

## Flora and Annual Distribution of Flowers and Fruits in the Ubajara National Park, Ceará, Brazil

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### Abstract

Although the conservation of tropical biodiversity depends on protected areas, there is still a very large 'gap' of knowledge on the flora of Brazilian reserves, especially in the Northeast region of Brazil. Field and herbarium surveys of the phanerogamic flora of the Ubajara National Park, located on the Brazilian Northeast, were made and analyses on phenology and dispersal syndromes were performed. 418 taxa (213 trees and shrubs, 100 terrestrial herbs, 68 climbing plants, 33 sub-shrubs, two epiphytes, one hemiparasite and one aquatic herb) were recorded. The most representative families were: Fabaceae, Malvaceae, Asteraceae, Rubiaceae and Euphorbiaceae. The annual flowering / fruiting peak hypothesis was not fully confirmed, therefore, the forest may be an important food resource for the fauna all year long (especially in the moister region). Zoochory was the predominant dispersal syndrome in the moister area, whereas, autochory and anemochory together, predominated in the drier area.

**Keywords:** biodiversity, mountain forest, protected areas, evergreen forest, deciduous forest.

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## 1. Introduction and objective

The Brazilian semi-arid domain covers an area with a huge physiographic and climatic heterogeneity (associated with continentality, altitude and slope) – which influences moisture and rainfall (Mantovani et al., 2017). In this context, many kinds of vegetation may occur, such as stepic savanna (*caatinga* and *carrasco*), savanna (*cerrado*), coastal semideciduous forest (*mata de tabuleiro*), semideciduous/deciduous forest (*mata seca*) and semideciduous/evergreen forest (*mata úmida*) – the last two can be found mainly in montane regions (Souza & Oliveira, 2006; IBGE, 2012; Moro et al., 2015; Mantovani et al., 2017). According to Zappi et al. (2015), at least 4,659 species of angiosperms were reported for all these plant formations.

The climate in montane regions of the Brazilian semi-arid domain is usually moister than the surroundings, due to orographic precipitation. These habitats are arranged like moist islands in a dry landscape, where forest flora and vegetation develop (Pereira et al., 2010; Nascimento et al., 2012; Pinto et al., 2012; Silva & Figueiredo, 2013). Known as *brejos de altitude*, they often shelter deciduous, semideciduous and/or evergreen forests, with high species richness in comparison with the surrounding semi-arid landscapes (Pereira et al., 2010; Nascimento et al., 2012; Pinto et al., 2012; Silva & Figueiredo, 2013). Thus, the *brejos de altitude* may form a patchy and fragmented mosaic of relic vegetation from a moist paleoclimate (Bétard et al., 2007; Mantovani et al., 2017).

The vegetation in the *brejos de altitude* is also an important resource to local and migratory fauna. The few researches made on these areas show that the seasonality and the water availability rule the phenological patterns and dispersion syndromes. It seems to be a tendency for this kind of biological community to have flower and fruit availabilities all year long (Locatelli & Machado, 2004). Also, it seems to be a predominance of zoochory in moist areas, while autochory and anemochory are predominant in dry areas (Diogo et al., 2016).

The Brazilian semi-arid domain, in which these montane forests are located, is also subjected to overpopulation, about 15% of the national population with 27 million inhabitants (Araújo, 2011), and to an intense rhythm of anthropic exploitation since the Portuguese colonization, especially on the highlands, which are moister than surrounding semi-arid depression (Lopes et al., 2017; Mantovani et al., 2017). Furthermore, protected areas in the Brazilian semi-arid domain account for only 7.8% of its area, of which only 1.3% is under the full protection usage regime, i.e. with restrictions to human intervention (Menezes et al., 2010). Thus, according to Rylands & Brandon (2005), it is one of the most poorly protected regions of Brazil.

Although the conservation of tropical biodiversity depends on protected areas and their surrounding vegetation (Mantovani et al., 2017), there is still a very large ‘gap’ on the knowledge of the

flora of Brazilian protected areas. Most of them are still poorly known, making a consistent analysis of their effectiveness for conservation very difficult (Oliveira et al., 2017; Mattar et al., 2018). According to Moro et al. (2015), floristic studies in the Ubajara mountain forest are highly desirable, since extensive floristic surveys for the Ceará highlands were only performed for Baturité and Araripe areas.

Thus, floristic surveys on Brazilian protected areas have a huge role on supporting conservation, management and restoration programs. Although many efforts have been made to assess the flora of Ceará (Loiola, 2013; Tabosa et al., 2016; Ribeiro & Loiola, 2017; Carneiro et al., 2018; Sampaio et al., 2019), there are still very few published studies on the flora of the protected areas of the state of Ceará. From an inventory of the phanerogamic flora, it could be presented some analysis on the floristic composition, the phenological patterns and the dispersal syndromes found in the Ubajara National Park, located in a montane region of the state of Ceará, Brazil. This protected area is considered of extreme biological importance due to its high diversity and for being listed as a priority area for conservation and sustainable use (Brasil, 2007).

## 2 Material and methods

### 2.1. Study area

The Ubajara National Park is a full protection reserve, created in 1959. After two additions (the first in 1973 and the second in 2002) to the Ubajara National Park, its protected area reached 6,288 ha. It is located in the north of the Ibiapaba plateau, near the coast (3° 45’ S, 40° 54’ W). Due to orographic rainfall, most part of the park is under a moister climate (Aw, Köppen-Geiger) than the surrounding valleys (Bsh, Köppen-Geiger). The terrain stands on a sedimentary sandstone on the higher altitude areas with outcrops of calcareous rocks on the windward slope. The Tropical Seasonal Deciduous Forest (TSDf) develops between 400-700 m and accounts for 72.1% of the area of the park. Between 700-900 m, there is a Tropical Seasonal Evergreen Forest (TSEF), accounting for 18% of the park; and in the lowlands (below 400 m), there is the stepic savanna, which accounts for 9.9% of the park (Figure 1). The park is well preserved, it has about 88.7% of conserved vegetation and only 1.9% of disturbed vegetation. On the surroundings of the park, there is significant anthropogenic disturbance, especially on the moist side, with permeability of only 36.8%, while on the dryer side the permeability is 56% (Mantovani et al., 2017).

On the lands with altitudes around 400-700 meters, the average annual rainfall is 950 mm, concentrated from January to June, and the temperature is 28.2 °C (Figure 2A). The soil is

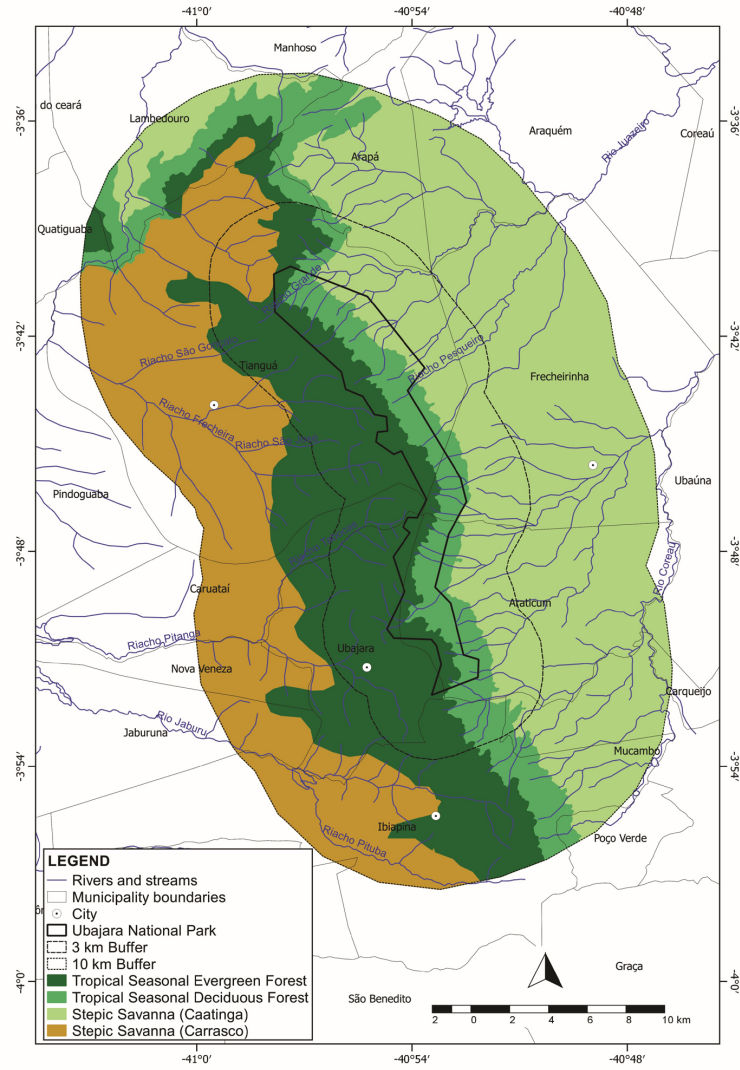


Figure 1. Vegetation of the Ubajara National Park in Ceara, Brazil.

