of the same genus, *R. reflexa* Zappi (Figure 2c) is considered endangered (EN) in RBBF, but

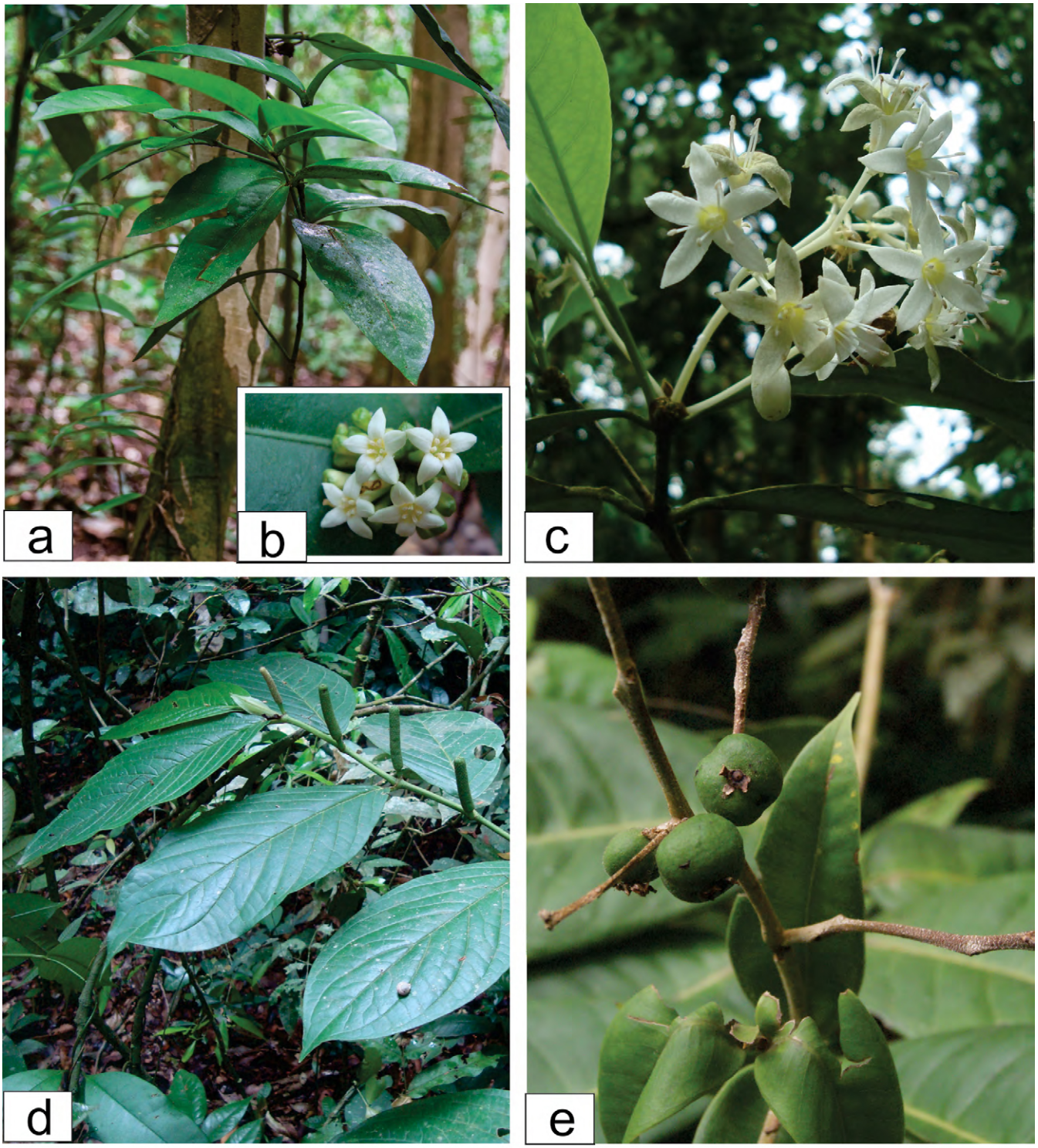

Figure 2. Some of the plant species found in the Mata das Flores State Park. A-B. *Rudgea coronata* ssp. *saint-hillaire* (habit and inflorescence); C. *Rudgea reflexa* (inflorescence); D. *Piper miquelianum* (inflorescence); E. *Myrcia limae* (immature fruits).

is not endemic to the Espírito Santo, also occurring in Bahia state. *Rudgea reflexa* and *R. coronata* subsp. *saint-hilaire* are very common understory species in the MFSP, being exclusively found in this layer of the forest.

