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LISTS OF SPECIES

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Checklist of the flora of the restingas of Piauí state, Northeast Brazil

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Abstract: Sandy coastal plain vegetation (*Restinga*) is composed of communities of plants that grow on Quaternary Neosols along the entire extension of the Brazilian coast. The state of Piauí has a coastal extension of 66 km and is entirely located in the semi-arid zone of Northeastern Brazil. This study catalogued the phanerogam species found along the coast of the state of Piauí, the data of which was compiled from surveys in online databases and literature, and herbarium collections. A total of 363 species distributed among 235 genera, and 74 families were identified. The families with the greatest number of species included Fabaceae (108 species), Euphorbiaceae (19), Amaranthaceae (13), Apocynaceae (12), Cyperaceae (12), Rubiaceae (12), Bignoniaceae (11), Malvaceae (11) and Poaceae (11) and represent over 57.6% of the species collected. Approximately 87% of the species were common to other restinga areas in Northeastern Brazil, and ca. 13% were restricted to the coast of the state of Piauí.

Key words: restinga vegetation, coastal vegetation, herbarium, Northeastern Brazil, Quaternary Neosols

INTRODUCTION

The restinga is an ecosystem associated with the Atlantic Forest (Scarano 2002) that shows extreme fragility because of its long occupation and human interference or increasing predation, in which degradation has been intensified by predatory human activity (Rocha et al. 2004; Santos-Filho et al. 2013).

In addition to being highly degraded, this ecosystem is recognized for presenting itself as an environment that is in the process of ecological succession because of its recent establishment during the Quaternary period (Zaluar and Scarano 2000; Santos-Filho et al. 2013). It is believed that species that colonized the restingas originated in the Atlantic forest or other adjacent ecosystems (Rizzini 1997; Araujo 2000; Scarano 2002) but adjusted to the new environmental conditions in the restingas.

Because soil and climatic conditions are the most influential factors for successfully establishing plant communities (Mather and Yoshioka 1968; Araújo et al. 2004), knowing which species are present and how these species are distributed along the Brazilian coast become important for better understanding the dynamics of restingas because such environments typically have poor soil with high salinity (Hay et al. 1981).

Among the Northeastern states, more floristic and structural studies of restinga ecosystems have been undertaken in Pernambuco, Piauí, Bahia, Paraíba and Rio Grande do Norte. In Pernambuco (Zickel et al. 2007) and Ceará (Santos-Filho et al. 2011), studies have provided catalogued the flora in their restingas through the compilation of species records for those that occur in this ecosystem.

Studies aimed at recognizing the species composition of coastal forests have proven to be essential in face of the constant threat of the eradication of these environments due to the rapid degradation and loss of habitat (Rocha et al. 2007), which could trigger the loss of biodiversity and the loss of endemic species in more severe cases (Silva and Tabarelli 2000).

Therefore, the compilation of records of punctual species from floristic inventories and herbarium collections makes it possible to understand the history of species that existed and were no longer collected either by lower collecting efforts or species extinction (Almeida Jr. et al.

2012). These data are important because they generate information about the biodiversity and conservation status of restinga areas.

The state of Piauí has 66 km of coastline that is predominantly composed of sea cliffs of the Barreiras Formation and quaternary quartz sand deposits. Restinga vegetation occupying dunes and inter-dune regions can be found along the entire coast of that state and can have different physiognomies that vary from grassy fields to shrublands or forests and grassy fields with "carnaubais" (*Copernicia prunifera*) (Santos-Filho et al. 2010).

Even with a small coastline, few studies have been conducted on the coast of Piauí including only two scientific (Santos-Filho et al. 2013; Santos-Filho and Zickel 2013) and one technical study (Fernandes et al. 1996) that has been published with data referring to the restinga vegetation in Piauí. In an effort to fill this lacuna, this study provides a catalog of the phanerogams registered in the restinga areas of Piauí state, Brazil.

MATERIALS AND METHODS

The state of Piauí has a total territorial area of 251.529 km², making it the third largest state in Northeastern Brazil (Figure 1). In addition to the Restinga, the vegetation cover of this area also includes a vegetation mosaic ecotone consisting of Cerrado, Caatinga and Cerrado-Caatinga transitions (Farias and Castro 2004). According to the classification proposed by Velloso et al. (2002), *Caatinga* occurs in the state in the "Depressão Sertaneja Setentrional" region and the "Campo Maior" and "Ibiapaba-Araripe" complexes.

The species listed in this study were compiled from data available at HAF, IPA, PEUFR and TEPB (acronyms according to Thiers 2014) and from floristic surveys performed in the Delta do Parnaíba Environmental Protection Area (Fernandes et al. 1996; Santos-Filho et al. 2013). All herbarium specimens were considered, including invasive species that grow in lacustrine environments and species typical of areas in contact with mangrove swamps and exotic species. Plants with incomplete or questionable identification were excluded.

The herbarium survey covered plants collected in the territory of the four cities of Piauí state's coast (Ilha Grande, Parnaíba, Luiz Correia and Cajueiro da Praia), which are all located in coastal plains with neosols predominantly quaternary or Barriers Formation (Santos-Filho 2009).

The catalog lists the botanical families and species in alphabetical order. The classification system used was based on APG III (2009). Current species names were confirmed by consulting the MOBOT database (2012), "Flora do Brasil" list (2014) and specialized literature for certain groups. The biological forms of species were identified based on the classification system of Whittaker (1975), and information on the life forms was obtained from herbarium labels.

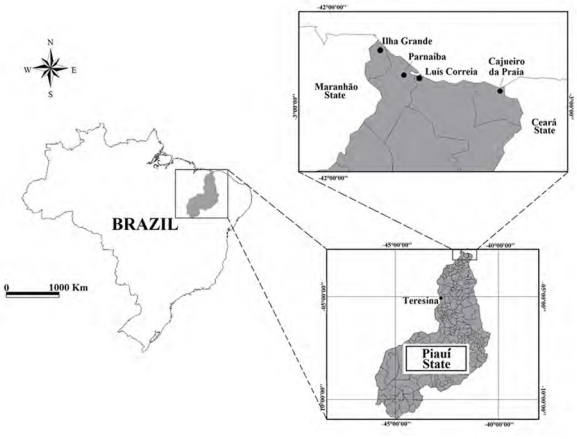

Figure 1. Map Piauí state, Brazil, along the Atlantic coast.

