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Floristic and ecological attributes of a Seasonal Semideciduous Atlantic Forest in a key area for conservation of the Zona da Mata region of Minas Gerais State, Brazil[1]

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ABSTRACT - (Floristic and ecological attributes of a Seasonal Semideciduous Atlantic Forest in a key area for conservation of the Zona da Mata region of Minas Gerais State, Brazil). We evaluated the floristic and ecological attributes of a seasonal semideciduous forest remnant (SSF) (500-1,050 m) located in a key area for biodiversity conservation. The importance of the fragment to the ecosystem conservation was revealed by its species richness (253), diversity (Shannon index = 4.6; Simpson's complementary index = 0.98) and evenness (Pielou index = 0.83), which are considered high values for a SSF. Zoochory occurred in 77% of the species, indicating the existence of important biotic interactions that ensure the occurrence of gene flow. We recorded 14 endangered species, among which two are rare (*Trigynaea oblongifolia* and *Trattinnickia ferruginea*) and two are indicators of mature forests (*Trattinnickia ferruginea* and *Virola bicuhyba*). We confirmed the importance of key areas for biodiversity conservation and of the Atlantic SSF located at the 0-1,000 m altitudinal range. These areas deserve attention from conservationists due to the high species richness and high number of endemic and endangered species.
Keywords: Floristic Survey, Endangered Species, *Hotspot*, Species Distribution

RESUMO - (Atributos florísticos e ecológicos de uma Floresta Estacional Semidecidual Atlântica em área-chave para a conservação na Zona da Mata do Estado de Minas Gerais, Brasil). Avaliamos atributos florísticos e ecológicos de um remanescente de Floresta Estacional Semidecidual (FESD) (500-1.050 m) localizado em uma área-chave para conservação da biodiversidade. Evidenciamos a importância da conservação do fragmento devido à riqueza de espécies arbóreas (253), diversidade (Índice de Shannon = 4,6; Índice complementar de Simpson = 0,98) e equabilidade (Índice de Pielou = 0,83), que são considerados valores altos para uma FESD. A síndrome zoocórica representou 77% das espécies, sugerindo a existência de interações bióticas importantes para a manutenção do fluxo gênico. Registramos 14 espécies ameaçadas de extinção, dentre as quais duas raras (*Trigynaea oblongifolia* e *Trattinnickia ferruginea*) e duas indicadoras de florestas maduras (*Trattinnickia ferruginea* e *Virola bicuhyba*). Confirmamos a importância de áreas-chave para a conservação da biodiversidade e da FESD Atlântica localizada em cotas altitudinais de 0-1.000 m, a qual merece atenção dos conservacionistas por apresentarem alta riqueza de espécies e elevado número de espécies endêmicas e ameaçadas.
Palavras-chave: Distribuição de Espécies, Espécies Ameaçadas, *Hotspot*, Levantamento Florístico

Introduction

Key areas for biodiversity conservation are sites of high value on a global scale (Giulietti *et al*. 2009). Such key areas are geographic units large enough to maintain viable populations and can be identified by criteria based on species vulnerability and endemism (Langhammer *et al.* 2007, Giulietti *et al.* 2009). In

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Brazil, the analysis of the occupation of key areas for biodiversity conservation reveals a predominance of these areas in the Atlantic Forest (Giulietti *et al.* 2009).

The Atlantic Forest is one of the 35 biodiversity hotspots in the world (Zachos & Habel 2011). More than 80% of its remnants have less than 50 ha; such remnants are damaged by border effect and by the distance between fragments (Ribeiro *et al.* 2009). These small fragments are also among the priorities for conservation of the Atlantic Forest and as such must be properly managed to keep the functional link among the vegetation mosaics, minimize border effect and improve connectivity between fragments (Ribeiro *et al.* 2009).

Connectivity between fragments aims to aid individual and gene flow among populations and subpopulations and to increase their chances of survival, thus enabling the maintenance of ecological and evolutionary processes on a large scale (Ayres *et al.* 2005). Management of connectivity between fragments has been made by means of ecological corridors. The Central Corridor of the Atlantic Forest, for instance, currently encompasses 11 areas of high priority for conservation of the region and possesses the highest vascular plant diversity in the world (Ayres *et al.* 2005).

The Parque Nacional do Caparaó, located between Minas Gerais and Espírito Santo States, Brazil, integrates the Central Corridor of the Atlantic Forest. Furthermore, that park, along with the Parque Estadual da Serra do Brigadeiro and their respective surrounding forest fragments, form a key area for biodiversity conservation (Giulietti *et al.* 2009). We aimed to study issues of floristic, ecological, and conservationist interest in a forest remnant between those two Protected Areas, by addressing the following questions: 1) What are the tree species composition and diversity in the area? 2) Which is the predominant seed dispersal syndrome in the area? 3) Are there endemic tree species in the studied fragment? 4) Which and how many tree species are threatened with extinction on a statewide (Red List of Plant Species Threatened with Extinction in Minas Gerais State; Biodiversitas 2008), nationwide (Martinelli & Moraes 2013), and worldwide scale (Red List of Threatened Species of the International Union for Conservation of Nature – IUCN)? 5) Which and how many species are classified as rare, following Giulietti *et al*. (2009) and Martinelli & Moraes (2013)? While answering these questions, we also aimed to address their implications on biodiversity conservation.

Material and methods

The study area consists in a Montane Seasonal Semideciduous Forest remnant in the Zona da Mata region of Minas Gerais State, Brazil, located in the surroundings of the Central Corridor of the Atlantic Forest, between Parque Nacional do Caparaó and Parque Estadual da Serra do Brigadeiro (figure 1). The region is considered key for the conservation of rare species (Giulietti *et al*. 2009).

The studied forest remnant is located within the private property Santa Rita Farm (20°46'S, 42°02'W), at Faria Lemos municipality, on the watershed of Paraíba do Sul river. The fragment extends throughout an area of ca. 219 ha, with altitudes ranging between 500 and 1,050 m. The history of occupation of the site reveals areas with different land uses: recovering areas, which were deforested in the 1960s and 1970s for coffee cultivation and wood exploitation; and predominantly well-preserved forest patches that did not undergo significant anthropic action.

