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The vascular epiphyte flora in a white-sand ecosystem of the Uatumã Sustainable Development Reserve, Central Amazon

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Abstract

Amazon ecosystems have suffered constant losses due to fragmentation processes, which as a result puts associated biodiversity at risk. Although vascular epiphytes constitute a representative component of tropical forests, they are still poorly studied in white-sand ecosystems. We present a description and checklist of the vascular epiphytes present in white-sand ecosystems (campinaranas) in the Central Amazon. We also analyzed the structure and determined of the value of epiphytic importance (VEI) for the species. We recorded 112 species, 58 genera, and 16 families of vascular epiphytes. The greatest richness (95 spp.) was observed in forested phytophysionomies. Orchidaceae (66 spp.), Bromeliaceae (12 spp.), and Araceae (9 spp.) were the richest families. *Prosthechea aemula* W.E.Higgins (Orchidaceae) had the highest VEI and accounted for about 28% of an abundance of individuals. Among the species, 36.6% have a distribution restricted to the Amazon region, which emphasizes the importance of the conservation of these environments.

Keywords

Amazon rainforest, campinaranas, epiphytic importance value, vertical occurrence

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Introduction

The Amazon occupies 40% of the territory of South America and possesses in its different ecosystems the greatest plant biodiversity on the planet (Mayer and Pimm 1997). It is estimated that 50,000 species of vascular plants occur in the Amazon, of which between 12,000 and 16,000 are tree species (Hubbell et al. 2008; ter Steege et al. 2013). For some groups of plants, such as

vascular epiphytes, the diversity of species is still little known due to the incipient number of studies carried out in the region (Quaresma et al. 2017), although they constitute some of the most diverse and expressive groups of plants of the world and represent about 10% of the richness of known species (Zotz 2013).

The vegetation that develops on white-sand soils is

known in Brazil as campinaranas, which are distributed over approximately 335,000 km² and cover about 5% of the Amazon region (Adeney et al. 2016). The general characteristics of the campinaranas include sandy, acidic, nutrient-poor soils (podzols) and water saturation or even exposure of the water table during rainy periods, but with a water deficit in dry periods (Rossetti et al. 2019; Capurucho et al. 2020). These combined characteristics act as environmental filters (Fine and Kembel 2011; Costa et al. 2020) which select plants with morphological, anatomical, and/or physiological adaptations, and, thus, there is a high number of endemic lineages and species (Fine et al. 2010; Fine and Baraloto 2016; Guevara et al. 2016; Capurucho et al. 2020). In recent decades, significant efforts have been made to determine the distribution patterns of the arboreal communities of the Amazonian campinaranas (Vicentini 2004; Fine and Kembel 2011; García-Villacorta et al. 2016). However, there is still a great lack of studies on the structure and, especially, on the underlying ecological patterns and processes that allow us to understand the distribution of epiphytic flora in these oligotrophic ecosystems (Zotz 2016).

Local studies in different regions of the Amazon have shown a low number of species of vascular epiphytes in the campinarana forests (ter Steege and Cornelissen 1989; Gottsberger and Morawetz 1993; Coomes and Grubb 1996; Mari et al. 2016). However, Braga (1982), who considered only the Orchidaceae, reported that 78% of the species (about 122 spp.) described for Amazonian campinaranas have an epiphytic habit, and if we consider the other epiphytic families, this number will certainly double. Considering the low representativeness of published studies on vascular epiphytes in these environments and the constant anthropic disturbance of campinaranas (Ferreira et al. 2013; Adeney et al. 2016; Demarchi et al. 2019), there is an urgent need to expand on floristic and ecological knowledge of epiphytic communities. Increased knowledge will help develop strategies for the conservation of the biodiversity of these ecosystems.

We describe the epiphytic flora and present a checklist of the species of vascular epiphytes that occur in the various phytophysiognomies of the campinaranas found in the Uatumã Sustainable Development Reserve (Uatumã SDR) in the state of Amazonas, Brazil. In addition, we quantitatively analyze the structure of the epiphytic assemblages and calculate the value of epiphytic importance (VEI) of the species for two local phytophysiognomies. A brief taxonomic description, ecological comments, and information on the geographical and local distribution of the species with the highest VEI are also presented and discussed.

Study Area

The Uatumã SDR is located in the Central Amazon, in northeastern Amazonas state, between the municipalities of Itapiranga and São Sebastião do Uatumã,

approximately 150 km from Manaus (Fig. 1A). This conservation unit covers an area of 4,244 km². It was established by State Decree no. 24.295 on 26 June 2004 in order to ensure the sustainable exploitation and conservation of renewable natural resources used by local traditional and riverine populations. In addition to the campinaranas, the ecosystems of Blackwater Flooded Forest (igapó) and Dense Ombrophilous Forest (terra firme) are also found in Uatumã SDR (Idesam 2009).

The climate in region is equatorial pluvial (Radam Brasil 1978), with an average annual precipitation of 2,077 mm. The rainy period extends from December to May, with a peak in March and April (monthly average 298.4 and 278.7 mm, respectively) (Carneiro and Trancoso 2007). The dry season lasts from June to October, with August and September driest (monthly average 72 mm). The annual average temperature is 27 °C (Carneiro and Trancoso 2007).

The studied areas are located between the coordinates -02.1991° to -02.1872° and -059.0137° to -059.0125° (Fig. 1) and are part of the research and permanent monitoring sites established within the framework of the Long-Term Ecological Program (PELD-MAUA; <https://peld-maua.inpa.gov.br/>). The campinaranas are located in areas adjacent to the terra firme forests (Fig. 1B). They are distributed within an area of approximately 400 ha and are physiognomically different in their vegetation structure. These physiognomies range from open formations, dominated mainly by shrubs and small trees to forested formations, composed of large trees with a height of over 20 meters (Klein and Piedade 2019).

Methods

Description of epiphytic assemblages in the phytophysiognomies of the campinaranas. Considering the proposed classifications for the Amazonian campinaranas (Velooso et al. 1991; IBGE 2012) and the local conditions, such as the exposure level to the water table and the structure and composition of the arboreal vegetation, the campinaranas of the Uatumã SDR were classified into six phytophysiognomies: open shrubby campinarana, dense shrubby campinarana, open arboreal campinarana, dense arboreal campinarana, open forested campinarana, and dense forested campinarana (see Demarchi et al. in press). Based on these classifications, we schematically represented (Figs. 2–4) the structure of the vascular epiphyte assemblages and highlighted the distribution patterns of the most frequently species for each of the phytophysiognomies present in the campinaranas of the Uatumã SDR.

Floristic survey. To verify the richness of vascular epiphytes in the campinaranas of Uatumã SDR, we carried out free rambles throughout the area (Filgueiras et al. 1994) from August 2016 to March 2020. For the observation of canopy species, binoculars (Bushnell, H2O waterproof, straight barrel, 10×42, FOV 305FT), a photographic camera with close-up lenses, and manual

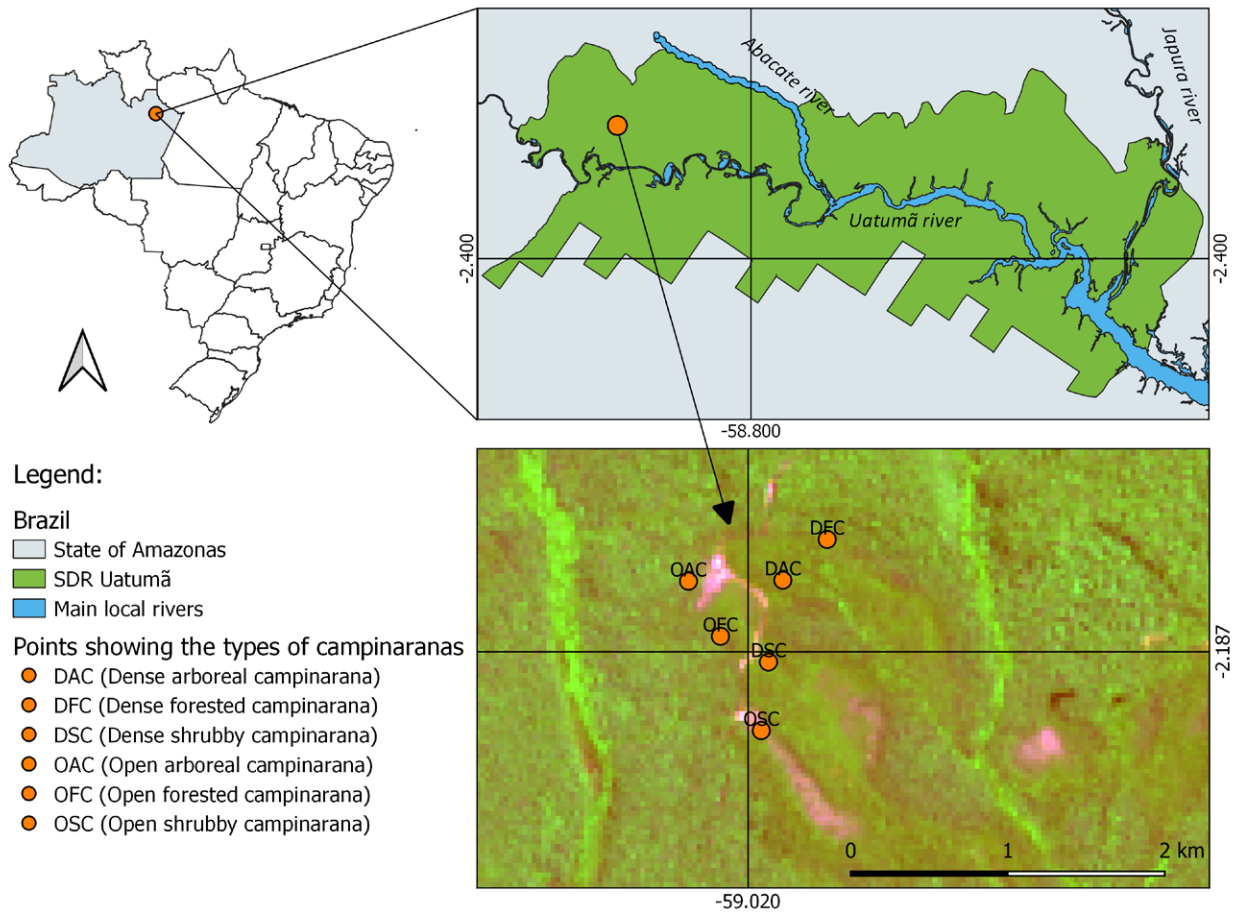


Figure 1. Map of the study area. In (a), the limits of the Uatumã Sustainable Development Reserve (Uatumã SDR) and main local rivers. In (b), the white sand ecosystems, with the points marking the different phytophysiognomies of campinaranas present in the area (Band composition source: Landsat-8, U.S. Geological Survey).

climbing of the phorophytes were used. With regard to life form, the vascular epiphytes were classified in holoepiphytes (never connecting to the ground), facultative (for those plants that can grow as either epiphytes or terrestrial), accidental (for plants usually terrestrial, but can casually grow as epiphytes), and hemiepiphytes (connection to the ground during part of their life cycle) following Benzing (1990). All species were recorded, together with their position in the vertical gradient of the phorophytes.

To assess the occurrence of species in vertical gradients, we use the method of dividing the phorophytes into zones, adapted from Johansson (1974). Where: **ZI** (exposed roots and phorophytes region close to the ground, height ≤ 50 cm); **ZII** (trunk region above the base to the first bifurcation); **ZIII** (first branches, region formed by older and thicker branches); **ZIV** (more external region, formed by newer and thinner branches, where most of the leaves are arranged). The evaluation of species occurrences in the vertical gradient of the phorophytes was used for the descriptive characterization of the epiphyte assemblages in the different phytophysiognomies of campinaranas.

The samples were collected, herborized and later deposited in the Herbarium of the National Institute of Amazonian Research (INPA Herbarium; acronyms according to Thiers 2021), Manaus, Amazonas. For the

identification of the species, we used literature indicated for the botanical families and genera (Mez 1891, 1892, 1894, 1896; Hoehne 1949; Harling 1958; Pabst and Dungs 1975, 1977; Croat 1988; Soares 1996; Kessler 2000; Zuquim et al. 2007), comparison with material deposited in the main herbariums of Brazil and the rest of the world (<http://www.splink.org.br/>), and consultation with the specialists in the given groups. The taxonomic classification for angiosperms follow the hierarchical system proposed by the Angiosperm Phylogeny Group (APG IV 2016) and to lycophytes and monilophytes (grouped as ferns), we follow the classification of Pteridophyte Phylogeny Group (PPG I 2016).

Structure of the epiphytic assemblages. Four plots of 25×25 m were marked, totaling 0.25 ha in phytophysiognomies of open arboreal campinarana and open forested campinarana. The canopy between the plots ranged from 12 to 22 m in height. All trees, with diameter at breast height (DBH) ≥ 10 cm inside the demarcated plots were examined and the epiphytes were identified and quantified. We considered an epiphytic individual to be any plant or cluster of plants geographically distinguishable from each other (Sanford 1968). We recorded all epiphytic individuals occurring in the phorophytes (juveniles and adults). Small individuals, less than 5 cm, were only included in the sample if found fertile (e.g.

Epidendrum apuahuense Mansf.).

The value of epiphytic importance (VEI) was calculated considering the relative frequency values of the epiphytic species on the phorophyte (FfR) and the relative abundance of the species at the site (AbR), according to equations as proposed by Waechter (1998):

$$\text{AbR} = 100 (\text{AbA} / \Sigma \text{AbA})$$

$$\text{FfR} = 100 (\text{FfA} / \Sigma \text{FfA})$$

$$\text{FfA} = 100 (\text{Nfe} / \text{Ntf})$$

$$\text{VEI} = (\text{AbR} + \text{FfR}) / 2$$

where, AbR = relative abundance of epiphytes, FfR = relative frequency of epiphytes on phorophytes, AbA = absolute abundance of epiphytes, FfA = absolute frequency of epiphytes on phorophytes, Nfe = number of phorophytes that were home to the epiphytic species, and Ntf = total number of phorophytes.

We provide herein a synopsis for the 25% of the species of vascular epiphytes with the highest VEI values for the sampled plots. Descriptions of morphological characteristics were based on material collected during the current study, on exsiccates deposited in the INPA Herbarium, and on digitized material in the NY Herbarium collected from white-sand ecosystems near the study site. Ecological and phenological information on the species were obtained through observations and field notes, and from material deposited in herbariums. Geographical distribution data were obtained from the information available from Flora do Brasil 2020, from the Species-Link integrated network of herbariums, in the databases of the Royal Botanic Gardens of Kew, and in the Missouri Botanical Garden (Flora do Brasil 2020; Govaerts et al. 2020; Tropicos 2020). For the geographical distribution patterns of the taxa, we classify the species in the categories: (a) Pantropical (PAN) for widely distributed species in tropical regions of the world, (b) Neotropical (NEO) for species restricted to tropical and/or subtropical regions of the Americas, (c) Amazon basin (AB) for species with a distribution restricted to the Amazon basin, (d) endemic (EN) for species restricted to Brazil, and (e) South America (SA) for species distributed in the Amazon and also in other biomes of Brazil and South America. For local distribution, we recorded the habitat that the species occupy locally, utilizing the proposed classification for the phytophysiognomies of the campinaranas of the Uatumã SDR (Demarchi et al. in press).

Results

Description of epiphytic flora in the phytophysiognomies of campinarana. The vascular epiphyte assemblages present different patterns of distribution and floristic composition among the phytophysiognomies of the campinaranas of the Uatumã SDR (Figs. 2–4; Appendix Table A1). The areas of open forest campinarana (95 spp.) and open arboreal campinarana (53 spp.) were the richest in species. Only four species (*Brassavola martiana* Lindl. (Orchidaceae), *Microgramma baldwinii* Brade (Polypodiaceae), *Prosthechea aemula* W.E.

Higgins (Orchidaceae), and *Tillandsia adpressiflora* Mez (Bromeliaceae) occurred in all phytophysiognomies, while 49 (43.7%) of the species occurred only in a single type of local phytophysiognomy (Appendix Table A1). A detailed description of the main characteristics of the phytophysiognomies and local distribution patterns for the most common vascular epiphyte species is presented below.