RESULTS

The final list of phanerogam species reported for restinga areas in the state of Piauí totaled 363 species distributed among 235 genera and 74 families (Table 1).

The families with the greatest number of species included the following: Fabaceae (108), Euphorbiaceae (19), Amaranthaceae (13), Apocynaceae (12), Cyperaceae (12), Rubiaceae (12), Bignoniaceae (11), Malvaceae (12) and Poaceae (11), which corresponds to 57.6% of the total number of species. Approximately 40.5% of the families were represented by only one species.

The most representative genera in this survey were *Mimosa* (11 spp.), *Aeschynomene* (7), *Senna* (7), *Alternanthera* (6), *Croton* (6), *Byrsonima* (5), *Chamaecrista* (5), *Bauhinia* (4), *Combretum* (4), *Copaifera* (4), *Cyperus* (4), *Ipomoea* (4), *Passiflora* (4) and *Solanum* (4), together representing 20.7% of all of the species recorded.

This study demonstrates that among the species surveyed, 102 (28%) were herbaceous, 92 (25.3%) were shrubs, 76 (20.9%) were trees, 49 (13.4%) were vines, 40 (11%) were subshrub, and 4 (1.1%) had hemiparasitic habit (Figure 2). Thus, our survey indicated that 39% of the species observed in the coastal areas of the state of Piauí were either herbaceous or subshrub plants.

DISCUSSION

Fabaceae, Poaceae, Cyperaceae, Rubiaceae, and Euphorbiaceae are the most cited families in floristic surveys in Brazilian restingas (D.S.D. Araujo, personal communication). A checklist prepared by Zickel et al. (2007) for Pernambuco state likewise mentioned the high frequency of Fabaceae (67 spp.), Poaceae (39 spp.), Cyperaceae (26 spp.), and Euphorbiaceae (25 spp.). Santos-Filho et al. (2011) prepared a catalog for the state of Ceará in which Fabaceae (130 spp.), Cyperaceae (51), Poaceae (47), Rubiaceae (27), Euphorbiaceae (19), Asteraceae (13), Myrtaceae (12), and Bignoniaceae (11) were the families with the greatest number of species.

Table 1. List of phanerogamic species of restinga areas in Piauí state.

Family / Species	Habit	Voucher
Acanthaceae		
Avicennia germinans (L.) L.	Tree	HAF (458)
Ruellia geminiflora Kunth	Herb	HAF (2254)
Ruellia paniculata L.	Herb	TEPB (9350)
Aizoaceae		
Sesuvium portulacastrum (L.) L.	Herb	IPA (44758)
Alismataceae		
Hydrocleys nymphoides (Willd.) Buchenau	Herb	PEUFR (41887)
Amaranthaceae		
Alternanthera brasiliana (L.) Kuntze	Herb	HAF (971)
Alternanthera littoralis P. Beauv.	Herb	HAF (1067)
Alternanthera littoralis var. *maritima* (Mart.) Pedersen	Herb	HAF (90)
Alternanthera paronychioides A. St.-Hil.	Herb	HAF (100)
Alternanthera regelii (Seub.) Schinz	Herb	HAF (2302)
Alternanthera sessilis (L.) R. Br.	Herb	HAF (76)
Amaranthus blitum L.	Herb	TEPB (839)
Amaranthus spinosus L.	Herb	TEPB (9304)
Amaranthus viridis L.	Herb	TEPB (21305)
Blutaparon portulacoides (A. St.-Hil.) Mears	Herb	TEPB (615)
Blutaparon vermiculare (L.) Mears	Herb	TEPB (9343)
Froelichia humboldtiana Seub.	Herb	HST 14829
Gomphrena demissa Mart.	Herb	TEPB (19128)
Anacardiaceae		
Anacardium occidentale L.	Tree	HAF (950)
Anacardium humile A. St.-Hil.	Tree	TEPB (20403)
Astronium fraxinifolium Schott	Tree	TEPB (2154)
Schinus terebinthifolius Raddi	Tree	TEPB (10404)
Apocynaceae		
Allamanda blanchetii A. DC.	Shrub	HAF (86)
Aspidosperma cuspa (Kunth) Blake	Tree	HAF (1047)
Aspidosperma pyrifolium Mart.	Shrub	TEPB (3865)
Calotropis procera (Aiton) W.T. Aiton	Shrub	HAF (2529)
Cryptostegia grandiflora R. Br.	Shrub	TEPB (23433)
Cryptostegia madagascariensis Bojer	Shrub	HAF (1032)