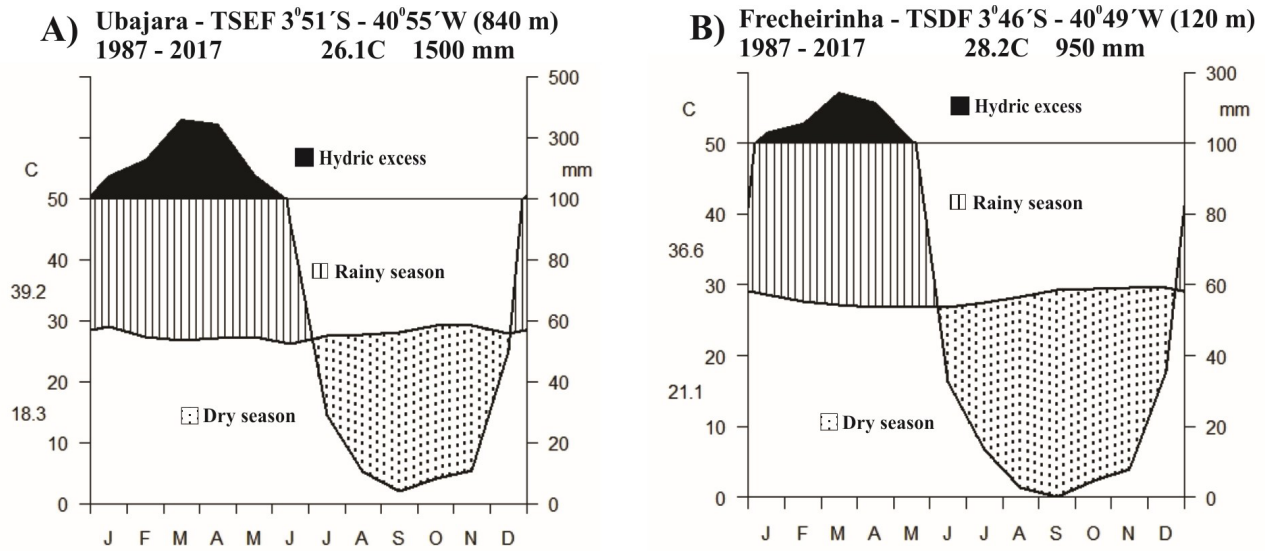


Figure 2. Walter & Lieth climatic diagrams for Vegetation of the Ubajara National Park, Ceara, Brazil. (A) Tropical Seasonal Deciduous Forest (TSDF); and (B) Tropical Seasonal Evergreen Forest (TSEF).

shallow and stony and could be classified as Dystrophic Regolith Neosol. The main headwaters of the Acaraú River basin are located inside the Ubajara National Park. Additionally, the rainfall of the eastern slope of Ibiapaba infiltrates into calcareous rocks and resurge in the lower altitudes. This water is used to irrigate agriculture and also for household use. However, both the headwaters and the resurgent water can deplete during the dry season of deforested area (inside or outside the park) during consecutive years of drought.

The TSEF area (above 700 m) exhibits average annual rainfall of 1,500 mm, concentrated from January to June, and an average temperature of 26.1 °C (Figure 2B). The soil was classified as deep Dystrophic Tb Haplic Cambisol (CXBd).

## 2.2. Data collection and analysis

During approximately six years, the team went through the main park trails and vegetation patches to collect samples of the flora. The first collection was made between 2011 and 2014, being part of the project “*Efetividade de UCs Federais do estado do Ceará na conservação biológica do semiárido brasileiro*” (CNPq/ICMBio 13/2011, N° 551998/2011-3). Additional samples were obtained between 2017 and 2018 during the project “*Conservação da biodiversidade em nível de paisagem: mudanças climáticas e distúrbios antropogênicos*” (CNPq/ICMBio/FAPs 18/2017, N° 421350/2017-2). Collections were also made in phytosociological and functional survey plots (unpublished data). Whenever possible, samples in reproductive state (with flowerbuds, flowers and/or fruits) were obtained. Vouchers were deposited in the Herbarium Prisco Bezerra (EAC) at the *Universidade Federal do Ceará* (UFC). The survey was complemented by gathering samples deposited by other researchers into the EAC collection.

The botanical determination was based on specialized literature, expert opinions and comparisons with other specimens from the EAC collection. The Angiosperm Phylogeny Group IV (APG IV, 2016) classification system was adopted. Names of the families, genera, species and authors names were confirmed on the International Plant Names Index (IPNI, 2019) and in the *Flora of Brazil 2020 under construction* website (JBRJ, 2019). The classification of exotic species was adopted, as suggested by Moro et al. (2012). It could be gathered data on family, species, vernacular name, main collector, plant formation, growth-form, flowering / fruiting period, fruit size, fruit type and dispersal syndrome only for native flora.

Classification of growth forms followed the *Instituto Brasileiro de Geografia e Estatística* (IBGE, 2012): tree – woody plants higher than 3 m; shrub – woody plants with the main branch up to 50 cm above the ground level and generally

shorter than 3 m; sub-shrub – plants with woody main stem and secondary herbaceous branches, generally having a height of less than 2 m; terrestrial herb – terrestrial plants with herbaceous aerial stem; epiphytic herb – plants with herbaceous stem which develop with another plant’s support; climbing plants – lianas or vine plants with elongated stems, that usually are supported by a substrate or epiphytes that rely on their phorophyte for support, and also hemiparasite – plants that use the resources of their host, but have chlorophyll and perform photosynthesis.

The reproductive phenophases data were compiled of exsiccates of the EAC. Fruit size information and diaspore dispersal syndromes were obtained from herbarium sheets whenever possible, and from the literature when not. Diaspores were classified in small, medium and large following the length/width ratio criterion, as proposed by Tabarelli & Peres (2002). The dispersal syndromes were classified as anemochorous, autochorous or zoochorous, followed by Van der Pijl (1982).

The number of species per growth form, dispersal syndromes and diaspore size were analyzed through frequency diagrams. Flowering and fruiting patterns throughout the year were analyzed through circular histograms made with ORIANA 4 software (Kovach, 2011), based on the percentage of species which were flowering and fruiting (there was data on flowering for 80% of the species and on fruiting for only 30%). The following parameters were calculated for the phenology evaluation (with months corresponding to 30° angles): mean angle ( $\mu$ ), representing the period of the year in which a particular phenophase occurred in most taxa; circular standard deviation (sd); Rayleigh (Z) test, which determines the significance of the mean angle; and vector ( $r$ ), which is a measure concentration around the mean angle. The null hypothesis on the (Z) test is that flowering and fruiting are distributed evenly throughout the year, and therefore there is no seasonality of each phenophase. The alternative hypothesis is that there is seasonality (if the mean angle is significant). The vector ( $r$ ) varies from 0 (when the phenological activity is evenly distributed throughout the year) to 1 (when the phenological activity is seasonal/concentrated in a period of the year).

## 3. Results and discussion

Were found 418 specific/sub-specific taxa (84 families; 274 genera) could be found, from which 335 were found in the TSEF, 53 in TSDF, and 30 in both vegetations. Due to the absence of flowers or fruits, from this total number of registered data, only 22 species were identified up to genus and four were only identified up to family (Appendix A). This floristic richness was higher than any other ever recorded in

montane forests of Brazilian semi-arid domain. According to the study of Nascimento et al. (2012), the researchers could find 293 species in *Planalto da Borborema* (Paraíba), nevertheless, Pereira et al. (2010) found 136 species in *Serra Negra* (Pernambuco), and Silva & Figueiredo (2013) only 100 species in *Serra da Meruoca* (Ceará). However, this disparity in the species richness of the Ubajara National Park may be due to the high number of terrestrial herbs recorded, in other words, 100 species that comprise 23.9% of the species; on the other hand, other studies did not indicate no more than 10% of herbs in the species richness. In addition, the other forests cited may have different areas and the respective surveys in each study may have different sampling effort, so the comparison may not be conclusive.

The families with the highest species richness were Fabaceae (64 spp.), Malvaceae (24 spp.), Asteraceae (20 spp.), Rubiaceae (18 spp.), Euphorbiaceae (16 spp.), Sapindaceae (14 spp.), Apocynaceae (13 spp.) and Myrtaceae (11 spp.). These data are in accordance to the same studies performed in other montane forests of the northeastern Brazil (Rodal & Nascimento, 2002; Nascimento et al., 2012; Silveira et al., 2019). All other families had 10 or less species each. The most numerous genera were *Erythroxylum* (9 spp.), *Passiflora* (7 spp.), *Croton* (7 spp.) and *Combretum* (6 spp.) – Appendix A.

In addition to the species listed in the Appendix A, 28 exotic species (26 genera, 17 families) could be cataloged – Appendix B. The families with greatest numbers of exotic species were Araceae (6 spp.), Apocynaceae and Amaryllidaceae (3 spp. each). These species are mostly ornamental and were planted on the park entrance and along the pathway to the cable car. Only five exotic species were found inside the park: *Cryptostegia madagascariensis* Bojer ex Decne., *Coffea arabica* L., *Artocarpus heterophyllus* Lam., *Mangifera indica* L. and *Bambusa* sp. In this case, the exotic species probably were present in the park before of its creation because it was a human occupied area. In the case of zoochorous plant species, exotic fruitful species may compete for the dispersers with native flora. Once the perpetuation of the native flora depends on both preservation and dispersal of diaspores (see Oliveira et al., 2017; Mattar et al., 2018), indigenous biodiversity may be somehow threatened.