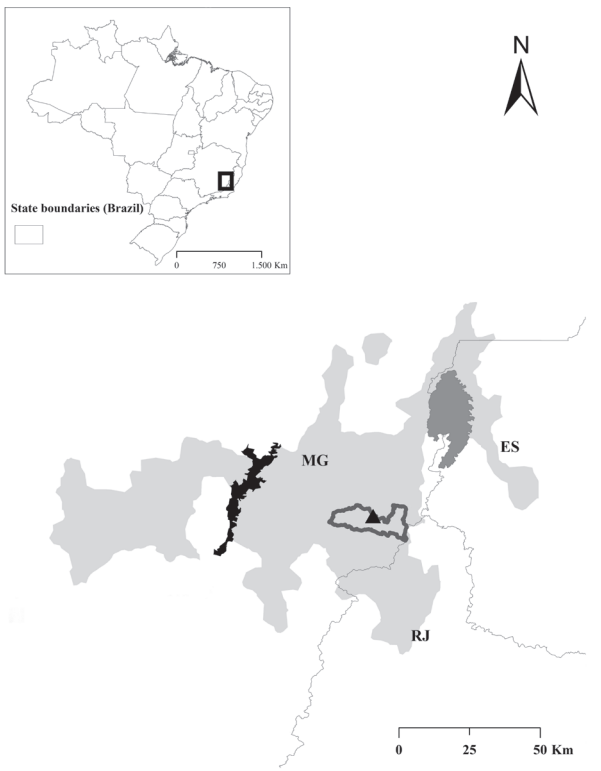

Figure 1. Geographic location of the Seasonal Semideciduous Atlantic Forest fragment at Santa Rita Farm, Faria Lemos municipality, Minas Gerais State, Brazil. ■ Key areas for conservation of rare plants, ■ Parque Estadual da Serra do Brigadeiro, ■ Parque Nacional do Caparaó, □ ▲ Santa Rita Farm, Faria Lemos, Minas Gerais State, Brazil.

Koppen's climate in the region is Tropical Aw, characterized by high temperatures, with an annual mean of 24.5 ºC (Peel *et al*. 2007). Mean annual precipitation is 1,200 mm, with high values being registered in the rainy season, which takes place from October through April.

For vegetation sampling, we established three transects 20 m wide and 400 m long each, parallel and distant 200 m from one another. In each transect we established 11 400-m^2 plots (20 × 20 m), totaling 33 plots and 1.32 ha of sampling area. Plots were placed in order to be equidistant 20 m from one another along transects. Then, we sampled all tree individuals having circumference at 1.30 m above ground level equal to or higher than 15 cm. Individuals with tillers below the 1.30-m mark above ground level had all their bifurcations included in the sampling whenever at least one of the tillers met the sampling criterion. Then, we measured the perimeter of each of the other bifurcations separately and calculated their respective basal areas; only then we calculated the sum of the basal area of tillers (Moro & Martins 2011). Botanical material was identified by consultation to herbaria Guido Frederico João Pabst (GFJP) and Herbário do Jardim Botânico do Rio de Janeiro (RB), review of specialized literature, and by sending duplicates to specialists. Species were grouped in families following the classification system APG III (2009) and species' authors were checked in the online platforms Missouri Botanical Garden (http://www.mobot.org/) and Flora do Brasil (http://floradobrasil.jbrj.gov.br/). All collected botanical material was deposited in the GFJP herbarium, in Carangola city, Minas Gerais State.

Floristic diversity in the study area was estimated by species richness, Simpson's complementary index (1-D), and Shannon-Wiener (H') and Pielou's evenness (J') indexes.

Species distribution was investigated based on two endemism criteria: (i) endemic to Brazil, and (ii) endemic to the Atlantic Forest. From this stage, we used only specimens identified at the species level in order to obtain higher data reliability in our analyses. To access such endemism criteria, we consulted databases Flora do Brasil (http://floradobrasil.jbrj.gov.br/) and SpeciesLink (http://splink.cria.org.br/), and the following literature: Catálogo das Árvores Nativas de Minas Gerais (Oliveira-Filho 2006), Plantas da Floresta Atlântica (Stehmann *et al.* 2009), and Árvores da Floresta Estacional Semidecidual - Guia de Identificação de Espécies (Ramos *et al.* 2008). Ecological representativeness of species was evaluated by their dispersal syndrome, which is an important attribute to characterize environments and can be measured by the amount of plants that have zoochoric or the different abiotic syndromes (Campassi 2006). In that sense, we classified syndromes under categories zoochoric or abiotic based on diaspore morphology and on the review of literature on fruit and seed dispersal (*e.g.*, van der Pijl 1982, Morellato *et al.* 2000, Catharino *et al.* 2006, Kinoshita *et al.* 2006, Campassi 2006, Yamamoto *et al.* 2007, Aquino & Barbosa 2009, Prado-Júnior *et al.* 2012).

The degree of threat to the sampled species was evaluated by consultation to the IUCN Red List of Threatened Species (http://www.iucnredlist.org/), Livro Vermelho da Flora do Brasil (Martinelli & Moraes 2013), and Lista Vermelha das Espécies da Flora Ameaçada de Extinção em Minas Gerais (Biodiversitas 2008). The rarity status of species was determined following Giulietti *et al*. (2009) and Martinelli & Moraes (2013).

Results and Discussion

We identified 253 tree species belonging to 130 genera and 49 botanical families. The families that showed highest species richness were Fabaceae (26 species), Lauraceae (21), Myrtaceae (19), Rubiaceae (16), and Annonaceae (10) (table 1).

Fabaceae, Rubiaceae, and Myrtaceae are among the 10 most representative botanical families in the Brazilian flora (BFG 2015). These families are also among the richest ones in terms of species and endemism in the Atlantic Forest (Stehmann *et al.* 2009).

Fabaceae genera that show high richness in the Atlantic Forest were found in the study area, such as *Inga* Mill. and *Machaerium* Pers. (Stehmann *et al.* 2009). According to Oliveira-Filho & Fontes (2000), the abovementioned genera are the most important ones in the Fabaceae that occur in seasonal forests, which is the case of the forest remnant we studied.