Hancornia speciosa Gomes	Tree	TEPB (2549)
Himatanthus drasticus (Mart.) Plumel	Tree	TEPB (21918)
Matelea maritima (Vell.) Fontella	Vine	TEPB (17131)
Schubertia grandiflora Mart. & Zucc.	Vine	HST (14830)
Tabernaemontana catharinensis A. DC.	Subshrub	TEPB (2186)
Tabernaemontana laeta Mart.	Subshrub	HST (14831)
Araceae		
Montrichardia linifera (Arruda) Schott	Herb	IPA (65599)
Pistia stratiotes L.	Herb	IPA (61119)
Taccarum peregrinum (Schott) Engl.	Herb	TEPB (11639)
Arecaceae		
Astrocaryum vulgare Mart.	Tree	TEPB (24035)
Attalea speciosa Mart. ex Spreng.	Tree	TEPB (20528)
Copernicia prunifera (Mill.) H.E. Moore	Tree	TEPB (22220)
Mauritia flexuosa L. f.	Tree	HAF (2333)
Asteraceae		
Elephantopus hirtiflorus DC.	Herb	TEPB (17927)
Chromolaena laevigata (Lam.) R.M. King & H. Rob.	Shrub	IPA (63633)
Mikania cordifolia (L. f.) Willd.	Herb	TEPB (915)
Pectis oligocephala (Gardner) Sch. Bip.	Herb	TEPB (20613)
Wedelia villosa Gardner	Herb	TEPB (4115)
Bignoniaceae		
Adenocalymma subsessilifolium DC.	Vine	TEPB (27808)
Amphilophium crucigerum (L.) L. G. Lohmann	Vine	IPA (61307)
Anemopaegma brevipes S. Moore	Vine	TEPB (21640)
Anemopaegma parkeri Sprague	Vine	PEUFR (51557)
Cuspidaria argentea (Wawra) Sandwith	Vine	TEPB (19771)
Fridericia platyphylla (Cham.) L. G. Lohmann	Vine	HST (19172)
Handroanthus impetiginosus (Mart. ex DC.) Mattos	Tree	HST (4348)
Neojobertia candolleana (Mart. ex DC.) Bureau & K.Schum.	Vine	TEPB (20112)
Pleonotoma jasminifolia (Kunth) Miers	Vine	HAF (484)
Tabebuia aurea (Silva Manso) Benth. & Hook. f. ex S. Moore	Tree	TEPB (18066)
Tabebuia roseoalba (Ridl.) Sandwith	Tree	IPA (59307)
Boraginaceae		
Cordia rufescens A. DC.	Tree	TEPB (11647)
Euploca polyphylla (Lehm.) J.I.M.Melo & Semir	Subshrub	IPA (86929)
Heliotropium angiospermum Murray	Subshrub	TEPB (3383)
Heliotropium indicum L.	Subshrub	TEPB (26577)
Myriopus rubicundus(Salzm. ex DC.) Luebert	Vine	IPA (65732)
Tournefortia candidula (Miers) I.M. Johnst.	Shrub	IPA (67421)
Bromeliaceae		
Bromelia karatas L.	Shrub	IPA (54807)
Burseraceae		
Commiphora leptophloeos (Mart.) J.B. Gillett	Tree	TEPB (9669)
Cabombaceae		
Cabomba furcata Schult. & Schult. f.	Herb	TEPB (10478)
Cactaceae		
Cereus jamacaru DC.	Shrub	TEPB (17298)
Pilosocereus catingicola subsp. *salvadorensis* (Werderm.) Zappi	Shrub	IPA (67007)
Cannabaceae		
Celtis iguanaea (Jacq.) Sarg.	Shrub	HST (14856)
Capparaceae		
Cynophalla flexuosa (L.) J. Presl	Tree	HAF (148)
Cynophalla hastata (Jacq.) J.Presl	Tree	IPA (85577)
Celastraceae		
Maytenus distichophylla Mart. ex Reissek (Figure 3A)	Shrub	TEPB (22777)
Maytenus gonoclada Mart.	Shrub	TEPB (27851)
Chrysobalanaceae		
Chrysobalanus icaco L.	Shrub	HAF (2254)
Licania tomentosa (Benth.) Fritsch	Tree	TEPB (27454)
Cleomaceae		
Gynandropsis gynandra (L.) Briq.	Shrub	HAF (2268)
Tarenaya spinosa (Jacq.) Raf.	Shrub	HAF (2321)
Clusiaceae		
Platonia insignis Mart.	Tree	HAF (2277)
Combretaceae		
Combretum glaucocarpum Mart.	Shrub	HAF (589)
Combretum laxum Jacq.	Shrub	HAF (770)
Combretum leprosum Mart.	Tree	HAF (157)
Combretum mellifluum Eichler	Shrub	HAF (60)
Conocarpus erectus L.	Shrub	HAF (2316)
Commelinaceae		
Commelina erecta L.	Herb	HAF (1136)
Commelina obliqua Vahl	Herb	HAF (2363)
Convolvulaceae		
Cuscuta racemosa Mart.	Vine	HAF (2315)
Evolvulus ovatus Fernald	Herb	HST (14834)
Evolvulus pterocaulon Moric.	Herb	HST (14828)
Ipomoea asarifolia (Desr.) Roem. & Schult.	Vine	HST (14833)
Ipomoea carnea subsp. *fistulosa* (Mart. ex Choisy) D.F.Austin	Vine	HAF (2390)
Ipomoea pes-caprae (L.) R. Br.	Vine	HAF (2366)