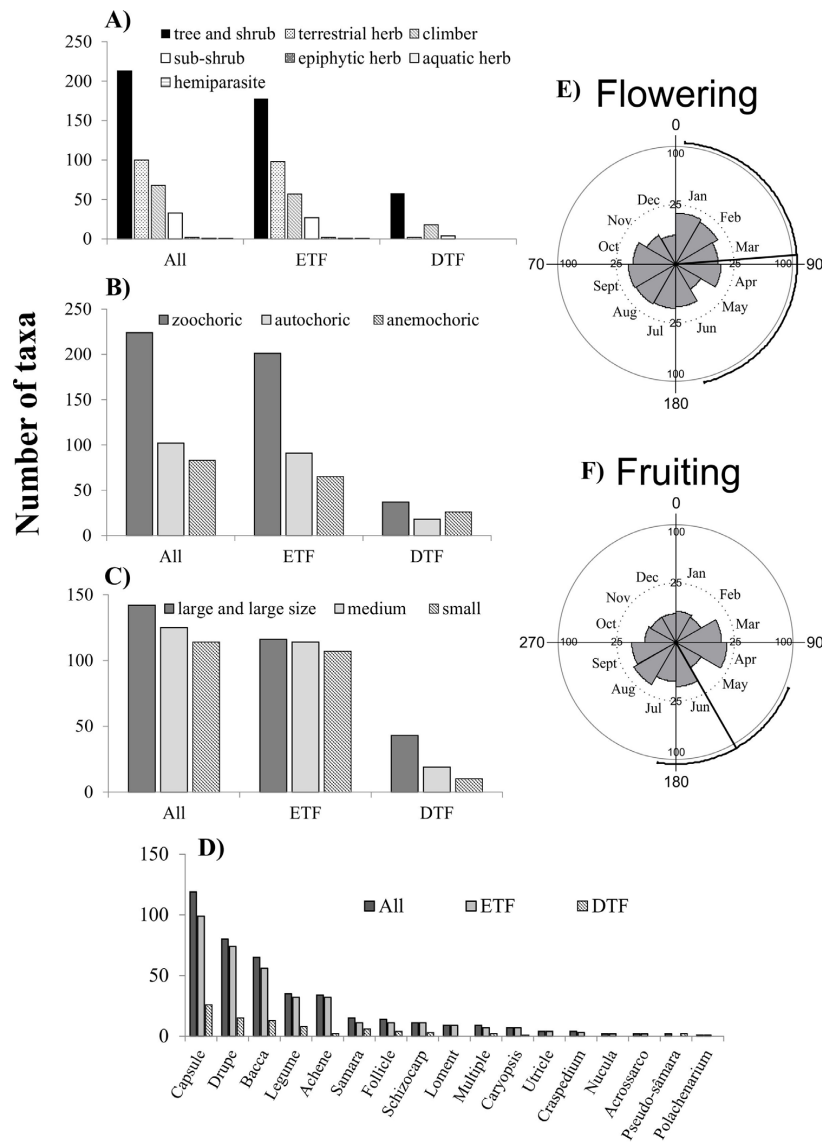
Regarding the growth form, considering only indigenous species, it could be recorded 213 trees and shrubs, 100 terrestrial herbs, 68 climbing, 33 sub-shrubs, two epiphytic herbs, one hemiparasite and one aquatic herb (Figure 3A). Forests usually have a low proportion of herb richness in comparison to trees and shrubs. One possible cause of the high proportion of herbs in the flora of the Ubajara National Park may be a consequence of the compilation of data from the herbarium

collection; while rainfall forest trees may exhibit supra-annual flowering/fruitletting patterns (see Pereira et al., 2008), herbs usually have annual patterns (increasing the chances of being incorporated to the herbarium – once EAC have not accepted vegetative samples in the last years). A complete floristic checklist for the Ubajara National Park will only be possible after a long-term phytosociological survey or reproductive phenodinic study on the future.

On spectrum of dispersal syndromes (Figure 3B), as expected, zoochory was predominant on the total flora (55%) and in the TSEF alone (201 species, 56%); while in the TSDF alone, the proportion of zoochory was lower (37 species, 46%). This predominance of zoochory in forests was found by Locatelli & Machado (2004) and by Diogo et al. (2016), showing that the Brazilian montane regions are important to preserve the richness of native species and available resource supply for local and migratory fauna. In both vegetations (TSEF and TSDF), the large and very large diaspores predominated, followed by medium and small ones (Figure 3C). The predominant type of fruit are capsule, drupe, bacca, legume, achene, samara, follicle and schizocarp (Figure 3D).

The Rayleigh test was only significant for fruit production (Figure 3F), seeing that this production is concentrated on June (in the end of the rainy season) with standard deviation from April to July ( $\mu = 150.334^\circ$ ,  $sd = 105.854^\circ$ ,  $Z = 4.215$ ,  $p = 0.02$ ,  $r = 0.181$ ). This fruiting peak in the beginning of the dry season seems to be an adaptation of plants from seasonal and dry climates, whose seeds have the following wet season to germinate and establish (Locatelli & Machado; 2004; Pau et al., 2011). On the other hand, the vectors  $r$  exhibited low results, indicating that the frequencies of the fruiting species are distributed evenly all year long. In addition, data on fruiting was available for only 30% of the species, so conclusions are not supported by these evidences. However, our results allowed generalizing that Ubajara National Park (as other montane forest from Northeast region of Brazil) offers resources for the fauna all year long.

Our results also showed that the Ubajara National Park has an important contribution to conservation of biodiversity, because the number of flowering plant species protected by this area is higher than those of other montane forests in Northeast region of Brazil (Carnaval et al., 2009; Homeier et al., 2010; Leite et al., 2016; Kamimura et al., 2017). The high diversity found in the Ubajara National Park may be attributed to its environmental heterogeneity, seeing that its topographic variation provides a range of different habitats, sheltering different vegetations and therefore a high floristic diversity.



**Figure 3.** Number of taxa of the Evergreen Tropical Forest (ETF) and the Deciduous Tropical Forest (DTF) of the Ubajara National Park-Ceara, Brazil: (A) growth form; (B) dispersal syndrome; (C) fruit size; (D) fruit types; (E) circular histogram of relative flowering frequency ( $\mu = 85.524^\circ$ ,  $sd = 167.128^\circ$ ,  $Z = 0.031$ ,  $p = 0.97$ ,  $r = 0.014$ ); and (F) circular histogram of relative fruiting frequency ( $\mu = 150.334^\circ$ ,  $sd = 105.854^\circ$ ,  $Z = 4.215$ ,  $p = 0.02$ ,  $r = 0.181$ ). The arrow shows the average date and its standard deviation.

#### 4. Conclusions

The Ubajara National Park exhibits a huge species richness and an outstanding floristic composition – which makes this protected area very important for preservation of the local biodiversity. Beside the preservation of the plant species, the diversity of phenological patterns, types of fruits and dispersal syndromes create a substantial resource supply for local fauna almost all year long.

These results derived from a long-term sampling effort – an unparalleled study in the whole Brazilian semi-arid region. They represent not only an important contribution for the knowledge

on the biodiversity of the semi-arid domain in northeast Brazil, but also a fundamental subside to the management of the park (including the formation of seed banks and seedlings production for restoration) and to further research on biodiversity, ecology, ethnobiology and effectiveness of protected areas.

Our results highlight the importance of studying the flora of the Brazilian protected areas. This is a fundamental step in assessing the effectiveness of protected areas in maintaining biodiversity.

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**Appendix A.** List of families and species of the Tropical Seasonal Deciduous Forest (TSDF) and the Tropical Seasonal Evergreen Forest (TSEF) of the Ubajara National Park in Ceará, Brazil, where x = presence of taxa.

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDF	TSEF	
<b>1. Acanthaceae</b>			
<i>Ruellia asperula</i> (Mart. ex Ness) Lindau		x	Fernandes, A. (EAC 27690)
<i>R. geminiflora</i> Kunth		x	Cavalcanti, F.S. 549
<b>2. Alstromeriaceae</b>			
<i>Bomarea edulis</i> (Tussac) Herb.		x	Loiola, M.I.B. 1591
<b>3. Amaranthaceae</b>			
<i>Alternanthera brasiliana</i> (L.) Kuntze		x	Castro, A.J. (EAC 6153)
<i>A. tenella</i> Colla		x	Loiola, M.I.B. 1528
<i>Cyathula achyranthoides</i> (Kunth) Moq.		x	Fernandes, A. (EAC 3973)
<i>Iresine diffusa</i> Humb. & Bonpl. ex Willd.		x	Fernandes, A. (EAC 5064)
<b>4. Amaryllidaceae</b>			
<i>Hippeastrum stylosum</i> Herb.		x	Cavalcanti, F.S. 595
<i>Zephyranthes cearensis</i> (Herb.) Baker		x	Cavalcanti, F.S. 594
<b>5. Anacardiaceae</b>			
<i>Astronium fraxinifolium</i> Schott	x		Fernandes, A. (EAC 15095)
<i>Myracrodruon urundeuva</i> Allemão	x		Matos (EAC 6897)
<i>Spondias mombin</i> L.	x		Freitas, B.
<i>Tapirira guianensis</i> Aubl.		x	Loiola, M.I.B. 1940
<i>Thyrsodium spruceanum</i> Benth.		x	Fernandes, A. (EAC 27839)
<b>6. Annonaceae</b>			
<i>Annona exsucca</i> DC.		x	Fernandes, A. (EAC 27751)
<i>A. leptopetala</i> (R.E.Fr.) H.Rainer		x	Fernandes, A. (EAC 8287)
<i>Annonaceae</i> sp1		x	Sterile material
<i>Guatteria pogonopus</i> Mart.		x	Loiola, M.I.B. 1939
<i>G. schomburgkiana</i> Mart.		x	Lima-Verde, L.W. 3542
<i>Guatteria</i> sp.		x	Sterile material
<i>Oxandra sessiliflora</i> R.E.Fr.		x	Loiola, M.I.B. 1489
<i>Xylopia</i> sp.	x		Sterile material
<b>7. Apiaceae</b>			
<i>Spananthe paniculata</i> Jacq.		x	Fernandes, A. (EAC 27943)
<b>8. Apocynaceae</b>			
<i>Aspidosperma pyriforme</i> Mart. & Zucc.	x		Loiola, M.I.B. 1872
<i>A. riedelii</i> subsp. <i>oliganthum</i> (Woodson) Marc.-Ferr.	x		Fernandes, A. (EAC 8895)
<i>A. subincanum</i> Mart.	x		Araújo, F.S. 699
<i>Forsteronia pubescens</i> A. DC.		x	Loiola, M.I.B. 2229
<i>Mandevilla hirsuta</i> (A.Rich.) K.Schum.		x	Fernandes, A. (EAC 27684)
<i>Mateleia denticulata</i> (Vahl) Fontella & E.A.Schwarz		x	Loiola, M.I.B. 1527
<i>Rauwolfia ligustrina</i> Willd.		x	Fernandes, A. (EAC 27923)
<i>R. paucifolia</i> A.DC.		x	Castro, A.S.J. 1377
<i>Schubertia grandiflora</i> Mart.		x	Fernandes, A. (EAC 27886)
<i>Tabernaemontana catharinensis</i> A.DC.		x	Fernandes, A. (EAC 3997)
<i>Apocynaceae</i> sp1		x	Sterile material
<i>Apocynaceae</i> sp2		x	Sterile material
<i>Apocynaceae</i> sp3		x	Sterile material
<b>9. Araceae</b>			
<i>Anthurium sinuatum</i> Benth. ex Schott		x	Fernandes, A. (EAC 27781)
<i>Caladium bicolor</i> (Aiton) Vent.		x	Fernandes, A. (EAC 28493)
<i>Monstera praetermissa</i> E.G.Gonç. & Temponi		x	Loiola, M.I.B. 1804
<i>Philodendron acutatum</i> Schott		x	Fernandes, A. (EAC 27815)
<i>P. ornatum</i> Schott		x	Fernandes, A. (EAC 28491)