The most representative genera in the study area were *Ocotea* Aubl., with seven species; *Eugenia* L., *Myrcia* DC. and *Licania* Aubl., with five species, each; and *Aspidosperma* Mart., *Cupania* L., and *Trichilia* P. Browne, with four species, each. *Ocotea* is the most species-rich genus of Lauraceae in Brazil, while *Eugenia* and *Myrcia* are the most diverse Myrtaceae genera (BFG 2015) and are among the 20 most diverse genera in the Atlantic Forest (Stehmann *et al.* 2009).

Other less diverse genera found, yet that are represented among the richest ones in the Brazilian

Table 1. List of angiosperm tree species found in a Seasonal Semideciduous Atlantic Forest remnant located at Santa Rita Farm, Faria Lemos municipality, Minas Gerais State, Brazil.

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Achariaceae				
Carpotroche brasiliensis (Raddi) A.Gray	Rocha, M.J.R., 1005	Yes	No	Zoochory
Anacardiaceae				
Astronium fraxinifolium Schott	Rocha, M.J.R., 1006	No	No	Abiotic
Anacardiaceae 1	Rocha, M.J.R., 1007	No	No	-
Annonaceae				
Anaxagorea dolichocarpa Sprague & Sandwith	Rocha, M.J.R., 1008	No	No	Zoochory
Annona cacans Warm.	Rocha, M.J.R., 1009	No	Yes	Zoochory
Guatteria campestris R.E. Fr.	Rocha, M.J.R., 1010	Yes	Yes	Zoochory
Guatteria pogonopus Mart.	Rocha, M.J.R., 1011	Yes	Yes	Zoochory
Guatteria sellowiana Schltdl.	Rocha, M.J.R., 1012	Yes	No	Zoochory
Oxandra nitida R.E. Fr.	Rocha, M.J.R., 1013	Yes	Yes	Zoochory
Trigynaea oblongifolia Schltdl.	Rocha, M.J.R., 1014	Yes	Yes	Zoochory
Xylopia brasiliensis Spreng. A.St.-Hil.	Rocha, M.J.R., 1015	Yes	Yes	Zoochory
Xylopia sericea A.St.-Hil.	Rocha, M.J.R., 1016	No	No	Zoochory
Xylopia sp. 1	Rocha, M.J.R., 1017	No	No	Zoochory
Apocynaceae				
Aspidosperma parvifolium A.DC.	Rocha, M.J.R., 1018	No	No	Abiotic
Aspidosperma polyneuron Müll.Arg.	Rocha, M.J.R., 1019	No	No	Abiotic
Aspidosperma sp. 1	Rocha, M.J.R., 1020	No	No	Abiotic
Aspidosperma sp. 2	Rocha, M.J.R., 1021	No	No	Abiotic
Himatanthus bracteatus (A.DC.) Woodson	Rocha, M.J.R., 1022	Yes	Yes	Abiotic
Tabernaemontana hystrix Steud.	Rocha, M.J.R., 1023	Yes	Yes	Zoochory
Apocynaceae 1	Rocha, M.J.R., 1024	No	No	-
Apocynaceae 2	Rocha, M.J.R., 1025	No	No	-
Aquifoliaceae				
Ilex cerasifolia Reissek	Rocha, M.J.R., 1026	Yes	Yes	Zoochory
Araliaceae				
Schefflera morototoni (Aubl.) Maguire, Steyerm. & Frodin	Rocha, M.J.R., 1027	No	No	Zoochory
Arecaceae				
Astrocaryum aculeatissimum (Schott) Burret	Rocha, M.J.R., 1028	Yes	Yes	Zoochory
Euterpe edulis Mart.	Rocha, M.J.R., 1029	No	No	Zoochory
Syagrus romanzoffiana (Cham.) Glassman	Rocha, M.J.R., 1030	No	No	Zoochory
Asteraceae				
Piptocarpha macropoda (DC.) Baker	Rocha, M.J.R., 1031	Yes	No	Abiotic
Vernonanthura discolor (Spreng.) H. Rob.	Rocha, M.J.R., 1032	No	No	Abiotic
Asteraceae 1	Rocha, M.J.R., 1033	No	No	-
Bignoniaceae				
Jacaranda sp. 1	Rocha, M.J.R., 1034	No	No	Abiotic
Sparattosperma leucanthum (Vell.) K.Schum.	Rocha, M.J.R., 1035	No	No	Abiotic