Open shrubby campinarana (OSC)

Figure 2A

In this phytophysiognomy, vascular epiphytes are commonly found on the phorophytes of the species *Aldina heterophylla* Spruce ex Benth. (Fabaceae) and *Cybianthus fulvopulverulentus* (Mez) G. Agostini (Primulaceae). In this area, the trees have low structural variation, due to their reduced heights (<5 m) and few horizontal branches, which are characteristics that reduce the formation of microhabitats as well as the area available for colonization by epiphytes. These characteristics related to the structure of the phorophytes may be one of the reasons why we have observed a low number of species and individuals in this phytophysiognomy. *Tillandsia adpressiflora* is the most common epiphyte in the area, and it forms large clusters of rosettes, mainly in the **ZIII** of the phorophytes. *Brassavola martiana* and *Prosthechea aemula* also occur in **ZIII** but are not frequent; *Encyclia mapuerae* (Huber) Brade & Pabst and *Sobralia granitica* G.A. Romero & Carnevalie occur mainly in terrestrial form in the area, but it is common to find individuals occurring as facultative epiphytes in the **ZI** of the phorophyte.

Dense shrubby campinarana (DSC)

Figure 2B

This phytophysiognomy is dominated by riparian shrubs. Vascular epiphytes are uncommon and tend to occur on *Aldina heterophylla* or near the ground in the small bushes of *Remijia morilloi* Steyerl (Rubiaceae). Among the characteristic species, we can highlight *Encyclia conchaechila* Barb.Rodr.) Porto & Brade which only occurs in this type of environment. *Hymenophyllum polyanthos* (Sw.) Sw. and *Tillandsia adpressiflora* are the most common species in this area. Some individuals of *Brassavola martiana* and *Microgramma baldwinii* were also observed in the **ZIV** of the phorophytes.

Open arboreal campinarana (OAC)

Figure 3A

In this phytophysiognomy, the trees possess greater heights, reaching up to 12 m, and have many horizontal branches, which increase the surface area for colonization of epiphytes. In these campinaranas, the highest density of epiphytic individuals is observed, especially on *Aldina heterophylla*, *Cybianthus fulvopulverulentus*, and *Emmotum orbiculatum* (Benth.) Miers (Metteniusaceae). *Prosthechea aemula* is the most common epiphyte, which when associated with other species, such as *Anthurium gracile* (Rudge) Lindl., *Brassavola martiana*, *Codonanthesis crassifolia* (H. Focke) Chautems & Mat. Perret, *Microgramma baldwinii*, *Philodendron pulchrum* G.M.

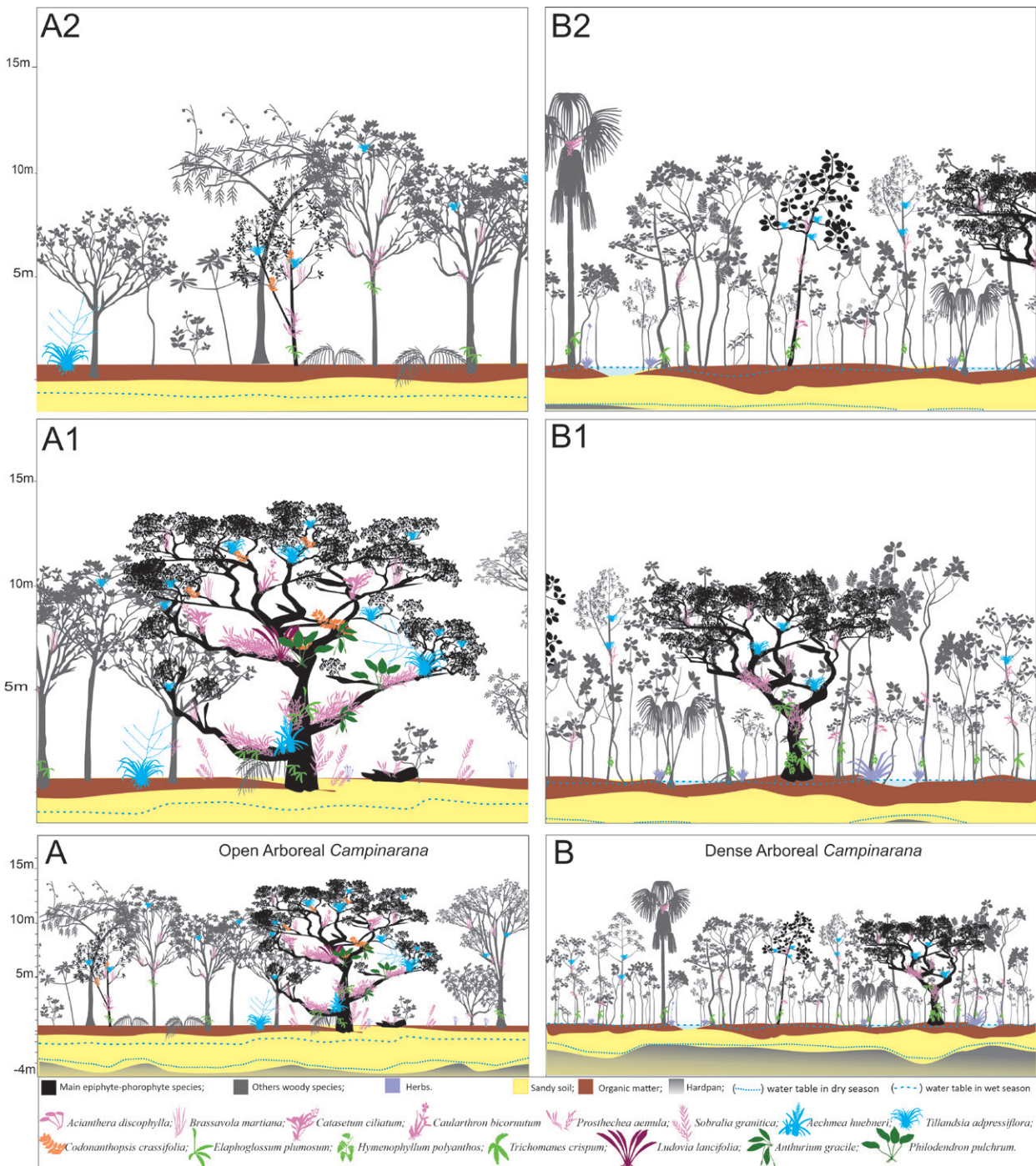


Figure 3. Schematic representation of the distribution patterns of vascular epiphytes for the phytophysiognomies. **A.** Open arboreal campinarana (OAC). **B.** Dense arboreal campinarana (DAC) in white sand ecosystems of the Uatumã Sustainable Development Reserve. Details for the distribution of vascular epiphytes in the most important phorophytes in each type of phytophysiognomy; *Aldina heterophylla* (**A1**, **B1**), *Cybianthus fulvopulverulentus* (**A2**), and *Emmotum orbiculatum* (**B2**).

Open forested campinarana (OFC)

Figure 4A

The main species of phorophytes are *Aldina heterophylla*, *Manilkara bidentata* (A. DC.) A. Chev. (Sapotaceae) and *Ternstroemia dentata* (Aubl.) Sw. (Pentaptylacaceae). In this phytophysiognomy, we found the greatest richness of vascular epiphytes (95 spp.), although the density of individuals is lower when compared with the areas of open forested campinarana. The distribution of epiphytes presents a clear, vertical

stratification, with different groups colonizing different regions of the phorophytes. In the **ZI** and **ZII** regions, closer to the ground, it is common to find species of ferns such as *Elaphoglossum obovatum* Mickel, *Hymenophyllum polyanthos*, and *Trichomanes humboldtii* (Bosch). Near the first bifurcations (end portion of **ZII** and beginning of **ZIII**), species of *Maxillaria* (*M. camaridii* Rchb.f., *M. parviflora* Garay and *M. superflua* Rchb.f) are frequent. Near the crowns of the phorophytes (**ZIII** and **ZIV**), a great diversity of species is found, and *Brassavola martiana*, *Codonanthesps*



Figure 4. Schematic representation of the distribution patterns of vascular epiphytes for the phytophysiognomies. **A.** Open forested campinarana (OFC). **B.** Dense forested campinarana (DFC) in white sand ecosystems of the Uatumã Sustainable Development Reserve. Details for the distribution of vascular epiphytes in the most important phorophytes in each type of phytophysiognomy; *Aldina heterophylla* (**A1**), *Manilkara bidentata* (**A2**, **B2**), and *Mauritia carana* (**B1**).

crassifolia, *Epidendrum bahiense* Rehb.f., *Prosthechea aemula*, and *Tillandsia adpressiflora* are the most common. In these forested areas, we also find the epiphytic individuals with larger sizes, such as the tank bromeliads *Aechmea beeriana* L.B. Sm. & M.A. Spencer and

Aechmea huebneri Harms, large orchids such as *Cattleya wallisii* (Linden) Linden ex Rehb.f., *Eriopsis sprucei* Rehb.f and *Maxillaria violaceopunctata* Rehb.f, and the Araceae *Anthurium eminens* Schott and *Philodendron billietiae* Croat.

Dense forested campinarana (DFC)

Figure 4B

This phytophysiognomy is dominated by the palm trees, *Euterpe catinga* Wallace, *Mauritia carana* Wallace, and *Mauritiella armata* (Mart.) Burret (all Arecaceae). The richness of epiphytes is low in the area; however, it is often possible to find *Hymenophyllum polyanthos*, *Hylaeorchis petiolaris* (Schltr.) Carnevali & G.A. Romero, and *Trichomanes humboldtii* settling in the **ZI** and **ZII** regions of the phorophytes, while *Brassavola martiana*, *Catasetum ciliatum*, and *Prosthechea aemula* colonize the **ZIV**. In this environment, it is common to find hemiepiphyte species and nomadic vines (*Clusia insignis* Mart., *Clusia nemorosa* G. Mey., *Philodendron megalophyllum* Schott, and *Vanilla bicolor* Lindl.) developing among the leaf sheaths of *Mauritia carana*.

Floristic composition of vascular epiphytes. A total of 112 species, 58 genera, and 16 families of vascular epiphytes were recorded in the campinaranas of the Uatumã SDR (Appendix Table A1). Angiosperms represented 86.6% of the species richness (97 spp.) and the remaining species (13.4%; 15 spp.) are ferns. Monocotyledons were the most diverse group (89 spp.). The largest contribution to species richness was found for Orchidaceae (66 spp.), Bromeliaceae (13 spp.), and Araceae (9 spp.). Similarly, the genera *Epidendrum* L. (10 spp.), *Maxillaria* Ruiz &

Pav. (9 spp.), and *Aechmea* Brongn. (7 spp.) were the richest in numbers of species.

Of the life forms, holoepiphytes (91 spp.) were dominant, representing 81% of the species, with orchids and ferns the most representative. The hemiepiphytes (11 spp.) accounted for 10% of the species richness, with a predominance of the family Araceae (Table 1). The other life forms, facultative (6 spp.) and accidental (4 spp.), represented 5% and 4% of the total species, respectively. Most of the species are Neotropical (57 spp.; 50.9%) or have a distribution that is restricted to the Amazon basin (42 spp.; 37.5%). Only six species (5.3%) are endemic to the Brazilian flora. Four species (3.6%) occur in the Amazon and other Brazilian phylogeographic domains, and only three species (2.7%) have a pantropical distribution. The species of Orchidaceae (32 spp.) are mainly restricted to the Amazon basin, while most of the taxa of Bromeliaceae (7 spp.) and Araceae (5 spp.) present a Neotropical distribution.

Structure of the epiphytic community. Vascular epiphytes occurred on 96 phorophytes (66% of the total trees sampled). A total of 62 species and 1,175 epiphytes (mean of 12.2 per phorophyte) were quantified in the sampled plots. The most species-rich families were Orchidaceae (32 spp.), Bromeliaceae (9 spp.), Araceae (6 spp.),

Table 1. Structural parameters of the 28 main species of vascular epiphytes in campinarana phytophysiognomies of the Uatumã Sustainable Development Reserve, Central Amazonia. Nfe = number of phorophytes that house the epiphyte species; AbA = absolute abundance of epiphyte; AbR = relative abundance of epiphyte; FfA = absolute frequency of epiphyte species on individual phorophytes; FfR = relative frequency of epiphyte species on individual phorophytes; VEI = value of epiphytic importance.

Species of vascular epiphytes	Nfe	AbA	AbR	FfA	FfR	VEI
<i>Prosthechea aemula</i>	21	336	28.60	21.88	8.11	18.35
<i>Elaphoglossum obovatum</i>	26	148	12.60	27.08	10.04	11.32
<i>Brassavola martiana</i>	28	114	9.70	29.17	10.81	10.26
<i>Tillandsia adpressiflora</i>	23	131	11.15	23.96	8.88	10.01
<i>Codonantheropsis crassifolia</i>	27	74	6.30	28.13	10.42	8.36
<i>Maxillaria superflua</i>	13	113	9.62	13.54	5.02	7.32
<i>Clusia nemorosa</i>	15	24	2.04	15.63	5.79	3.92
<i>Epidendrum bahiense</i>	13	27	2.30	13.54	5.02	3.66
<i>Sobralia granitica</i>	11	24	2.04	11.46	4.25	3.14
<i>Elaphoglossum plumosum</i>	9	15	1.28	9.38	3.47	2.38
<i>Epidendrum strobiliferum</i>	6	28	2.38	6.25	2.32	2.35
<i>Elaphoglossum discolor</i>	7	11	0.94	7.29	2.70	1.82
<i>Microgramma baldwinii</i>	5	20	1.70	5.21	1.93	1.82
<i>Bifrenaria longicornis</i>	6	8	0.68	6.25	2.32	1.50
<i>Prosthechea vespa</i>	5	6	0.51	5.21	1.93	1.22
<i>Epidendrum microphyllum</i>	2	15	1.28	2.08	0.77	1.02
<i>Caularthron bicornutum</i>	2	13	1.11	2.08	0.77	0.94
<i>Epidendrum micronocturnum</i>	3	6	0.51	3.13	1.16	0.83
<i>Aechmea mertensii</i>	3	4	0.34	3.13	1.16	0.75
<i>Aechmea huebneri</i>	3	4	0.34	3.13	1.16	0.75
<i>Octomeria grandiflora</i>	3	4	0.34	3.13	1.16	0.75
<i>Rudolfiella aurantiaca</i>	3	4	0.34	3.13	1.16	0.75
<i>Anthurium obtusum</i>	3	3	0.26	3.13	1.16	0.71
<i>Anthurium gracile</i>	2	6	0.51	2.08	0.77	0.64
<i>Epidendrum apuahuense</i>	2	6	0.51	2.08	0.77	0.64
<i>Moranopteris nana</i>	2	5	0.43	2.08	0.77	0.60
<i>Maxillaria parviflora</i>	2	4	0.34	2.08	0.77	0.56
<i>Hymenophyllum polyanthos</i>	2	4	0.34	2.08	0.77	0.56

and Dryopteridaceae (3 spp.). The species that presented the highest value of importance (Table 1) were *Prosthechea aemula* (VEI = 18.35), *Elaphoglossum obovatum* (VEI = 11.32), *Brassavola martiana* (VEI = 10.26), *Tillandsia adpressiflora* (VEI = 10.01), and *Codonanthesis crassifolia* (VEI = 8.36). Together these five species were responsible for 58.3% of the VEI obtained in the plots and are the most frequent species in environments of campinarana that were studied.

In the open arboreal campinarana plots, we recorded 38 species and 496 individuals of vascular epiphytes distributed on 38 phorophytes. *Prosthechea aemula* (137 ind.), *Maxillaria superflua* (53 ind.), and *Codonanthesis crassifolia* (52 ind.) were the most abundant species in this phytophysiognomy. In open forested campinarana plots, 46 species and 679 individuals were recorded. The most abundant species in this phytophysiognomy were *P. aemula* (199 ind.), *E. obovatum* (101 ind.), and *T. adpressiflora* (78 ind.).

Below we present the material examined for all vascular epiphytes recorded in the white-sand ecosystems of the Uatumã SDR. For the 25 % of the species with the highest VEI (Table 1), we also provide a brief description of taxonomic, information on ecology, phenology, and geographical distribution.

Araceae Juss.

Anthurium bonplandii Bunting

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1849, -059.0217; 40 m; 25 Mar. 2019; V. Klein 293 leg.; INPA 286939 • *ibid*; V. Klein 292 leg.; INPA 286940.

Anthurium eminens Schott

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1150, -059.0081; 40 m; 21 Apr. 2019; L.O. Demarchi 840 leg.; INPA 277951.