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDF	TSEF	
<i>Spathicarpa gardneri</i> Schott		x	Andrade, I.M. (EAC 28492)
<i>Taccarum ulei</i> Engl. & K.Krause		x	Loiola, M.I.B. 2215
<b>10. Areaceae</b>			
<i>Acrocomia aculeata</i> (Jacq.) Lodd. ex Mart.		x	Observed
<i>Attalea speciosa</i> Mart. ex Spreng.		x	Balick, M.J. 1354
<b>11. Asteraceae</b>			
<i>Acanthospermum australe</i> (Loefl.) Kuntze		x	Fernandes, A. (EAC 2948)
<i>Acmella uliginosa</i> (Sw.) Cass.		x	Matias, L.Q. 677
<i>Ageratum conyzoides</i> L.		x	Fernandes, A. (EAC 3940)
<i>Aspilia andrade-limae</i> J.U.Santos		x	Fernandes, A. (EAC 5066)
<i>Blainvillea acmella</i> (L.) Philipson		x	Fernandes, A. (EAC 3937)
<i>Bidens cynapiifolia</i> Kunth		x	Castro, A.J. (EAC 6152)
<i>B. pilosa</i> L.		x	Fernandes, A. (EAC 16657)
<i>Brickellia diffusa</i> (Vahl) A.Gray		x	Fernandes, A. (EAC 4008)
<i>Centratherum punctatum</i> Camss.		x	Fernandes, A. (EAC 3993)
<i>Conocliniopsis prasiifolia</i> (DC.) R.M.King & H.Rob.		x	Fernandes, A. (EAC 3899)
<i>Elephantopus mollis</i> Kunth		x	Fernandes, A. (EAC 5083)
<i>Emilia fosbergii</i> Nicolson		x	Loiola, M.I.B. 1523
<i>E. sonchifolia</i> (L.) DC. ex Wight		x	Fernandes, A. (EAC 27850)
<i>Galinsoga parviflora</i> Cav.		x	Loiola, M.I.B. 1511
<i>Gymnanthemum amygdalinum</i> (Delile) Sch.Bip. ex Walp.		x	Fernandes, A. (EAC 27478)
<i>Lepidaploa salzmännii</i> (DC.) H.Rob.		x	Fernandes, A. (EAC 3887)
<i>Sphagneticola trilobata</i> (L.) Pruski		x	Alves M. 421
<i>Pseudogynoxys cabreræ</i> H.Rob. & Cuatrec		x	Loiola, M.I.B. 1506
<i>Trixis antimenorrhoea</i> (Schrank) Kuntze		x	Fernandes, A. (EAC 27768)
<i>Wedelia villosa</i> Gardner		x	Fernandes, A. (EAC 27803)
<b>12. Begoniaceae</b>			
<i>Begonia reniformis</i> Dryand.		x	Fernandes, A. (EAC 3983)
<i>B. saxicola</i> A.DC.		x	Fernandes, A. (EAC 27773)
<b>13. Bignoniaceae</b>			
<i>Anemopaegma citrinum</i> Mart. ex DC.		x	Andrade, I.M. (EAC 28494)
<i>Bignonia</i> sp.		x	Fernandes, A. (EAC 27788)
<i>Dolichandra unguis-cati</i> (L.) L.G.Lohmann		x	Fernandes, A. (EAC 27948)
<i>Fridericia dispar</i> (Bureau ex K.Schum.) L.G.Lohmann	x		Loiola, M.I.B. 1837
<i>F. platyphylla</i> (Cham.) L.G.Lohmann	x		Sterile material
<i>F. triplinervea</i> (Mart. ex DC.) L.G.Lohmann	x		Sterile material
<i>Handroanthus impetiginosus</i> (Mart. ex DC.) Mattos	x	x	Sterile material
<i>H. serratifolium</i> (A.H.Genter) S. Grose	x	x	Sterile material
<i>Zeyheria tuberculosa</i> (Vell.) Bureau ex Verl.		x	Fernandes, A. (EAC 27955)
<b>14. Bixaceae</b>			
<i>Cochlospermum vitifolium</i> (Willd.) Spreng.	x		Sterile material
<b>15. Boraginaceae</b>			
<i>Cordia bicolor</i> A.DC.		x	Loiola, M.I.B. 1919
<i>C. rufescens</i> A.DC.		x	Sterile material
<i>C. toqueve</i> Aubl.	x	x	Fernandes, A. (EAC 27816)
<i>C. trichotoma</i> (Vell.) Arráb. ex Steud.		x	Loiola, M.I.B. 1820
<i>Euploca procumbens</i> (Mill.) Diane & Hilger		x	Fernandes, A. (EAC 27855)
<i>Tournefortia membranacea</i> (Gardner) DC.		x	Fernandes, A. (EAC 27761)
<i>Varronia leucomaloides</i> (Taroda) J.S.Mill.		x	Fernandes, A. (EAC 8282)
<i>V. polycephala</i> Lam.		x	Soares Neto, R.L. 34
<b>16. Burseraceae</b>			
<i>Protium heptaphyllum</i> (Aubl.) Marchand		x	Loiola, M.I.B. 1922

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDF	TSEF	
<i>P. warmingianum</i> Marchand		x	Mata, M.F. (EAC 15587)
<b>17. Cactaceae</b>			
<i>Cereus jamacaru</i> DC.	x		Observed
<i>Epiphyllum phyllanthus</i> (L.) Haw.		x	Loiola, M.I.B. 2202
<b>18. Campanulaceae</b>			
<i>Centropogon cornutus</i> (L.) Druce		x	Fernandes, A. (EAC 5090)
<b>19. Cannabaceae</b>			
<i>Celtis brasiliensis</i> (Gardner) Planch.		x	Fernandes, A. (EAC 27793)
<i>C. iguanaea</i> (Jacq.) Sarg.		x	Loiola, M.I.B. 1822
<i>Trema micrantha</i> (L.) Blume		x	Nunes, E. (EAC 27875)
<b>20. Capparaceae</b>			
<i>Cynophalla flexuosa</i> (L.) J. Presl	x		Fernandes, A. (EAC 27673)
<i>C. hastata</i> (Jacq.) J.Presl		x	Fernandes, A. (EAC 27991)
<b>21. Chrysobalanaceae</b>			
<i>Hirtella glandulosa</i> Spreng.		x	Fernandes, A. (EAC 3970)
<b>22. Clusiaceae</b>			
<i>Clusia pana-panari</i> (Aubl.) Choisy		x	Fernandes, A. (EAC 27766)
<b>23. Combretaceae</b>			
<i>Buchenavia tetraphylla</i> (Aubl.) R.A.Howard.		x	Fernandes, A. (EAC 27750)
<i>Combretum duarteanum</i> Cambess.		x	Fernandes, A. (EAC 4002)
<i>C. fruticosum</i> (Loefl.) Stuntz	x		Loiola, M.I.B. 1845
<i>C. glaucocarpum</i> Mart.	x	x	Loiola, M.I.B. 2219
<i>C. lanceolatum</i> Pohl ex Eichler		x	Loiola, M.I.B. (EAC 53995)
<i>C. laxum</i> Jacq.		x	Cavalcanti, F.S. 551
<i>C. leprosum</i> Mart.	x	x	Nunes, E. (EAC 27829)
<b>24. Commelinaceae</b>			
<i>Dichorisandra hexandra</i> (Aubl.) Kuntze ex Hand-Mazz.		x	Loiola, M.I.B. 2273
<i>Floscopa glabrata</i> (Kunth) Hassk.		x	Cavalcanti, F.S. 550
<b>25. Convolvulaceae</b>			
<i>Distimake macrocalyx</i> (Ruiz & Pav.) A.R. Simões & Staples		x	Fernandes, A. (EAC 27495)
<i>Ipomoea alba</i> L.	x	x	Cavalcanti, F.S. (EAC 28459)
<i>I. blanchetii</i> Choisy		x	Fernandes, A. (EAC 27907)
<i>I. brasiliana</i> (Choisy) Meisn.	x		Araújo, F.S. 602
<i>I. marcellia</i> Meisn.	x		Sterile material
<i>Merremia umbellata</i> (L.) Hallier f.		x	Observed
<b>26. Cucurbitaceae</b>			
<i>Cayaponia tayuya</i> (Vell.) Cogn.	x	x	Cavalcanti, F.S. 554
<i>Psiguria ternata</i> (M.Roem.) C.Jeffrey		x	Loiola, M.I.B. 2263
<i>P. umbrosa</i> (Kunth) C.Jeffrey		x	Fernandes, A. (EAC 27884)
<i>Rytidostylis amazonica</i> (Mart. ex Cogn.) Kuntze		x	Loiola, M.I.B. 2244
<b>27. Cyperaceae</b>			
<i>Cyperus laxus</i> Lam.		x	Loiola, M.I.B. 1545
<i>C. odoratus</i> L.		x	Loiola, M.I.B. 1790
<i>C. simplex</i> Kunth		x	Loiola, M.I.B. 1797
<i>Fuirena umbellata</i> Rottb.		x	Fernandes, A. (EAC 5073)
<i>Rhynchospora corymbosa</i> (L.) Britton		x	Fernandes, A. (EAC 27882)
<i>Scleria latifolia</i> Sw.		x	Fernandes, A. (EAC 3978)
<i>S. secans</i> (L.) Urb.		x	Loiola, M.I.B. 1490
<b>28. Dilleniaceae</b>			
<i>Doliocarpus dentatus</i> (Aubl.) Standl.		x	Cavalcanti, F.S. (EAC 28474)