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Tabebuia sp1	Rocha, M.J.R., 1036	No	No	Abiotic
Zeyheria tuberculosa (Vell.) Bureau *ex* Verl.	Rocha, M.J.R., 1037	No	No	Abiotic
Burseraceae				
Protium heptaphyllum (Aubl.) Marchand	Rocha, M.J.R., 1038	No	No	Zoochory
Protium tenuifolium (Engl.) Engl.	Rocha, M.J.R., 1039	No	No	Zoochory
Trattinnickia ferruginea Kuhlm.	Rocha, M.J.R., 1040	Yes	Yes	Zoochory
Caricaceae				
Jacaratia spinosa (Aubl.) A.DC.	Rocha, M.J.R., 1041	No	No	Zoochory
Celastraceae				
Cheiloclinium anomalum Miers	Rocha, M.J.R., 1042	No	No	Zoochory
Maytenus sp1	Rocha, M.J.R., 1043	No	No	Zoochory
Tontelea corcovadensis A.C. Sm	Rocha, M.J.R., 1044	Yes	Yes	Zoochory
Celastraceae 1	Rocha, M.J.R., 1045	No	No	-
Chrysobalanaceae				
Hirtella hebeclada Moric. *ex* DC.	Rocha, M.J.R., 1046	Yes	No	Zoochory
Hirtella sp. 1	Rocha, M.J.R., 1047	No	No	Zoochory
Licania cf. *blackii* Prance	Rocha, M.J.R., 1048	No	No	-
Licania kunthiana Hook.f.	Rocha, M.J.R., 1049	Yes	No	Zoochory
Licania sp. 1	Rocha, M.J.R., 1050	No	No	Zoochory
Licania sp. 2	Rocha, M.J.R., 1051	No	No	Zoochory
Licania sp. 3	Rocha, M.J.R., 1052	No	No	Zoochory
Chrysobalanaceae 1	Rocha, M.J.R., 1053	No	No	-
Clusiaceae				
Clusia sp. 1	Rocha, M.J.R., 1054	No	No	-
Garcinia gardneriana (Planch. & Triana) Zappi	Rocha, M.J.R., 1055	No	No	Zoochory
Tovomita cf. *riedeliana* Engl.	Rocha, M.J.R., 1056	No	No	Zoochory
Tovomita sp. 1	Rocha, M.J.R., 1057	No	No	Zoochory
Tovomitopsis sp. 1	Rocha, M.J.R., 1058	Yes	Yes	Zoochory
Clusiaceae 1	Rocha, M.J.R., 1059	No	No	Zoochory
Combretaceae				
Buchenavia sp. 1	Rocha, M.J.R., 1060	No	No	Zoochory
Elaeocarpaceae				
Sloanea guianensis (Aubl.) Benth.	Rocha, M.J.R., 1061	No	No	Zoochory
Sloanea hirsuta (Schott) Planch. *ex* Benth.	Rocha, M.J.R., 1062	Yes	Yes	Zoochory
Erythroxylaceae				
Erythroxylum citrifolium A.St.-Hil.	Rocha, M.J.R., 1063	No	No	Zoochory
Erythroxylum pulchrum A.St.-Hil.	Rocha, M.J.R., 1064	Yes	Yes	Zoochory
Euphorbiaceae				
Joannesia princeps Vell.	Rocha, M.J.R., 1065	Yes	No	Zoochory
Mabea fistulifera Mart.	Rocha, M.J.R., 1066	No	No	Zoochory

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Sapium sp. 1	Rocha, M.J.R., 1067	No	No	Zoochory
Sebastiania sp.	Rocha, M.J.R., 1068	No	No	Abiotic
Senefeldera verticillata (Vell.) Croizat	Rocha, M.J.R., 1069	Yes	Yes	Abiotic
Euphorbiaceae 1	Rocha, M.J.R., 1070	No	No	-
Fabaceae				
Anadenanthera colubrina (Vell.) Brenan	Rocha, M.J.R., 1071	No	No	Abiotic
Anadenanthera peregrina (L.) Speg	Rocha, M.J.R., 1072	No	No	Abiotic
Apuleia leiocarpa (Vogel) J.F. Macbr.	Rocha, M.J.R., 1073	No	No	Abiotic
Bauhinia sp. 1	Rocha, M.J.R., 1074	No	No	Abiotic
Cassia ferruginea (Schrad.) DC.	Rocha, M.J.R., 1075	No	No	Abiotic
Copaifera trapezifolia Hayne	Rocha, M.J.R., 1076	No	Yes	Zoochory
Dalbergia nigra (Vell.) Benth.	Rocha, M.J.R., 1077	Yes	Yes	Abiotic
Inga capitata Desv.	Rocha, M.J.R., 1078	No	No	Zoochory
Inga striata Benth.	Rocha, M.J.R., 1079	No	No	Zoochory
Inga vera Willd.	Rocha, M.J.R., 1080	No	No	Zoochory
Machaerium nyctitans (Vell.) Benth.	Rocha, M.J.R., 1081	No	No	Abiotic
Machaerium sp. 1	Rocha, M.J.R., 1082	No	No	Abiotic
Melanoxylon brauna Schott	Rocha, M.J.R., 1083	Yes	No	Abiotic
Myrocarpus frondosus Allemao	Rocha, M.J.R., 1084	No	Yes	Abiotic
Myroxylon peruiferum L.f.	Rocha, M.J.R., 1085	No	No	Abiotic
Piptadenia gonoacantha Mart. J.F. Macbr.	Rocha, M.J.R., 1086	No	Yes	Abiotic
Platypodium elegans Vogel	Rocha, M.J.R., 1087	No	No	Abiotic
Pseudopiptadenia contorta DC.) G.P. Lewis & M.P. Lima	Rocha, M.J.R., 1088	Yes	No	Abiotic
Swartzia sp.1	Rocha, M.J.R., 1089	No	No	-
Vataireopsis araroba (Aguiar) Ducke	Rocha, M.J.R., 1090	Yes	Yes	Abiotic
Fabaceae 1	Rocha, M.J.R., 1091	No	No	-
Fabaceae 2	Rocha, M.J.R., 1092	No	No	-
Fabaceae 3	Rocha, M.J.R., 1093	No	No	-
Fabaceae 4	Rocha, M.J.R., 1094	No	No	-
Fabaceae 5	Rocha, M.J.R., 1095	No	No	-
Fabaceae 6	Rocha, M.J.R., 1096	No	No	-
Lacistemataceae				
Lacistema pubescens Mart.	Rocha, M.J.R., 1097	Yes	No	Zoochory
Lamiaceae				
Aegiphila integrifolia (Jacq.) B.D.Jacks.	Rocha, M.J.R., 1098	No	No	Zoochory
Vitex megapotamica (Spreng.) Moldenke	Rocha, M.J.R., 1099	No	No	Zoochory
Lauraceae				
Aiouea saligna Meisn.	Rocha, M.J.R., 1100	Yes	No	Zoochory
Aiouea sp. 1	Rocha, M.J.R., 1101	No	No	Zoochory