Anthurium gracile (Rudge) Lindl.

Figure 5A

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1831, -059.0226; 40 m; 26 Mar. 2019; V. Klein 323 leg.; INPA 286963 • *ibid*; 1 Nov. 2019; V. Klein 372 leg.; INPA 286983.

Identification. Holoepiphyte. Herb erect, 20–50 cm long. Cataphylls and prophylls brown, persistent and fibrous. Leaves 4–12, elliptical to lanceolate, 5.0–14.4 × 3.8–5.8 cm, acute apex, entire margin. Inflorescence shorter than leaves (5.8–12.5 cm long); spathe reflex, 0.5–2.1 × 0.7–1.4 cm, lanceolate, greenish; spadix erect to subpendent, 1.2–5.0 × 0.4–0.6 cm, sessile, yellowish to greenish. Infructescence 3.5–6.6 × 0.8–1.4 cm, globose berries, 3–8 mm in diameter, reddish purple.

Geographic distribution. Neotropical. Widely distributed in the Central and South America. In Brazil this species occurs in the North, Northeast and Central-West regions (Flora do Brasil 2020; Tropicos 2021).

Ecological and phenological information. The species is common in OSC and OAC. Usually occurring in ZIII region, associated with *Prosthechea aemula* forming large clusters over the phorophytes. Observed with flowers and fruits between March and November.

Anthurium obtusum (Engl.) Grayum

Figure 5B

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1843, -059.0230; alt. 40 m; 23 Apr. 2017; V. Klein 125 leg.; INPA 286912.

Identification. Holoepiphyte. Herb erect, 15–30 cm long. Cataphylls and prophylls brown, persistent. Leaves 3–7, ovate to elliptic, 7.0–12.0 × 3.8–5.23 cm, apiculate apex, entire margin. Inflorescence shorter than the leaves (3.8–4.5 cm long); spathe erect 1.7–2.1 × 0.7–1.1 cm, lanceolate, greenish; spadix erect, 2.2–4.0 × 0.4–0.8 cm, sessile, greenish white to pinkish. Infructescence 3.8–7.0 × 0.8–1.4 cm, globose berries, 5–7 mm in diameter, white or sometimes pale lavender.

Geographic distribution. Neotropical. Widely distributed in the Central and South America. In Brazil the species occurs in the North Region (Flora do Brasil 2020; Tropicos 2020).

Ecological and phenological information. The species occurs in OFC and DFC. Usually grows in ZII region of the phorophytes. Observed with flowers and fruits between April and August.

Philodendron billietiae Croat

Material examined. BRAZIL • Amazonas, Manaus, Reserva Florestal Adolpho Ducke; -02.9301, -059.9803; alt. 50 m; 23 Aug. 2011; L.L. Oliveira 40 leg.; INPA 241196.

Philodendron distantilobum K.Krause

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, REBIO Uatumã; -01.8083, -059.2729; alt. 40 m; 10 Jul. 2008; J.F. Stanck 466 leg.; INPA 225245.

Philodendron megalophyllum Schott

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, REBIO Uatumã; -01.8054, -059.2719; alt. 40 m; 21 Jul. 2015; M.M. Pombo 647 leg.; INPA 278623.

Philodendron pulchrum G.M.Barroso

Material examined. BRAZIL • Amazonas, Manuas, Br. 174, Reserva da Campina; -02.595, -060.2505; alt. 52 m; 19 Jun. 1996; M.A. Nadruz 1234 leg.; INPA 192925.

Thaumatophyllum spruceanum Schott

Material examined. BRAZIL • Amazonas, Manuas, Br. 174, Reserva da Campina; -02.595, -060.2505; alt. 52 m; 19 Jun. 1996; M.A. Nadruz 1233 leg.; INPA 192924.

Aspleniaceae Newman

Asplenium serratum L.

Material examined. BRAZIL • Amazonas, São Seba-

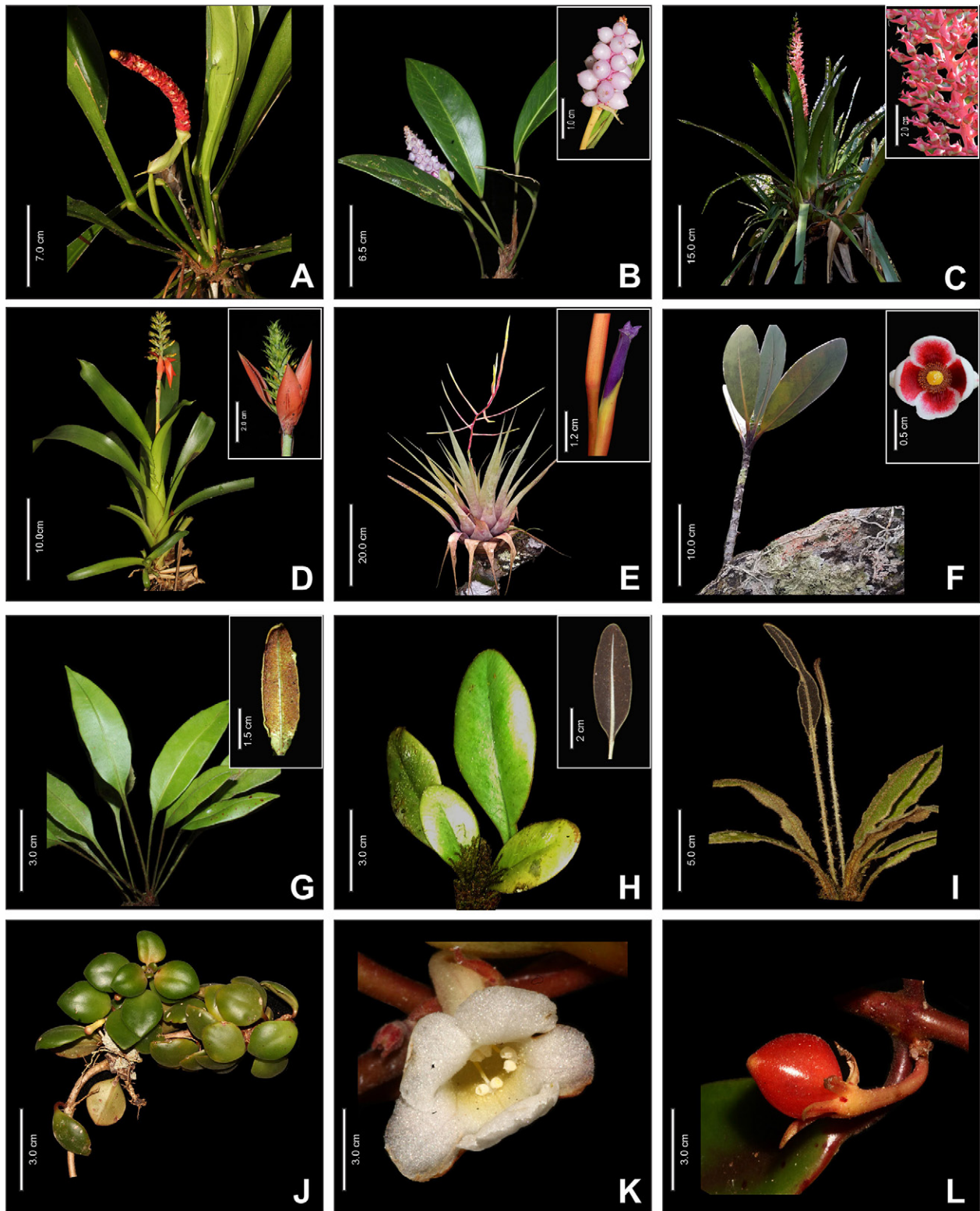


Figure 5. Species of vascular epiphytes with greater value of epiphytic importance (VEI) for the white-sand ecosystems of the Uatamã Sustainable Development Reserve. **A.** *Anthurium gracile*. **B.** *Anthurium obtusum*. **C.** *Aechmea huebneri*. **D.** *Aechmea mertensii*. **E.** *Tillandsia adpressiflora*. **F.** *Clusia nemorosa*. **G.** *Elaphoglossum discolor*. **H.** *Elaphoglossum obovatum*. **I.** *Elaphoglossum plumosum*. **J–L.** *Codonanthes crassifolia*.

stião do Uatumã, Uatumã SDR; -02.1862, -059.0231; alt. 40 m; 10 Jul. 2017; L.O. Demarchi 840 leg.; INPA 277951 • *ibid*; 11 May 2019; V. Klein 306 leg.; INPA 286951.

Bromeliaceae A.Juss.

***Aechmea beeriana* L.B.Sm. & M.A.Spencer**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1752, -059.0451; alt. 40 m; 7 Nov. 2018; L.O. Demarchi 1419 leg.; INPA 288546 • *ibid*; 1 Dec. 2006; J.G. Carvalho-Sobrinho, 1331 leg.; INPA 2225313.

***Aechmea bromeliifolia* (Rudge) Baker**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Rio Uatumã; -02.0833, -059.201; alt. 40 m; 13 Aug. 1979; C.A.C. Ferreira 259 leg.; INPA 87295.

***Aechmea huebneri* Harms**

Figure 5C

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1859, -059.0241; alt. 40 m; 6 Jun. 2018; L.O. Demarchi 1223 leg.; INPA 288387.

Identification. Facultative epiphytes. Tubular rosette herb, forming tank developed. Leaves 6–12, lanceolate, 35–120 × 5.8–10.4 cm, acuminate apex, serrated margin. Floral scape and inflorescence longer than leaves (30–100 cm long); escape bracts 1.5–4.2 × 1.5–3.5 cm, lanceolate, greenish pink, pungent apex; floral bracts 0.3–0.8 × 0.3–0.5 cm, ovoid, pink, pungent apex, shorter than the sepals. Flowers attractive, sessile; sepals 0.15–0.3 × 0.15–0.2 cm, asymmetric, reddish, acute apex; petals 0.2–0.7 × 0.2–0.4 cm, spatulate, purple, acuminate apex. Fruits not observed.

Geographic distribution. Amazon basin and Atlantic Forest. Occurs in South America (Brazil and Colombia). In Brazil the species occurs in the North and Northeast regions (Flora do Brasil 2020; Tropicos 2021).

Ecological and phenological information. The species is common in OAC. Grows in the ZIII region of the phorophytes. Observed with flowers between June and October.

***Aechmea longifolia* (Rudge) L.B.Sm. & M.A.Spencer**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1823, -059.0011; alt. 40 m; 20 May 2021; V. Klein 433 leg.; INPA 289249.

***Aechmea mertensii* (G.Mey.) Schult. & Schult.f.**

Figure 5D

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1759, -059.0105; alt. 40 m; 2 Oct. 2016; L.O. Demarchi 2018 leg.; INPA 288500.

Identification. Holoepiphyte. Tubular rosette herb. Leaves 5–9, ovate to elliptical, 12.8–34.0 × 1.2–4.3 cm, attenuate apex, serrated margin and retrospinous spines.

Floral scape and inflorescence longer than leaves (12–35 cm long); escape bracts 2–7.25 × 0.3–2.6 cm, elliptical or lanceolate, red, pungent apex; floral bracts 0.2–2.9 × 0.2–2.5 cm, ovoid, greenish yellow, mucronate apex, shorter than the sepals. Flowers attractive, sessile, greenish yellow; sepals 0.2–0.5 × 0.15–0.3 cm, asymmetric, yellow, mucronate apex; petals 0.4–0.8 × 0.2–0.4 cm, ligulates, yellowish, mucronate apex. Fruits not observed.

Geographic distribution. Neotropical. Occurs in South America (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela). In Brazil the species occurs in the North, Northeast, and Central-West regions (Flora do Brasil 2020; Tropicos 2021).

Ecological and phenological information. The species is common in OAC. Growing preferably in the ZIV region of the phorophytes. Usually associated with ant gardens. Observed with flowers between October and November.

***Aechmea rodriguesiana* (L.B.Sm.) L.B.Sm.**

Material examined. BRAZIL • Amazonas, Manaus, Reserva Florestal Adolpho Ducke; -02.9301, -059.9803; alt. 50 m; 23 Aug. 2011; J.E.L. Ribeiro 1272 leg.; INPA 178866.

***Aechmea setigera* Mart. ex Schult. & Schult.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Rio Uatumã, Ramal da Morena; -02.9790, -060.0543; alt. 40 m; 13 Aug. 1979; D.A.C. Ferreira 346 leg.; INPA 87712.

***Araeococcus micranthus* Brongn.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1919, -059.2103; alt. 40 m; 3 Oct. 2018; L.O. Demarchi 1386 leg.; INPA 288516 • *ibid*; -02.1907, -059.1423; 23 Mar. 2007; J.G. Carvalho-Sobrinho, 1498 leg.; INPA 225300.

***Billbergia violacea* Bee**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Rio Uatumã; -02.0833, -059.201; alt. 40 m; 29 Apr. 1985; C.A.C. Ferreira 5874 leg.; INPA 127339.

***Bromelia grandiflora* Mez**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1776, -059.0223; alt. 40 m; 25 Feb. 2020; V. Klein 447 leg.; INPA 289259.

***Neoregelia eleutheropetala* (Ule) L.B.Sm.**

Material examined. BRAZIL • Amazonas, Manaus, Br. 174, Reserva da Campina; -02.5921, -060.2425; alt. 52 m; 2 Dec. 2000; G.M. Souza 453 leg.; INPA 207064.

***Tillandsia adpressiflora* Mez**

Figure 5E

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1766, -059.0103; alt. 40 m; 8 Feb. 2015; L.O. Demarchi 18 leg.; INPA 287405.

Identification. Facultative epiphytes. Tubular rosette herb. Leaves 8–14, lanceolate to triangular, 20–80 × 8.0–16.4 cm, acuminate apex, entire margin. Floral scape and inflorescence longer than leaves (40–120 cm long); escape bracts 4.5–7.2 × 1.5–3.5 cm, closely lanceolate, reddish, acute apex; floral bracts 3.2–6.1 × 1.2–2.8 cm, closely lanceolate, reddish yellow, acute apex, bigger than sepals. Flowers attractive, sessile; sepals 2.5–3.8 × 1.0–1.8 cm, lanceolate, reddish, acute apex; petals 5.4–7.2 × 0.8–1.3 cm, elliptical, purple, acute apex. Fruits elliptical 4.2–5.1 cm long.

Geographic distribution. Restricted to the Amazon basin. Occurs in Bolivia, Brazil, Colombia, Ecuador, French Guiana, and Peru. In Brazil the species occurs in the North Region (Flora do Brasil 2020; Tropicós 2021).

Ecological and phenological information. This species occurs in all local campinarana phytophysiognomies, but it is abundant in OSC and OAC. Occurs usually in ZIII and ZIV regions of the phorophytes, forming large tanks. Observed with flowers and fruits between September and January.

***Tillandsia bulbosa* Hook.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1768, –059.0253; alt. 40 m; 9 May 2017; L.O. Demarchi 926 leg.; INPA 278025 • *ibid*; –02. 1919, –059.1833; 10 Nov. 2019; L.O. Demarchi 1615 leg.; INPA 288695.

Cactaceae Juss.

***Epiphyllum phyllanthus* (L.) Haw.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1801, –059.0177; alt. 40 m; 16 Aug. 2019; L.O.A. Teixeira 1982 leg.; INPA 87667.

Clusiaceae Lindl.

***Clusia insignis* Mart.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1833, –059.0223; alt. 40 m; 1 Sep. 2015; L.O. Demarchi 651 leg.; INPA 274278.

***Clusia nemorosa* G. Mey.**

Figure 5F

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1833, –059.02407; alt. 40 m; 11 Jan. 2019; L.O. Demarchi 1465 leg.; INPA 288591 • *ibid*; –02.1855, –059.0177; 11 Aug. 2019; L.O. Demarchi 1560 leg.; INPA 288647 • *ibid*; –02.1759, –059.0105; 10 Feb. 2021; L.O. Demarchi 1665 leg.; INPA 288734.

Identification. Hemiepiphyte. Dioecious plant. Shrub erect, up to 7 meters tall. Cylindrical stem, exudate white to orange; Leaves obovate, 8.8–14.2 × 4.2–5.8 cm, opposite disposition, coriaceous texture, rounded apex. Inflorescence terminal 1.3–2.2 cm, cymose. Flowers 1–3,

attractive; sepals 4–5, free, orbicularis, 0.5–0.8 × 0.3–0.6 cm, greenish color; petals 5–7, free, elliptical, 1.8–4.0 × 0.8–2.18 cm, white with macule reddish to pink internally; staminate flowers composed by numerous free stamens with the upper surface covered by a mixture of resin and pollen during anthesis. Pistillate flowers composed by 6–10-locular ovary, terminal stigmas, staminodes resinous forming a ring around the ovary. Fruits orbicular, globose, 2–5 × 1.4–3.5 cm, whitish when immature, green to vinaceous when ripe, dehiscent by 6–10 longitudinal slits.