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDf	TSEf	
<b>29. Dioscoreaceae</b>			
<i>Dioscorea dodecaneura</i> Vell.		x	Sterile material
<i>D. hassleriana</i> Chodat		x	Fernandes, A. (EAC 28016)
<i>D. multiflora</i> Mart. ex Griseb		x	Loiola, M.I.B. 1547
<i>D. orthogoneura</i> Uline ex Hochr.		x	Fernandes, A. (EAC 5003)
<i>D. piperifolia</i> Humb. & Bonpl. ex Willd.		x	Fernandes, A. (EAC 8239)
<b>30. Ebenaceae</b>			
<i>Diospyros inconstans</i> subsp. <i>obovata</i> (Mart. ex Miq.) B.Walln.		x	Fernandes, A. (EAC 5096)
<i>D. sericea</i> A.DC.		x	Fernandes, A. (EAC 27869)
<b>31. Elaeocarpaceae</b>			
<i>Sloanea obtusa</i> (Splitg.) Schum.		x	Fernandes, A. (EAC 8264)
<b>32. Erythroxylaceae</b>			
<i>Erythroxylum barbatum</i> O.E.Schulz	x	x	Fernandes, A. (EAC 27852)
<i>E. citrifolium</i> A.St.-Hil.		x	Loiola, M.I.B. 1778
<i>E. deciduum</i> A.St.-Hil.		x	Loiola, M.I.B. 2231
<i>E. laetevirens</i> O.E.Schulz		x	Araújo, F.S. 827
<i>E. mucronatum</i> Benth.		x	Loiola, M.I.B. 2255
<i>E. pulchrum</i> A.St.-Hil.		x	Castro, A.S.F. 1378
<i>E. simonis</i> Plowman		x	Loiola, M.I.B. 2211
<i>E. subglaucescens</i> Peyr.	x		Fernandes, A. (EAC 27910)
<i>E. subrotundum</i> A.St.-Hil.		x	Costa-Lima, J.L. 2263
<b>33. Euphorbiaceae</b>			
<i>Acalypha poiretii</i> Spreng.	x		Fernandes, A. (EAC 27936)
<i>A. villosa</i> Jacq.	x		Nunes, E. (EAC 27830)
<i>Cnidocolus urens</i> (L.) Arthur	x		Fernandes, A. (EAC 27716)
<i>Croton adenocalyx</i> Baill.		x	Nunes, E. (EAC 27876)
<i>C. betaceus</i> Baill.	x		Loiola, M.I.B. 2180
<i>C. blanchetianus</i> Baill.		x	Loiola, M.I.B. 2183
<i>C. floribundus</i> Spreng.		x	Fernandes, A. (EAC 27925)
<i>C. hirtus</i> L'Hér.	x		Fernandes, A. (EAC 27927)
<i>C. jacobinensis</i> Baill.		x	Loiola, M.I.B. 2214
<i>C. triqueter</i> Lam.		x	Loiola, M.I.B. 2200
<i>Dalechampia pernambucensis</i> Baill.		x	Fernandes, A. (EAC 27952)
<i>D. tiliifolia</i> Lam.		x	Fernandes, A. (EAC 15081)
<i>Joannesia princeps</i> Vell.		x	Loiola, M.I.B. 2233
<i>Margaritaria nobilis</i> L.f.		x	Loiola, M.I.B. 1590
<i>Microstachys corniculata</i> (Vahl) Griseb.		x	Fernandes, A. (EAC 27935)
<i>Tragia cearensis</i> Pax & K.Hoffm.		x	Loiola, M.I.B. 1475
<b>34. Fabaceae</b>			
<i>Aeschynomene paniculata</i> Willd. ex Vogel		x	Fernandes, A. (EAC 8241)
<i>A. sensitiva</i> Sw.		x	Fernandes, A. (EAC 3949)
<i>Albizia polycephala</i> (Benth.) Killip ex Record		x	Loiola, M.I.B. 1938
<i>Anadenanthera colubrina</i> var. <i>cebil</i> (Griseb.) Altschul	x	x	Fernandes, A. (EAC 27782)
<i>Ancistrotropis peduncularis</i> (Kunth) A.Delgado		x	Fernandes, A. (EAC 3930)
<i>Andira vermifuga</i> Mart. ex Benth.		x	Fernandes, A. (EAC 7947)
<i>Apuleia leiocarpa</i> (Vogel) J.F.Macbr.		x	Fernandes, A. (EAC 4094)
<i>Ateleia guaraya</i> Herzog		x	Fernandes, A. (EAC 3957)
<i>Bauhinia pulchella</i> Benth.	x	x	Loiola, M.I.B. 1978
<i>B. unguolata</i> L. var. <i>ungulata</i>	x		Loiola, M.I.B. 1947
<i>Bowdichia virgilioides</i> Kunth		x	Fernandes, A. (EAC 3936)
<i>Calopogonium mucunoides</i> Desv.		x	Fernandes, A. (EAC 4012)