Continued

Table 1. *Continued.*

Family / Species	Habit	Voucher
Ipomoea procumbens Mart. *ex* Choisy	Vine	HAF (175)
Jacquemontia montana (Moric.) Meisn.	Herb	HST (14904)
Merremia aegyptia (L.) Urb.	Vine	HAF (1701)
Operculina macrocarpa (L.) Urb.	Vine	HST (14832)
Cucurbitaceae		
Ceratosanthes palmata (L.) Urb.	Vine	IPA (83307)
Luffa cylindrica M. Roem.	Vine	HAF (49)
Luffa operculata (L.) Cogn.	Vine	TEPB (27240)
Momordica charantia L.	Vine	HAF (2472)
Cyperaceae		
Bulbostylis capillaris (L.) C.B. Clarke	Herb	TEPB (20271)
Bulbostylis scabra (J. Presl & C. Presl) C.B. Clarke	Herb	TEPB (10216)
Cyperus aggregatus (Willd.) Endl.	Herb	TEPB (10219)
Cyperus articulatus L.	Herb	TEPB (9308)
Cyperus crassipes Vahl	Herb	TEPB (27787)
Cyperus ligularis L.	Herb	TEPB (23258)
Eleocharis geniculata (L.) Roem. & Schult.	Herb	TEPB (10275)
Eleocharis interstincta (Vahl) Roem. & Schult.	Herb	TEPB (27290)
Fimbristylis cymosa R. Br.	Herb	TEPB (27307)
Kyllinga squamulata Thonn. *ex*. Vahl	Herb	TEPB (9307)
Remirea maritima Aubl.	Herb	TEPB (8554)
Rhynchospora riparia (Nees) Boeckeler	Herb	TEPB (25740)
Dilleniaceae		
Curatella americana L.	Tree	HAF (1994)
Davilla cearensis Huber	Vine	RB (444275)
Dioscoreaceae		
Dioscorea ovata Vell.	Vine	TEPB (17679)
Eriocaulaceae		
Leiothrix rufula (A. St.-Hil.) Ruhland	Herb	IPA (63663)
Euphorbiaceae		
Cnidoscolus urens var. *neglectus* (Pohl) Lourteig	Shrub	PEUFR (41185)
Cnidoscolus urens (L.) Arthur	Shrub	PEUFR (32496)
Croton adamantinus Müll. Arg.	Shrub	HAF (1876)
Croton blanchetianus Baill.	Shrub	HAF (1970)
Croton glandulosus L.	Subshrub	HAF (1188)
Croton hirtus L'Hér.	Subshrub	HAF (196)
Croton jacobinensis Baill.	Subshrub	HAF (312)
Croton pedicellatus Kunth	Subshrub	HAF (747)
Dalechampia pernambucensis Baill.	Vine	TEPB (10608)
Dalechampia scandens L.	Vine	HAF (746)
Euphorbia hirta L.	Herb	HAF (205)
Euphorbia hyssopifolia L.	Herb	HAF (1855)
Euphorbia tirucalli L.	Shrub	TEPB (25436)
Jatropha mollissima (Pohl) Baill.	Tree	TEPB (23022)
Manihot dichotoma Ule	Tree	TEPB (10566)
Manihot carthaginensis subsp. *glaziovii* (Müll. Arg.) Allem	Tree	TEPB (16829)
Manihot tristis Mull. Arg.	Tree	TEPB (25906)
Ricinus communis L.	Tree	TEPB (25439)
Tragia volubilis L.	Vine	TEPB (21533)
Fabaceae		
Abrus precatorius L. (Figure 3B)	Vine	HST (14901)
Aeschynomene brasiliana (Poir) DC.	Subshrub	TEPB (5681)
Aeschynomene brevipes Benth.	Subshrub	TEPB (17177)
Aeschynomene evenia C.Wright & Sauvalle	Subshrub	HST (14910)
Aeschynomene histrix Poir.	Subshrub	HST (14933)
Aeschynomene paniculata Willd. ex Vogel	Subshrub	TEPB (27640)
Aeschynomene sensitiva Sw.	Shrub	TEPB (490)
Aeschynomene viscidula Michx.	Subshrub	TEPB (848)
Albizia niopoides (Spruce ex Benth.) Burkart	Shrub	HAF (2968)
Alysicarpus vaginalis (L.) DC.	Herb	HST 14902
Amburana cearensis (Allemão) A.C. Sm.	Tree	TEPB (17260)
Ancistrotropis peduncularis (Kunth) A.lgado	Vine	TEPB (17045)
Andira legalis (Vell.) Toledo	Tree	PEUFR (10760)
Andira nitida Mart. ex Benth.	Tree	PEUFR (35870)
Apuleia leiocarpa (Vogel) J.F. Macbr.	Tree	TEPB (8016)
Bauhinia acuruana Moric.	Shrub	TEPB (27605)
Bauhinia dubia G. Don	Shrub	TEPB (18152)
Bauhinia forficata Link	Shrub	TEPB (29086)
Bauhinia ungulata L.	Shrub	TEPB (26970)
Calliandra fernandesii Barneby	Subshrub	TEPB (13557)
Canavalia brasiliensis Mart. ex Benth.	Vine	TEPB (8952)
Canavalia dictyota Piper	Vine	PEUFR (37683)
Centrosema brasilianum (L.) Benth.	Vine	HAF (1218)
Centrosema rotundifolium Mart. ex Benth.	Vine	TEPB (9793)
Chamaecrista desvauxii (Collad.) Killip	Herb	IPA (12278)
Chamaecrista ensiformis (Vell.) H.S. Irwin & Barneby	Shrub	IPA (29514)
Chamaecrista flexuosa (L.) Greene	Subshrub	HAF (1976)
Chamaecrista hispidula (Vahl) H.S. Irwin & Barneby	Herb	IPA (39901)
Chamaecrista ramosa (Vogel) H.S. Irwin & Barneby	Herb	IPA (40097)
Chloroleucon acacioides (Ducke) Barneby & J.W. Grimes	Tree	IPA (84407)
Clitoria fairchildiana R.A. Howard	Tree	HAF (2268)
Copaifera coriacea Mart.	Shrub	TEPB (20874)
Copaifera langsdorffii Desf.	Tree	TEPB (29128)
Copaifera luetzelburgii Harms	Shrub	TEPB (27653)
Copaifera martii Hayne	Shrub	TEPB (20691)
Crotalaria incana L.	Subshrub	HAF (2253)
Crotalaria mucronata Desv.	Subshrub	PEUFR (25777)
Crotalaria pallida Aiton.	Subshrub	PEUFR (38798)
Dalbergia ecastaphyllum (L.) Taub.	Shrub	TEPB (21897)
Desmodium glabrum (Mill.) DC.	Subshrub	HAF (1282)
Dimorphandra gardneriana Tul	Tree	TEPB (20669)
Dioclea grandiflora Mart. ex Benth.	Vine	HAF (1055)
Dioclea reflexa Hook. f.	Vine	IPA (906)
Dioclea violacea Mart. ex Benth.	Vine	PEUFR (43874)
Enterolobium contortisiliquum (Vell.) Morong	Tree	PEUFR (43923)
Erythrina velutina Willd.	Tree	PEUFR (47973)
Galactia paraguariensis Chodat & Hassl.	Vine	TEPB (23346)
Galactia striata (Jacq.) Urb.	Vine	TEPB (22920)
Hymenaea courbaril L.	Tree	TEPB (20263)
Hymenaea stigonocarpa Mart. ex Hayne	Tree	TEPB (20238)
Hymenaea velutina Ducke	Tree	TEPB (20681)
Indigofera microcarpa Desv.	Subshrub	HAF (1486)
Indigofera spicata Forssk.	Subshrub	HST (14909)
Inga bahiensis Benth.	Tree	HAF (2253)
Inga vera subsp. *affinis* (DC.) T.D. Penn.	Tree	TEPB (8901)
Libidibia ferrea (Mart. ex Tul.) L.P.Queiroz ·.	Tree	HAF (138)
Luetzelburgia auriculata (Allemão) Ducke	Tree	TEPB (27032)
Machaerium acutifolium Vogel	Tree	TEPB (8481)
Machaerium inundatum (Mart. ex Benth.) Ducke	Tree	TEPB (16767)
Machaerium lunatum (L. f.) Ducke	Tree	TEPB (6078)
Macroptilium atropurpureum (Moc. & Sessé ex DC.) Urb.	Herb	IPA (45341)
Macroptilium lathyroides (L.) Urb.	Herb	HAF (58)
Macroptilium panduratum (Benth.) Maréchal & Baudet	Herb	HAF (3303)
Mimosa acutistipula (Mart.) Benth.	Shrub	HAF (3134)
Mimosa caesalpiniifolia Benth.	Shrub	HAF (1315)