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Aniba firmula (Nees & Mart.) Mez	Rocha, M.J.R., 1102	Yes	No	Zoochory
Aniba sp. 1	Rocha, M.J.R., 1103	No	No	Zoochory
Beilschmiedia emarginata (Meisn.) Kosterm.	Rocha, M.J.R., 1104	Yes	Yes	Zoochory
Licaria armeniaca (Nees) Kosterm.	Rocha, M.J.R., 1105	No	No	Zoochory
Nectandra cuspidata Nees & Mart.	Rocha, M.J.R., 1106	No	No	Zoochory
Nectandra lanceolata Nees & Mart.	Rocha, M.J.R., 1107	Yes	No	Zoochory
Ocotea citrosmoides (Nees) Mez	Rocha, M.J.R., 1108	Yes	Yes	Zoochory
Ocotea divaricata (Nees) Mez	Rocha, M.J.R., 1109	Yes	Yes	Zoochory
Ocotea indecora (Schott) Mez	Rocha, M.J.R., 1110	Yes	Yes	Zoochory
Ocotea sp. 1	Rocha, M.J.R., 1111	No	No	Zoochory
Ocotea sp. 2	Rocha, M.J.R., 1112	No	No	Zoochory
Ocotea sp. 3	Rocha, M.J.R., 1113	No	No	Zoochory
Ocotea spixiana (Nees) Mez	Rocha, M.J.R., 1114	Yes	No	Zoochory
Lauraceae 1	Rocha, M.J.R., 1115	No	No	-
Lauraceae 2	Rocha, M.J.R., 1116	No	No	-
Lauraceae 3	Rocha, M.J.R., 1117	No	No	-
Lauraceae 4	Rocha, M.J.R., 1118	No	No	-
Lauraceae 5	Rocha, M.J.R., 1119	No	No	-
Lauraceae 6	Rocha, M.J.R., 1120	No	No	-
Lecythidaceae				
Cariniana legalis (Mart.) Kuntze	Rocha, M.J.R., 1121	Yes	Yes	Abiotic
Lecythis sp. 1	Rocha, M.J.R., 1122	No	No	-
Malpighiaceae				
Byrsonima sp. 1	Rocha, M.J.R., 1123	No	No	Zoochory
Malvaceae				
Ceiba speciosa (A.St.-Hil.) Ravenna	Rocha, M.J.R., 1124	No	No	Abiotic
Eriotheca sp. 1	Rocha, M.J.R., 1125	No	No	-
Eriotheca sp. 2	Rocha, M.J.R., 1126	No	No	-
Luehea divaricata Mart.	Rocha, M.J.R., 1127	No	No	Abiotic
Pseudobombax grandiflorum (Cav.) A. Robyns	Rocha, M.J.R., 1128	Yes	Yes	Abiotic
Spirotheca sp. 1	Rocha, M.J.R., 1129	Yes	Yes	-
Sterculia apetala (Jacq.) H. Karst.	Rocha, M.J.R., 1130	No	No	Abiotic
Melastomataceae				
Miconia altissima Cogn.	Rocha, M.J.R., 1131	Yes	Yes	Zoochory
Miconia lepidota Schrank & Mart. *ex* DC	Rocha, M.J.R., 1132	No	No	Zoochory
Tibouchina estrellensis (Raddi) Cogn.	Rocha, M.J.R., 1133	Yes	Yes	Abiotic
Meliaceae				
Cedrela fissilis Vell.	Rocha, M.J.R., 1134	No	No	Abiotic
Guarea kunthiana A. Juss.	Rocha, M.J.R., 1135	No	No	Zoochory

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Trichilia elegans A. Juss.	Rocha, M.J.R., 1136	Yes	No	Zoochory
Trichilia pallida Sw.	Rocha, M.J.R., 1137	No	No	Zoochory
Trichilia sp. 1	Rocha, M.J.R., 1138	No	No	Zoochory
Trichilia sp. 2	Rocha, M.J.R., 1139	No	No	Zoochory
Meliaceae 1	Rocha, M.J.R., 1140	No	No	-
Meliaceae 2	Rocha, M.J.R., 1141	No	No	-
Monimiaceae				
Mollinedia acutissima Perkins	Rocha, M.J.R., 1142	Yes	Yes	Zoochory
Mollinedia widgrenii A. DC.	Rocha, M.J.R., 1143	Yes	No	Zoochory
Moraceae				
Brosimum glaziovii Taub.	Rocha, M.J.R., 1144	Yes	Yes	Zoochory
Brosimum guianense (Aubl.) Huber *ex* Ducke	Rocha, M.J.R., 1145	No	No	Zoochory
Clarisia ilicifolia (Spreng.) Lanj. & Rossbach	Rocha, M.J.R., 1146	No	No	Zoochory
Ficus adhatodifolia Schott	Rocha, M.J.R., 1147	No	No	Zoochory
Ficus mariae C.C.Berg, Emygdio & Carauta	Rocha, M.J.R., 1148	No	Yes	Zoochory
Ficus trigona L.f.	Rocha, M.J.R., 1149	No	No	Zoochory
Sorocea bonplandii (Baill.) W.C.Burger, Lanj. & de Boer	Rocha, M.J.R., 1150	No	No	Zoochory
Myristicaceae				
Virola bicuhyba (Schott) Warb.	Rocha, M.J.R., 1151	Yes	Yes	Zoochory
Virola gardneri (A.DC.) Warb.	Rocha, M.J.R., 1152	Yes	Yes	Zoochory
Myrtaceae				
Campomanesia sp. 1	Rocha, M.J.R., 1153	No	No	Zoochory
Eugenia cf. *florida* DC.	Rocha, M.J.R., 1154	No	No	Zoochory
Eugenia cf. *magnifica* Spring *ex* Mart.	Rocha, M.J.R., 1155	No	No	Zoochory
Eugenia sp. 1	Rocha, M.J.R., 1156	No	No	Zoochory
Eugenia sp. 2	Rocha, M.J.R., 1157	No	No	Zoochory
Eugenia sp. 3	Rocha, M.J.R., 1158	No	No	Zoochory
Marlierea excoriata Mart.	Rocha, M.J.R., 1159	Yes	Yes	Zoochory
Myrcia guianensis (Aubl.) DC.	Rocha, M.J.R., 1160	No	No	Zoochory
Myrcia insigniflora M.F. Santos	Rocha, M.J.R., 1161	Yes	Yes	Zoochory
Myrcia sp. 1	Rocha, M.J.R., 1162	No	No	Zoochory
Myrcia splendens (Sw.) DC.	Rocha, M.J.R., 1163	Yes	No	Zoochory
Myrcia tenuivenosa Kiaersk.	Rocha, M.J.R., 1164	Yes	Yes	Zoochory
Myrciaria floribunda (H.West *ex* Willd.) O. Berg	Rocha, M.J.R., 1165	No	No	Zoochory
Psidium guajava L.	Rocha, M.J.R., 1166	No	No	Zoochory
Myrtaceae 1	Rocha, M.J.R., 1167	No	No	-
Myrtaceae 2	Rocha, M.J.R., 1168	No	No	-