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDf	TSEf	
<i>C. velutinum</i> (Benth.) Amshoff		x	Fernandes, A. (EAC 27497)
<i>Canavalia grandiflora</i> Benth.		x	Loiola, M.I.B. 1935
<i>Cassia ferruginea</i> (Schrad.) Schrad. ex DC.		x	Loiola, M.I.B. 2234
<i>Centrosema brasilianum</i> (L.) Benth. var. <i>brasilianum</i>		x	Fernandes, A. (EAC 3929)
<i>C. sagittatum</i> (Humb. & Bonpl. Ex Willd.) Brandegee		x	Loiola, M.I.B. 1486
<i>Chamaecrista duckeana</i> (P.Bezerra & Afr.Fern.) H.S.Irwin & Barneby		x	Fernandes, A. (EAC 27853)
<i>Chamaecrista rotundifolia</i> (Pers.) Greene		x	Fernandes, A. (EAC 27990)
<i>Copaifera duckei</i> Dwyer		x	Loiola, M.I.B. 1895
<i>Crotalaria incana</i> L.		x	Fernandes, A. (EAC 3964)
<i>C. retusa</i> L.		x	Fernandes, A. (EAC 3984)
<i>C. stipularia</i> Desv.		x	Fernandes, A. (EAC 3948)
<i>Dalbergia cearensis</i> Ducke	x		Fernandes, A. (EAC 3935)
<i>Deguelia nitidula</i> (Benth.) A.M.G.Azevedo & R.A. Camargo	x	x	Araújo, F.S. (UEC 96442)
<i>Desmodium axillare</i> (Sw.) DC.		x	Loiola, M.I.B. 1488
<i>D. barbatum</i> (L.) Benth.		x	Fernandes, A. (EAC 3913)
<i>D. distortum</i> (Aubl.) J.F.Macbr.		x	Fernandes, A. (EAC 3900)
<i>D. incanum</i> (Sw.) DC.		x	Fernandes, A. (EAC 27749)
<i>D. uncinatum</i> (Jacq.) DC.		x	Fernandes, A. (EAC 3934)
<i>Dioclea megacarpa</i> Rolfe	x		Loiola, M.I.B. 1864
<i>D. sclerocarpa</i> Ducke		x	Loiola, M.I.B. 1805
<i>D. virgata</i> (Rich.) Amshoff		x	Cavalcanti, F.S. 560
<i>Galactia striata</i> (Jacq.) Urb.		x	Fernandes, A. (EAC 4009)
<i>Hymenaea coubaril</i> L.		x	Loiola, M.I.B. 1926
<i>Indigofera suffruticosa</i> Mill.		x	Cavalcanti, F.S. (EAC 28463)
<i>Inga alba</i> (Sw.) Willd.		x	Loiola, M.I.B. 1921
<i>I. ingoides</i> (Rich.) Willd.		x	Loiola, M.I.B. 1829
<i>Libidibia ferrea</i> (Mart. ex Tul.) L.P.Queiroz var. <i>ferrea</i>	x	x	Loiola, M.I.B. 1846
<i>Machaerium acutifolium</i> Vogel	x	x	Cavalcanti, F.S. 534
<i>M. amplum</i> Benth.		x	Loiola, M.I.B. 1827
<i>M. hirtum</i> (Vell.) Stellfeld		x	Loiola, M.I.B. 1930
<i>Mimosa caesalpinifolia</i> Benth.	x		Loiola, M.I.B. 2191
<i>M. candollei</i> R. Grether		x	Fernandes, A. (EAC 27893)
<i>M. paraibana</i> Barneby		x	Fernandes, A. (EAC 3962)
<i>M. xanthocentra</i> Mart.		x	Fernandes, A. (EAC 3908)
<i>Mucuna sloanei</i> Fawc. & Rendle		x	Loiola, M.I.B. (EAC 52593)
<i>Myroxylon peruiferum</i> L.f.		x	Fernandes, A. (EAC 10788)
<i>Ormosia arborea</i> (Vell.) Harms		x	Fernandes, A. (EAC 27778)
<i>Periandra coccinea</i> (Schrad.) Benth.	x	x	Loiola, M.I.B. 1815
<i>Phanera glabra</i> (Jacq.) Vaz		x	Loiola, M.I.B. 1928
<i>P. outimouta</i> (Aubl.) L.P.Queiroz		x	Andrade, M. (EAC 28711)
<i>Pterocarpus</i> sp.	x		Sterile material
<i>Pterogyne nitens</i> Tul.		x	Fernandes, A. (EAC 3938)
<i>Rhynchosia phaseoloides</i> (Sw.) DC.		x	Fernandes, A. (EAC 15585)
<i>Senegalia polyphylla</i> (DC.) Britton & Rose	x	x	Loiola, M.I.B. 1931
<i>S. tenuifolia</i> (L.) Britton & Rose		x	Loiola, M.I.B. 1544
<i>Senna pendula</i> var. <i>dolichandra</i> H.S.Irwin & Barneby		x	Fernandes, A. (EAC 3906)
<i>S. obtusifolia</i> (L.) H.S.Irwin & Barneby	x		Fernandes, A. (EAC 27921)
<i>S. pilifera</i> (Vogel) H.S.Irwin & Barneby		x	Fernandes, A. (EAC 4000)
<i>S. rizzinii</i> H.S.Irwin & Barneby		x	Cavalcanti, F.S. 539
<i>Stryphnodendron guianense</i> (Aubl.) Benth.		x	Loiola, M.I.B. 1936

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDf	TSEf	
<i>Stylosanthes capitata</i> Vogel		x	Fernandes, A. (EAC 3958)
<i>S. scabra</i> Vogel		x	Fernandes, A. (EAC 3965)
<b>35. Gesneriaceae</b>			
<i>Drymonia serrulata</i> (Jacq.) Mart.		x	Castro, A.S.F. (EAC 24892)
<i>Sinningia nordestina</i> Chautems, Baracho & Siqueira-Filho		x	Loiola, M.I.B. 1812
<i>Sphaerorrhiza sarmentiana</i> (Gardner ex Hook) Roalson & Boggan		x	Fernandes et al. (EAC 28014)
<b>36. Heliconiaceae</b>			
<i>Heliconia psittacorum</i> L.f.		x	Loiola, M.I.B. 1780
<i>H. spathocircinata</i> Aristeg.		x	Fernandes, A. (EAC 3971)
<b>37. Hernandiaceae</b>			
<i>Sparattanthelium botocudorum</i> Mart.		x	Loiola, M.I.B. 2242
<b>38. Hypericaceae</b>			
<i>Vismia guianensis</i> (Aubl.) Choisy		x	Fernandes, A. (EAC 27762)
<b>39. Iridaceae</b>			
<i>Eleutherine bulbosa</i> (Mill.) Urb.		x	Nunes, E. (EAC 27872)
<b>40. Lamiaceae</b>			
<i>Hyptis atrorubens</i> Poit.		x	Fernandes, A. (EAC 3967)
<i>Cantinoa mutabilis</i> (Rich.) Harley & J.F.B. Pastore		x	Fernandes, A. (EAC 3979)
<i>Marsypianthes chamaedrys</i> (Vahl) Kuntze		x	Fernandes, A. (EAC 27890)
<i>Ocimum gratissimum</i> L.		x	Fernandes, A. (EAC 3992)
<i>Vitex pashiniana</i> Moldenke		x	Fernandes, A. (EAC 14839)
<b>41. Lauraceae</b>			
<i>Aiouea saligna</i> Meissn.		x	Sterile material
<i>Ocotea glomerata</i> (Nees) Mez		x	Fernandes, A. (EAC 28013)
<i>Ocotea</i> sp.		x	Sterile material
<b>42. Lythraceae</b>			
<i>Cuphea impatientifolia</i> A. St.-Hil.	x		Fernandes, A. (EAC 27912)
<b>43. Loganiaceae</b>			
<i>Strychnos</i> sp.	x		Sterile material
<b>44. Malpighiaceae</b>			
<i>Banisteriopsis stellaris</i> (Griseb.) B. Gates	x		Sterile material
<i>Bunchosia pernambucana</i> W.R.Anderson		x	Fernandes, A. (EAC 27801)
<i>Byrsonima crispa</i> A.Juss.		x	Loiola, M.I.B. 1933
<i>B. sericea</i> DC.		x	Fernandes, A. (EAC 3914)
<i>Byrsonima</i> sp.		x	Sterile material
<i>Diplopterys pubipetala</i> (A.Juss.) W.R. Anderson & C. Davis		x	Fernandes, A. (EAC 27736)
<i>Heteropterys coeloptera</i> A.Juss.	x		Sterile material
<i>H. macrodena</i> (DC.) W.R.Anderson	x	x	Fernandes, A. (EAC 7940)
<i>Janusia anisandra</i> (A.Juss.) Griseb	x		Sterile material
<b>45. Malvaceae</b>			
<i>Apeiba tibourbou</i> Aubl.		x	Loiola, M.I.B. 2224
<i>Briquetiastrum spicatum</i> (Kunth) Bovini		x	Fernandes, A. (EAC 4007)
<i>Byttneria catalpifolia</i> Jacq.		x	Loiola, M.I.B. 2265
<i>Callianthe bezerrae</i> (Monteiro) Donnel		x	Fernandes, A. (EAC 31063)
<i>Ceiba glaziovii</i> (Kuntze) K. Schum.	x		Observed
<i>Guazuma ulmifolia</i> Lam.	x	x	Loiola, M.I.B. 1542
<i>Helicteres heptandra</i> L.B.Sm.	x	x	Loiola, M.I.B. 2220
<i>Luehea</i> sp.	x		Sterile material
<i>Melochia nodiflora</i> Sw.		x	Fernandes, A. (EAC 4003)
<i>Pavonia cancellata</i> (L.) Cav.		x	Lima-Verde, L.W. 2390

