DISPERSAL SYNDROMES IN A CONSERVATION AREA IN A BRAZILIAN SEMIARID REGION

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Abstract. The Brazilian semiarid region, the phytogeographic domain of the Caatinga, presents a wide floristic diversity and, paradoxically, human actions, such as deforestation for agriculture and livestock, that present constant threats to the reduction of its vegetation cover. In order to avoid the complete loss of plant and animal diversity, Conservation Units have been created, areas for which it is necessary to understand ecological processes, especially those that maintain biodiversity. In this context, the present study verified the dispersal strategies of angiosperms in the Ecological Reserve Olho d'Água das Onças (REODDO), a conservation area located in the municipality of Picuí, a semiarid region of Paraíba state, Northeast Brazil. Twelve field trips were made between August 2022 and July 2023. The specimens obtained are incorporated into the HACAM Herbarium collection (not indexed). Ninety-five species of angiosperms belonging to 28 families were recorded, and we verified that 74.5% of those species had dry fruits and disperse their seeds through abiotic mechanisms (autochory or anemochory). Only 25.5% of the total number of species disperse their seeds via zoochoric means. This is likely a result of the semiarid nature of this phytogeographical domain, where fruits with large pericarps that are normally attractive to larger animals are atypical. Our results are fundamental to understanding ecological processes in natural environments in the semiarid regions of Brazilian and demonstrate the predominance of abiotic syndromes even in an Ecological Reserve area, where faunal diversity is probably greater than in non-protected areas. These results also contribute essential information that can be incorporated into management and restoration plans in Caatinga areas.

Keywords: biodiversity, conservation, ecological processes, flora, semiarid

Resumo. No semiárido brasileiro, o domínio fitogeográfico da Caatinga apresenta uma ampla diversidade florística e paradoxalmente as ações antrópicas, como o desmatamento para a agricultura e pecuária, representam ameaças constantes à redução da sua cobertura vegetal. No intuito de evitar a perda completa da diversidade vegetal e animal vêm sendo criadas as Unidades de Conservação, áreas para as quais torna-se necessário compreender as interações ecológicas, em especial, àquelas mantenedoras da biodiversidade. Nesse contexto, o presente estudo verificou as estratégias de dispersão das angiospermas na Reserva Ecológica Olho d'Água das Onças (REODDO), área de conservação localizada no município de Picuí, semiárido paraibano, Nordeste brasileiro. Os trabalhos de campo foram feitos entre agosto/2022 e julho/2023, totalizando 12 incursões. Os espécimes obtidos incorporados ao acervo do Herbário HACAM (não indexado). Foram registradas 95 espécies de angiospermas pertencentes a 28 famílias e verificou-se a prevalência das plantas que se dispersam por meio de vetores abióticos, ou seja, por autocoria e anemocoria, Condição esperada dadas a presença conspícuas de frutos secos, totalizando 74,5% das espécies, enquanto as espécies zoocóricas totalizaram apenas 25,5% do total, resultado da deficiência hídrica característica desse domínio fitogeográfico que não permite a presença de frutos de pericarpo com biomassa elevada, normalmente atrativos de animais de maior porte e, portanto, atípicos na vegetação xérica. Nossos resultados são fundamentais para a compreensão do funcionamento em ambientes naturais no semiárido brasileiro, demonstrando a predominância de síndromes abióticas mesmo em uma área de Reserva Ecológica, onde provavelmente a diversidade faunística seria maior que em áreas não protegidas; contribuindo com informações indispensáveis para a incorporação em planos de manejo e restauração em áreas de Caatinga.

Palavras-chave: biodiversidade, conservação, flora, processos ecológicos, semiárido

The Caatinga phytogeographic domain typically has a low forest phytophysiognomy, due to low soil water availability, and has relatively high floristic diversity (Francisco et al., 2020; Prado and Trovão, 2023; Silva et al., 2010). Annual precipitation rates vary between 250–1200 mm (Braga, 2016), and the region boasts 6348 recorded species of angiosperms belonging to 177 families (Flora e Funga do Brasil, continuously updated). In the Caatinga domain, deforestation is due to several factors, such as agriculture, harvesting of firewood, and pasture formation (Alves et al., 2008). Other aggravating factors, such as the incorrect disposal of waste produced in urban centers (which sometimes do not have suitable places for their treatment) and the installation of wind farms, cause significant changes in the floristic composition (Araújo and Moura, 2017; Lima et al., 2020). In this scenario, diaspore dispersal (fruits and seeds) is an extremely important phase in the life cycle of all plants, constituting one of the ways in which they expand their populations and geographic range (Venzke et al., 2014). The study of dispersal modes is, therefore, an important

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tool for planning actions that could promote the expansion of species populations, and is, likewise, fundamental to the recovery of degraded areas (Howe, 2016; Oliveira et al., 2022).

Dispersal syndromes are classified according to how a plant's seeds are dispersed and can be abiotic (principally autochory, in which the seeds fall from the fruit close to the mother plant, and anemochory, where the seeds are wind-dispersed) or biotic (zoochory, when the dispersal vectors or agents are animals) (Stefanello et al., 2009). There is still no full understanding of which factors define the strategies plants use to disperse their diaspores, making such detailed ecological studies informative (Valenta and Nevo, 2020). Concomitantly, conservation areas are necessary for the preservation of native vegetation fragments, that can provide diaspore sources for repopulating degraded areas, as well as sites for future studies of dispersal syndromes.

There are currently 234 conservation areas in the Caatinga phytogeographic domain that are recognized by the Brazilian National Register of Conservation Areas (CNUC); 12 of them are located in Paraíba State. The Olho d'Água das Onças Ecological Reserve, located in the Seridó-Curimataú Paraibano region, represents an important protected area with high biodiversity within the Caatinga domain.

The present study presents a survey of dispersal syndromes in the Olho d'Água das Onças Ecological Reserve in the municipality of Picuí, in the semiarid region of Paraíba State in northeastern Brazil and aims to contribute to the knowledge concerning the ecological processes that maintain Caatinga biodiversity.

Materials and Methods

Study area

The present study was carried out in the Olho d'Água das Onças Ecological Reserve (REODDO), a conservation area of dry forest located in the municipality of Picuí, Seridó-Curimataú transition zone, Paraíba State, in northeastern Brazil. Picuí (6°28'–6°69'S, 36°21'–36°46'W covers 668 km^2) Instituto Brasileiro de Geografia e Estatística (IBGE) 2021, and is located between the Borborema mesoregion and the Seridó Paraibano microregion (Francisco et al., 2012).

The Olho d'Água das Onças Ecological Reserve is located in a rural area approximately 11 km from the municipal seat (Fig. 1). The Reserve occupies an area of 20.73 ha, of which approximately 18.26 ha correspond to the conservation area. According to the Köppen system (1936), the municipality of Picuí has a BShw type climate, which is hot and semiarid, with temperatures ranging between 78.8°F–89.6°F. The expected annual average rainfall is approximately 339.1mm/year. However, the years 2022 and 2023 (the period during which this study was carried out) were atypical, since the average recorded rainfall exceeded expectations, reaching 453.1 mm/yr and 481.5 mm/yr, respectively, with rainfall peaks between the months of March and May (Accuweather, continuously updated; AESA, continuously updated; Francisco et al., 2012).

Sampling procedures

Botanical collections were made monthly between August 2022 and July 2023, covering both the dry and rainy seasons. Photographic records were made of the collected plants and their reproductive structures (especially their fruits), as well as of the surrounding environment; geographic coordinates were also noted. The specimens were dried (Rotta et al., 2008) in the Manuel de Arruda Câmara Herbarium (HACAM), Campus I, at the State University of Paraíba (UEPB), Campina Grande, Paraíba State, Brazil.

Laboratory procedures

Taxonomic identifications of species were based mainly on the scientific literature, principally Queiroz (2021) and Ferreira et al. (2009) for the identification of Fabaceae and Poaceae species, respectively, and the Flora e Funga do Brasil website (continuously updated) was consulted for the species of other angiosperm families. The collected material was also compared with specimens deposited in the following herbaria: the Manuel de Arruda Câmara Herbarium (HACAM), Campus I, State University of Paraíba; the Lauro Pires-Xavier Herbarium (JPB) and the Jayme Côelho de Moraes Herbarium (EAN), both located at the Federal University of Paraíba (UFPB) in the municipalities of João Pessoa (Campus I) and Areia (Campus II), respectively, and were accessed through the *SpeciesLink* platform.