Geographic distribution. Neotropical. Occurs in South America (Brazil, French Guiana, Guyana, Suriname and Venezuela). In Brazil this species occurs in all regions, except in the South Region (Flora do Brasil 2020; Tropicós 2020).

Ecological and phenological information. The species is common in DFC. Usually presents the hemiepiphyte habit, germinating on the phorophytes and subsequently reaching contact with the soil. Observed with flowers and fruits between August and February.

Cyclanthaceae Poit. ex A.Rich.

***Ludovia lancifolia* Brongn.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1877, –059.0201; alt. 40 m; 10 Oct. 2019; L.O. Demarchi 1603 leg.; INPA 288684.

Dryopteridaceae Herter

***Elaphoglossum discolor* (Kuhn) C.Chr.**

Figure 5G

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1875, –059.0198; alt. 40 m; 23 Apr. 2017; V. Klein 126 leg.; INPA 286913.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 3.8.0–7.9 × 0.2–0.4 cm, covered by brown scale. Leaves 3–9, entire; sterile leaves, petiole (2–5.6 cm long), leaf blade 3.4–8.7 × 3.5–5.4 cm, triangular to lanceolate, acuminate apex, orange reddish scales in the underside of the leaf; fertile leaves longer petiole (4.6–7.3 cm long), leaf blade 3.2–5.6 × 1.8–3.5 cm, narrow-elliptical, acute apex. Sori light brown, throughout the entire underside of the leaf.

Geographic distribution. Amazon basin and Atlantic Forest. Occurs in South America (Brazil, Colombia, Ecuador, Peru and Venezuela). In Brazil the species occurs in the North, Northeast, and Central-West regions (Flora do Brasil 2020; Tropicós 2021).

Ecological and phenological information. This species is common in areas with high moisture, occurring mainly in DAC, DFC, and OFC. Usually growing in ZI and ZII regions of the phorophytes. Observed in fertile stage between April and May.

***Elaphoglossum glabellum* J.Sm.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1832, -059.02304; alt. 40 m; 11 Jun. 2019; V. Klein 313 leg.; INPA 286956 • *ibid*; -02.1827, -059.02303; 11 Jun. 2019; V. Klein 314 leg.; INPA 286957.

***Elaphoglossum obovatum* Mickel**

Figure 5H

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1871, -059.0183; alt. 40 m; 23 Apr. 2017; V. Klein 126 leg.; INPA 286913.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 4.2–8.0 × 0.2–0.4 cm, covered by brown scale. Leaves 2–9, entire; sterile leaves, short petiole (1–2 cm long), leaf blade 5.0–9.4 × 4.5–5.4 cm, obovate, rounded apex, light chestnut scales in the underside of the leaf; fertile leaves, longer petiole (3–5 cm long), leaf blade 4.0–6.6 × 1.8–2.8 cm, narrow-elliptical, rounded apex. Sori black, throughout the entire underside of the leaf.

Geographic distribution. Neotropical. Widely distributed in American continent, occurring from Mexico to Brazil. In Brazil the species occurs in the North region (Flora do Brasil 2020; Tropicós 2021).

Ecological and phenological information. The species is common in areas with high moisture, occurring mainly in DAC and DFC. Occurs usually growing in the lower parts of the trunk (ZI and ZII). Observed in fertile stage between February and April.

***Elaphoglossum plumosum* (Fée) T.Moore**

Figure 5I

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1832, -059.02304; alt. 40 m; 16 Jun. 2017; V. Klein 181 leg.; INPA 286915 • *ibid*; -02.1812, -059.0202; 11 May 2019; V. Klein 299, 300 leg.; INPA 286944, 286945.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 3.2–6.6 × 0.2–0.5 cm, covered by brown scale. Leaves 3–8, entire; sterile leaves, short petiole (2.0 cm long), leaf blade 8.0–19.6 × 2.8–4.2 cm, lanceolate, acute to acuminate apex, abundance of light-brown and golden scales in leaf; fertile leaves, longer petiole (10.0 cm long), leaf blade 5.2–7.5 × 1.3–2.6 cm, narrow-lanceolate, rounded to acute apex. Sori dark, throughout the entire underside of the leaf.

Geographic distribution. Amazon basin and Atlantic Forest. Occurs in South America (Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela). In Brazil the species occurs in the North, Northeast, and Southeast regions. (Flora do Brasil 2020; Tropicós 2020).

Ecological and phenological information. The species is common in areas with high moisture, occurring mainly in DAC, OFC, and DFC. Usually growing in ZI and ZII region of the phorophytes. Observed in fertile stage between May and August.

Gesneriaceae Rich. & Juss. ex DC.

***Codonanthis crassifolia* (H. Focke) Chautems & Mat. Perret**

Figure 5J–L

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1811, -059.0246; alt. 40 m; 28 Oct. 2019; V. Klein 371 leg.; INPA 286982.

Identification. Holoepiphyte. Herb pendant. Stem cylindrical 40–175.0 × 0.10–0.20 cm, long-creeping stem. Leaves 12–27, distichous along the stem, elliptical, 2.2–5.3 × 1.8–3.9 cm, acute apex. Inflorescence 1.2–2.3 cm long, lateral, cymose. Flowers 1–3, attractive; sepal 5, linear narrow, 0.6–1.2 × 0.10–0.25 cm, white flowers, internally with yellow spots. Fruits, ovoid berries, 10–20 mm in diameter, pink to red.

Geographic distribution. Neotropical. The species is widely distributed in Central and South America. In Brazil the species occurs in the North and Central-West regions (Flora do Brasil 2020; Tropicós 2020).

Ecological and phenological information. The species is common in OAC and OFC. Grows preferably in the ZIV region of the phorophytes, usually associated with ant gardens. Observed with flowers and fruits between October and January.

***Codonanthis ulei* Mansf.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1812, -059.0202; alt. 40 m; 20 Apr. 2017; L.O. Demarchi 277 leg.; INPA 277928.

Hymenophyllaceae Gaudich.

***Hymenophyllum polyanthos* (Sw.) Sw.**

Figure 6A

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1801, -059.0256; alt. 40 m; 11 May 2019; V. Klein 305 leg.; INPA 286950 • *ibid*; -02.1810, -059.0211; 7 Sep. 2019; V. Klein 336 leg.; INPA 286970.

Identification. Holoepiphyte. Herb subpendent. Stem cylindrical, 15–20 × 0.05–0.10 cm, creeping stem, rust colored. Leaves 9–14, distichous along the stem, 3-pinnate, 6.6–13.8 × 2.0–3.6 cm, very thin and delicate. Sori formed by two flat valves, localized in the margin of leaves, at the ends of the veins.

Geographic distribution. Pantropical. In America is widely distributed in tropical forests from Mexico to Paraguay. Also, in eastern Asia and Africa. In Brazil, this species occurs in the North and Southeast regions. (Flora do Brasil 2020; Tropicós 2020).

Ecological and phenological information. This species is common in areas with high moisture, occurring mainly in DAC and DFC. Usually growing in ZI and ZII region of the phorophytes. Observed in fertile stage between May and September.

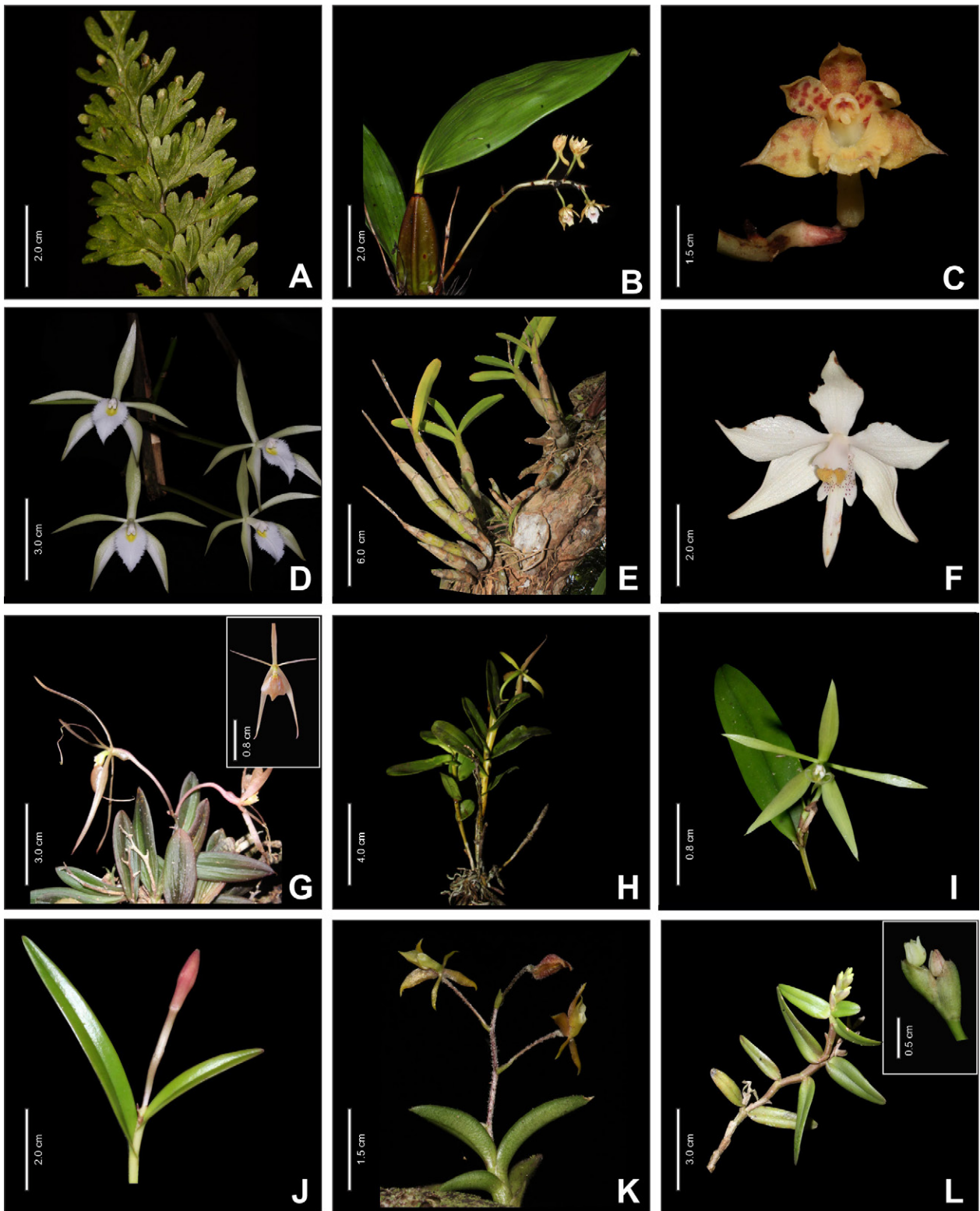


Figure 6. Species of vascular epiphytes with greater value of epiphytic importance (VEI) for the white-sand ecosystems of the Uatumā Sustainable Development Reserve. **A.** *Hymenophyllum polyanthos*. **B, C.** *Bifrenaria longicornis*. **D.** *Brassavola martiana*. **E, F.** *Caularthron bicornutum*. **G.** *Epidendrum apuahense*. **H, I.** *Epidendrum bahiense*. **J.** *Epidendrum micronoturnum*. **K.** *Epidendrum microphyllum*. **L.** *Epidendrum strobiliferum*.

***Trichomanes crispum* L.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1811, -059.0246; alt. 40 m; 11 May. 2019; V. Klein 301 leg.; INPA 286946.

***Trichomanes humboldtii* (Bosch) Lellinger**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1811, -059.0246; alt. 40 m; 11 May. 2019; V. Klein 302 leg.; INPA 286947 • *ibid*; -02.1810, -059.0211; 22 May 2021; V. Klein 432 leg.; INPA 289248.

Moraceae Gaudich.

***Ficus mathewsii* (Miq.) Miq.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, REBIO Uatumã; -1.8083, -059.2729; alt. 40 m; 18 May 2015; D.P. Saraiva 606 leg.; INPA 272956.

Orchidaceae Juss.

***Acianthera discophylla* Luer & Carneval**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1714, -059.0240; alt. 40 m; 17 Jun. 2017; V. Klein 167 leg.; INPA 280994.

***Acianthera fockei* (Lindl.) Pridgeon & M.W.Chase**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1712, -059.0314; alt. 40 m; 7 Nov. 2016; V. Klein 69 leg.; INPA 280908 • *ibid*; -02.1712, -059.0211; alt. 40 m; 26 Mar. 2019; V. Klein 289 leg.; INPA 286938.

***Acianthera miqueliana* (H.Focke) Pridgeon & M.W.Chase**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1727, -059.0140; alt. 40 m; 13 Jun. 2019; V. Klein 320 leg.; INPA 286962 • *ibid*; -02.1802, -059.0001; 1 Jul. 2019; V. Klein 373 leg.; INPA 286984.

***Aganisia fimbriata* Rehb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1842, -059.0130; alt. 40 m; 20 May 2018; V. Klein 251 leg.; INPA 286917.

***Batemannia colleyi* Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1921, -059.0220; alt. 40 m; 12 Jun. 2019; V. Klein 318 leg.; INPA 286960.

***Bifrenaria longicornis* Lindl.**

Figure 6B, C

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1731, -059.01240; alt. 40 m; 28 Feb. 2017; V. Klein 108 leg.; INPA 280944 • *ibid*; -02.1810, -059.0201; 17 Jun. 2017; V. Klein 150 leg.; INPA 280981 • *ibid*; -02.1831, -059.0240; Apr.2018;

L.O. Demarchi 1155 leg.; INPA 284814.

Identification. Holoepiphyte. Herb erect. Pseudobulb elliptical tetragonal 4.8–6.0 × 1.8–2.0 cm. Leaves 1, elliptical, 15.0–21.0 × 4.0–6.5 cm, acute apex. Inflorescence 8.0–14.0 cm long, lateral, in a raceme. Flowers 6–12, attractive, pale-yellow with brown spots; dorsal sepal 1.0–1.2 × 0.3–0.5 cm, oblong, acute apex; lateral sepals 1.2–2.2 × 0.3–0.5 cm, connate at the base forming a spur, oblong, acute apex; petals 0.8–1.2 × 0.2–0.4 cm, oblong, acuminate apex; lip 1.2–1.7 × 0.9–1.3 cm, trilobed, white with purple veins. Fruits elliptical, 2.0–3.0 × 0.8–1.0 cm.

Geographic distribution. Amazon basin. Occurs in Bolivia, Brazil, Colombia, Guyana, French Guiana, Peru, Suriname, and Venezuela. In Brazil the species occurs in the North region (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. Occurs in OAC and OFC. Usually growing in ZII region of the phorophytes. Observed with flowers and fruits between February and June.

***Brassavola martiana* Lindl.**

Figure 6D

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1831, -059.0240; alt. 40 m; 5 Nov. 2016; V. Klein 58 leg.; INPA 280901 • *ibid*; -02.1906, -059.0190 Jan. 2017; V. Klein 94 leg.; INPA 280932 • *ibid*; -02.1833, -059.2407; 20 Aug. 2017; V. Klein 207 leg.; INPA 281023.

Identification. Holoepiphyte. Herb subpendant. Stem cylindrical, 5.2–13.0 × 0.2–0.4 cm. Leaves 1, cylindrical, 11.0–22.0 × 0.3–0.6 cm, acute apex. Inflorescence 3.8–6.1 cm long, terminal, in a raceme. Flowers 6–14, attractive, yellowish; dorsal sepal 2.0–2.5 × 0.4–0.6 cm, elliptical to lanceolate, acute apex; lateral sepals 2.2–2.5 × 0.4–0.6 cm, elliptical-falcate, acute apex; petals 2.0–2.4 × 0.2–0.5 cm, elliptical-falcate, acute apex; lip 1.4–2.2 × 1.0–1.2 cm, ovate, white with yellow spot on disc. Fruits elliptical, 8.0–10.2 × 1.4–1.8 cm.