## Appendix A. Continued..

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDf	TSEf	
<i>P. malacophylla</i> (Link & Otto) Garcke		x	Loiola, M.I.B. 1929
<i>Peltaea trinervis</i> (C.Presl) Krapov. & Cristóbal		x	Fernandes, A. (EAC 5074)
<i>Pseudobombax marginatum</i> (A.St.-Hil., Juss. & Cambess.) A. Robyns	x		Sterile material
<i>Sida acuta</i> Burm.f.	x		Fernandes, A. (EAC 27937)
<i>Sida cordifolia</i> L.		x	Fernandes, A. (EAC 27693)
<i>S. glutinosa</i> Comm. ex Cav.		x	Fernandes, A. (EAC 4195)
<i>S. rhombifolia</i> L.		x	Fernandes, A. (EAC 27894)
<i>S. urens</i> L.		x	Mata, M.F. (EAC 15599)
<i>Sidastrum micranthum</i> (A.St.-Hil.) Fryxell		x	Fernandes, A. (EAC 5091)
<i>Sterculia striata</i> A.St.-Hil. & Naudin	x		Sterile material
<i>Triumfetta semitriloba</i> Jacq.		x	Cavalcanti, F.S. 556
<i>Urena lobata</i> L.		x	Fernandes, A. (EAC 27821)
<i>Waltheria viscosissima</i> A.St.-Hil.		x	Fernandes, A. (EAC 4004)
<i>Wissadula periplocifolia</i> (L.) C.Presl. ex Thwaites		x	Fernandes, A. (EAC 2750)
<b>46. Marantaceae</b>			
<i>Goepertia effusa</i> Saka & Lombradi		x	Fernandes, A. (EAC 27840)
<i>G. squarros</i> (Anderss. & Kennedy) Borchs. & S.Suárez		x	Fernandes et al. (EAC 27920)
<i>Maranta protracta</i> Miq.		x	Fernandes, A. (EAC 27774)
<b>47. Melastomataceae</b>			
<i>Acisanthera variabilis</i> (Mart. & Schrank) Triana.		x	Fernandes, A. (EAC 27755)
<i>Clidemia biserrata</i> DC.		x	Loiola, M.I.B. 1491
<i>C. debilis</i> Crueg.		x	Castro, A.S.F. 154
<i>C. hirta</i> (L.) D.Don		x	Fernandes, A. (EAC 27866)
<i>Miconia minutiflora</i> (Bonpl.) DC.		x	Cavalcanti, F.S. (EAC 28472)
<i>M. nervosa</i> (Sm.) Triana		x	Fernandes, A. (EAC 27834)
<i>M. prasina</i> (Sw.) DC.		x	Fernandes, A. (EAC 8211)
<b>48. Meliaceae</b>			
<i>Cedrela odorata</i> L.		x	Matos (EAC 6897)
<i>Guarea macrophylla</i> subsp. <i>tuberculata</i> (Vell.) T.D.Penn.		x	Fernandes, A. (EAC 27775)
<i>Trichilia hirta</i> L.		x	Fernandes, A. (EAC 5009)
<b>49. Molluginaceae</b>			
<i>Mollugo verticillata</i> L.		x	Fernandes, A. (EAC 27823)
<b>50. Moraceae</b>			
<i>Brosimum gaudichaudii</i> Trécul	x	x	Fernandes, A. (EAC 27739)
<i>Ficus broadwayi</i> Urb.		x	Loiola, M.I.B. 1543
<i>Maclura tinctoria</i> (L.) D.Don ex Steud.		x	Fernandes, A. (EAC 27838)
<b>51. Myrsinaceae</b>			
<i>Myrsineguianensis</i> (Aubl.) Kuntze		x	Fernandes, A. (EAC 27857)
<b>52. Myrtaceae</b>			
<i>Campomanesia aromatica</i> (Aubl.) Griseb.		x	Fernandes et al. (EAC 27806)
<i>Eugenia supraaxilaris</i> Spring	x		Sterile material
<i>E. dysenterica</i> DC.	x		Sterile material
<i>E. flavescens</i> DC.	x		Sterile material
<i>E. florida</i> DC.		x	Fernandes, A. (EAC 28012)
<i>E. pachnantha</i> O.Berg		x	Fernandes, A. (EAC 4011)
<i>Eugenia</i> sp.	x		Sterile material
<i>Myrcia multiflora</i> (Lam.) DC		x	Sterile material
<i>Myrcia</i> sp.1		x	Fernandes, A. (EAC 27800)
<i>Myrcia</i> sp.2		x	Sterile material
<i>Psidium</i> sp.		x	Fernandes, A. (EAC 27502)
<b>53. Nyctaginaceae</b>			

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSEF	TSEF	
<i>Guapira graciliflora</i> (Mart. ex Schmidt) Lundell		x	Fernandes, A. et al. (EAC 28018)
<i>G. opposita</i> (Vell.) Reitz	x		Sterile material
<b>54. Ochnaceae</b>			
<i>Ouratea salicifolia</i> (A.St.-Hil. & Tul.) Engl.		x	Fernandes, A. (EAC 5010)
<i>Sauvagesia erecta</i> L.		x	Fernandes, A. (EAC 27776)
<b>55. Olacaceae</b>			
<i>Cathedra rubricaulis</i> Miers		x	Fernandes, A. (EAC 5025)
<b>56. Opiliaceae</b>			
<i>Agonandra brasiliensis</i> Miers ex Benth. & Hook.f.	x	x	Fernandes, A. (EAC 27758)
<b>57. Orchidaceae</b>			
<i>Oeceoclades maculata</i> (Lind.) Lindl.		x	Loiola, M.I.B. 1538
<i>Polystachya concreta</i> (Jacq.) Garay & Sweet		x	Fernandes, A. (EAC 27905)
<b>58. Oxalidaceae</b>			
<i>Oxalis alstonii</i> Lourteig		x	Loiola, M.I.B. 2197
<i>O. cratensis</i> Oliv. ex Hook.		x	Loiola, M.I.B. 1496
<i>O. grisea</i> A.St.-Hil. & Naudin		x	Loiola, M.I.B. 1539
<i>O. triangularis</i> A.St.-Hil.		x	Loiola, M.I.B. 1507
<b>59. Passifloraceae</b>			
<i>Passiflora cincinnata</i> Mast.		x	Fernandes, A. (EAC 27757)
<i>P. glandulosa</i> Cav.		x	Castro, A.S.F. 1653
<i>P. laurifolia</i> L.		x	Fernandes, A. (EAC 27825)
<i>P. misera</i> Kunth		x	Sterile material
<i>P. suberosa</i> L.		x	Sterile material
<i>P. tricuspis</i> Mast.		x	Sterile material
<i>Passiflora</i> sp.		x	Sterile material
<b>60. Phyllanthaceae</b>			
<i>Phyllanthus subermarginatus</i> Mull.Arg.		x	Castro, A.S.F. 1654
<i>P. tenellus</i> Roxb.		x	Loiola, M.I.B. 1498
<b>61. Phytolaccaceae</b>			
<i>Gallesia integrifolia</i> (Spreng.) Harms		x	Fernandes, A. (EAC 8668)
<i>Microtea glochidiata</i> Moq.		x	Fernandes, A. (EAC 27859)
<b>62. Piperaceae</b>			
<i>Peperomia circinnata</i> Link		x	Loiola, M.I.B. 1844
<i>Piper arboreum</i> Aubl.	x	x	Fernandes, A. (EAC 27753)
<i>P. caldense</i> C.DC.		x	Fernandes, A. (EAC 27727)
<i>P. divaricatum</i> G.Mey.		x	Fernandes, A. (EAC 27939)
<i>P. hispidum</i> Sw.		x	Fernandes, A. (EAC 27731)
<i>P. tuberculatum</i> Jacq.		x	Cavalcanti, F.S. (EAC 28461)
<b>63. Plantaginaceae</b>			
<i>Scoparia dulcis</i> L.		x	Loiola, M.I.B. 1526
<b>64. Plumbaginaceae</b>			
<i>Plumbago scandens</i> L.		x	Cavalcanti, F.S. (EAC 28466)
<b>65. Poaceae</b>			
<i>Homolepis isocalycia</i> (G.Mey.) Chase		x	Fernandes, A. (EAC 28221)
<i>Lasiacis ligulata</i> Hitchc. & Chase		x	Fernandes, A. (EAC 3912)
<i>Megathyrsus maximus</i> (Jacq.) B.K.Simon & S.W.L.Jacobs		x	Fernandes, A. (EAC 27804)
<i>Olyra latifolia</i> L.		x	Fernandes, A. (EAC 27895)
<i>Oplismenus hirtellus</i> (L.) P.Beauv.		x	Loiola, M.I.B. 1796
<i>Panicum millegrana</i> Poir.		x	Fernandes, A. (EAC 4225)
<i>Setaria adhaerens</i> (Forssk.) Chiov.		x	Fernandes, A. (EAC 27911)
<b>66. Podostemaceae</b>			
<i>Apinagia gardneriana</i> Tul.		x	Fernandes, A. (EAC 8671)



## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDF	TSEF	
<b>67. Polygalaceae</b>			
<i>Bredemeyera brevifolia</i> (Benth.) Klotzsch ex A.W.Benn.		x	Bezerra, P. (EAC 5095)
<i>Bredemeyera floribunda</i> Willd.		x	Fernandes, A. (EAC 3890)
<i>Polygala</i> sp.		x	Martins, P. (EAC 8238)
<b>68. Polygonaceae</b>			
<i>Coccoloba mollis</i> Casar		x	Loiola, M.I.B. 1924
<i>Triplaris gardneriana</i> Wedd.	x		Loiola, M.I.B. 2059
<b>69. Portulacaceae</b>			
<i>Talinum triangulare</i> (Jacq.) Willd.		x	Fernandes, A. (EAC 27950)
<b>70. Ranunculaceae</b>			
<i>Clematis affine</i> A.St.-Hil.		x	Fernandes, A.P. (EAC 15141)
<b>71. Rhamnaceae</b>			
<i>Gouania virgata</i> Reissek	x	x	Loiola, M.I.B. 1546
<i>Ziziphus undulata</i> Reissek	x		Fernandes, A. (EAC 27499)
<b>72. Rubiaceae</b>			
<i>Bertiera guianensis</i> Aubl.		x	Loiola, M.I.B. 1480
<i>Borreria verticillata</i> (L.) G.Mey.		x	E.B. Souza
<i>Chomelia pohliana</i> Müll.Arg.		x	Brandão, E.K.S. 56
<i>Coussarea hydrangeifolia</i> (Benth.) Müll.Arg.		x	Souza, E.B. 2042
<i>Coutarea hexandra</i> (Jacq.) K. Schum.		x	Sterile material
<i>Geophila repens</i> (L.) I.M.Johnst.		x	Loiola, M.I.B. 1786
<i>Guettarda viburnoides</i> Cham. & Schtdl.	x	x	Loiola, M.I.B. 2205
<i>Ixora brevifolia</i> Benth.		x	Fernandes, A. (EAC 3943)
<i>Palicourea marcgravii</i> A.St.-Hil.		x	Loiola, M.I.B. 1479
<i>Psychotria bahiensis</i> DC.		x	Loiola, M.I.B. 1478
<i>P. capitata</i> Ruiz & Pav.		x	Loiola, M.I.B. 1783
<i>P. carthagenensis</i> Jacq.		x	Loiola, M.I.B. 1789
<i>P. colorata</i> (Willd. ex Schult.) Müll.Arg.		x	Loiola, M.I.B. 1482
<i>P. deflexa</i> DC.		x	Loiola, M.I.B. 1781
<i>Psychotria</i> sp.	x		Sterile material
<i>Randia armata</i> (Sw.) DC.	x	x	Loiola, M.I.B. 1847
<i>Rudgea</i> sp.		x	Fernandes, A. (EAC 28000)
<i>Sabicea cinerea</i> Aubl.		x	Fernandes, A. (EAC 4215)
<b>73. Rutaceae</b>			
<i>Ertela trifolia</i> (L.) Kuntze		x	Souza, E.B. 3974
<i>Esenbeckia grandiflora</i> Mart.		x	Cavalcanti, F.S. (EAC 28460)
<i>Zanthoxylum caribaeum</i> Lam.		x	Fernandes, A. (EAC 27752)
<i>Z. rhoifolium</i> Lam.		x	Loiola, M.I.B. 2239
<b>74. Salicaceae</b>			
<i>Banara guianensis</i> Aubl.	x	x	Loiola, M.I.B. 2232
<i>Casearia commersoniana</i> Cambess.		x	Fernandes, A. (EAC 27685)
<i>C. decandra</i> Jacq.	x		Loiola, M.I.B. 2208
<i>C. grandiflora</i> Cambess.	x	x	Fernandes, A. (EAC 27744)
<i>C. javitensis</i> Kunth		x	Loiola, M.I.B. (EAC 53993)
<i>Xylosma ciliatifolia</i> (Clos) Eichler	x		Lima-Verde, L.W. (EAC 27836)
<b>75. Santalaceae</b>			
<i>Phoradendron piperoides</i> (Kunth) Trel.		x	Fernandes, A. (EAC 27833)
<b>76. Sapindaceae</b>			
<i>Allophylus edulis</i> (A.St.-Hil. et al.) Hieron. ex Niederl.		x	Loiola, M.I.B. 1474
<i>A. puberulus</i> Radlk		x	Fernandes, A. (EAC 27917)
<i>Cardiospermum corindum</i> L.		x	Castro, A.J. (EAC 6149)
<i>Cupania impressinervia</i> Acev.-Rodr.		x	Fernandes, A. (EAC 5004)