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Myrtaceae 3	Rocha, M.J.R., 1169	No	No	-
Myrtaceae 4	Rocha, M.J.R., 1170	No	No	-
Myrtaceae 5	Rocha, M.J.R., 1171	No	No	-
Nyctaginaceae				
Guapira opposita (Vell.) Reitz	Rocha, M.J.R., 1172	No	No	Zoochory
Olacaceae				
Heisteria silvianii Schwacke	Rocha, M.J.R., 1173	Yes	No	Zoochory
Tetrastylidium grandifolium (Baill.) Sleumer	Rocha, M.J.R., 1174	Yes	Yes	Zoochory
Primulaceae				
Myrsine umbellata Mart.	Rocha, M.J.R., 1175	No	No	Zoochory
Phyllanthaceae				
Hieronyma alchorneoides Allemão	Rocha, M.J.R., 1176	No	No	Zoochory
Picramniaceae				
Picramnia glazioviana Engl.	Rocha, M.J.R., 1177	No	No	Zoochory
Proteaceae				
Roupala sp. 1	Rocha, M.J.R., 1178	No	No	Abiotic
Rhamnaceae				
Rhamnidium sp. 1	Rocha, M.J.R., 1179	No	No	Zoochory
Rosaceae				
Prunus myrtifolia (L.) Urb.	Rocha, M.J.R., 1180	No	No	Zoochory
Rubiaceae				
Amaioua guianensis Aubl.	Rocha, M.J.R., 1181	No	No	Zoochory
Bathysa australis (A.St.-Hil.) K. Schum.	Rocha, M.J.R., 1182	No	No	Abiotic
Coussarea congestiflora Müll. Arg.	Rocha, M.J.R., 1183	No	No	Zoochory
Ixora brevifolia Benth.	Rocha, M.J.R., 1184	-	No	Zoochory
Posoqueria acutifolia Mart.	Rocha, M.J.R., 1185	Yes	No	Zoochory
Psychotria hastisepala Müll. Arg.	Rocha, M.J.R., 1186	Yes	No	Zoochory
Psychotria sp. 1	Rocha, M.J.R., 1187	No	No	Zoochory
Psychotria vellosiana Benth.	Rocha, M.J.R., 1188	No	No	Zoochory
Randia armata (Sw.) DC.	Rocha, M.J.R., 1189	No	No	Zoochory
Randia sp. 1	Rocha, M.J.R., 1190	No	No	Zoochory
Rudgea jasminoides subsp. *corniculata* (Benth.) Zappi	Rocha, M.J.R., 1191	No	No	Zoochory
Simira sampaioana (Standl.) Steyerm.	Rocha, M.J.R., 1192	Yes	No	Abiotic
Tocoyena sellowiana (Cham. & Schltdl.) K.Schum.	Rocha, M.J.R., 1193	Yes	No	Zoochory
Rubiaceae 1	Rocha, M.J.R., 1194	No	No	-
Rubiaceae 2	Rocha, M.J.R., 1195	No	No	-
Rubiaceae 3	Rocha, M.J.R., 1196	No	No	-
Rutaceae				
Esenbeckia sp. 1	Rocha, M.J.R., 1197	No	No	-

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Zanthoxylum rhoifolium Lam.	Rocha, M.J.R., 1198	No	No	Zoochory
Zanthoxylum sp. 1	Rocha, M.J.R., 1199	No	No	Zoochory
Rutaceae 1	Rocha, M.J.R., 1200	No	No	
Salicaceae				
Casearia decandra Jacq.	Rocha, M.J.R., 1201	Yes	No	Zoochory
Casearia sp. 1	Rocha, M.J.R., 1202	No	No	Zoochory
Casearia sylvestris Sw.	Rocha, M.J.R., 1203	No	No	Zoochory
Macrothumia kuhlmannii (Sleumer) Alford	Rocha, M.J.R., 1204	Yes	Yes	Zoochory
Xylosma prockia (Turcz.) Turcz.	Rocha, M.J.R., 1205	No	No	Zoochory
Sapindaceae				
Allophylus sp. 1	Rocha, M.J.R., 1206	No	No	Zoochory
Cupania ludowigii Somner & Ferrucci	Rocha, M.J.R., 1207	Yes	Yes	Zoochory
Cupania sp. 1	Rocha, M.J.R., 1208	No	No	Zoochory
Cupania sp. 2	Rocha, M.J.R., 1209	No	No	Zoochory
Cupania vernalis Cambess.	Rocha, M.J.R., 1210	No	No	Zoochory
Matayba elaeagnoides Radlk.	Rocha, M.J.R., 1211	No	No	Zoochory
Sapindaceae 1	Rocha, M.J.R., 1212	No	No	-
Sapindaceae 2	Rocha, M.J.R., 1213	No	No	-
Sapindaceae 3	Rocha, M.J.R., 1214	No	No	-
Sapotaceae				
Chrysophyllum sp. 1	Rocha, M.J.R., 1215	No	No	Zoochory
Micropholis gardneriana (A.DC.) Pierre	Rocha, M.J.R., 1216	No	No	Zoochory
Pouteria torta (Mart.) Radlk.	Rocha, M.J.R., 1217	No	No	Zoochory
Siparunaceae				
Siparuna guianensis Aubl.	Rocha, M.J.R., 1218	No	No	Zoochory
Siparuna sp. 1	Rocha, M.J.R., 1219	No	No	Zoochory
Solanaceae				
Solanum intermedium Sendtn.	Rocha, M.J.R., 1220	Yes	Yes	Zoochory
Solanum sp. 1	Rocha, M.J.R., 1221	No	No	Zoochory
Symplocaceae				
Symplocos estrellensis Casar.	Rocha, M.J.R., 1222	Yes	Yes	Zoochory
Symplocos sp. 1	Rocha, M.J.R., 1223	No	No	-
Urticaceae				
Cecropia glaziovii Snethl.	Rocha, M.J.R., 1224	Yes	Yes	Zoochory
Cecropia hololeuca Miq.	Rocha, M.J.R., 1225	Yes	Yes	Zoochory
Coussapoa curranii S.F. Blake	Rocha, M.J.R., 1226	Yes	No	Zoochory
Pourouma guianensis Aubl	Rocha, M.J.R., 1227	No	No	Zoochory
Vochysiaceae				
Qualea gestasiana A.St.-Hil.	Rocha, M.J.R., 1228	Yes	Yes	Abiotic
Vochysia sp. 1	Rocha, M.J.R., 1229	No	No	Abiotic
Morphospecies 1	Rocha, M.J.R., 1230			

continue

Table 1 (continuation)