Data analyses

Dispersal syndrome types were verified based on field observations and complemented by the specialized literature, mainly Spjut (1994) for the identification of fruit types, and Van der Pijl (1982) to verify diaspore distribution vectors.

Results and Discussion

Dispersal syndromes were identified for 95 species belonging to 28 families, including basal angiosperms (ANA grade = Amborellales, Nymphaeales and Austrobaileyales) and Mesangiosperms (Magnoliids, Chloranthales, monocots, Ceratophyllales and eudicots) (Table 1 and Fig. 2–4). Of these 95 species, Fabaceae was the most diverse (18 species), followed by Euphorbiaceae (11 species), Malvaceae (seven species), and Poaceae (six species, five of which are native and one naturalized [*Digitaria ciliaris* (Retz.) Koeler)]). Fabaceae and Euphorbiaceae are often identified as the most diverse families in Caatinga areas in the Brazilian semiarid region (Guedes et al., 2012; Flora e Funga do Brasil, continuously updated; Silva et al. 2013), corroborating the results of our study.

The types of habit identified in the study area were: herbaceous (35 spp.; 37.2%), for which autochory predominated, with 26 species showing this type of dispersal, followed by anemochory with four species, epizoochoric, with three species each, and saurochory and ornithochoric syndromes, represented by one species each (Fig. 5A). The shrubby habit is associated with 26 species (27.2%), of which 18 are autochoric, six ornithochoric, one mammaliochoric, and one anemochoric (Fig. 5B). The arboreal habit included 18 species (19.1%), of which seven were autochoric, four ornithochoric, three mammaliochoric, one epizoochoric, two anemochoric, and one saurochoric

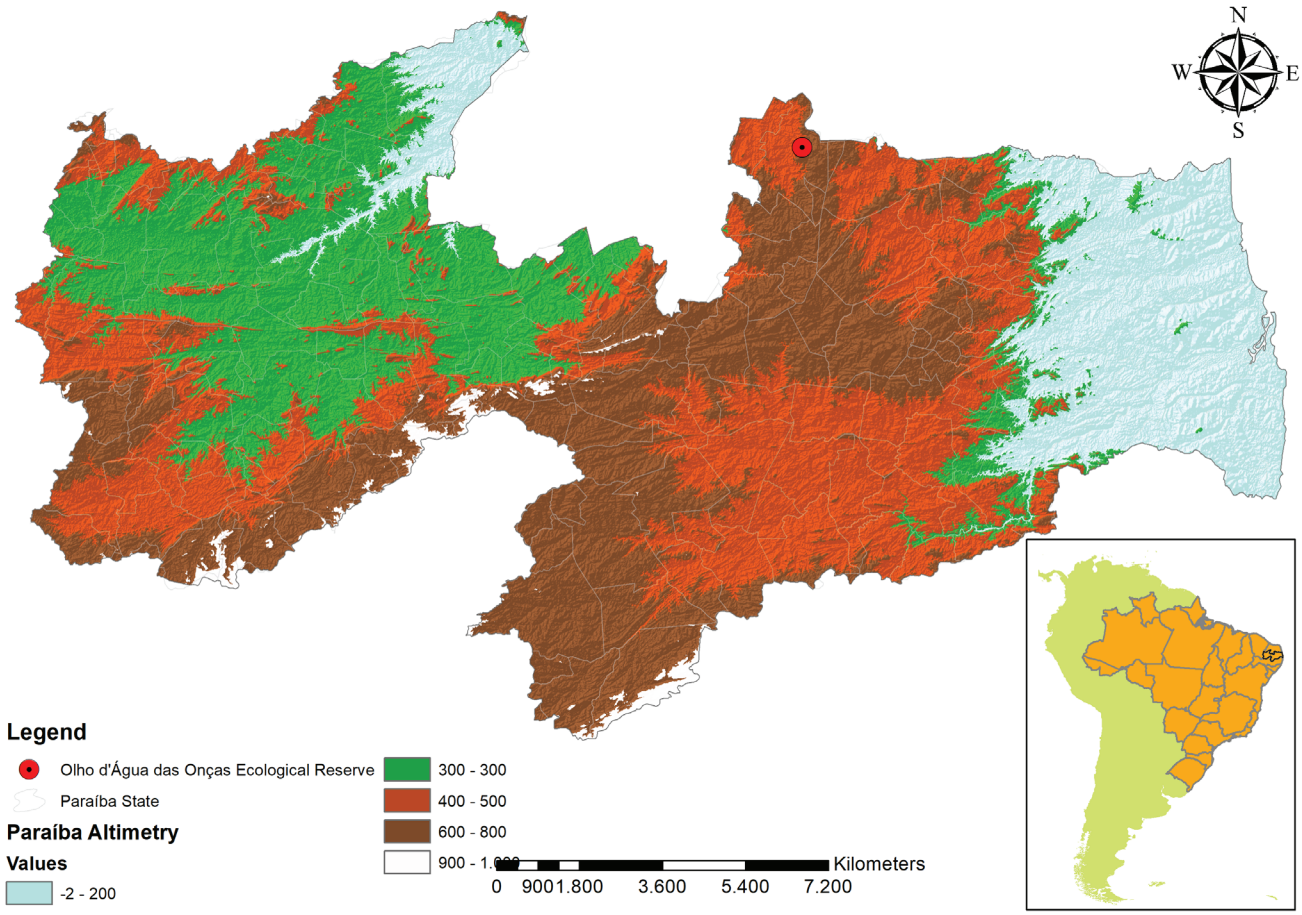

FIGURE 1. Map of the Paraíba State, Brazil, highlighting the study area, Olho d'Água das Onças Ecological Reserve, municipality of Picuí. By E. M. Rodrigues.

(Fig. 5C). The subshrub habit encompassed 15 spp. (16%), of which nine are autochoric, two ornithochoric, two epizoochoric, and two anemochoric (Fig. 5D).

The predominant dispersal syndrome was autochory, observed in 63.8% of the total sampled species (N = 60 spp.); of these, 45% were herbaceous (N = 27 spp.), 30% shrubs (N = 18 spp.), 15% subshrubs (N = 9 spp.), and 10% trees (N = 6 spp.) (Fig. 6A). The second most common dispersal syndrome was zoochory, observed in 27.7% of the species (25 spp.); of these, 36% were arboreal (N = 9 spp.), 28% shrubs (N = 7 spp.), 20% herbaceous (N = 5 spp.), and 16% subshrubs (N = 4 spp.) (Fig. 6B). Anemochory was the least prevalent dispersal syndrome, 8.5%, and was associated with eight species. With regard to anemochory, the predominant habit type was herbaceous (3 spp.; 37.5%), followed by arboreal and subshrub plants (2 spp. each; 25% each), and, finally, shrubs (1 spp.; 12.5%) (Fig. 6C).

The diaspores exhibiting autochoric and anemochoric syndromes were observed on fully fruiting species during the dry season, which is similar to reports from other Caatinga areas in northeastern Brazil (e.g., Córdula et al., 2014). According to Howe and Smallwood (1982) and Pereira et al. (2022), anemochory and autochory predominate in seasonal open-canopy environments (e.g., the Caatinga sensu stricto). This fact is related to the lack of physical barriers, such as understories and plants with a very large leaf area, which makes these types of syndromes more efficient, causing diaspores to reach areas farther away from the mother plant, thus avoiding the competition (Silva et al., 2012 Pereira et al., 2022). Furthermore, in the Caatinga there are constant episodes of drought, reducing the number of biotic dispersers due to the reduced supply of meatier fruits (Costa et al., 2004; Butler et al., 2007; Silva and Rodal, 2009; Silva et al., 2013; Santos et al., 2020). According to Vieira et al. (2008), this dispersal strategy can be advantageous for dispersing diaspores over wide territorial extensions.

Silva and Rodal (2009), studying the distribution of patterns of plant dispersion syndromes in the Caatinga vegetation, observed that vertical stratification had no influence on changing the type of dispersion, with autochory and anemochory prevailing, a fact also not observed in this work, where in all strata both dispersion syndrome types prevailed.