Continued

Table 1. *Continued.*

Family / Species	Habit	Voucher
Mimosa hirsutissima Mart. (Figure 3C)	Shrub	HAF (1321)
Mimosa invisa Mart. ex Colla	Shrub	HAF (1425)
Mimosa ophthalmocentra Mart. ex Benth.	Shrub	HAF (1882)
Mimosa pigra L.	Shrub	HAF (1874)
Mimosa pudica L.	Shrub	HAF (527)
Mimosa sensitiva L.	Subshrub	HAF (2174)
Mimosa tenuiflora (Willd.) Poir.	Shrub	HAF (2178)
Mimosa ursina Mart.	Shrub	HAF (2216)
Mimosa verrucosa Benth.	Subshrub	HAF (2287)
Mucuna urens (L.) Medik.	Vine	TEPB (762)
Neptunia oleracea Lour.	Subshrub	TEPB (1834)
Neptunia plena (L.) Benth.	Subshrub	TEPB (23516)
Parkia platycephala Benth.	Tree	TEPB (25763)
Parkinsonia aculeata L.	Tree	TEPB (23516)
Peltogyne confertiflora (Mart. ex Hayne) Benth.	Shrub	TEPB (18557)
Pityrocarpa moniliformis (Benth.) Luckow & R.W.Jobson (Figure 3D)	Shrub	HST (14911)
Piptadenia stipulacea (Benth.) Ducke	Shrub	HAF (2132)
Pithecellobium longiflorum (Humb. & Bonpl. ex Willd.) Standl.	Shrub	TEPB (2552)
Pityrocarpa obliqua (Pers.) Brenan	Shrub	HAF (2770)
Platypodium elegans Vogel	Tree	HAF (2480)
Poincianella bracteosa (Tul.) L.P.Queiroz	Tree	TEPB (27571)
Poincianella pyramidalis var. *diversifolia* (Benth.) L.P.Queiroz	Shrub	TEPB (24437)
Pterocarpus rohrii Vahl	Tree	HAF (1679)
Senegalia polyphylla (DC.) Britton & Rose	Shrub	TEPB (27475)
Senna alata (L.) Roxb.	Shrub	HAF (1045)
Senna gardneri (Benth.) H.S. Irwin & Barneby	Shrub	TEPB (21408)
Senna latifolia (G. Mey.) H.S. Irwin & Barneby	Shrub	HAF (2355)
Senna obtusifolia (L.) H.S. Irwin & Barneby	Herb	HST (15843)
Senna occidentalis (L.) Link	Shrub	HAF (2362)
Senna splendida (Vogel) H.S. Irwin & Barneby	Shrub	HAF (2435)
Senna trachypus (Benth.) H.S. Irwin & Barneby	Shrub	HAF (130)
Sesbania exasperata Kunth	Herb	TEPB (9653)
Stryphnodendron coriaceum Benth.	Tree	TEPB (18108)
Stylosanthes angustifolia Vogel	Subshrub	TEPB (22035)
Stylosanthes guianensis (Aubl.) Sw.	Subshrub	HAF (1919)
Stylosanthes humilis Kunth	Subshrub	TEPB (9398)
Swartzia flaemingii Raddi	Tree	TEPB (22968)
Tachigali vulgaris L.F. Gomes da Silva & H.C. Lima	Tree	TEPB (27554)
Tephrosia cinerea (L.) Pers.	Subshrub	TEPB (6554)
Tephrosia purpurea (L.) Pers.	Subshrub	TEPB (1514)
Vachellia farnesiana (L.) Wight & Arn.	Shrub	TEPB (9907)
Vatairea macrocarpa (Benth.) Ducke	Tree	TEPB (5584)
Zornia sericea Moric.	Herb	TEPB (11001)
Krameriaceae		
Krameria tomentosa A. St.-Hil.	Shrub	HAF (470)
Lamiaceae		
Amasonia campestris (Aubl.) Moldenke	Subshrub	TEPB (23229)
Leonotis nepetifolia (L.) R. Br.	Shrub	TEPB (18838)
Marsypianthes chamaedrys (Vahl) Kuntze	Herb	TEPB (11109)
Mesosphaerum pectinatum (L.) Kuntze	Herb	TEPB (22295)
Mesosphaerum suaveolens (L.) Kuntze	Herb	TEPB (26961)
Lauraceae		
Cassytha filiformis L.	Hemiparasite	TEPB (27335)
Lecythidaceae		
Lecythis pisonis Cambess.	Tree	TEPB (20512)
Lentibulariaceae		
Genlisea violacea A. St.-Hil.	Herb	TEPB (22836)
Loganiaceae		
Spigelia anthelmia L.	Herb	TEPB (22749)
Loranthaceae		
Psittacanthus robustus (Mart.) Mart.	Hemiparasite	TEPB (22559)
Struthanthus flexicaulis (Mart. ex Schult. f.) Mart.	Hemiparasite	TEPB (24892)
Lythraceae		
Crenea maritima Aubl.	Herb	HAF (2321)
Cuphea flava Spreng.	Herb	TEPB (13575)
Malpighiaceae		
Byrsonima crassifolia (L.) Kunth	Shrub	HAF (2263)
Byrsonima gardneriana A. Juss.	Shrub	HAF (2264)
Byrsonima intermedia A. Juss.	Shrub	HAF (2319)
Byrsonima orbignyana A. Juss.	Shrub	HAF (2223)
Byrsonima verbascifolia (L.) DC. (Figure 3E)	Shrub	HAF (2248)
Diplopterys lutea (Griseb.) W.R. Anderson & C. Davis (Figure 3F)	Vine	TEPB (23948)
Stigmaphyllon bannisterioides (L.) C.E. Anderson	Subshrub	PEUFR (25221)
Stigmaphyllon paralias A. Juss.	Subshrub	PEUFR (36443)
Malvaceae		
Apeiba tibourbou Aubl.	Tree	TEPB (28674)
Byttneria divaricata Benth.	Shrub	TEPB (23531)
Byttneria filipes Mart. ex K. Schum.	Shrub	IPA (28066)
Helicteres muscosa Mart.	Shrub	HAF (2516)
Helicteres pentandra L.	Shrub	HAF (341)
Pachira aquatica Aubl.	Tree	TEPB (8203)
Sida ciliaris L.	Herb	HAF (2053)
Sida linifolia Cav.	Herb	HAF (1311)
Sterculia striata A. St.-Hil. & Naudin	Tree	HAF (781)
Waltheria americana L.	Subshrub	HAF (1410)
Waltheria viscosissima A. St.-Hil.	Subshrub	HAF (1605)
Melastomataceae		
Mouriri guianensis Aubl.	Shrub	TEPB (27237)
Mouriri pusa Gardner	Shrub	HAF (2549)
Pterolepis glomerata (Rottb.) Miq.	Herb	TEPB (26612)
Meliaceae		
Cedrela odorata L.	Tree	TEPB (21936)
Menyanthaceae		
Nymphoides indica (L.) Kuntze	Herb	TEPB (27283)
Molluginaceae		
Mollugo verticillata L.	Herb	TEPB (10995)
Moraceae		
Ficus gomelleira Kunth & C.D. Bouché	Tree	TEPB (27047)
Maclura tinctoria (L.) D. Don ex Steud.	Tree	IPA (80908)
Myrtaceae		
Campomanesia aromatica (Aubl.) Griseb.	Shrub	TEPB (28705)
Eugenia excelsa O. Berg	Shrub	HAF (657)
Eugenia punicifolia (Kunth.) DC. (Figure 3G)	Shrub	TEPB (24760)
Eugenia stictopetala Mart. ex DC.	Shrub	IPA (52931)
Myrcia guianensis (Aubl.) DC.	Shrub	HAF (658)
Myrcia multiflora (Lam.) DC.	Tree	HAF (763)
Myrcia splendens (Sw.) DC.	Shrub	HAF (1329)
Myrciaria cuspidata O.Berg	Shrub	TEPB (27829)
Nymphaeaceae		
Nymphaea ampla (Salisb.) DC.	Herb	TEPB (27280)
Nyctaginaceae		
Boerhavia coccinea Mill.	Herb	TEPB (27841)
Ochnaceae		
Ouratea fieldingiana (Gardner) Engl. (Figure 3H)	Shrub	HAF (2506)