Geographic distribution. Restricted to the Amazon basin. Occurs in Bolivia, Brazil, Colombia, Guyana, French Guiana, Peru, Suriname, and Venezuela. In Brazil this species occurs in the North and Central-West regions (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. The species is abundant and common in all local campinarana phytophysognomies. Occurs mainly in the ZIII and ZIV region of the phorophytes. Observed with flowers and fruits between June and December.

***Bulbophyllum setigerum* Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1921, -059.0423; alt. 40 m; 15 Jun. 2017; V. Klein 154 leg.; INPA 280985.

***Campylocentrum fasciola* (Lindl.) Cogn.**

Material examined. BRAZIL • Amazonas, São Sebastião

do Uatumã, Uatumã SDR; -02.1944, -059.0354; alt. 40 m; 5 Aug. 2018; V. Klein 353 leg.; INPA 286980.

***Catasetum discolor* (Lindl.) Lindl**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1931, -059.0233; alt. 40 m; 20 Mar. 2017; V. Klein 112 leg.; INPA 280947 • *ibid*; -02.1813, -059.0211; 29 Apr. 2017; V. Klein 134 leg.; INPA 280965.

***Catasetum rivularium* Barb.Rodr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1855, -059.0177; alt. 40 m; 10 Fev. 2018; L.O. Demarchi 1118 leg.; INPA 284797.

***Catasetum tigrinum* Rchb.f.**

Material examined. BRAZIL • Amazonas, Manaus, Reserva Florestal Adolpho Ducke; -02.9301, -059.9803; alt. 50 m; 19 Nov. 1996; J.E. Ribeiro 1861 leg.; INPA 195192.

***Cattleya wallisii* (Linden) Linden ex Rchb.f**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1912, -059.01334; alt. 40 m; 5 Nov. 2016; V. Klein 68 leg.; INPA 280907 • *ibid*; -02.5981, -060.0305; 28 Jun. 2018; D.R.P. Krahl 41 leg.; INPA 285412.

***Caularthron bicornutum* (Hook.) Raf.**

Figure 6E, F

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1903, -059.0234; alt. 40 m; 8 Aug. 2016; V. Klein 53 leg.; INPA 280896 • *ibid*; -02.1906, -059.0190; 19 Sep. 2017; A.C. Quaresma 44 leg.; INPA 280285.

Identification. Holoepiphyte. Herb erect. Pseudobulb oblong, 8.0–14.0 × 2.0–2.3 cm. Leaves 5–7 per pseudobulb, oblong, 9.0–12.2 × 0.8–1.2 cm, emarginate apex. Inflorescence 40.0–56.0 cm long, terminal, in a raceme. Flowers 3–9, attractive, white; dorsal sepal 2.5–3.0 × 0.9–1.2 cm, obovate to elliptical, acute apex; lateral sepals 2.2–3.0 × 0.9–1.2 cm, obovate, cuneate apex; petals 2.5–3.0 × 1.2–1.5 cm, elliptical, acute apex; lip 2.3–2.7 × 1.0–1.3 cm, trilobed, white with purple spots 2.0–2.5 × 0.4–0.6 cm. Fruits not observed.

Geographic distribution. Neotropical. Occurs in Central and South America (Brazil, Colombia, Guyana, Trinidad and Tobago, and Venezuela). In Brazil the species occurs in the North and Central-West regions (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is common in OAC. Usually growing on *Aldina heterophylla* in ZIII and ZIV regions. Observed with flower in August.

***Dichaea anchoraelabia* C.Schweinf.**

Material examined. BRAZIL • Amazonas, São Sebastião

do Uatumã, Uatumã SDR; -02.1847, -059.0345; alt. 40 m; 12 Apr. 2017; V. Klein 116 leg.; INPA 280951.

***Dichaea picta* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1921, -059.0124; alt. 40 m; 20 Feb. 2017; V. Klein 111 leg.; INPA 280846 • *ibid*; -02.1806, -059.0220; 19 Fev. 2018; V. Klein 260 leg.; INPA 281063.

***Encyclia chloroleuca* (Hook.) Neumann**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1801 -059.0301; alt. 40 m; 5 May 2018; V. Klein 236 leg.; INPA 281046.

***Encyclia conchaechila* Barb.Rodr.) Porto & Brade**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1811, -059.0314; alt. 40 m; 5 Nov. 2016; V. Klein 71 leg.; INPA 280910 • *ibid*; -02.1826, -059.0242; 20 Aug. 2017; V. Klein 204 leg.; INPA 281021.

***Encyclia mapuerae* (Huber) Brade & Pabst**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1812, -059.0101; alt. 40 m; 5 Nov. 2016; V. Klein 60 leg.; INPA 280903 • *ibid*; -02.1722, -059.0423; 20 Aug. 2017; V. Klein 203 leg.; INPA 281022.

***Epidendrum apuahuense* Mansf.**

Figure 6G

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1855, -059.0177; alt. 40 m; 11 May 2017; L.O. Demarchi 912 leg.; INPA 278517 • *ibid*; -02.1907, -059.0193; 15 Jun. 2017, V. Klein 156 leg.; INPA 278519.

Identification. Holoepiphyte. Herb erect. Pseudobulb ovoid, 0.2–0.5 × 0.2–0.30 cm. Leaves 2–3 per pseudobulb, elliptical to oblong, 1.2–3.9 × 2.8–1.3 cm, acute apex. Inflorescence 0.9–3.3 cm long, terminal, in a raceme. Flowers 2–4, attractive, ochre; dorsal sepal 2.0–3.8 × 0.2–0.4 cm, narrowly elliptical, acuminate apex; lateral sepals 2.0–3.4 × 0.2–0.4 cm, narrowly lanceolate, acuminate apex; petals 2.2–4.0 × 0.1–0.2 cm, linear, acuminate apex; lip 1.5–2.5 × 1.0–1.5 cm, entire, ovate to distinctly 3-lobed trilobed, light pink with reddish veins. Fruits not observed.

Geographic distribution. Amazon basin. Occurs in South America (Brazil and Venezuela). In Brazil this species occurs in the North Region (Flora do Brasil 2020)

Ecological and phenological information. Rare species, recently recollected for the Brazilian Amazon. Occurs in DAC and OFC. Usually growing in ZII region of the phorophytes. Observed with flowers between May and August.

***Epidendrum bahiense* Rchb.f.**

Figure 6H, I

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1803, -059.0227; alt. 40 m; 8 Aug. 2016; V. Klein 46 leg.; INPA 280889 • *ibid*; -02.1845, -059.0171; 21 Apr. 2017; V. Klein 117 leg.; INPA 280952 • *ibid*; -02.1906, -059.0190; 1 Sep. 2015; L.O. Demarchi 654 leg.; INPA 274281 • *ibid*; -02.1833, -059.2407; 24 Sep. 2017; V. Klein 177 leg.; INPA 271000.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 14.0–24.0 × 0.3–0.4 cm. Leaves 4–6 distichous along the stem, elliptical, 5.5–9.8 × 0.5–1.7 cm, retuse apex. Inflorescence 1.6–2.1 cm long, terminal, in a raceme. Flowers 1–3, attractive, yellow-greenish; dorsal sepal 1.9–2.8 × 0.2–0.4 cm, elliptical, acuminate apex; lateral sepals 2.2–3.0 × 0.3–0.5 cm, elliptical-falcate, acuminate apex; petals 1.9–2.8 × 0.15–0.2 cm, narrow-elliptical, acuminate apex; lip 1.3–2.1 × 1.1–1.6 cm, trilobed-clawed, greenish-white. Fruits fusiform, 5.6–6.8 × 0.8–1.3 cm.

Geographic distribution. Neotropical. This species is widely distributed in Central and South America. In Brazil this species occurs in all regions, except the South Region (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. The species is common in OSC, OAC, and OFC. Occurs mainly in the ZII region of the phorophytes. Observed with flowers and fruits between June and November.

Epidendrum carpophorum Barb.Rodr.

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1822, -059.0123; alt. 40 m; 21 Apr. 2017; V. Klein 117 leg.; INPA 280952 • *ibid*; -02.1832, -059.02304; 15 May 2018; V. Klein 138 leg.; INPA 280969.

Epidendrum compressum Griseb.

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1819, -059.0103; alt. 40 m; 11 Oct. 2017; V. Klein 245 leg.; INPA 280951 • *ibid*; -02.1821, -059.0234; 6 Feb. 2018; V. Klein 255; INPA 281059.

Epidendrum micronoturnum Carnevali &

G.A.Romero

Figure 6J

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1829, -059.0221; alt. 40 m; 21 Apr. 2017; V. Klein 122 leg.; INPA 280957 • *ibid*; -02.1832, -059.0204; 5 Jun. 2017; V. Klein 160 leg.; INPA 280987.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 3.8–5.0 × 0.15–0.25 cm. Leaves 2–5 distichous along the stem, narrow-linear, 4.0–8.1 × 0.4–0.6 cm, retuse apex. Inflorescence 0.8–1.2 cm long, terminal, in a raceme. Flowers 1–2, attractive, greenish-pink; dorsal sepal 1.7–1.9 × 0.2–0.3 cm, narrow elliptical, acuminate apex; lateral sepals 1.5–1.65 × 0.4–0.5 cm, elliptical, acuminate apex; petals 1.8–2.0 × 0.1–0.2 cm, linear-falcate, acuminate apex; lip 1.0–1.5 × 1.2–1.2 cm, trilobed,

white. Fruits fusiform, 2.8–3.0 × 0.6–1.1 cm.

Geographic distribution. Amazon basin. Occurs in South America (Brazil, Colombia, Ecuador, Guyana, Peru, and Venezuela). In Brazil this species occurs in the North and Central-West regions (Govaerts et al. 2021; Flora do Brasil 2020).

Ecological and phenological information. The species occurs in DSC, OAC, and DAC. Usually grows in ZIII region of the phorophytes. Observed with flowers and fruits between April and June.

Epidendrum microphyllum Lindl.

Figure 6K

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1782, -059.0180; alt. 40 m; 11 Feb. 2017; V. Klein 105 leg.; INPA 280942 • *ibid*; -02.1803, -059.2207; 6 Feb. 2018; V. Klein 273 leg.; INPA 286921 • *ibid*; -02.1906, -059.0190; 28 April 2018; L.O. Demarchi 678 leg.; INPA 284734.

Identification. Holoepiphyte. Herb reptant. Stem cylindrical 3.8–4.2 × 0.15–0.3 cm. Leaves 4–6 distichous along the stem, linear, 2.0–2.5 × 0.5–0.7 cm, acute apex. Inflorescence 4.2–6.3 cm long, terminal, in a raceme. Flowers 3–7, discreet, greenish; dorsal sepal 0.4–0.6 × 0.2–0.3 cm, elliptical, acute apex; lateral sepals 0.4–0.5 × 0.2–0.3 cm, elliptical-falcate, attenuate apex; petals 0.4–0.5 × 0.1–0.2 cm, linear, acute apex; lip 0.4–0.6 × 0.2–0.4 cm, ovoid, greenish. Fruits not observed.

Geographic distribution. Neotropical. Occurs in Central and South America (Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Panama, Peru, Suriname, and Venezuela). In Brazil this species occurs in the North region (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. Occurs in OAC and OFC. Usually grows in ZII region, forming clusters of small individuals on the phorophytes. Observed with flowers between February and April.

Epidendrum orchidiflorum (Salzm.) Lindl.

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1723, -059.0210; alt. 40 m; 8 Nov. 2016; V. Klein 74 leg.; INPA 280912.

Epidendrum rigidum Jacq.

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1814, -059.0237; alt. 40 m; 21 Apr. 2017; V. Klein 115 leg.; INPA 280950 • *ibid*; -02.1803, -059.0234; 21 Apr. 2017; V. Klein 118 leg.; INPA 280953.

Epidendrum sculptum Rchb.f.

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1812, -059.0131; alt. 40 m; 3 May 2017; V. Klein 135 leg.; INPA 280966 • *ibid*; -02.1803, -059.0234; 8 May 2018; V. Klein 238 leg.; INPA 281048.

***Epidendrum strobiliferum* Rchb.f.**

Figure 6L

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1831, -059.0240; alt. 40 m; 16 Aug. 2016, V. Klein 52 leg.; INPA280895 • *ibid*; -02.1833, -059.2407; 16 Jun. 2017; V. Klein 140 leg.; INPA 280971 • *ibid*; -02.1903, -059.0122 29 Apr. 2018; L.O. Demarchi 1159 leg.; INPA 284817.

Identification. Holoepiphyte. Herb pendant to subpendant. Stem cylindrical 5.5–9.4 × 0.3–0.5 cm. Leaves 4–9 distichous along the stem, oblong, 1.2–3.6 × 0.4–0.7 cm, emarginate apex. Inflorescence 0.8–2.5 cm long, terminal, in a raceme. Flowers 2–6, inconspicuous, whitish; dorsal sepal 0.3–0.6 × 0.15–0.2 cm, elliptical, cuneate apex; lateral sepals 0.3–0.6 × 0.15–0.2 cm, elliptical, acute apex; petals 0.2–0.5 × 0.05–0.1 cm, linear-falcate, rounded apex; lip clawed 0.3–0.4 × 0.15–0.25 cm, cordate, whitish. Fruits elliptical, 0.6–1.0 × 0.3–0.6 cm.

Geographic distribution. Neotropical. Widely distributed in the American continent. In Brazil the species occurs in all regions. (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is common in OAC. Usually growing in ZIV region of the phorophytes. Observed with flowers and fruits between February and November.

***Eriopsis sceptrum* Rchb.f. & Warsz.**

Material examined. BRAZIL • Amazonas, Manaus, Rio Cuieiras; -02.6000, -060.3330; alt. 50 m; 9 Apr. 1974; D.G. Campelli 21975 leg.; INPA 459153.

***Jacquinella globosa* Schltr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1912, -059.0170; alt. 40 m; 21 Apr. 2017; V. Klein 123 leg.; INPA 280858.

***Hylaeorchis petiolaris* (Schltr.) Carnevali & G.A.Romero**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1722, -059.0210; alt. 40 m; 8 Aug. 2016; V. Klein 106 leg.; INPA 280843 • *ibid*; -02.1823, -059.0243; 17 Jul. 2017, V. Klein 165 leg.; INPA 280992.

***Madisonia kerrii* Luer**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1923, -059.0120; alt. 40 m; 15 Jun. 2017; V. Klein 146 leg.; INPA 280977.

***Maxillaria brasiliensis* Brieger & Illg**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1820, -059.0422; alt. 40 m; 25 Apr. 2017; V. Klein 230 leg.; INPA 280961.

***Maxillaria camaridii* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião

do Uatumã, Uatumã SDR; -02.17893, -059.0112; alt. 40 m; 16 Feb. 2017; V. Klein 102 leg.; INPA 280939.

***Maxillaria crassifolia* (Lindl.) Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1702, -059.0345; alt. 40 m; 16 Fev. 2017; V. Klein 103 leg.; INPA 280940.

***Maxillaria desvauxiana* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1848, -059.0268; alt. 40 m; 9 Nov. 2016; V. Klein 79 leg.; INPA 280817 • *ibid*; -02.1731, -059.0223; 14 Jun. 2017, V. Klein 143 leg.; INPA 280974.

***Maxillaria kegelii* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1822, -059.0355; alt. 40 m; 29 Mar. 2017; V. Klein 114 leg.; INPA 280949 • *ibid*; -02.1831, -059.0244; 28 Oct. 2018, V. Klein 253 leg.; INPA 281057.

***Maxillaria parviflora* (Poepp. & Endl.) Garay**

Figure 7A

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1875, -059.0198; alt. 40 m; 8 Aug. 2016; V. Klein 50 leg.; INPA 280893 • *ibid*; -02.1831, -059.0240; 7 Aug. 2017, V. Klein 202 leg.; INPA 281020.

Identification. Holoepiphyte. Herb pendant. Pseudobulb ovate, laterally flattened 1.4–2.1 × 0.3–0.5 cm. Leaves 1 per pseudobulb, lanceolate, 8.0–12.0 × 0.9–1.2 cm, acute apex. Inflorescence 0.2–0.3 cm long, lateral, single-flower. Flowers 1, inconspicuous, whitish; dorsal sepal 0.4–0.6 × 0.2–0.3 cm, elliptical, cuneate apex; lateral sepals 0.3–0.5 × 0.2–0.3 cm, oblong, cuspidate apex; petals 0.2–0.5 × 0.1–0.2 cm, elliptical, cuspidate apex; lip 0.5–0.6 × 0.2–0.3 cm, lightly trilobed, white. Fruits not observed.