According to the type of vector and the type of fruit, zoochoric syndromes are divided into subcategories (Fig. 7). Zoochoric species predominated during the rainy season given that they have a greater dependence on water during the development of their fruits, and, in the dry season, seeds of species dispersed by abiotic vectors predominated, (Costa et al., 2004; Domingues et al. 2013; Paula et al., 2021; Silva and Rodal, 2009). In the study area, we observed that

TABLE 1. Families, species, and types of habit and dispersal syndromes in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil, followed by voucher. Legends: Habits (H); Herb (Her); Subshrub (Sub); Shrub (Shr); Tree (Tre); Dispersal syndromes (D.S.): Anemochory (Ane); Autochory (Aut); Zoochory (Zoo).

FAMILY/SPECIES	H	D.S.	VOUCHER
Amaranthaceae			
Quaternella ephedroides Pedersen	Her	Aut	*Rocha et al. 102*
Anacardiaceae			
Schinopsis brasiliensis Engl.	Tre	Ane	*Luz et al. 46*
Spondias tuberosa Arruda	Tre	Zoo	*Rocha 195*
Apocynaceae			
Aspidosperma pyrifolium Mart. & Zucc.	Tre	Ane	*Luz et al. 70*
Bromeliaceae			
Aechmea aquilega (Salisb.) Griseb.	Her	Aut	*Luz et al. 40*
Tillandsia recurvata (L.) L.	Her	Ane	*Luz et al. 36*
Tillandsia streptocarpa Baker	Her	Ane	*Luz et al. 39*
Cactaceae			
Cereus jamacaru DC.	Tre	Zoo	*Luz et al. 60*
Melocactus zehntneri (Britton & Rose) Luetzelb.	Her	Zoo	*Rocha et al. 188*
Pilosocereus pachycladus F. Ritter	Tre	Zoo	*Luz et al. 69*
Tacinga inamoena (K. Schum.) N.P. Taylor & Stuppy	Sub	Zoo	*Luz et al. 19*
Xiquexique gounellei (F.A.C. Weber) Lavor & Calvente	Shr	Zoo	*Luz et al. 68*
Capparaceae			
Cynophalla flexuosa (L.) J. Presl	Tre	Zoo	*Luz et al. 38*
Neocalyptrocalyx longifolium (Mart.) Cornejo & Iltis	Tre	Zoo	*Luz et al. 35*
Combretaceae			
Combretum leprosum Mart.	Tre	Ane	*Luz et al. 72*
Convolvulaceae			
Evolvulus filipes Mart.	Her	Aut	*Rocha et al. 384*
Evolvulus frankenioides Moric.	Her	Aut	*Rocha et al. 46*
Evolvulus glomeratus Nees & Mart.	Her	Aut	*Luz et al. 45*
Cordiaceae			
Varronia globosa Jacq.	Shr	Zoo	*Rocha et al. 171*
Varronia leucomalloides (Taroda) J.S. Mill.	Shr	Zoo	*Rocha et al. 231*
Varronia mariana E.C.O. Chagas & Costa-Lima	Shr	Zoo	*Luz et al. 73*

TABLE 1 CONT. Families, species, and types of habit and dispersal syndromes in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil, followed by voucher. Legends: Habits (H); Herb (Her); Subshrub (Sub); Shrub (Shr); Tree (Tre); Dispersal syndromes (D.S.): Anemochory (Ane); Autochory (Aut); Zoochory (Zoo).

FAMILY/SPECIES	H	D.S.	VOUCHER
Euphorbiaceae			
Acalypha multicaulis Müll. Arg.	Sub	Aut	*Rocha et al. 203*
Argythamnia malpighiacea Ule	Shr	Aut	*Luz et al. 26*
Cnidoscolus urens (L.) Arthur	Sub	Aut	*Rocha et al. 104*
Croton adenocalyx Baill.	Shr	Aut	*Luz et al. 83*
Croton blanchetianus Baill.	Shr	Aut	*Luz et al. 53*
Croton glandulosus L.	Her	Aut	*Luz et al. 85*
Croton grewioides Baill.	Shr	Aut	*Luz et al. 25*
Croton heliotropiifolius Kunth	Shr	Aut	*Luz et al. 23*
Jatropha mollissima (Pohl) Baill.	Tre	Aut	*Luz et al. 64*
Jatropha ribifolia (Pohl) Baill.	Shr	Aut	*Luz et al. 17*
Manihot carthagenensis (Jacq.) Müll. Arg.	Tre	Aut	*Luz et al. 79*
Stillingia trapezoidea Ule	Shr	Aut	*Rocha et al. 192*
Erythroxylaceae			
Erythroxylum caatingae Plowman	Shr	Zoo	*Luz et al. 32*
Erythroxylum pyan Costa-Lima	Tre	Zoo	*Luz et al. 44*
Fabaceae			
Bauhinia cheilantha (Bong.) Steud.	Tre	Aut	*Rocha et al. 308*
Cenostigma nordestinum Gagnon & G.P. Lewis	Tre	Aut	*Luz et al. 66*
Chamaecrista absus (L.) H.S. Irwin & Barneby	Sub	Aut	*Rocha et al. 360*
Chamaecrista calycioides (DC. ex Collad.) Greene	Sub	Aut	*Luz et al. 55*
Chamaecrista duckeana (P. Bezerra & Afr. Fern.) H.S. Irwin & Barneby	Sub	Aut	*Rocha et al. 298*
Chamaecrista rotundifolia (Pers.) Greene	Sub	Aut	*Luz et al. 59*
Chamaecrista zygophilloides (Taub.) H.S. Irwin & Barneby	Shr	Aut	*Luz et al. 34*
Indigofera suffruticosa Mill.	Shr	Aut	*Luz et al. 14*
Libidibia ferrea (Mart. ex Tul.) L.P. Queiroz	Tre	Aut	*Luz et al. 48*
Mimosa candollei R. Grether	Sub	Aut	*Rocha et al. 61*
Mimosa paraibana Barneby	Shr	Aut	*Luz et al. 90*
Mimosa tenuiflora (Willd.) Poir.	Shr	Aut	*Luz et al. 07*
Peltogyne pauciflora Benth.	Shr	Aut	*Luz et al. 52*

TABLE 1 CONT. Families, species, and types of habit and dispersal syndromes in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil, followed by voucher. Legends: Habits (H); Herb (Her); Subshrub (Sub); Shrub (Shr); Tree (Tre); Dispersal syndromes (D.S.): Anemochory (Ane); Autochory (Aut); Zoochory (Zoo).

FAMILY/SPECIES	H	D.S.	VOUCHER
Fabaceae cont.			
Senna macranthera (DC. ex Collad.) H.S. Irwin & Barneby	Shr	Zoo	*Luz et al. 71*
Senna trachypus (Benth.) H.S. Irwin & Barneby	Shr	Aut	*Luz et al. 88*
Zornia brasilensis Vogel	Sub	Zoo	*Rocha et al. 179*
Zornia leptophylla (Benth.) Pittier	Sub	Zoo	*Rocha et al. 36*
Zornia reticulata Sm.	Sub	Zoo	*Rocha et al. 26*
Heliotropiaceae			
Euploca procumbens (Mill.) Diane & Hilger	Her	Aut	*Rocha et al. 32*
Heliotropium angiospermum Murray	Sub	Aut	*Luz et al. 58*
Loranthaceae			
Pusillanthus pubescens (Rizzini) Caires	Her	Zoo	*Luz et al. 10*
Lythraceae			
Cuphea impatientifolia A. St.-Hil.	Sub	Aut	*Rocha et al. 359*
Malvaceae			
Gaya domingensis Urb.	Sub	Aut	*Luz et al. 57*
Helicteres eichleri K. Schum.	Shr	Aut	*Luz et al. 42*
Herissantia tiubae (K. Schum.) Brizicky	Shr	Aut	*Luz et al. 18*
Melochia tomentosa L.	Sub	Aut	*Luz et al. 30*
Sida galheirensis Ulbr.	Sub	Aut	*Luz et al. 12*
Sida spinosa L.	Sub	Aut	*Luz et al. 54*
Sidastrum paniculatum (L.) Fryxell	Sub	Aut	*Luz et al. 49*
Nyctaginaceae			
Boerhavia coccinea Mill.	Her	Zoo	*Luz et al. 51*
Boerhavia erecta L.	Her	Zoo	*Luz et al. 74*
Plantaginaceae			
Scoparia dulcis L.	Sub	Aut	*Luz et al. 61*
Poaceae			
Cenchrus echinatus L.	Her	Aut	*Luz et al. 03*
Chloris barbata Sw.	Her	Aut	*Rocha et al. 216*
Chloris virgata Sw.	Her	Aut	*Rocha et al. 198*
Digitaria ciliaris (Retz.) Koeler	Her	Aut	*Rocha et al. 199*
Tragus berteronianus Schult.	Her	Aut	*Luz et al. 56*
Urochloa mollis (Sw.) Morrone & Zuloaga	Her	Aut	*Luz et al. 87*

TABLE 1 CONT. Families, species, and types of habit and dispersal syndromes in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil, followed by voucher. Legends: Habits (H); Herb (Her); Subshrub (Sub); Shrub (Shr); Tree (Tre); Dispersal syndromes (D.S.): Anemochory (Ane); Autochory (Aut); Zoochory (Zoo).