None of the Piperaceae species that occur in the MFSP is endemic to Espírito Santo, and *Piper piliovarium* Yunck is a new occurrence for this state. Individuals of this species occur strictly within the forest and show an aggregated distribution. *Piper vicosanum* Yunck. (Figure 2d) is the only species categorized under some threat criteria. The species is considered endangered (EN) in the ESFES list. In the MFSP, isolated individuals occur both inside the forest and in roadsides.

Amongst the three species of Myrtaceae that are endemic of ES and occur in the MFSP, two are categorized in some of the IUCN (2013) threat category. *Myrcia limae* Barroso and Peixoto (Figure 2e) is also an endemic species of the ES, categorized as endangered (EN) by RBBF and vulnerable (VU) by the ESFES lists. This species was previously known by few collections from four municipalities (Conceição da Barra, Nova Venécia, Linhares and Santa Teresa). The distribution of *M. limae* is therefore expanded in Espírito Santo. Moreover, the specimens collected in the MFSP also add to the knowledge about the morphology of the fruits of this species, which were not described at the species' protologue. Another species of note in the same genus is *Myrcia follii* Barroso & Peixoto. This species is indicated as critically endangered (CR) in the RBBF and vulnerable (VU) in the ESFES, and was previously known for 20 samples gathered in three municipalities of Espírito Santo.

The genus *Dorstenia* (Moraceae) comprises four species in MFSP, which apparently occur in different habitats. Topography and light seem to explain the differences in the spatial organization of the different species in the park. Populations of *D. arifolia* (Figure 3a, b) are always ombrophilous and occur in aggregated patches, preferentially in hill slopes. *D. bonijesu* (Figure 3c) does not show an aggregate pattern of organization. Its isolated individuals occur in both shaded areas of hilltops, and open areas of roadsides. This species was classified as vulnerable (VU) in the ESFES. However, in the MFSP this species is quite common, occurring even in disturbed areas at roadsides. Individuals show a low size variation. Finally, *D. elata* (Figure 3d, e) occurs exclusively in shaded forest interiors instead. At last, populations of *D. hirta* (Figure 3f, g) were found in shaded areas and below canopy gaps. In these sites, observed individuals varied from 20 cm to 1 m height, respectively.

Even though Rutaceae presented low species richness in the studied site, *Almeidea rubra* A.St.-Hil. is the most commonly found understory species, as well as *Clavija caloneura* Mart. ex Miq. (Primulaceae). The individuals of *A. rubra* in MFSP show an aggregated distribution in space, occurring from valleys to hilltops. Individuals of *C. caloneura,* on the contrary, were commonly observed at the valleys, and apparently are not distributed in aggregate populations.

DISCUSSION

Our results show that the conservation value of small sized fragments (ca. 150 ha) can be quite high, considering their overall species richness and number of endangered species they can hold. It is noteworthy that such small remnants can comprise about 12% of what remains in forest cover from this biome (Ribeiro et al. 2009). Our results also highlight the need for time consuming, intensive, floristic inventories in order to encompass the flowering time of most plant species occurring in a site. Because snapshot inventories may not detect several plant species with short flowering periods, we concentrated the sampling effort within this 144 ha remnant for a relatively long period (two years), with a high visiting frequency (weekly).

The overall pattern of species richness, especially within the families Rubiaceae, Piperaceae, and Myrtaceae, is that expected for Lowland Dense Ombrophilous Forests (Carvalho 2006) and other physiognomies of the Atlantic Forest (Amorim et al. 2009; Carvalho et al. 1996; Carvalho et al. 2000). Floristic surveys in different vegetation types of Espírito Santo confirm the high richness of Myrtaceae and Rubiaceae in this state (Assis et al. 2004; Jesus and Rolim 2005; Rolim et al. 2006; Saiter et al. 2011). However, the high species richness of Piperaceae was an unexpected result, considering that Myrtaceae is the richest angiosperm family of the Brazilian flora (Forzza et al 2010), and is highly representative in the Atlantic Forest (Mori et al. 1983; Oliveira-Filho and Fontes 2000). A possible explanation for this result is the fact that the increased heterogeneity created by trails and roads, and their related edge effects, seems to favor species of Piperaceae more than species of Myrtaceae. The open areas within the MFSP are represented by roads that cross the fragment and by trails inside the forest reportedly created by motocross practice in the past. *Piper* species usually occurs near roadsides and in trails inside the forest. The fruit dispersal made by bats is one possible reason to explain this spatial occupation (Thiers and Kalko 2004). These animals predominantly forage in open areas (Coffin 2007), leading seeds to fall during the flight.