Geographic distribution. Neotropical. Widely distributed in the Central and South America. In Brazil the species occurs in all regions (Flora do Brasil 2020; Tropicos 2021).

Ecological and phenological information. Occurs mainly in OFC and DFC. Usually grows in ZII region of the phorophytes. Observed with flowers in August.

***Maxillaria superflua* Rchb.f.**

Figure 7B

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1935, -059.1882; alt. 40 m; 9 Nov. 2016; V. Klein 78 leg.; INPA 280916 • *ibid*; -02.1847, -059.0215; 3 Apr. 2017; V. Klein 132 leg.; INPA 280963 • *ibid*; -02.1774, -059.0213; 4 May 2018; L.O. Demarchi 1193 leg.; INPA 284829 • *ibid*; -02.1782, -059.0180; 13 Feb. 2019; V. Klein 274 leg.; INPA 286225.

Identification. Holoepiphyte. Herb erect. Pseudobulb oblong, laterally flattened 1.5–3.3 × 0.6–0.8 cm. Leaves

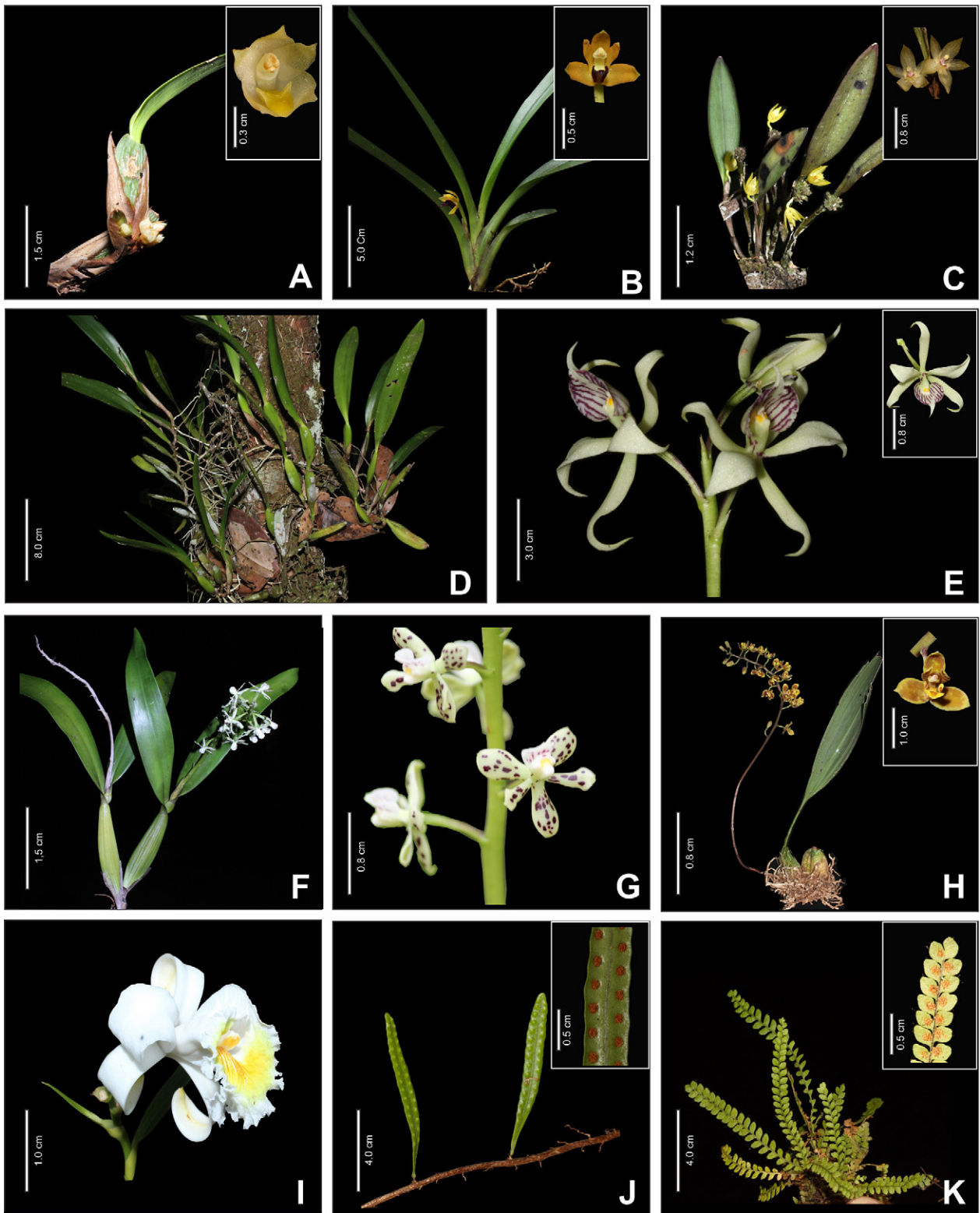


Figure 7. Species of vascular epiphytes with greater value of epiphytic importance (VEI) for the white-sand ecosystems of the Uatumā Sustainable Development Reserve. **A.** *Maxillaria parviflora*. **B.** *Maxillaria superflua*. **C.** *Octomeria grandiflora*. **D, E.** *Prosthechea aemula*. **F, G.** *Prosthechea crassilabia*. **H.** *Rudolfiella aurantiaca*. **I.** *Sobralia granitica*. **J.** *Microgramma baldwinii*. **K.** *Moranopteris nana*.

1 per pseudobulb, oblong, 14.3–27.2 × 0.8–1.6 cm, emarginate apex. Inflorescence 3.1–4.7 cm long, lateral, single-flower. Flowers 1, attractive, yellow; dorsal sepal 1.2–1.7 × 0.3–0.5 cm, elliptical, obtuse apex; lateral sepals 1.0–1.6 × 0.3–0.5 cm, elliptical, obtuse apex; petals 1.0–1.6 × 0.2–0.4 cm, lanceolate, acute apex; lip 1.3–1.6 × 0.6–0.7 cm, minutely trilobed, dark purple. Fruits fusiform 1.8–3.2 × 0.6–0.9 cm.

Geographic distribution. Neotropical. Occurs in South America (Bolivia, Brazil Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela). In Brazil this species occurs in the North and Central-West regions (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is common in OAC and OFC. Occurs mainly in the ZII and ZIII regions of the phorophytes. Observed with flowers and fruits throughout the year.

***Maxillaria tenuis* C.Schweinf.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1841, –059.0204; alt. 40 m; 2 Jan. 2017; V. Klein 91 leg.; INPA 280923.

***Maxillaria violaceopunctata* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1831, –059.0334; alt. 40 m; 16 Feb. 2017; V. Klein 99 leg.; INPA 280936.

***Notylia yauaperyensis* Barb.Rodr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1912, –059.01334; alt. 40 m; 11 Oct. 2017; V. Klein 246 leg.; INPA 281052 • *ibid*; –059.1711, –059.0305; 16 Oct. 2017; V. Klein 248 leg.; INPA 281053.

***Octomeria erosilabia* C.Schweinf.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1809, –059.0355; alt. 40 m; 26 Mar. 2017; V. Klein 113 leg.; INPA 280948 • *ibid*; –02.1813, –059.0345; 18 Jun. 2017; V. Klein 180 leg.; INPA 281003.

***Octomeria grandiflora* Lindl.**

Figure 7C

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1789, –059.0354; alt. 40 m; 16 Feb. 2017 V. Klein 81 leg.; INPA 280919 • *ibid*; –02.1810, –059.0211; 15 Jun. 2017; V. Klein 147 leg.; INPA 280978.

Identification. Holoepiphyte. Herb erect. Stem cylindrical at base and flattened at apex, 5.1–6.6 × 0.2–0.3 cm. Leaves 1 per pseudobulb, lanceolate, 6.1–7.6 × 0.7–0.9 cm, emarginate apex. Inflorescence 0.3–0.4 cm long, terminal, in a fascicle. Flowers 1–3, discreet, yellowish; dorsal sepal 0.6–0.8 × 0.2–0.3 cm, elliptical to oblong, cuneate apex; lateral sepals 0.6–0.9 × 0.2–0.3 cm, elliptical, cuneate apex; petals 0.6–0.9 × 0.15–0.2, elliptical,

acute apex; lip 0.4–0.6 × 0.25–0.4 cm, trilobed, yellow with red macules on disc. Fruits not observed.

Geographic distribution. Neotropical. Occurs in South America (Brazil, Colombia, Ecuador, Peru, and Venezuela). In Brazil this species is widely distributed, occurs in all regions (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is common in OFC and DFC, mainly in small sub-canopy trees. Occurs mainly in the ZII region of the phorophytes. Observed with flowers and fruits between February and November.

***Octomeria sagittata* (Rchb.f.) Garay**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1847, –059.1732; alt. 40 m; 21 Apr. 2017; V. Klein 120 leg.; INPA 280955.

***Octomeria scirpoidea* (Poepp. & Endl.) Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1825, –059.0345; alt. 40 m; 14 Jun. 2017; V. Klein 144 leg.; INPA 280975 • *ibid*; –02.1821, –059.0433; 18 Jun. 2017; V. Klein 182 leg.; INPA 281004.

***Octomeria taracuana* Schltr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1923, –059.0212; alt. 40 m; 2 Jan. 2017; V. Klein 97 leg.; INPA 2808935.

***Octomeria yauaperyensis* Barb.Rodr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1874, –059.0247; alt. 40 m; 21 Jun. 2017; V. Klein 182 leg.; INPA 281006 • *ibid*; –02.1800, –059.0212; 12 Aug. 2017; V. Klein 214 leg.; INPA 281028.

***Orleanesia amazonica* Barb.Rodr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1935, –059.1882; alt. 40 m; 5 Nov. 2016; V. Klein 55 leg.; INPA 280898 • *ibid*; –02.1774, –059.0213; 17 Jun. 2017; L.O. Demarchi 947 leg.; INPA 284769.

***Pabstiella yauaperyensis* (Barb.Rodr.) F.Barros**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1737, –059.0356; alt. 40 m; 16 Nov. 2017; V. Klein 249 leg.; INPA 281054 • *ibid*; –02.1833, –059.0423; 15 May 2018; V. Klein 261 leg.; INPA 281064.

***Polystachya foliosa* (Hook.) Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; –02.1827, –059.1882; alt. 40 m; 15 Jun. 2017; V. Klein 152 leg.; INPA 280983 • *ibid*; –02.19217, –059.0225; 5 Jun. 2018; V. Klein 239 leg.; INPA 281049.

***Polystachya stenophylla* Schltr.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1935, -059.0882; alt. 40 m; 9 Nov. 2016; V. Klein 78 leg.; INPA 280915 • *ibid*; -02.1847, -059.1756; 5 May 2018; V. Klein 265 leg.; INPA 281068.

***Prosthechea aemula* W.E.Higgins**

Figure 7D, E

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1856, -059.02357; alt. 40 m; 9 Nov. 2016; V. Klein 80 leg.; INPA 280918 • *ibid*; -02.1812, -059.0202; 2 Feb. 2017; V. Klein 104 leg.; INPA 280941 • *ibid*; -02.1831, -059.0240; 3 May 2017; V. Klein 136 leg.; INPA 280967.

Identification. Holoepiphyte. Herb erect. Pseudobulb elliptical, 3.2–6.4 × 0.6–1.2. Leaves 1 per pseudobulb, elliptical to lanceolate, 13.6–17.3 × 1.1–1.5 cm, attenuate apex. Inflorescence 3.4–6.2 cm long, terminal, in a raceme. Flowers 2–4, attractive, greenish-white; dorsal sepal 2.2–2.4 × 0.4–0.6 cm, lanceolate, attenuate apex; lateral sepals 2.2–2.4 × 0.4–0.6 cm, lanceolate-falcate, attenuate apex; petals 2.2–2.4 × 0.2–0.35 cm, lanceolate, attenuate apex; lip 1.4–1.6 × 1.0–1.3 cm, sub-orbiculate, concave, white with purple vein. Fruits wide-elliptical, 3.2–3.5 × 1.5–1.7.

Geographic distribution. Neotropical. This species is widely distributed in Central and South America. In Brazil this species occurs in all the regions (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is abundant and common in all local campinarana phytophysognomies, forming large clusters on the phorophytes. Occurs mainly in the ZIII and ZIV regions. Observed with flowers and fruits between January and June.

***Prosthechea crassilabia* (Poepp. & Endl.) Carnevali & I.Ramírez**

Figure 7F, G

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1866, -059.0232; alt. 40 m; 8 Aug. 2016; V. Klein 48 leg.; INPA 280892 • *ibid*; -02.1812, -059.0202; 17 Jun. 2017; V. Klein 148 leg.; INPA 280979 • *ibid*; -02.1906, -059.0190; 28 Apr. 2018; L.O. Demarchi 1153 leg.; INPA 284812.

Identification. Holoepiphyte. Herb erect. Pseudobulb ovoid, 5.5–9.7 × 1.0–1.2. Leaves 2 per pseudobulb, elliptical to lanceolate, 16.2–24.9 × 1.5–2.7 cm, retuse apex. Inflorescence 5.5–21.4 cm long, terminal, in a raceme. Flowers 6–22, attractive, greenish with purplish macules; dorsal sepal 0.9–1.1 × 0.3–0.5 cm, oblong, attenuate apex; lateral sepals 0.9–1.1 × 0.3–0.5 cm, elliptical, cuneate apex; petals 0.9–1.1 × 0.1–0.15 cm, oblanceolate, rounded apex; lip 0.8–0.9 × 0.6–0.7 cm, obtrullate, white with purple veins. Fruits not observed.

Geographic distribution. Endemic to Brazil, distributed in all regions of the country (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species occurs in OAC and OFC. Usually growing in ZII and ZIII regions of the phorophytes. Observed with flowers between June and November.

***Quekettia microscopica* Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1812, -059.0426; alt. 40 m; 11 Jan. 2018, V. Klein 250 leg.; INPA 281055.

***Rudolfiella aurantiaca* (Lindl.) Hoehne**

Figure 7H

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1803, -059.0432; alt. 40 m; 13 Oct. 2015; L.O. Demarchi 697 leg.; INPA 274324 • *ibid*; -02.1852, -059.0274; 2 Oct. 2018; V. Klein 269 leg.; INPA 286920.

Identification. Holoepiphyte. Herb erect. Pseudobulb ovoid tetragonal, 3.5–5.2 × 2.2–3.1. Leaves 1 per pseudobulb, elliptical to lanceolate, 16.2–24.9 × 1.5–2.7 cm, acute apex. Inflorescence 5.5–21.4 cm long, terminal, in a raceme. Flowers 12–23, attractive, yellow with brown macules; dorsal sepal 1.0–1.2 × 0.4–0.5 cm, oblong, rounded apex; lateral sepals 1.0–1.2 × 0.4–0.6 cm, oblong-falcate, attenuate apex; petals 1.0–1.2 × 0.15–0.2 cm, linear-falcate, attenuate apex; lip 0.9–1.1 × 0.7–0.9 cm, trilobed, yellow with brown macules. Fruits not observed.

Geographic distribution. Restricted to the Amazon basin. Occurs in South America (Brazil, Bolivia; Colombia, Peru, Suriname, and Venezuela). In Brazil this species occurs in the North Region (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. The species occur in OAC and OFC. Usually growing in ZII region of the phorophytes. Observed with flowers in October.

***Scaphyglottis reflexa* Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1713, -059.0433; alt. 40 m; 8 Nov. 2016; V. Klein 75 leg.; INPA 280813 • *ibid*; -02.1812, -059.0202; 17 Jun. 2017; V. Klein 164 leg.; INPA 280991.

***Scaphyglottis sickii* Pabst**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1821, -059.0322; alt. 40 m; 14 Jun. 2017; V. Klein 142 leg.; INPA 280873 • *ibid*; -02.1862, -059.0212; 8 May 2018; V. Klein 237 leg.; INPA 281047.

***Scaphyglottis stellata* Lodd. ex Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1831, -059.0240; alt. 40 m; 10 Jun. 2017; V. Klein 200 leg.; INPA 281018.

***Scuticaria steelei* (Hook.) Lindl.**

Material examined. BRAZIL • Amazonas, São Seba-

stão do Uatumã, Uatumã SDR; -02.1823, -059.0322 alt. 40 m; 28 Apr. 2017; V. Klein 133 leg.; INPA 280964.