FAMILY/SPECIES	H	D.S.	VOUCHER
Polygalaceae			
Asemeia martiana (A.W. Benn.) J.F.B. Pastore & J.R. Abbott	Sub	Aut	*Rocha et al. 142*
Asemeia violacea (Aubl.) J.F.B. Pastore & J.R. Abbott	Her	Aut	*Rocha et al. 259*
Portulacaceae			
Portulaca elatior Mart. ex Rohrb.	Her	Aut	*Luz et al. 82*
Portulaca halimoides L.	Her	Aut	*Rocha et al. 35*
Portulaca mucronata Link	Her	Aut	*Rocha et al. 338*
Sapotaceae			
Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.	Tre	Zoo	*Luz et al. 24*
Solanaceae			
Schwenckia americana Rooyen ex L.	Her	Aut	*Luz et al. 11*
Rhamnaceae			
Sarcomphalus joazeiro (Mart.) Hauenschild	Tre	Zoo	*Luz et al. 27*
Rubiaceae			
Cordiera rigida (K. Schum.) Kuntze	Tre	Zoo	*Luz et al. 16*
Hexasepalum teres (Walter) J.H. Kirkbr.	Her	Aut	*Luz et al. 75*
Mitracarpus baturitensis Sucre	Her	Aut	*Rocha et al. 31*
Talinaceae			
Talinum fruticosum (L.) Juss.	Her	Aut	*Rocha et al. 17*
Talinum paniculatum (Jacq.) Gaertn.	Her	Aut	*Luz et al. 28*
Turneraceae			
Piriqueta viscosa Griseb.	Her	Aut	*Rodrigues et al. 60*
Turnera blanchetiana Urb.	Shr	Aut	*Luz et al. 03*
Turnera pumilea L.	Her	Aut	*Rocha et al. 42*
Turnera subulata Sm.	Her	Aut	*Rocha et al. 215*
Verbenaceae			
Lantana radula Sw.	Shr	Zoo	*Luz et al. 65*
Lantana tiliaefolia Cham.	Shr	Zoo	*Luz et al. 06*
Stachytarpheta coccinea Schauer	Shr	Aut	*Luz et al. 05*
Violaceae			
Pombalia arenaria (Ule) Paula-Souza	Her	Aut	*Luz et al. 76*

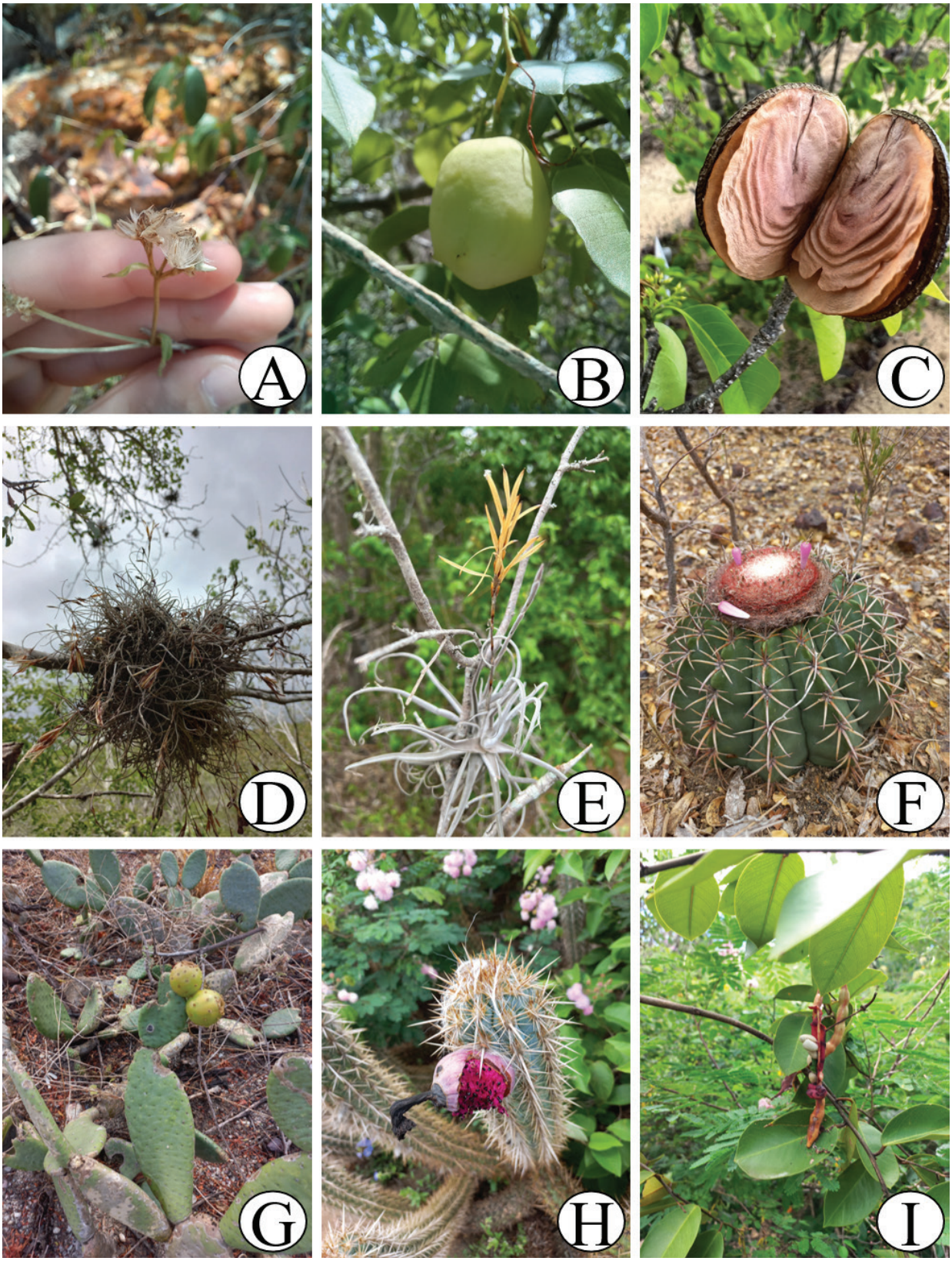

FIGURE 2. Species found in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil: **A**, Amaranthaceae, *Quaternella ephedroides*; **B**, Anacardiaceae, *Spondias tuberosa*; **C**, Apocynaceae, *Aspidosperma pyrifolium*; **D**, Bromeliaceae, *Tillandsia recurvata*; **E**, Bromeliaceae, *Tillandsia streptocarpa*; **F**, Cactaceae, *Melocactus zehntneri*; **G**, Cactaceae, *Tacinga inamoena*; **H**, Cactaceae, *Xiquexique gounellei*; **I**, Capparaceae, *Cynophalla flexuosa*. Photographs by B. F. Rocha (A–B, F, H–I), M. G. M. Gonçalves (C, E), and T. E. D. Correia (D, G).