Family/Species	Collector, Collector Number	Endemic to Brazil	Endemic to the Atlantic Forest	Dispersal Syndrome
Morphospecies 2	Rocha, M.J.R., 1231			
Morphospecies 3	Rocha, M.J.R., 1232			
Morphospecies 4	Rocha, M.J.R., 1233			
Morphospecies 5	Rocha, M.J.R., 1234			
Morphospecies 6	Rocha, M.J.R., 1235			
Morphospecies 7	Rocha, M.J.R., 1236			
Morphospecies 8	Rocha, M.J.R., 1237			
Morphospecies 10	Rocha, M.J.R., 1238			
Morphospecies 11	Rocha, M.J.R., 1239			
Morphospecies 12	Rocha, M.J.R., 1240			
Morphospecies 13	Rocha, M.J.R., 1241			
Morphospecies 14	Rocha, M.J.R., 1242			
Morphospecies 15	Rocha, M.J.R., 1243			
Morphospecies 17	Rocha, M.J.R., 1244			
Morphospecies 18	Rocha, M.J.R., 1245			
Morphospecies 19	Rocha, M.J.R., 1246			
Morphospecies 20	Rocha, M.J.R., 1247			
Morphospecies 21	Rocha, M.J.R., 1248			
Morphospecies 22	Rocha, M.J.R., 1249			
Morphospecies 23	Rocha, M.J.R., 1250			
Morphospecies 24	Rocha, M.J.R., 1251			
Morphospecies 25	Rocha, M.J.R., 1252			
Morphospecies 26	Rocha, M.J.R., 1253			
Morphospecies 28	Rocha, M.J.R., 1254			
Morphospecies 29	Rocha, M.J.R., 1255			
Morphospecies 30	Rocha, M.J.R., 1256			
Morphospecies 31	Rocha, M.J.R., 1257			

flora, were: *Miconia* Ruiz & Pav., *Solanum* L., *Psychotria* L., and *Tibouchina* Aubl. *Solanum*, *Miconia*, and *Tibouchina* are also among the 20 most diverse genera in the Atlantic Forest (Stehmann *et al.* 2009).

Species diversity in the study area was 4.6 according to Shannon-Wiener's index (H') and 0.98 according to Simpson's complementary index (1-D). Pielou's evenness (J') was 0.83. Meira-Neto & Martins (2000) established maximum and minimum values for Shannon (H' between 3.2 and 4.2) and evenness (J' between 0.73 and 0.88) indexes to the Zona da Mata region of Minas Gerais State. Our data thus yielded results above those marks. In comparison with studies performed in other seasonal semideciduous forest remnants that used similar sampling methods (*e.g.*, Silva *et al.* 2004, Marangon *et al.* 2007, Leite & Rodrigues 2008, Dias-Neto *et al.* 2009, Braga *et al.* 2011, Santos *et al.* 2013, Coelho *et al.* 2016), the values of richness, diversity, and evenness found at Santa Rita Farm were also higher. The high values of those indexes found in our study provide evidence of the ecological importance of the studied fragment, which is located between two important Protected Areas (PAs) of the Atlantic Forest, namely the Parque Estadual da Serra do Brigadeiro and the Parque Nacional do Caparaó. In that sense, should an ecological corridor be implemented between those PAs, the remnant might well represent a strategic area for the maintenance of gene flow in the region.

A total 140 specimens were identified at the species level. Regarding their distribution in Brazil, 77 species (55%) are not endemic and 62 (44%) are endemic to the country. This latter value reflects the pattern overall found in the Brazilian flora, which has a high degree of endemism of seed plants - 57.4% of all phanerogams occurring in Brazil (BFG 2015). *Psidium guajava* L. was the only non-native species registered in our study (Sobral *et al.* 2016) while *Ixora brevifolia* Benth was the only species whose distribution is currently unknown (Di Maio 2016).

We registered 44 species endemic to the Atlantic Forest (31%) (table 1). The Atlantic Forest is known by its high endemism (Myers *et al.* 2000; Ribeiro *et al.* 2011). However, the percentage of endemic species in this hotspot has slightly decreased from 50.2% in 2010 to 49.5% in 2015 (BFG 2015). Such reduction in the percentage of endemism can be justified by the increase in knowledge on the distribution of species and by the area of Atlantic Forest inserted in other vegetation domains, like the gallery forests in the Cerrado and the enclaves in the Caatinga (BFG 2015).

The most representative dispersal syndrome was zoochory, which was found in 108 species (77%). The abiotic dispersal syndrome, on the other hand, was found in 32 species, which represent 23% of all sampled species (table 1). Our results are in line with the pattern found in the Atlantic Rainforest, in which, analogously to other tropical forests (Fleming 1979, Jordano 2000), zoochory is the predominant syndrome (Campassi 2006). Such pattern found in tropical forests is related to the absence of long seasonal periods (*e.g.*, Morellato *et al*. 2000). In other words, rates of zoochorous dispersal decrease with increasing rainfall seasonality.

Forest fragmentation, fruit collection by humans, and long-term defaunation are the major factors responsible for the loss of interaction between dispersers and dispersed species (Fuentes 2000). Evidence that defaunation, especially of large frugivorous species, can lead to the disappearance of plant species with large seeds that significantly contribute to the maintenance of carbon stock in the Atlantic Forest has been reported (Bello *et al.* 2015). In that sense, it is worth noting that the studied remnant plays an important ecological role in the region, as it provides food to local fauna. However, performing a floristic survey and implementing management practices for conservation of animal species in the region are essential to maintain the more than 70% of angiosperm species therein.