***Sobralia bletiae* Rchb.f.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1872, -059.0316 alt. 40 m; 28 Jun. 2017; V. Klein 183 leg.; INPA 281005.

***Sobralia granitica* G.A.Romero & Carnevali**

Figure 7I

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1902, -059.0156 alt. 40 m; 8 Aug. 2016; V. Klein 48 leg.; INPA 280891 • *ibid*; -02.1805, -059.0221; 5 Aug. 2016; V. Klein 51 leg.; INPA 280894 • *ibid*; -02.1709, -059.0091; 15 Jun. 2017; V. Klein 145 leg.; INPA 281002.

Identification. Accidental epiphyte. Herb erect. Stem cylindrical, 64.8–150.5 × 0.3–0.5 cm. Leaves 9–16, distichous along the stem, lanceolate, plicate, 17.7–24.33 × 3.0–3.6 cm, acute apex. Inflorescence 5.5–21.4 cm long, terminal, in a raceme. Flowers 2–4, attractive, white; dorsal sepal 5.5–5.8 × 1.3–1.5 cm, oblong, attenuate apex; lateral sepals 5.3–5.5 × 1.1–1.3 cm, elliptical-falcate, obtuse apex; petals 5.3–5.5 × 1.0–1.2, elliptical, obtuse apex; lip 5.2–5.4 × 3.8–4.0 cm, discreetly trilobed to obovate, white with yellow veins, lateral lobes hugging the column. Fruits oblong, 4.8–5.3 × 1.7–2.2 cm.

Geographic distribution. Restricted to the Amazon basin. Occurs in South America (Brazil, Colombia, and Venezuela). In Brazil this species occurs in the North Region. (Flora do Brasil 2020; Govaerts et al. 2021).

Ecological and phenological information. This species is common in OSC. It is generally observed with terrestrial habit, but occasionally occurs as epiphyte in the lower parts (ZI and ZII) of the phorophytes. Observed with flowers and fruits between June and November

***Specklinia picta* (Lindl.) Pridgeon & M.W.Chase**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1802, -059.0423 alt. 40 m; 11 Jan. 2018; V. Klein 254 leg.; INPA 281058.

***Trichosalpinx orbicularis* (Lindl.) Luer**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1752, -059.0333 alt. 40 m; 5 Nov. 2016; V. Klein 56 leg.; INPA 280895 • *ibid*; -02.1812, -059.0121; 17 Jun. 2017; V. Klein 163 leg.; INPA 280990.

***Vanilla bicolor* Lindl.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1822, -059.0356 alt. 40 m; 23 Apr. 2017; V. Klein 124 leg.; INPA 280959 • *ibid*; -02.1805, -059.0221; 25 Apr. 2017; V. Klein 129 leg.; INPA 280960.

Polypodiaceae J.Presl

***Cochlidium serrulatum* (Sw.) L.E.Bishop**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1862, -059.0100; alt. 40 m; 11 May 2019; V. Klein 303 leg.; INPA 286948 • *ibid*; -02.1906, -059.0190; 25 Feb. 2020; V. Klein 398 leg.; INPA 289216.

***Microgramma baldwinii* Brade**

Figure 7J

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1782, -059.0180; alt. 40 m; 5 May 2019; V. Klein 297 leg.; INPA 286943 • *ibid*; -02.1906, -059.0190; 7 Sep. 2019; V. Klein 332 leg.; INPA 286968.

Identification. Holoepiphyte. Herb pendant. Stem cylindrical, 80–250.0 × 0.15–0.25 cm, long-creeping stem, covered by light brown scale. Leaves 5–22, distichous along the stem; sterile leaves, elliptical, 3.3–5.2 × 0.5–1.1 cm, acute apex; fertile leaves lanceolate to linear, 4.0–6.2 × 0.3–0.8 cm, acute apex. Sori round, distributed in two linear rows, without indusium, printed on the leaf blade, leaving marks (scar) on the upper side of the leaf.

Geographic distribution. Amazon basin. Occurs in South America (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, and Venezuela). In Brazil the species occurs in the North Region (Flora do Brasil 2020; Tropicos 2020).

Ecological and phenological information. The species is common in all local campinarana phytophysiognomies. Usually, the species is spread over the entire length of phorophytes, is common in ZII and ZIV regions. Observed in fertile stage between February and May.

***Moranopteris nana* (Fée) R.Y. Hirai & J. Prado**

Figure 7K

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1852, -059.0240; alt. 40 m; 11 May 2019; V. Klein 304 leg.; INPA 286949.

Identification. Holoepiphyte. Herb erect. Stem cylindrical, 0.5–1.1 × 0.05–0.10 cm, covered by yellow-brown to orange-brown scales. Leaves 4–6, laminae linear, pinnatisect; 4.3–9.8 × 1.0–2.0 cm, acute apex; fertile leaves lanceolate to linear, 4.0–6.2 × 0.3–0.8 cm, acute apex. Sori one per segment, round, (0.5–)1.2–1.5 mm in diameter.

Geographic distribution. Neotropical. Widely distributed in the Central and South America. In Brazil the species occurs in the North, Northeast, and Central-West regions (Flora do Brasil 2020; Tropicos 2020).

Ecological and phenological information. This species occurs in moist areas of OFC and DFC. Usually grows in ZI region of the phorophytes. Observed in fertile stage between May and August.

***Pleopeltis bombycina* (Maxon) A.R.Sm.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1852, -059.0240; alt. 40 m; 26 Nov. 2006; C.E. Zartman 6248 leg.; INPA 226324 • *ibid*; -02.1906, -059.0190; 20 May 2021; V. Klein 426 leg.; INPA289242.

***Serpocaulon triseriale* (Sw.) A.R.Sm.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1845, -059.0234; alt. 40 m; 25 Feb 2020; V. Klein 393 leg.; INPA 289211.

Pteridaceae E.D.M.Kirchn.

***Vittaria lineata* (L.) Sm.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1852, -059.0240; alt. 40 m; 20 Mar. 2007; C.E. Zartman 7064 leg.; INPA 226368 • *ibid*; -02.1906, -059.0190; 25 Feb. 2020; V. Klein 392 leg.; INPA289210.

Schizaeaceae Kaulf.

***Actinostachys pennula* (Sw.) Hook.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1856, -059.0203; alt. 40 m; 16 Jul. 2017; V. Klein 169 leg.; INPA 286914.

Rubiaceae Juss.

***Hillia illustris* (Vell.) K.Schum.**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Uatumã SDR; -02.1866, -059.0232; alt. 40 m; 12 Dec. 2016; L.O. Demarchi 1619 leg.; INPA 288699.

Urticaceae Juss.

***Coussapoa asperifolia* Trécul**

Material examined. BRAZIL • Amazonas, São Sebastião do Uatumã, Ramal da Morena; -01.9155, -059.4734; alt. 40 m; 3 Sep. 1987; F.D. Mattos 177 leg.; INPA 148153.

Discussion

Knowledge of the composition and distribution of species in Amazonian campinaranas has mainly focused on tree communities (e.g., Vicentini 2004; Fine and Kembel 2011; Stropp et al. 2011; García-Villacorta et al. 2016; Demarchi et al. 2018; Costa et al. 2020), while for vascular epiphytes, the numbers of studies are still relatively modest (Braga 1982; ter Steege and Cornelissen 1989; Gottsberger and Morawetz 1993; Coomes and Grubb 1996; Mari et al. 2016; Klein and Piedade 2019).

The campinaranas of the Uatumã SDR present remarkable variation in the structure of their vegetation, even within small distances, and form a set of physiognomies with differences in the richness and density of vascular epiphytes. The forested (OFC) and arboreal (OAC)

campinarana areas present the most species and individuals of vascular epiphytes (Appendix Table A1). In these typologies, the tree communities are more diverse, and the trees have larger sizes (diameter and height) (Targhetta et al. 2015; Demarchi et al. in press). Structural variables of the trees, mainly related to the size and canopy area, are positively correlated with the increase in richness and abundance of epiphytes (Zotz and Vollrath 2003; Laube and Zotz 2007; Wang et al. 2016; Quaresma et al. 2017). The sum of the structural characteristics, together with a greater diversity of phorophytes, provides greater environmental heterogeneity and availability of new microhabitats, enabling the establishment of different epiphytic groups (Zotz and Vollrath 2003; Woods et al. 2015).

Another important factor to be considered is species adaptations. Differences in the occurrence of taxa among phytophysiognomies may reflect morphological, anatomical, and physiological adaptations that enable different groups to establish and occupy different microhabitats without overlap (Agudelo et al. 2019). Some epiphytes (e.g., *Brassavola martiana*, *Epidendrum strobiliferum*, and *Tillandsia adpressiflora*) present carbon-fixation pathways of the crassulacean acid metabolism (CAM) type, which allows epiphytes to settle in environments with higher luminous incidence, such as the phytophysiognomies of OAC and OSC (Braga 1977a; Bonates and Braga 1992; Bonates 1993). On the other hand, species more sensitive to light and which undergo rapid desiccation (e.g., *Hymenophyllum polyanthos* and *Trichomanes humboldtii*) occurred more frequently in areas with higher humidity such as the DAC and DFC phytophysiognomies. Zuquim et al. (2012) observed that the composition of ferns in campinaranas show a strong correlation with the opening of the canopy. A similar pattern was reported by Daly et al. (2016), who highlighted that *Elaphoglossum discolor* and *Trichomanes bicorne* Hook were characteristic of campinaranas that undergo seasonal flooding, while other species (e.g., *Codonanthe carnosa* (Gardner) Hanst) are common in open campinaranas.

In addition to the vegetation structure (size, density, and composition of tree species) and species adaptations (morphological, anatomical, physiological, and ecological), other environmental and microclimatic characteristics may be associated with the distribution of species in these phytophysiognomies. Studies in different regions, report differences in species distribution as a function of light and moisture gradients that vary at the forest-atmosphere interface (Johansson 1974; Krömer et al. 2007; Sporn et al. 2010; Marcusso et al. 2019). Similarly, Larea and Wener (2010), when evaluating the distribution of the vascular epiphytes assemblage in environments with different canopy structure, attributed changes in species composition primarily to microclimate alterations towards higher levels of light and desiccation stress. Future studies relating environmental variables to the floristic and functional composition of vascular epiphytes

are fundamental to elucidate the questions about the distribution patterns and occurrences of the species and the different phytosociologies of Amazonian campinaranas.

Our results revealed a high number of species (112 spp.) when compared to the quantitative studies carried out by ter Steege and Cornelissen (1989) in campinarana forests of Guyana (67 spp.), by Gottsberger and Morawetz (1993) in the southwest of the Brazilian Amazon (7 spp.), by Coomes and Grubb (1996) in campinaranas of Venezuela (12 spp.), and by Mari et al. (2016) in 36 focal *A. heterophylla* phorophytes in areas of campinarana of the central Amazon (68 spp.). Contrary to the studies mentioned above, in which the species were recorded only within the sample units (plots), we also carried out ramblings throughout the area, which may explain the greater richness found. Kersten and Waechter (2011) reported that floristic sampling, even in a few sample units, is sufficient to evaluate the structural parameters of the communities, but they highlighted that the sampling of trees around the plots favors more accurate floristic lists and increases the chance of inclusion of rare species, besides bringing important biogeographic information. The quantitative results that we obtained corroborate the postulation of Kersten and Waechter (2011), since if we considered only the species in the plots (62 spp.), the richness of the vascular epiphytes of the campinaranas of the Uatumã SDR would be underestimated by approximately 45%.

Also of importance when comparing the species richness observed in the current study with other studies published for the Amazonian campinaranas is the structure of the analyzed vegetation. In the campinaranas studied by ter Steege and Cornelissen (1989), the trees reached heights of up to 30 m and there is a high density of individuals (500-600 ind/ha), but those authors emphasized that the vegetation is formed by a large proportion of small trees. Similarly, for the campinaranas analyzed in Venezuela, Coomes and Grubb (1996) also reported the absence of trees with diameter ≥ 30 cm and Gottsberger and Morawetz (1993) characterized their study area as being formed by isolated trees and grass savanna. Thus, substrate availability and phorophyte size can be a limiting factor for the occurrence of epiphyte species, since the colonization by epiphytes is positively correlated with phorophyte size and composition in local tree communities (Burns et al. 2010; Marcusso et al. 2019). Our results are closer to those observed by Mari et al. (2016), with 36 species shared between the studies. In addition to the geographical proximity of the areas, the campinaranas of Central Amazonia have different phytophysiologies, ranging from open areas to forest formations, dominated by large trees, such as *Aldina heterophylla* that can reach diameters greater than 80 cm and is recognized as one of the main phorophytes for epiphytes in these environments (Mari et al. 2016; Klein and Piedade 2019).

The representativeness at family level follow the pattern described for the Neotropical regions (Gentry and Dodson 1987), with Orchidaceae, Bromeliaceae, and

Araceae representing 80% of the species. This pattern is also widely reported for different Amazonian environments (Nieder et al. 2000; Benavides et al. 2011; Obummulder et al. 2011, 2014; Irumé et al. 2013; Quaresma and Jardim 2013; Boelter et al. 2014; Quaresma et al. 2017, 2018) and includes campinarana environments (ter Steege and Cornelissen 1989; Mari et al. 2016). The selection of some characteristics, such as velamen-coated roots, water storage structures, a thick cuticle, an aquifer hypodermis, specialized stomata, and CAM metabolism, reflect adaptations that have enabled these families great success in colonizing the forest canopy (Dubuisson et al. 2009; Zotz 2016; Agudelo et al. 2019). This feat is so evident that the tropical regions of South America are considered the main center of diversification for several epiphyte lineages, especially for Bromeliaceae and Orchidaceae (e.g., Kreier et al. 2008; Mendoza et al. 2017; Pérez-Escobar et al. 2017).

Most of the vascular epiphytes recorded in this study (87%) have wide geographical distributions and occur in virtually all Neotropical humid lowlands around the Amazon basin. This broad pattern of distribution can be attributed to two main factors: the high ecophysiological plasticity (Ibisch et al. 1996; Kessler 2001; Fontoura and Santos 2010) and the high dispersal ability of the main groups (Tremblay 1997; Kessler 2001, 2002; Kreft et al. 2004; Küper et al. 2004; Acevedo et al. 2020). Nieder et al. (1999) highlighted that the extensive lowland plains of the Amazon (altitude <400 m) favor the long dispersion of propagules, which for most epiphytes is anemochoric, and which results in a flora with a low degree of heterogeneity. Although most epiphytes have wide distributions, campinaranas are recognized as being a habitat of an endemic and specialized flora (Fine et al. 2010; Fine and Kembel 2011; Fine and Baraloto 2016; Guevara et al. 2016). Among the species of epiphytes restricted to the campinaranas, we can highlight *Cattleya wallisii*, *Elaphoglossum discolor*, *Hylaeorchis petiolaris*, and *Sobralia granitica* (Flora do Brasil 2020).

A small number of species (6 spp.) was responsible for more than 70% of the recorded epiphyte abundance, while the majority of the species (47 spp.) can be considered “rare” locally, since they have an abundance of less than five individuals. The presence of few abundant species and many species with a low abundance of individuals is a recurrent pattern for epiphytic assemblages (Nieder et al. 2000; Kersten and Silva 2002; Quaresma et al. 2017). However, several species considered rare were recorded in the qualitative survey (outside the plots), which leads to the belief that the “rarity” for many species is only an artifact of sampling.

Prosthechea aemula stood out as the most abundant species (336 individuals), while *Brassavola martiana* colonized more phorophytes (28), which is a pattern similar to that shown for other Amazonian campinaranas (Braga 1977b; Mari et al. 2016). The high representativeness of these species may indicate that both have adaptations or functional traits that cause them to have greater

success in the colonization of campinaranas. *P. aemula* allocates energy to rapid vegetative growth, constantly adding new pseudobulbs, which leads to the formation of large clusters of individuals on the phorophytes (Braga 1977b, 1981). The species also presents a set of phenological and floral characteristics, such as a resupinate lip and longitudinal striae, which act as nectar guides, and osmophores that release a strong aroma, which direct the floral visitor, thus resulting in greater reproductive success (Braga 1977b; Krahl 2020). For *B. martiana*, physiological adaptations that allow to alternate the pathway of atmospheric carbon fixation from C₃ to CAM during dry and hot periods are reported (Bonates and Braga 1992; Bonates 1993, 2007). The CAM metabolic pathway is associated with strategies for water conservation and confers advantages in environments that have periods of water stress (Lambers and Oliveira 2019). Crassa leaves, a thick cuticle and stomatal predominance in the abaxial epidermis also enable *B. martiana* to withstand the water stress that is characteristic of the epiphytic habit and potentiated in campinarana environments, and may justify the wide local distribution of the species (Bonates 2007).