## Appendix A. Continued...

FAMILY / SPECIES	VEGETATION		MAIN COLLECTOR
	TSDF	TSEF	
<i>C. oblongifolia</i> Mart.		x	Sterile material
<i>Matayba guianensis</i> Aubl.		x	Fernandes, A. (EAC 27742)
<i>Paullinia cearensis</i> Somner & Ferrucci		x	Fernandes, A. (EAC 27799)
<i>P. pinnata</i> L.		x	Fernandes, A. (EAC 27796)
<i>Paullinia</i> sp.	x		Sterile material
<i>Serjania glabrata</i> Kunth		x	Loiola, M.I.B. 1821
<i>S. hebecarpa</i> Benth.		x	Fernandes, A. (EAC 3928)
<i>Serjania</i> sp.	x	x	Sterile material
<i>Talisia esculenta</i> (Cambess.) Radlk.	x	x	Loiola, M.I.B. 1920
<i>Urvillea laevis</i> Radlk.		x	Fernandes, A. (EAC 15135)
<b>77. Sapotaceae</b>			
<i>Chrysophyllum arenarium</i> Allemão		x	Cavalcanti, F.S. 530
<i>C. rufum</i> Mart.		x	Fernandes, A. (EAC 7950)
<i>Pouteria macrophylla</i> (Lam.) Eyma	x	x	Loiola, M.I.B. 2210
<b>78. Simaroubaceae</b>			
<i>Simarouba amara</i> Aubl.		x	Fernandes, A. (EAC 27737)
<b>79. Smilacaceae</b>			
<i>Smilax irrorata</i> Mart. ex Griseb		x	Loiola, M.I.B. 2212
<b>80. Solanaceae</b>			
<i>Acnistus arborescens</i> (L.) Schldtl.		x	Nunes, E. (EAC 27789)
<i>Capsicum parvifolium</i> Sendtn.		x	Fernandes, A. (EAC 27826)
<i>Cestrum axillare</i> Vell.		x	Mata, M.F. (EAC 15617)
<i>C. latifolium</i> Lam.		x	Fernandes, A. (EAC 5081)
<i>Schwenckia grandiflora</i> Benth.		x	Fernandes, A. (EAC 3968)
<i>Solanum asperum</i> Rich.		x	Loiola, M.I.B. 2237
<i>S. campaniforme</i> Roem. & Schult.		x	Fernandes, A. (EAC 27843)
<i>S. robustum</i> H.L.Wendl.		x	Fernandes, A. (EAC 27957)
<i>S. stipulaceum</i> Willd. ex Roem. & Schult.		x	Fernandes, A. (EAC 27870)
<b>81. Urticaceae</b>			
<i>Cecropia pachystachya</i> Trécul		x	Cavalcanti, F.S. 533
<i>Urera caracasana</i> (Jacq.) Gaudich. ex Griseb.	x		Carauta, J.P.P. 550
<b>82. Verbenaceae</b>			
<i>Citharexylum</i> sp.		x	Fernandes, A. (EAC 6840)
<i>Lantana canescens</i> Kunth		x	Fernandes, A. (EAC 4005)
<i>L. fucata</i> Lindl.		x	Fernandes, A. (EAC 7939)
<i>Stachytarpheta cayenensis</i> (Rich.) Vahl.		x	Fernandes, A. (EAC 3999)
<b>83. Violaceae</b>			
<i>Pombalia communis</i> (A.St.-Hil.) Paula-Souza		x	Fernandes, A. (EAC 5655)
<b>84. Vitaceae</b>			
<i>Cissus gongylodes</i> (Baker) Planch.	x		Loiola, M.I.B. 1593
<i>Clematicissus simsiana</i> (Schult. & Schult.f.) Lombardi	x	x	Fernandes, A. (EAC 27929)

**Appendix B.** List of alien species of the Tropical Seasonal Evergreen Forest (TSEF) and the Tropical Seasonal Deciduous Forest (TSDF) of the Ubajara National Park in Ceará, Brazil, where VN = vernacular name; GF = Growth form: tree (tr), shrub (sh), climber (cl), terrestrial herb (th); O = outskirts, I = inside, x = presence of taxa, \* absence of vernacular name.

FAMÍLIA/ESPÉCIE	VN	GF	TSEF		TSDF		
			O	I	O	I	
<b>1. Amaryllidaceae</b>							
<i>Crinum procerum</i> Carey ex Herb.	crino-branco	th	x				
<i>Eucharis grandiflora</i> Planch. & Linden	estrela-d'alva	th	x				
<i>Hymenocallis littoralis</i> (Jacq.) Salisb	lírio-aranha	th	x				
<b>2. Anacardiaceae</b>							
<i>Mangifera indica</i> L.	mangueira	tr	x	x	x	x	x
<b>3. Annonaceae</b>							
<i>Annona squamosa</i> L.	ata	tr	x	x	x	x	x
<b>4. Apocynaceae</b>							
<i>Allamanda cathartica</i> L.	alamanda	cl	x				
<i>Calotropis procera</i> (Aiton) W.T.Aiton	algodão-da-praia	th				x	
<i>Cryptostegia madagascariensis</i> Bojer ex Decne.	unha-do-diabo	th				x	x
<b>5. Araceae</b>							
<i>Aglaonema commutatum</i> Schott	café-de-salão-dourado	th	x				
<i>Anthurium andraeanum</i> L.	antúrio	th	x				
<i>Caladium x hortulanum</i> Birdsey	tinhorão	th	x				
<i>Dieffenbachia amoena</i> Bull.	comigo-ninguém-pode	th	x				
<i>Philodendron imbe</i> Schott ex Endl	*	th	x				
<i>Spathiphyllum cannifolium</i> (Dryand. ex Sims) Schott	*	th	x				
<b>6. Arecaceae</b>							
<i>Chamaedorea cataractarum</i> Mart.	palmeira-cascata	tr	x				
<b>7. Balsaminaceae</b>							
<i>Impatiens walleriana</i> Hook.f.	maria-sem-vergonha	th	x				
<b>8. Davalliaceae</b>							
<i>Nephrolepis biserrata</i> (Sw.) Schott	rabo-de-peixe	th	x				
<i>N. pectinata</i> (Willd.) Schott	samambaia	th	x				
<b>9. Heliconiaceae</b>							
<i>Heliconia bihai</i> L.	*	tr	x				
<i>H. psittacorum</i> L.	helicônia, bananinha	tr	x				
<b>10. Iridaceae</b>							
<i>Neomarica candida</i> (Hassl.) Sprague	falso-iris	th	x				
<b>11. Melastomataceae</b>							
<i>Tibouchina</i> sp.	quaresmeira	sh	x				
<b>12. Meliaceae</b>							
<i>Azadirachta indica</i> A. Juss	nim	tr				x	
<b>13. Moraceae</b>							
<i>Artocarpus heterophyllus</i> Lam.	jaqueira	tr	x	x			
<b>14. Poaceae</b>							
<i>Bambusa</i> sp.	bambu	tr	x	x			
<b>15. Rubiaceae</b>							
<i>Coffea arabica</i> L.	café	sh		x			
<b>16. Rutaceae</b>							
<i>Citrus latifolia</i> Tan.	limoeiro	tr				x	
<b>17. Zingiberaceae</b>							
<i>Alpinia purpurata</i> (Vieill.) K.Schum.	*	sh	x				