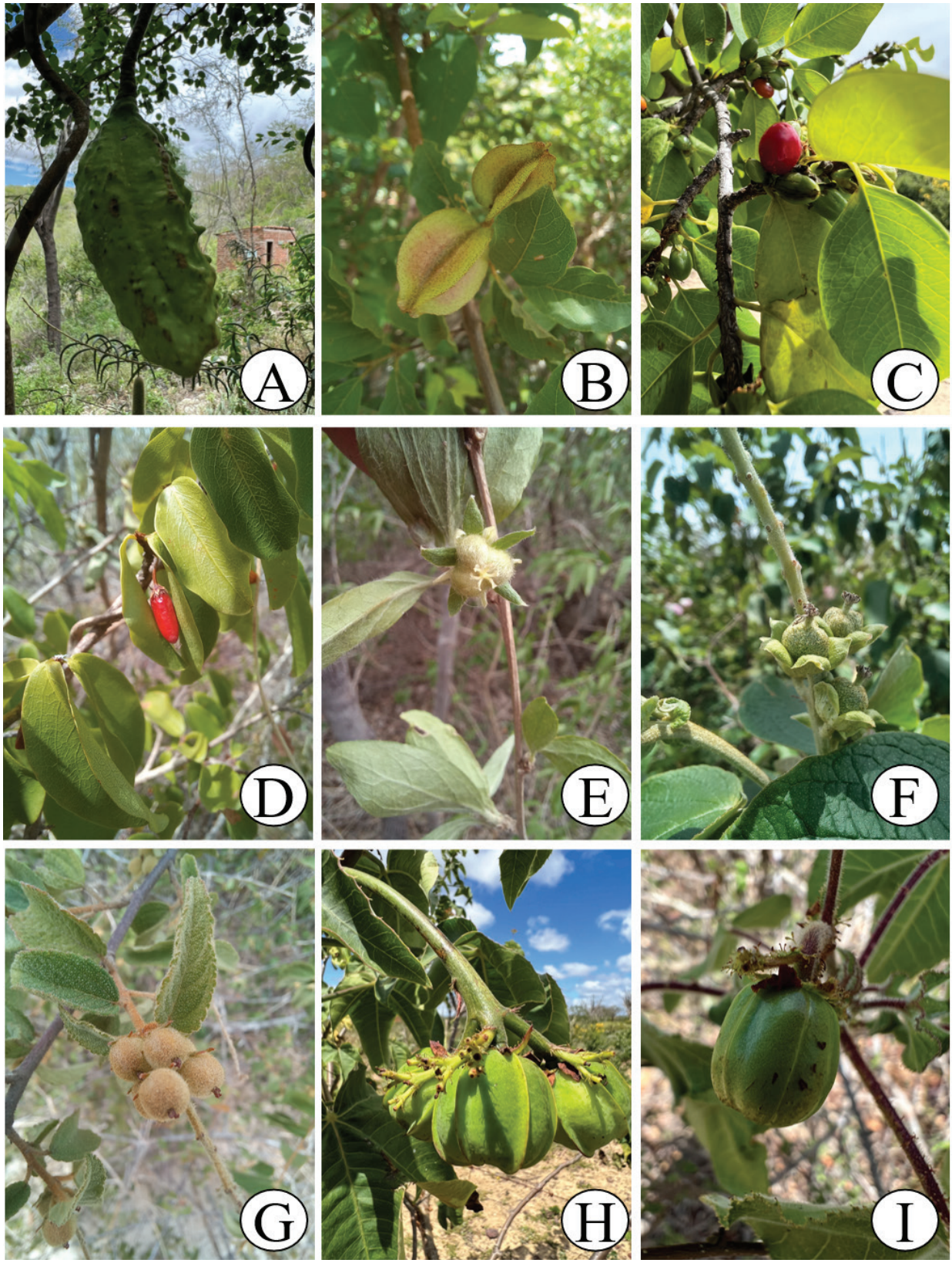

FIGURE 3. Species found in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil: **A**, Capparaceae, *Neocalyptrocalyx longifolium*; **B**, Combretaceae, *Combretum leprosum*; **C**, Erythroxylaceae, *Erythroxylum caatingae*; **D**, Erythroxylaceae, *Erythroxylum pyan*; **E**, Euphorbiaceae, *Argythamnia malphigiacea*; **F**, Euphorbiaceae, *Croton blanchetianus*; **G**, Euphorbiaceae, *C. grewioides*; **H**, Euphorbiaceae, *Jatropha mollissima*; **I**, Euphorbiaceae, *J. ribifolia*. Photographs by M. G. M. Gonçalves (A, G, H–I) and B. F. Rocha (B–F).

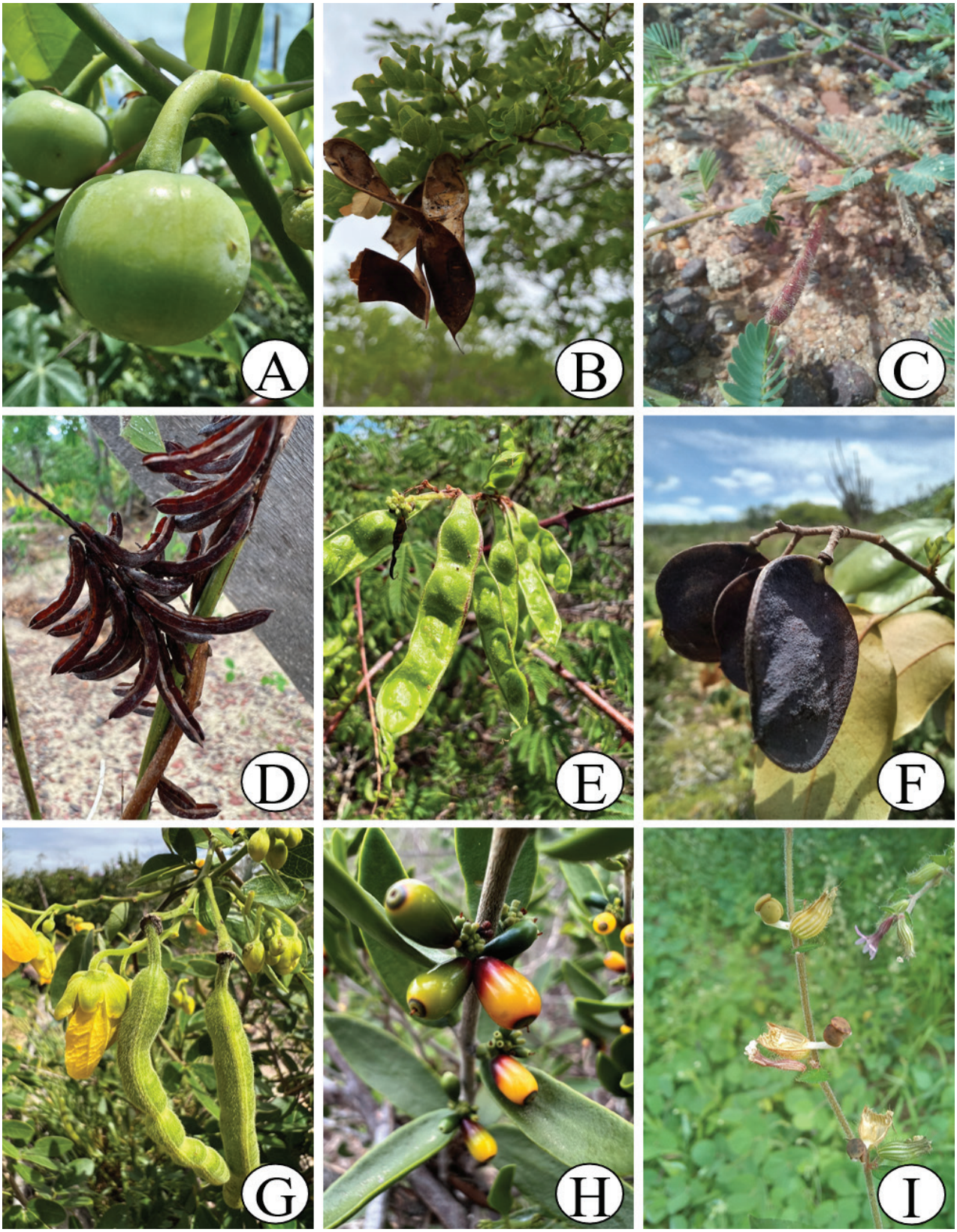

FIGURE 4. Species found in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil: **A**, Euphorbiaceae, *Manihot carthagenensis*; **B**, Fabaceae, *Cenostigma nordestinum*; **C**, Fabaceae, *Chamaecrista calycioides*; **D**, Fabaceae, *Indigofera suffruticosa*; **E**, Fabaceae, *Mimosa tenuiflora*; **F**, Fabaceae, *Peltogyne pauciflora*; **G**, Fabaceae, *Senna macranthera*; **H**, Loranthaceae, *Pusillanthus pubescens*; **I**, Lythraceae, *Cuphea impatientifolia*. Photographs by B. F. Rocha (9A, C, F, I) and M. G. M. Gonçalves (B, D–E, G–H).