Continued

Table 1. *Continued.*

Family / Species	Habit	Voucher
Olacaceae		
Ximenia americana L.	Shrub	HAF (720)
Onagraceae		
Ludwigia hyssopifolia (G. Don) Exell.	Herb	HAF (662)
Passifloraceae		
Passiflora cincinnata Mast.	Vine	TEPB (22001)
Passiflora foetida L.	Vine	HST (14905)
Passiflora mucronata Lam.	Vine	HAF (2378)
Passiflora rubra L.	Vine	HAF (1353)
Plantaginaceae		
Scoparia dulcis L.	Herb	TEPB (27977)
Plumbaginaceae		
Plumbago scandens L.	Subshrub	TEPB (27833)
Poaceae		
Aristida setifolia Kunth	Herb	TEPB (21873)
Dactyloctenium aegyptium (L.) Willd.	Herb	TEPB (27779)
Digitaria nuda Schumach.	Herb	TEPB (9942)
Eleusine indica (L.) Gaertn.	Herb	TEPB (9954)
Paspalum maritimum Trin.	Herb	TEPB (27772)
Paspalum scutatum Nees ex Trin.	Herb	IPA (86422)
Spartina alterniflora Loisel.	Herb	HAF (3145)
Sporobolus virginicus (L.) Kunth	Herb	IPA (23379)
Steinchisma hians (Elliott) Nash	Herb	HAF (1113)
Streptostachys asperifolia Desv.	Herb	IPA (73705)
Urochloa fusca (Sw.) B.F. Hansen & Wunderlin	Herb	IPA (60376)
Polygalaceae		
Asemeia monticola (Kunth) J.F.B.Pastore & J.R.Abbott	Herb	IPA (74241)
Asemeia violacea (Aubl.) J.F.B.Pastore & J.R.Abbott	Herb	IPA (43036)
Polygala lycopodioides Chodat	Herb	IPA (44678)
Polygonaceae		
Coccoloba ramosissima Wedd.	Shrub	TEPB (27542)
Triplaris gardneriana Wedd.	Tree	TEPB (29001)
Pontederiaceae		
Eichornia crassipes (Mart.) Solius	Herb	TEPB (22803)
Pontederia cordata L.	Herb	TEPB (22778)
Portulacaceae		
Portulaca oleracea L.	Herb	TEPB (20753)
Portulaca umbraticola Kunth	Herb	IPA (65218)
Rhamnaceae		
Ziziphus joazeiro Mart.	Tree	TEPB (24709)
Rubiaceae		
Borreria verticillata (L.) G. Mey.	Herb	TEPB (27304)
Borreria spinosa Cham. & Schltdl.	Herb	TEPB (24767)
Chiococca alba (L.) Hitchc. (Figure 3I)	Shrub	IPA (26228)
Coutarea hexandra (Jacq.) K. Schum.	Shrub	IPA (48092)
Diodella apiculata (Willd. ex Roem. & Schult.) Delprete	Herb	TEPB (28203)
Genipa americana L.	Tree	TEPB (29647)
Guettarda angelica Mart. ex Müll.Arg.	Shrub	TEPB (23051)
Guettarda platypoda DC.	Shrub	TEPB (28588)
Randia armata (Sw.) DC.	Herb	TEPB (16913)
Richardia grandiflora (Cham. & Schltdl.) Steud.	Herb	HAF (1066)
Staelia virgata (Link ex Roem. & Schult.) K.Schum.	Subshrub	HAF (624)
Tocoyena sellowiana (Cham. & Schltdl.) K.Schum	Tree	HAF (1311)
Rutaceae		
Pilocarpus microphyllus Stapf ex Wardleworth	Tree	IPA (75564)
Santalaceae		
Phoradendron constrictum Griseb.	Hemiparasite	IPA (84835)
Sapindaceae		
Cardiospermum corindum L.	Vine	IPA (40689)
Dodonaea viscosa Jacq.	Vine	IPA (40701)
Magonia pubescens A. St.-Hil.	Tree	HAF (830)
Urvillea stipitata Radlk.	Vine	IPA (48711)
Sapotaceae		
Manilkara cavalcantei Pires & W.A. Rodrigues ex T.D. Penn.	Tree	UEC (97106)
Manilkara salzmannii (A. DC.) H. J. Lam	Tree	IPA (86359)
Manilkara triflora (Allemão) Monach.	Shrub	RB (444274)
Simaroubaceae		
Simarouba versicolor A. St.-Hil.	Tree	HAF (749)
Solanaceae		
Datura stramonium L.	Subshrub	TEPB (18244)
Physalis angulata L.	Herb	HAF (2394)
Solanum crinitum Lam.	Shrub	HAF (1852)
Solanum depauperatum Dunal	Shrub	HAF (1879)
Solanum paludosum Moric.	Shrub	HAF (1848)
Solanum rhytidoandrum Sendtn.	Shrub	HAF (1976)
Turneraceae		
Turnera serrata Vell.	Herb	HAF (787)
Turnera subulata Sm.	Herb	HAF (933)
Turnera ulmifolia L.	Herb	HAF (1427)
Typhaceae		
Typha domingensis Pers.	Herb	IPA (61868)
Verbenaceae		
Lantana camara L.	Shrub	HAF (1443)
Lippia alba (Mill.) N.E. Br. *ex* P. Wilson	Herb	HAF (664)
Stachytarpheta sessilis Moldenke	Herb	HAF (1071)
Violaceae		
Pombalia calceolaria (L.) Paula-Souza	Herb	HAF (353)
Vitaceae		
Cissus erosa Rich.	Vine	HAF (1070)
Cissus verticillata (L.) Nicolson & C.E. Jarvis	Vine	HAF (354)
Vochysiaceae		
Qualea grandiflora Mart.	Tree	HAF (759)
Qualea parviflora Mart.	Tree	HAF (680)