A total 14 threatened species were recorded in our survey (table 2). The main threat to populations of *Aspidosperma polyneuron* Müll.Arg., *Apuleia leiocarpa* (Vogel) J.F. Macbr., *Cedrela fissilis* Vell., *Dalbergia nigra* (Vell.) Allemão *ex* Benth., *Joannesia princeps* Vell., *Melanoxylon brauna* Schott, and *Zeyheria tuberculosa* (Vell.) Bureau *ex* Verl. is related to predatory exploitation by the timber industry and rural producers for manufacture of laminate and solid wood furniture as well as of ornamental structures, all of which have been historically leading to population decline in those species (Biodiversitas 2008, Martinelli & Moraes 2013, IUCN 2016). *Trigynaea oblongifolia* Schltdl. is considered rare (Martinelli & Moraes 2013), and similarly to *Brosimum glaziovii* Taub. (IUCN 2016), the species has a restricted distribution, which is the major threatening factor to both species. Populations of *T. oblongifolia* are threatened by loss of habitat quality (Martinelli & Moraes 2013). *Euterpe edulis* Mart. is threatened by its intense exploitation for palm heart harvest across the entire area where it occurs and by the consequent decline of its populations. *Trattinnickia ferruginea* Kuhlm. is a rare species (Giulietti *et al*. 2009), with populations restricted to well preserved Atlantic Forest remnants in Minas Gerais State; additionally, it is threatened by loss of its occurrence area and of habitat quality due to deforestation for charcoal production, pastures, and silviculture. *Cariniana legalis* (Mart.) Kuntze populations are declining not only due to intense exploitation for wood extraction, but also due to their occurrence in fertile lands widely used in agriculture. *Virola bicuhyba* (Schott) Warb. is endemic to ombrophilous and semideciduous Atlantic Forests and occurs preferentially in areas at advanced stages of regeneration or at climax (Martinelli & Moraes 2013). *V. bicuhyba* has medicinal value and its wood has high economic importance. Its major threat is the reduction of its populations, which is mainly caused by selective extraction and habitat conversion (Martinelli & Moraes 2013).

Besides the rare and threatened species recorded in our survey, the studied fragment has also other species classified under those categories, like *Mascagnia velutina* C.E. Anderson, which is rare (Giulietti *et al.* 2009) and is considered vulnerable due to high fragmentation of five among ten localities of its occurrence (Biodiversitas 2008), and *Sinningia carangolensis* Chautems, which is a rare species restricted to the region of Carangola municipality, Minas Gerais State, and is thus considered endangered

Table 2. Rare and threatened species found in the present study at Santa Rita Farm, Faria Lemos municipality, Minas Gerais State, Brazil, according to the Red List of the IUCN (2016), Martinelli & Moraes (2013), and Biodiversitas (2008).

Family	Species	IUCN (2016)	Martinelli & Moraes(2013)	Biodiversitas (2008)
Apocynaceae	*Aspidosperma polyneuron*	Endangered A1acd+2cd	-	-
Annonaceae	*Trigynaea oblongifolia*	-	Endangered B1ab(iii)	-
Arecaceae	*Euterpe edulis*	-	Vulnerable A1acd	Endangered A4cd
Bignoniaceae	*Zeyheria tuberculosa*	Vulnerable A1cd	-	-
Burseraceae	*Trattinnickia ferruginea*	-	Endangered B1ab(ii,iii)+2ab(ii,iii)	Critically endangered B1ab(ii,iii) + C2(ii)
Euphorbiaceae	*Joannesia princeps*	Vulnerable A1cd	-	-
Fabaceae	*Apuleia leiocarpa*	-	Vulnerable A2d	-
	Dalbergia nigra	Vulnerable A1cd	Vulnerable A4bcd	Vulnerable A2cd + B2ab(iii)
	Melanoxylon brauna	-	Vulnerable D2	Vulnerable A2cd + C2a(i)
Lecythidaceae	*Cariniana legalis*	Vulnerable A1ac	Endangered A2cd	-
Meliaceae	*Cedrela fissilis*	Endangered A1acd+2cd	Vulnerable A2cd	-
Moraceae	*Brosimum glaziovii*	Endangered B1+2bc	-	-
Myristicaceae	*Virola bicuhyba*	-	Endangered A4ac	-
Urticaceae	*Coussapoa curranii*	Vulnerable A1c	-	-

(Martinelli & Moraes 2013, Biodiversitas 2008). *Anthurium santaritensis* Nadruz & Croat is not under any threatened status in any of the analyzed lists, although according to the SpeciesLink platform (http://splink.cria.org.br/) it occurs only at the Santa Rita Farm fragment (locality of the *typus*) and at Alegre and Vila Velha municipalities, Espírito Santo State. The species *Dichorisandra leonii* Aona & M.C.E. Amaral, *Dichorisandra rupicola* Aona & M.C.E. Amaral, *Myrcia concisa* Sobral & Leoni, and *Calyptranthes carangola* Sobral & Leoni were recently described (Sobral & Leoni 2010; Aona-Pinheiro & Amaral 2012; Sobral *et al.* 2016) based on material collected at Santa Rita Farm and its surroundings.

The studied remnant has important attributes that indicate its preservation degree as well as the importance of its conservation. Its high degree of preservation is demonstrated by the high values of richness, diversity, and evenness; by the high proportion of zoochorous species, which provide food to local fauna and thus contribute to the maintenance of ecological interactions; and by the presence of populations of several threatened species, two of which (*Virola bicuhyba* and *Trattinnickia ferruginea*) occur in mature forests (Martinelli & Moraes 2013). The presence of the rare species *Trigynaea oblongifolia* and *Trattinnickia ferruginea* reiterates and subsidizes the importance of conserving the studied fragment, which is located in a key area for biodiversity conservation. Furthermore, our results reinforce the evidence found by Rezende *et al.* (2015), according to which areas located at the 0-1,000 m altitudinal range in the Seasonal Semideciduous Atlantic Forest deserve attention in terms of the need for conservation measures, due to their high species richness and high number of endemic and threatened species.

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