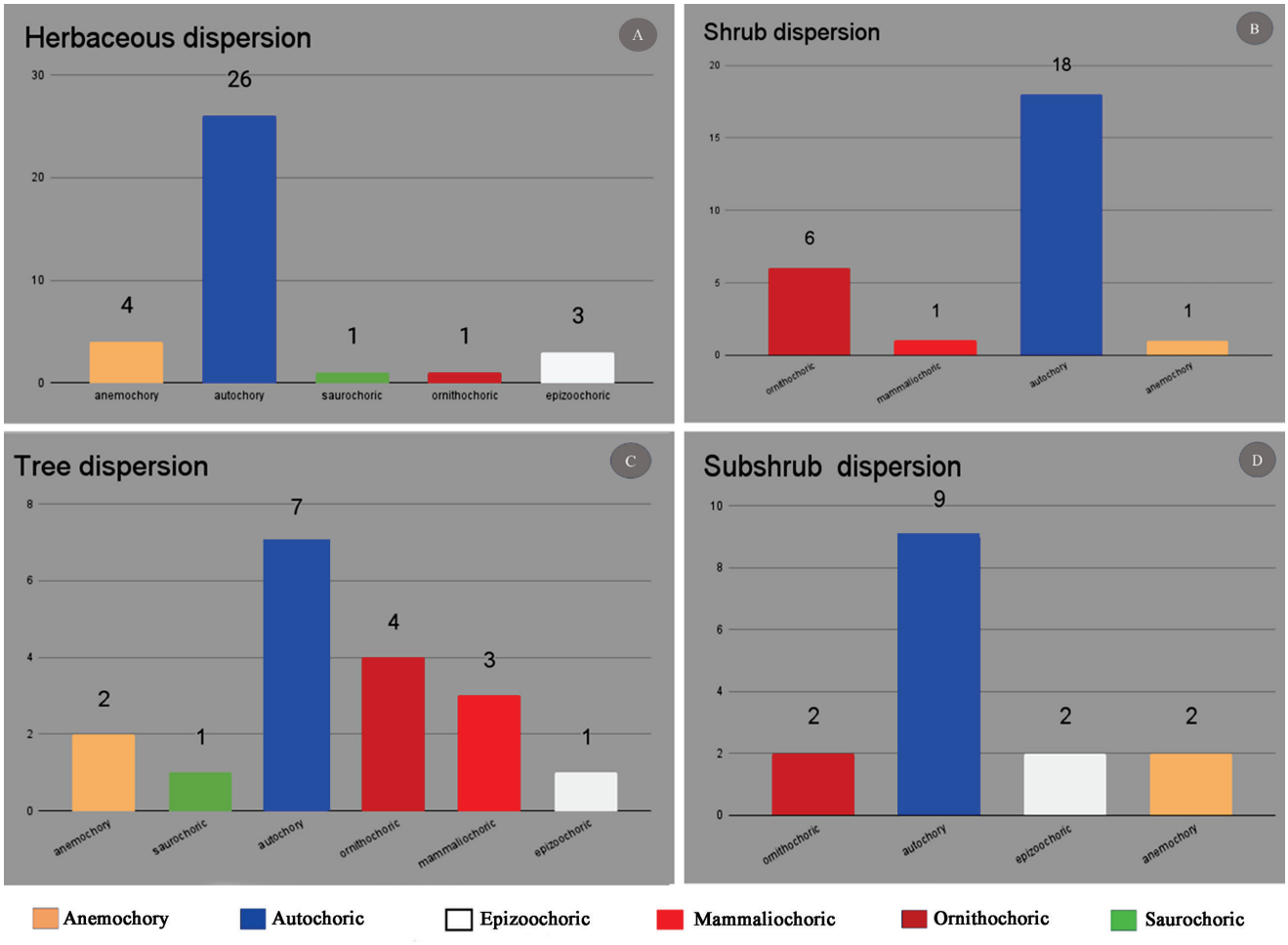

FIGURE 5. Dispersal types associated with the types of habitats recorded, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil; **A**, Herbaceous; **B**, Shrub; **C**, Arboreal; **D**, Subshrub. By: Luz, G.A.

fleshy fruits are available mainly close to the rainy season, while dry fruits are dispersed in the dry season, as they, for the most part, are epizoochoric (Table 2). On the other hand, autochoric and anemochoric species depend less on abundant water resources, especially because they do not need to develop mucilage.

The results obtained here corroborate other studies with similar ecological focuses undertaken within the Caatinga phytogeographic domain, where abiotic syndromes predominate over all others in all seasons. This is probably associated with soil types and rainfall instability and led to the predominance of dry as opposed to fleshy fruits (e.g., Griz and Machado, 2001; Costa et al., 2015; Lima and Melo, 2015). According to Gentry (1982), this predominance would be expected in dry forests. Although the species recorded in this study principally disperse their diaspores through primary syndromes, they can also exhibit secondary dispersal mechanisms, which are likewise of great importance to the maintenance of the ecosystem (Silva et al., 2013).

Additionally, two alien species were recorded at the study site: *Digitaria ciliaris* (Retz.) Koeler (Poaceae), a naturalized herbaceous plant that does not heavily compete with the native flora, and *Neltuma juliflora* (Sw.) Raf. (Fabaceae), an arboreal plant that presents a great invasive capability (allelopathic) and competitively occupies spaces previously populated by native species (Pegado et al., 2006; Andrade et al., 2010).

Based on the studied components of the flora of the REODDO, autochory is the predominant dispersal syndrome, and zoochory was second, followed by anemochory. These data reinforce the results found in other studies conducted in areas of the Caatinga vegetation and are probably related to low water availability and high temperatures in the semiarid Caatinga domain of northeastern Brazil. This ecological approach in a conservation area allowed a better understanding of the functioning of the Ecological Reserve ecosystem and its importance to other groups of organisms in the Brazilian semiarid region.