The results found in MFSP reveal the importance of small forest fragments in conserving endemic species known for a small number of populations. Many other collection gaps in southeast Brazil deserve future floristic inventories, especially in the southern portion of Espírito Santo state. Field studies on small sized remnants within areas with collection gaps are essential to improve herbaria collections and biodiversity databases of the Atlantic Forest.

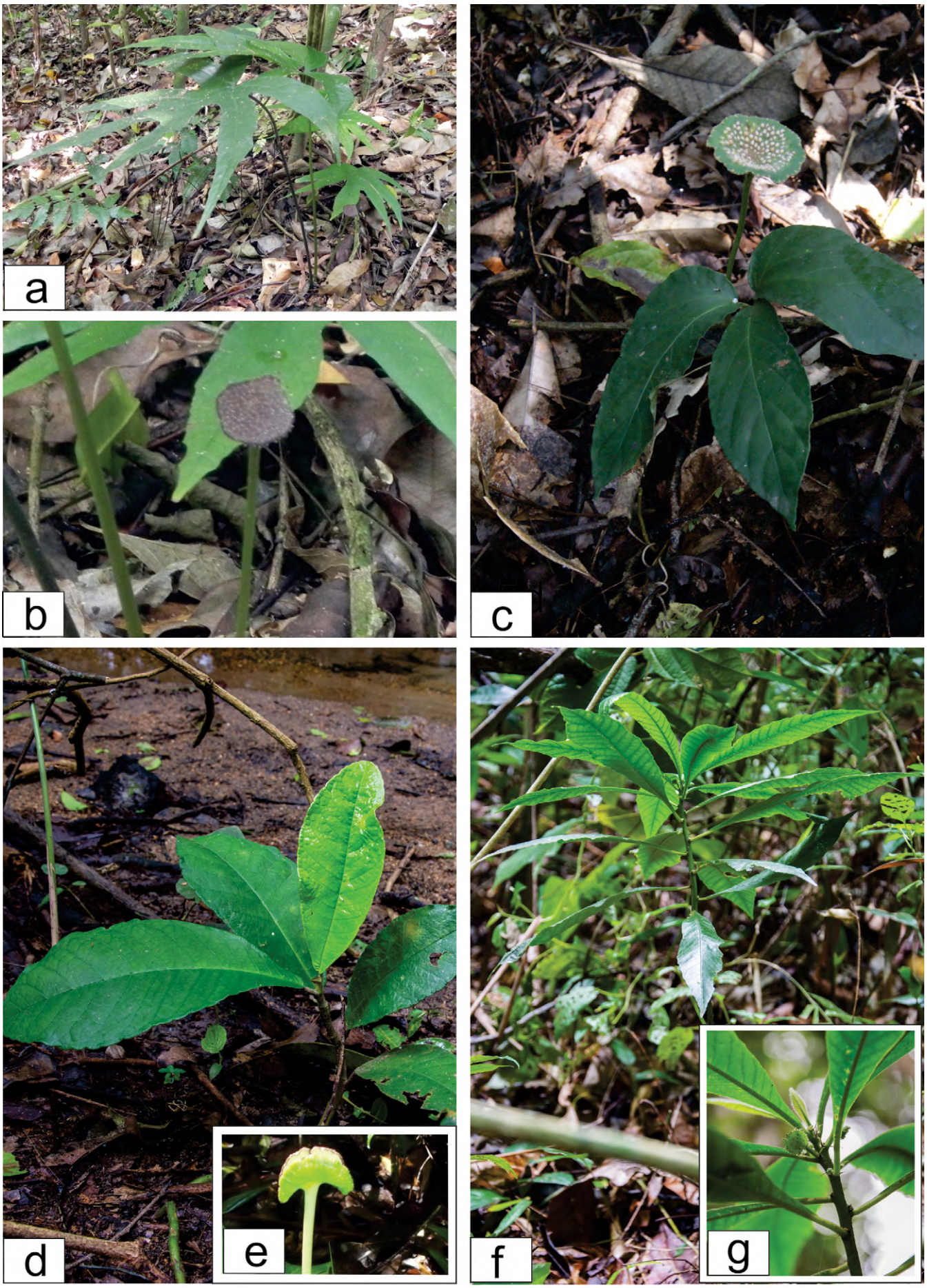

Figure 3. *Dorstenia* species from Mata das Flores State Park. A-B. *D. arifolia* (habit and inflorescence); C. *D. bonijesu* (habit); D-E. *D. elata* (habit and inflorescence); F-G. *D. hirta* (habit and inflorescence).

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