In a recent floristic survey performed in Piauí state that included part of the upper Northeastern coast (Santos-Filho et al. 2013), the Fabaceae, Poaceae, Cyperaceae, and Euphorbiaceae were found to have the highest number of species. These same families together with the Orchidaceae, Bromeliaceae, and Sapotaceae (Araújo and Henriques 1984; Assis et al. 2004; Martins et al. 2008) are well represented in restinga areas in Southeastern Brazil.

In general, the composition of species observed along the coast of Northeast Brazil resembles the one at the Cerrado and Caatinga. The influence of these biomes on

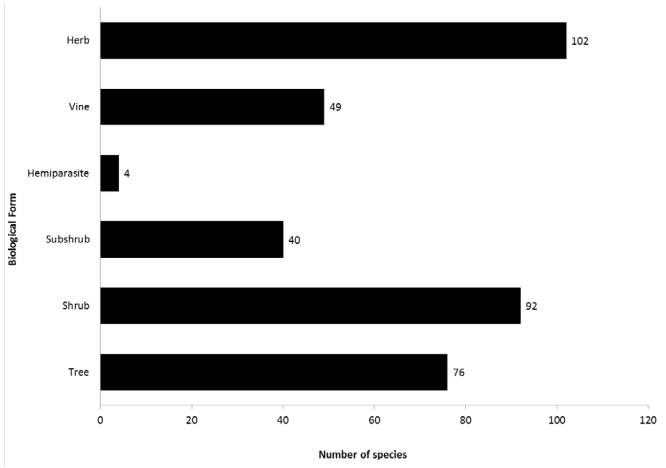

Figure 2. Distribution of the number of species in relation to the biological form of the species listed in the coastal areas of Piauí state, Brazil.

the species composition of restingas in the Northeast was also confirmed for the coast of Piauí, in which 48 species (13% of species surveyed in this study) were previously cited in other floristic studies carried in Cerrado and Caatinga areas of this state (Lemos and Rodal 2002; Lemos 2004; Chaves et al. 2007; Castro et al. 2007; Mesquita and Castro 2007; Castro et al. 2009; Mendes and Castro 2010; Oliveira et al. 2011; Pessoa and Santos-Filho 2011). Among the woody species, *Allamanda blanchetii*, *Cordia rufescens*, *Croton blanchetianus*, *Jatropha molissima*, *Copaifera luetzelburgii*, *Copaifera martii*, *Piptadenia moniliformis* were notable, and *Borreria spinosa*, *Marsypianthes chamaedrys*, *Pectis oligocephala*, and *Zornia sericea* were prominent among herbaceous species.

In addition, nine species belonging to the Amazon Domain were recorded and are specific to the conditions of the ecotonal state of Piauí. These species represent 2.5% of the species in this survey and include *Byttneria divaricata*, *Crenea maritima*, *Helicteres pentandra*, *Machaerium inundatum*, *Machaerium lunatum*, *Manihot tristis*, *Manilkara cavalcantei*, *Pachira aquatica*, and *Pilocarpus microphyllus* (Table 1). Among the species cited, it is noteworthy that *Manilkara cavalcantei* was first recorded on the coast of Piauí state by Almeida Jr. et al. (2011). This fact demonstrates the importance of conserving the remaining restingas, since *Manilkara cavalcantei* figures in the list of endangered species (IUCN 2012).

Among the species listed, 37% were the first records in the state of Piauí, including *Anemopaegma brevipes*, *Cereus jamacaru*, *Maytenus distichophylla*, *Commelina erecta*, *Andira nitida*, *Cuphea flava*, *Byrsonima verbascifolia*, and *Chiococca alba*. This percentage is due primarily to the low record samples (Almeida Jr. et al. 2012) and scarcity of studies in the Northern coastal restinga (Santos-Filho and Zickel 2013), which indicates the importance of not only further floristic but also taxonomic and ecological studies.

The species composition observed were reflections of not only the peculiarities of the restinga ecosystem (with high salinity and low levels of soil nutrients among others) but also environmental degradation (Santos-Filho et al. 2011). *Blutaparon portulacoides*, *Chamaecrista flexuosa, Ipomoea asarifolia*, *Ipomoea pes-caprae*, *Mollugo verticillata, Remirea maritima*, *Richardia grandiflora* and *Sesuvium portulacastrum* (in addition to many members of the Fabaceae, Poaceae and Cyperaceae families) are among the most common plants in dune areas and restingas in Ceará (Matias and Nunes 2001; Santos-Filho et al. 2011), Rio Grande do Norte (Almeida Jr. et al. 2006; Almeida Jr. and Zickel 2009), and Pernambuco states (Zickel et al. 2007; Silva et al. 2008, Almeida Jr. et al. 2009; Cantarelli et al. 2012).