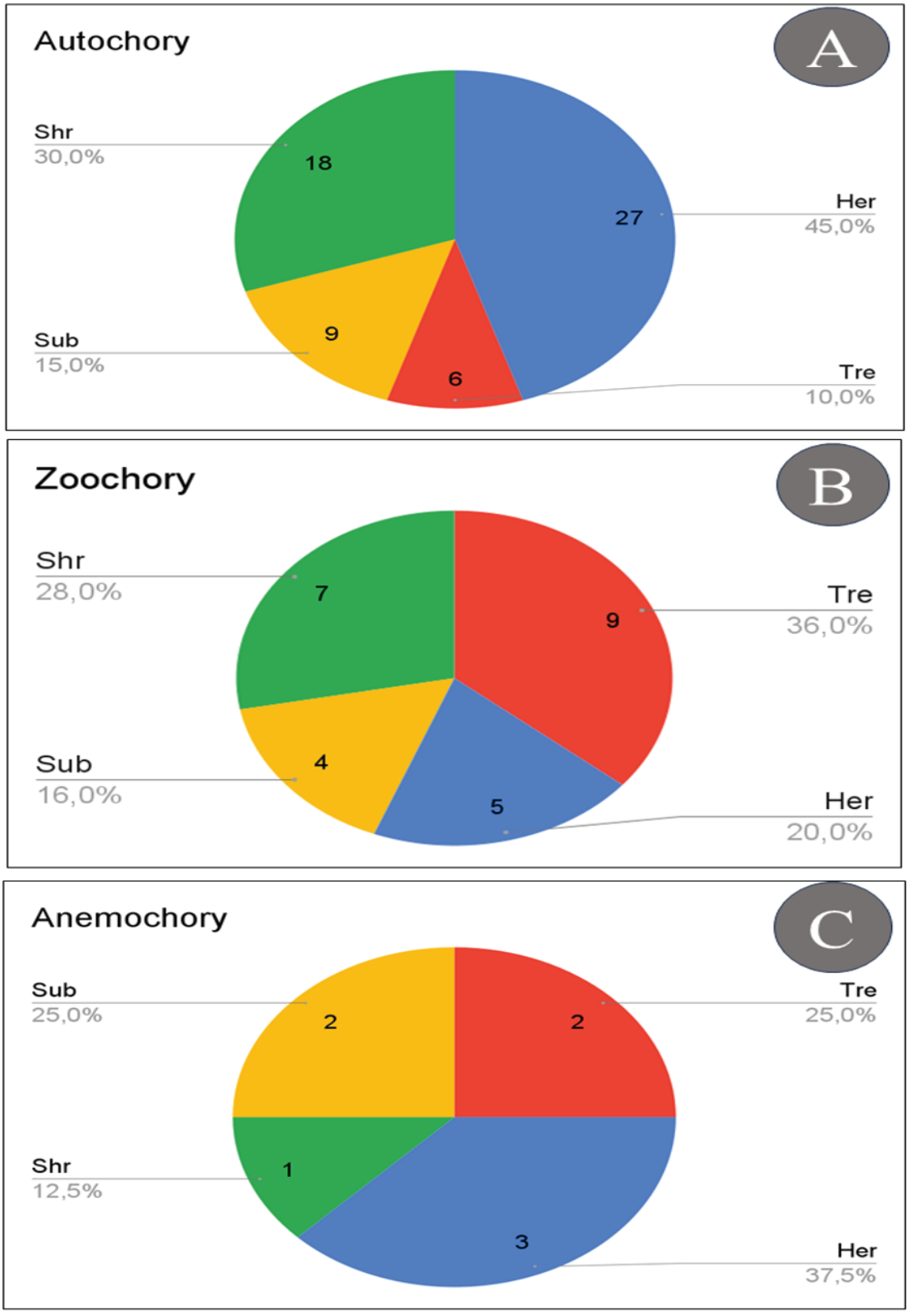

FIGURE 6. **A**, Percentage of the types of habits associated with autochoric syndromes, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil; **B**, Percentage of the types of habits associated with zoochoric syndromes; **C**, Percentage of the types of habits associated with anemochoric syndromes. Legends: Her= Herb; Sub=Subshrub; Shr=Shrub; Tre=Tree. By G. A. Luz.

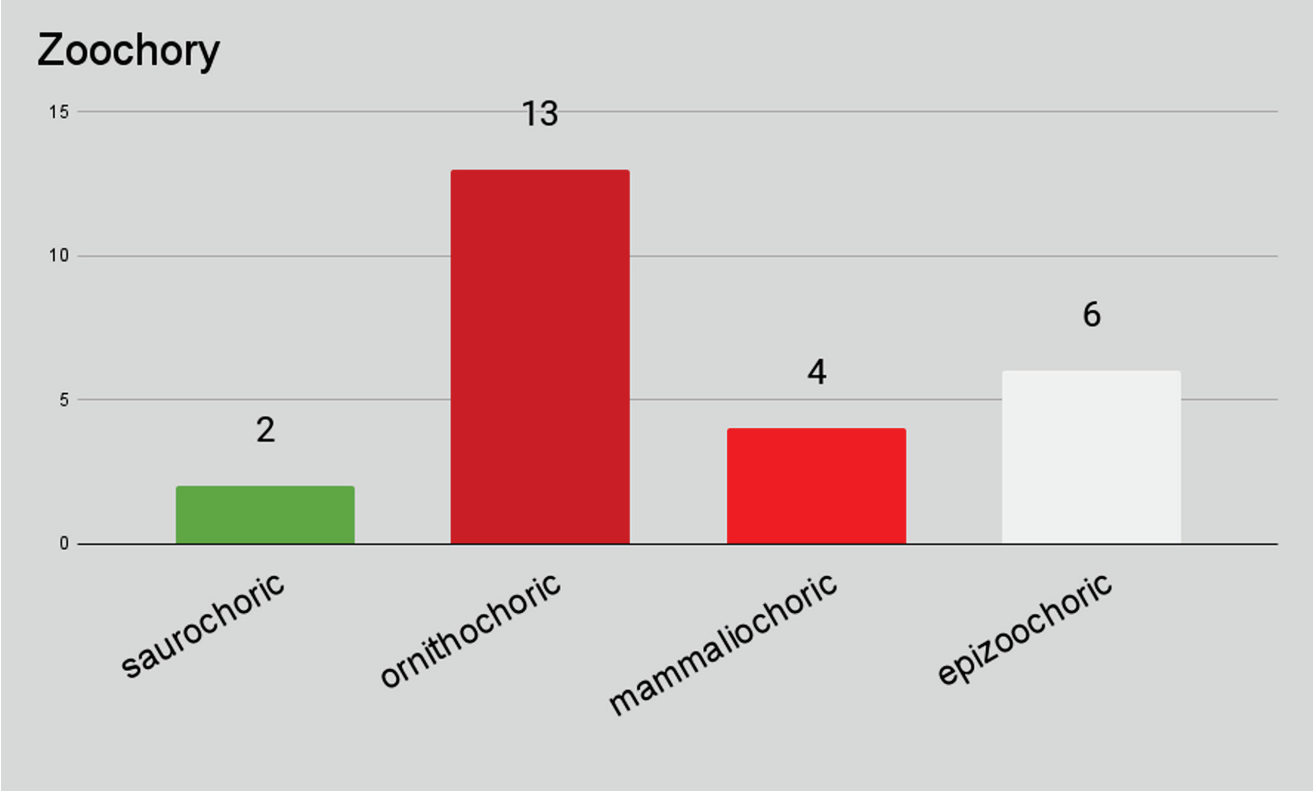

FIGURE 7. Zoochoric sub syndrome most recorded, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil. By G. A. Luz.

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TABLE 2. Species fruiting calendar of the species in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil. Legends: F = in fruit; – not in fruit.

SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Quaternella ephedroides Pedersen	–	–	–	–	–	–	–	–	F	–	–	—
Schinopsis brasiliensis Engl.	–	–	F	–	–	–	–	–	–	F	F	–
Spondias tuberosa Arruda	–	F	F	–	–	–	–	–	–	–	–	–
Aspidosperma pyrifolium Mart. & Zucc.	–	–	F	–	–	–	F	–	–	–	–	F
Aechmea aquilega (Salisb.) Griseb.	–	F	–	–	–	–	–	–	–	–	F	–
Tillandsia recurvata (L.) L.	F	F	–	–	–	–	–	–	F	–	–	–
Tillandsia streptocarpa Baker	–	F	–	–	–	–	–	–	F	–	–	F
Cereus jamacaru DC.	–	–	F	–	–	–	–	–	–	–	–	–
Melocactus zehntneri (Britton & Rose) Luetzelb.	–	F	–	–	–	–	–	–	–	–	–	–
Pilosocereus pachycladus F. Ritter	–	F	F	–	–	–	–	–	–	–	–	–
Tacinga inamoena (K. Schum.) N.P. Taylor & Stuppy	–	–	–	–	–	–	–	–	F	–	–	F
Xiquexique gounellei (F.A.C. Weber) Lavor & Calvente	–	F	F	–	–	–	–	–	–	–	–	–
Cynophalla flexuosa (L.) J. Presl	F	–	F	–	–	–	–	–	–	–	–	F
Neocalyptrocalyx longifolium (Mart.) Cornejo & Iltis	F	F	–	–	–	–	–	–	–	–	–	–
Combretum leprosum Mart.	–	–	F	–	–	–	–	–	–	–	–	–
Evolvulus filipes Mart.	–	–	–	F	–	F	F	–	–	–	–	–
Evolvulus frankenioides Moric.	–	–	–	–	–	–	F	F	–	–	–	–
Evolvulus glomeratus Nees & Mart.	–	–	–	–	–	–	–	F	–	–	–	F
Varronia globosa Jacq.	F	–	F	–	–	–	–	–	–	–	–	–
Varronia leucomalloides (Taroda) J.S. Mill.	–	–	F	–	–	–	–	–	–	–	–	–
Varronia mariana E.C.O. Chagas & Costa-Lima	–	–	F	F	–	–	–	–	–	–	–	–
Acalypha multicaulis Müll. Arg.	–	–	F	–	–	–	–	–	–	–	–	–
Argythamnia malpighiacea Ule	F	–	–	–	–	–	–	–	–	–	F	–
Cnidoscolus urens (L.) Arthur	–	F	–	–	–	–	–	–	F	–	–	–

TABLE 2 CONT. Species fruiting calendar of the species in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil. Legends: F = in fruit; – not in fruit.

SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Croton adenocalyx Baill.	–	–	F	F	–	–	–	–	–	–	–	–
Croton blanchetianus Baill.	–	–	F		–	–	–	–	–	–	–	F
Croton glandulosus L.	–	–	F	F	–	–	–	–	–	–	–	–
Croton grewioides Baill.	F	–	–	–	–	–	–	–	–	–	–	–
Croton heliotropiifolius Kunth	F	F	F	F	–	–	–	–	–	–	–	–
Jatropha mollissima (Pohl) Baill.	–	–	F	–	–	–	–	F	–	–	–	F
Jatropha ribifolia (Pohl) Baill.	F	F	–	–	–	–	–	–	–	–	–	F
Manihot carthagenensis (Jacq.) Müll. Arg.	–	F	F	–	–	–	–	–	–	–	–	–
Stillingia trapezoidea Ule	–	F	–	–	–	–	–	–	–	–	–	–
*Erythroxylum caatinga*e Plowman	F	F	–	–	–	–	–	–	–	–	–	–
Erythroxylum pyan Costa-Lima	F	–	–	–	–	–	–	–	–	–	–	F
Bauhinia cheilantha (Bong.) Steud.	–	–	–	F	–	–	–	–	–	–	–	–
Cenostigma nordestinum Gagnon & G.P. Lewis	–	F	–	–	–	–	F	–	–	–	–	F
Chamaecrista absus (L.) H.S. Irwin & Barneby	–	–	–	F	–	–	–	–	–	–	–	–
Chamaecrista calycioides (DC. ex Collad.) Greene	–	–	F	–	–	–	–	F	–	–	–	–
Chamaecrista duckeana (P. Bezerra & Afr. Fern.) H.S. Irwin & Barneby	–	–	F	–	–	–	F	–	–	–	–	–
Chamaecrista rotundifolia (Pers.) Greene	–	–	F	–	–	–	F	–	–	–	–	–
Chamaecrista zygophilloides (Taub.) H.S. Irwin & Barneby	F	–	F	–	–	–	–	–	–	–	–	F
Indigofera suffruticosa Mill.	–	–	F	F	–	–	–	–	–	–	–	F
Libidibia ferrea (Mart. ex Tul.) L.P. Queiroz	–	–	F	–	–	–	–	–	–	–	–	–
Mimosa candollei R. Grether	–	–	–	–	–	–	–	F	–	–	–	F
Mimosa paraibana Barneby	–	–	–	F	–	–	F	–	–	–	–	–
Mimosa tenuiflora (Willd.) Poir.	–	–	–	–	–	–	–	–	–	–	–	F

TABLE 2 CONT. Species fruiting calendar of the species in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil. Legends: F = in fruit; – not in fruit.

SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Peltogyne pauciflora Benth.	–	–	F	–	–	–	–	–	–	–	–	–
Senna macranthera (DC. ex Collad.) H.S. Irwin & Barneby	–	–	F	–	–	–	F	F	–	–	–	–
Senna trachypus (Benth.) H.S. Irwin & Barneby	–	–	F	–	–	–	–	–	–	–	–	–
Zornia brasilensis Vogel	F	–	–	–	–	–	–	–	–	–	–	–
Zornia leptophylla (Benth.) Pittier	–	–	–	F	–	–	–	F	–	–	–	–
Zornia reticulata Sm.	–	–	–	–	–	–	F	F	–	–	–	–
Euploca procumbens (Mill.) Diane & Hilger	–	–	–	–	–	–	–	F	–	–	–	–
Heliotropium angiospermum Murray	–	–	F	–	–	–	–	F	–	–	–	–
Pusillanthus pubescens (Rizzini) Caires	–	–	–	–	–	–	–	–	F	–	–	F
Cuphea impatientifolia A. St.-Hil.	–	–	–	F	F	F	–	–	–	–	–	–
Gaya domingensis Urb.	–	–	F	F	–	–	–	–	–	–	–	–
Helicteres eichleri K. Schum.	–	F	–	–	–	–	–	–	F	–	–	F
Herissantia tiubae (K. Schum.) Brizicky	F	–	–	–	–	–	–	F	F	–	–	F
Melochia tomentosa L.	F	–	–	–	–	–	–	–	–	–	–	–
Sida galheirensis Ulbr.	–	–	–	–	–	–	–	F	–	–	–	F
Sida spinosa L.	–	–	F	–	–	–	–	–	–	–	–	–
Sidastrum paniculatum (L.) Fryxell	–	–	F	–	–	–	–	–	–	–	–	–
*Boerhavia coccine*a Mill.	–	–	F	–	–	–	–	–	–	–	–	–
Boerhavia erecta L.	–	–	F	–	–	–	–	–	–	–	–	–
Scoparia dulcis L.	–	–	F	–	–	–	–	–	–	–	–	–
Cenchrus echinatus L.	–	–	–	–	–	–	–	F	–	–	–	–
Chloris barbata Sw.	–	–	F	–	–	–	–	–	–	–	–	–
Chloris virgata Sw.	–	F	–	–	–	–	–	–	–	–	–	–
Digitaria ciliaris (Retz.) Koeler	–	F	–	–	–	–	–	–	–	–	–	–
Tragus berteronianus Schult.	–	F	F	–	–	–	–	–	–	–	–	–

TABLE 2 CONT. Species fruiting calendar of the species in the study area, Olho d'Água das Onças Ecological Reserve, Picuí, Paraíba State, Brazil. Legends: F = in fruit; – not in fruit.

SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Urochloa mollis (Sw.) Morrone & Zuloaga	–	–	F	–	–	–	–	–	–	–	–	–
Asemeia martiana (A.W. Benn.) J.F.B. Pastore & J.R. Abbott	–	–	F	F	–	–	F	–	–	–	–	F
Asemeia violacea (Aubl.) J.F.B. Pastore & J.R. Abbott	–	–	F	F	–	–	–	–	–	–	–	–
Portulaca elatior Mart. ex Rohrb.	–	–	F	–	–	–	–	–	–	–	–	–
Portulaca halimoides L.	–	–	–	–	–	–	–	F	F	–	–	–
Portulaca mucronata Link	–	–	–	F	–	–	–	–	–	–	–	–
Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.	F	–	–	–	–	–	–	–	–	–	–	–
Schwenckia americana Rooyen ex L.	–	–	–	–	–	–	–	–	–	–	–	F
Sarcomphalus joazeiro (Mart.) Hauenschild	F	F	–	F	–	–	–	–	–	–	–	F
Cordiera rigida (K. Schum.) Kuntze	–	–	–	–	–	–	–	–	–	F	–	F
Hexasepalum teres (Walter) J.H. Kirkbr.	–	–	F	–	–	–	–	F	–	–	–	–
Mitracarpus baturitensis Sucre	–	–	–	–	–	–	F	–	–	–	–	–
Talinum fruticosum (L.) Juss.	–	–	F	–	–	–	–	–	–	–	–	–
Talinum paniculatum (Jacq.) Gaertn.	F	–	–	–	–	–	–	F	–	–	–	–
Piriqueta viscosa Griseb.	–	–	F	–	–	–	–	–	–	–	–	–
Turnera blanchetiana Urb.	F	–	F	F	–	–	–	–	–	–	–	–
Turnera pumilea L.	–	–	–	–	–	–	–	F	–	–	–	–
Turnera subulata Sm.	–	F	F	F	–	–	–	–	–	–	–	–
Lantana radula Sw.	–	–	F	–	–	–	–	–	–	–	–	–
Lantana tiliaefolia Cham.	–	F	–	F	–	–	–	–	–	–	–	F
Stachytarpheta coccinea Schauer	–	–	–	–	–	–	–	–	–	–	F	F
Pombalia arenaria (Ule) Paula-Souza	–	–	F	–	–	–	F	–	–	–	–	–