In comparison with other surveys of restingas in Northeastern Brazil (Maranhão [Cabral-Freire and Monteiro 1993]; Ceará [Matias and Nunes 2001; Santos-Filho et al. 2011; Castro et al. 2012]; Rio Grande do Norte [Freire 1990; Almeida Jr. et al. 2006; Almeida Jr. and Zickel 2009]; Paraíba [Carvalho and Oliveira-Filho 1993; Oliveira-Filho and Carvalho 1993; Pontes and Barbosa 2008]; Pernambuco [Andrade-Lima 1951, 1960, 1979; Leite and Andrade 2004; Almeida Jr. et al. 2007; Sacramento et al. 2007; Silva et al. 2008; Almeida Jr. et al. 2009]; Alagoas [Esteves 1980]; and Bahia [Pinto et al. 1984, Viana et al. 2006, Queiroz 2007, Menezes et al. 2012, Queiroz et al. 2012]), 85.2% of the species listed for Piauí were also reported in other coastal areas of Northeastern Brazil, and the remaining 14.8% were recorded only in the restingas in Piauí (including *Anacardium humile*, *Attalea speciosa*, *Bromelia karatas*, *Pilosocereus catingicola*, *Platonia insignis and Ruellia paniculata*) (Table 1). Despite the fact that these species occur in many other restinga areas, specific localities tend to have their own floras due to environmental factors that influence species composition (Barros 2009), particularly under the influence of surrounding ecosystems.

As the biological forms, the results reflects the significant presence of pioneer species that rapidly colonize this environment, mainly dune areas typical of the coast of the state of Piauí, which is similar to that found for the state of Ceará (Santos-Filho et al. 2011) with low open physiognomies of erect herbaceous species and vine-psammophytes.

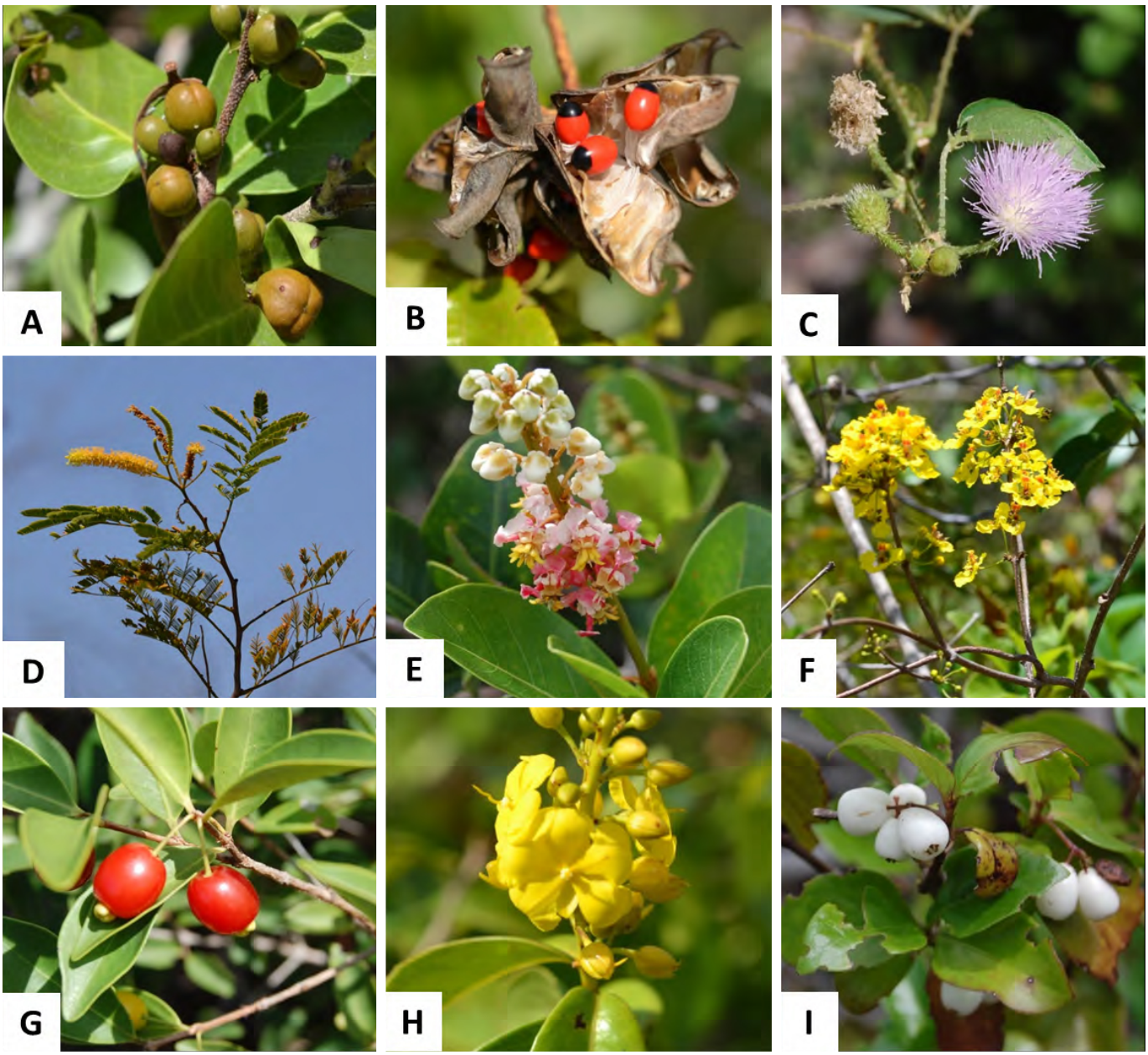

Figure 3. Flowers and fruits of species from the restingas of Piauí state, Brazil. A- *Maytenus distichophylla* Mart. ex Reissek; B- *Abrus precatorius* L.; C- *Mimosa hirsutissima* Mart.; D- *Pityrocarpa moniliformis* (Benth.) Luckow & R.W.Jobson; E- *Byrsonima verbascifolia* (L.) DC.; F- *Diplopterys lutea* (Griseb.) W.R. Anderson & C. Davis; G- *Eugenia punicifolia* (Kunth.) DC.; H- *Ouratea fieldingiana* (Gardner) Engl.; I- *Chiococca alba* (L.) Hitchc. (Photos: F.S. Santos-Filho)

The data presented here indicate the importance of herbaceous species in the physiognomic composition of beach areas. However, as occurs in other coastal areas of Northeastern Brazil (Silva et al. 2008; Almeida Jr. et al. 2009; Santos-Filho et al. 2011; Cantarelli et al. 2012), it is quite possible that due to their immediate proximity to the ocean, the restinga areas of Piauí state have been widely altered due to human activity, namely leisure and tourism. Therefore, conservation efforts focusing on these coastal vegetation communities must include quantitative studies and attempt to decelerate anthropogenic impact.

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