In recent years, the environments of campinarana have been undergoing increasing processes of fragmentation and suppression of vegetation (Ferreira et al. 2013; Adeney et al. 2016; Demarchi et al. 2019), which is extremely worrying considering the low resilience of these environments and the fact that they are poorly represented in conservation units (Capurucho et al. 2020). A continuous effort by researchers to catalog the diversity of the plants in these ecosystems is necessary, especially for the epiphytic flora, which is sensitive to minor environmental changes. Information on the local distribution patterns of taxa and issues involving the interaction of epiphytes with their respective phorophytes are key points to be considered in subsequent studies. A better understanding of the processes that structure the dynamics of plant communities in campinarana environments, including the epiphytic component, is essential in order to guide discussions and planning that have the aim of the conservation and preservation of the biodiversity of these fragile Amazonian environments.

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Authors' Contributions

Conceptualization: VPK, LOD, ACQ, MTFP. Data curation: VPK, LOD, ACQ. Formal analysis: VPK. Funding acquisition: ACQ, MTFP. Investigation: VPK, LOD, ACQ. Methodology: VPK, LOD, ACQ, JC. Project administration: VPK, ACQ, MTFP. Resources: ACQ, MTFP. Software: VPK, JC. Supervision: ACQ, MTFP. Validation: VPK, LOD, ACQ, JC, MTFP. Visualization: VPK, LOD, ACQ, JC, MTFP. Writing – original draft: VPK, LOD, ACQ, JC, MTFP. Writing – review & editing: VPK, LOD, ACQ, JC, MTFP.

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Appendix

Table A1. Vascular epiphytes flora in a white-sand ecosystem in Uatumã Sustainable Development Reserve. Ecological categories: Hol (characteristic epiphytes); Fac (Facultative epiphytes); Acc (accidental epiphyte) and Hem (hemiepiphytes). Types of campinaranas: **OSC** (Open Shrubby Campinarana); **DSC** (Dense Shrubby Campinarana); **OAC** (Open Arboreal Campinarana); **DAC** (Dense Arboreal Campinarana); **OFC** (Open Forested Campinarana) and **DFC** (Dense Forested Campinarana). Geographic distribution: (PAN) pantropical; (NEO) Neotropical; (BA) restricted to the Amazon basin; (EN) restricted to Brazil; (SA) Amazon basin + other Brazilian vegetations.

Group/family/species	Life form	Types of campinarana	Geographic distribution	Voucher
FERNS				
Aspleniaceae				
<i>Asplenium serratum</i> L.	Hol	OFC	NEO	INPA 277951, 286951
Dryopteridaceae				
<i>Elaphoglossum discolor</i> (Kuhn) C.Chr.	Hol	OFC DFC DAC	SA	INPA 286913
<i>Elaphoglossum glabellum</i> J.Sm.	Hol	OFC	NEO	INPA 286956, 286957
<i>Elaphoglossum obovatum</i> Mickel	Hol	OFC DFC DAC	NEO	INPA 286945, 286913
<i>Elaphoglossum plumosum</i> (Fée) T.Moore	Hol	OFC DFC DAC OAC	SA	INPA 286915, 286944
Hymenophyllaceae				
<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	Hol	OFC DFC DAC DSC	PAN	INPA 286950, 286970
<i>Trichomanes crispum</i> L.	Hol	OFC DFC DAC	NEO	INPA 286946
<i>Trichomanes humboldtii</i> (Bosch) Lellinger	Fac	OFC DFC DAC DSC	BA	INPA 286947
Polypodiaceae				
<i>Cochlidium serrulatum</i> (Sw.) L.E.Bishop	Hol	OFC DFC	PAN	INPA 286948
<i>Microgramma baldwinii</i> Brade	Hol	OFC DFC DAC OAC DSC OSC	BA	INPA 277937, 286943
<i>Moranopteris nana</i> (Fée) R.Y. Hirai & J. Prado	Hol	OFC DFC	NEO	INPA 286949, 87746
<i>Pleopeltis bombycina</i> (Maxon) A.R.Sm.	Hol	OFC DFC	NEO	INPA 87423, 226324
<i>Serpocaulon attenuatum</i> (C. Presl) A.R. Sm.	Hol	OFC	NEO	INPA 10553
Pteridaceae				
<i>Vittaria lineata</i> (L.) Sm.	Hol	OFC	PAN	INPA 226368
Schizaeaceae				
<i>Actinostachys pennula</i> (Sw.) Hook.	Hol	OFC OAC	NEO	INPA 286914
ANGIOSPERMS				
Araceae				
<i>Anthurium bonplandii</i> Bunting	Hol	OFC OAC	BA	INPA 286939, 286940
<i>Anthurium eminens</i> Schott	Hem	OFC	NEO	INPA 277951
<i>Anthurium gracile</i> (Rudge) Lindl.	Hol	OFC DFC OAC OSC	NEO	INPA 286963, 286983

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<i>Anthurium obtusum</i> (Engl.) Grayum	Hol	OFC DFC	NEO	INPA 286912
<i>Philodendron billietiae</i> Croat	Hem	OFC	BA	INPA 241196
<i>Philodendron distantilobum</i> K.Krause	Hem	OFC OAC	BA	INPA 225245
<i>Philodendron megalophyllum</i> Schott	Hem	OFC	NEO	INPA 274318
<i>Philodendron pulchrum</i> G.M.Barroso	Hem	OFC DFC	NEO	INPA 192925
<i>Thaumatococcus spruceanum</i> Schott	Hem	OFC	BA	MNHN 1750689
Bromeliaceae				
<i>Aechmea beeriana</i> L.B.Sm. & M.A.Spencer	Fac	OFC OAC	BA	INPA 288546
<i>Aechmea bromeliifolia</i> (Rudge) Baker	Fac	OFC OAC	NEO	INPA 87295, 225305
<i>Aechmea huebneri</i> Harms	Fac	OFC OAC OSC DSC	NEO	INPA 288387
<i>Aechmea longifolia</i> (Rudge) L.B.Sm. & M.A.Spencer	Hol	OFC OAC	NEO	INPA 225296
<i>Aechmea mertensii</i> (G.Mey.) Schult. & Schult.f.	Hol	OFC OAC OSC	NEO	INPA 288500, 225303
<i>Aechmea rodriguesiana</i> (L.B.Sm.) L.B.Sm.	Hol	OFC	EN	INPA 178866
<i>Aechmea setigera</i> Mart. ex Schult. & Schult.f.	Fac	OFC OAC	NEO	INPA 87712
<i>Araeococcus micranthus</i> Brongn.	Hol	OFC OAC	NEO	INPA 288516
<i>Billbergia violacea</i> Bee	Hol	OFC	BA	INPA 127339
<i>Bromelia grandiflora</i> Mez	Acc	OFC OAC	EN	IAN 83619
<i>Neoregelia eleutheropetala</i> (Ule) L.B.Sm.	Hol	OFC	NEO	INPA 207064
<i>Tillandsia adpressiflora</i> Mez	Hol	OFC DFC DAC OAC DSC OSC	BA	INPA 287405
<i>Tillandsia bulbosa</i> Hook.f.	Hol	OFC	NEO	INPA 278025, 288695
Cactaceae				
<i>Epiphyllum phyllanthus</i> (L.) Haw.	Hol	OFC	NEO	INPA 87667
Clusiaceae				
<i>Clusia insignis</i> Mart.	Hem	OFC DFC OAC DAC	NEO	INPA 274278
<i>Clusia nemorosa</i> G.Mey.	Hem	OFC DFC OAC	NEO	INPA 151875, 274269
Cyclanthaceae				
<i>Ludovia lancifolia</i> Brongn.	Hol	OFC	NEO	INPA 288684
Gesneriaceae				
<i>Codonanthesis crassifolia</i> (H. Focke) Chautems & Mat. Perret	Hol	OFC DFC OAC OSC	NEO	INPA 286982
<i>Codonanthesis ulei</i> Mansf.	Hol	OFC	BA	INPA 277928
Moraceae				
<i>Ficus mathewsii</i> (Miq.) Miq.	Hem	OFC	NEO	INPA 272956
Orchidaceae				
<i>Acianthera discophylla</i> Luer & Carneval	Hol	DAC	BA	INPA 280994
<i>Acianthera fockei</i> (Lindl.) Pridgeon & M.W.Chase	Hol	OFC OAC	BA	INPA 280908, 280927
<i>Acianthera miqueliana</i> (H.Focke) Pridgeon & M.W.Chase	Hol	OFC	BA	INPA 280909
<i>Agansia fimbriata</i> Rchb.f.	Hol	OFC	BA	INPA 286917
<i>Batemanina colleyi</i> Lindl.	Hol	OFC	BA	INPA 280962
<i>Bifrenaria longicornis</i> Lindl.	Hol	OFC OAC	BA	INPA 280944, 280981
<i>Brassavola martiana</i> Lindl.	Hol	OFC DFC DAC OAC DSC OSC	BA	INPA 280932, 281023
<i>Bulbophyllum setigerum</i> Lindl.	Hol	DAC	BA	INPA 280985
<i>Campylocentrum fasciola</i> (Lindl.) Cogn.	Hol	OAC	NEO	INPA 286980
<i>Catasetum discolor</i> (Lindl.) Lindl.	Hol	OFC DFC OAC	BA	INPA 280947, 280965
<i>Catasetum rivularium</i> Barb.Rodr.	Hol	OFC	BA	INPA 284797, 284801
<i>Catasetum tigrinum</i> Rchb.f.	Hol	DFC	EN	INPA 195192
<i>Cattleya wallisii</i> (Linden) Linden ex Rchb.f.	Hol	OFC OAC	EN	INPA 280907
<i>Caularthron bicornutum</i> (Hook.) Raf.	Hol	OFC OAC	NEO	INPA 280896
<i>Dichaea anchoraelabia</i> C.Schweinf.	Hol	OFC	BA	INPA 280951
<i>Dichaea picta</i> Rchb.f.	Hol	OFC OAC	BA	INPA 280946, 281063
<i>Encyclia chloroleuca</i> (Hook.) Neumann	Hol	OFC	NEO	INPA 281046
<i>Encyclia conchaechila</i> (Barb.Rodr.) Porto & Brade	Hol	DSC	BA	INPA 280910, 281021
<i>Encyclia mapuerae</i> (Huber) Brade & Pabst	Fac	OSC OAC	BA	INPA 280903, 281022
<i>Epidendrum apuahense</i> Mansf.	Hol	OFC DAC	BA	INPA 278517, 278519
<i>Epidendrum bahiense</i> Rchb.f.	Hol	OFC OAC DSC OSC	NEO	INPA 280889, 280952
<i>Epidendrum carpophorum</i> Barb.Rodr.	Hol	OFC OAC	NEO	INPA 280952, 280969
<i>Epidendrum compressum</i> Griseb.	Hol	OFC	NEO	INPA 281051, 281059
<i>Epidendrum micronoturnum</i> Carnevali & G.A.Romero	Hol	OFC OAC DAC DSC	BA	INPA 280957, 280968
<i>Epidendrum microphyllum</i> Lindl.	Hol	OFC OAC	NEO	INPA 280942
<i>Epidendrum orchidiflorum</i> (Salzm.) Lindl.	Acc	OAC OSC	SA	INPA 280912
<i>Epidendrum rigidum</i> Jacq.	Hol	OAC	NEO	INPA 280950, 280953
<i>Epidendrum sculptum</i> Rchb.f.	Hol	OFC OAC	NEO	INPA 280966, 281048

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<i>Epidendrum strobiliferum</i> Rchb.f.	Hol	OFC DFC OAC OSC	NEO	INPA 280954, 281067
<i>Eriopsis sceptrum</i> Rchb.f. & Warsz.	Hol	OFC	BA	INPA 45915
<i>Jacquinella globosa</i> Schltr.	Hol	OAC OSC	NEO	INPA 280958
<i>Hylaeorchis petiolaris</i> (Schltr.) Carnevali & G.A.Romero	Hol	OFC CAD	BA	INPA 280943, 280992
<i>Madisonia kerrii</i> Luer	Hol	OFC	BA	INPA 280977
<i>Maxillaria brasiliensis</i> Brieger & Illg	Hol	OFC	EN	INPA 280961
<i>Maxillaria camaridii</i> Rchb.f.	Hol	OFC DFC OAC	NEO	INPA 280939
<i>Maxillaria crassifolia</i> (Lindl.) Rchb.f.	Hol	OFC OAC	NEO	INPA 280940
<i>Maxillaria desvauxiana</i> Rchb.f.	Hol	OFC	NEO	INPA 280917, 280974
<i>Maxillaria kegelii</i> Rchb.f.	Hol	OFC	BA	INPA 280949, 281057
<i>Maxillaria parviflora</i> (Poepp. & Endl.) Garay	Hol	OFC DFC OAC	NEO	INPA 280893, 281020
<i>Maxillaria superflua</i> Rchb.f.	Hol	OFC DFC OAC DAC	NEO	INPA 280963, 280938
<i>Maxillaria tenuis</i> C.Schweinf.	Hol	OFC	BA	INPA 280929
<i>Maxillaria violaceopunctata</i> Rchb.f.	Hol	OFC	NEO	INPA 280936
<i>Notylia yauaperyensis</i> Barb.Rodr.	Hol	OFC	BA	INPA 281052, 281053
<i>Octomeria erosilabia</i> C.Schweinf.	Hol	OFC DFC OAC	BA	INPA 280948, 281003
<i>Octomeria grandiflora</i> Lindl.	Hol	OFC DFC OAC	NEO	INPA 280919, 280978
<i>Octomeria sagittata</i> (Rchb.f.) Garay	Hol	OFC	EN	INPA 280955
<i>Octomeria scirpoidea</i> (Poepp. & Endl.) Rchb.f.	Hol	OAC DAC	NEO	INPA 281004, 280975
<i>Octomeria taracuana</i> Schltr.	Hol	DAC	BA	INPA 280935
<i>Octomeria yauaperyensis</i> Barb.Rodr.	Hol	DAC	BA	INPA 281006, 281028
<i>Orleanesia amazonica</i> Barb.Rodr.	Hol	OAC	BA	INPA 280898
<i>Pabstiella yauaperyensis</i> (Barb.Rodr.) F.Barros	Hol	OFC	BA	INPA 281064, 281054
<i>Polystachya foliosa</i> (Hook.) Rchb.f.	Hol	OFC OAC	NEO	INPA 281049, 280983
<i>Polystachya stenophylla</i> Schltr.	Hol	OFC OAC	BA	INPA 280915, 281068
<i>Prosthechea aemula</i> W.E.Higgins	Hol	OFC DFC OAC DAC OSC DSC	NEO	INPA 280918, 280967
<i>Prosthechea crassilabia</i> (Poepp. & Endl.) Carnevali & I.Ramirez	Hol	OFC OAC	SA	INPA 280892, 280890
<i>Quekettia microscopica</i> Lindl.	Hol	OFC	BA	INPA 281055
<i>Rudolfiella aurantiaca</i> (Lindl.) Hoehne	Hol	OFC OAC	BA	INPA 274324, 286920
<i>Scaphyglottis reflexa</i> Lindl.	Hol	OFC	NEO	INPA 280913, 280991
<i>Scaphyglottis sickii</i> Pabst	Hol	OAC OSC	NEO	INPA 280973, 281047
<i>Scaphyglottis stellata</i> Lodd. ex Lindl.	Hol	OFC OAC	NEO	INPA 281018
<i>Scuticaria steelei</i> (Hook.) Lindl.	Hol	OFC	BA	INPA 280964
<i>Sobralia bletiae</i> Rchb.f.	Hol	OFC	NEO	INPA 281005
<i>Sobralia granitica</i> G.A.Romero & Carnevali	Acc	OAC OSC	BA	INPA 280891, 280894
<i>Specklinia picta</i> (Lindl.) Pridgeon & M.W.Chase	Hol	OFC OAC	NEO	INPA 280951, 281058
<i>Trichosalpinx orbicularis</i> (Lindl.) Luer	Hol	OFC OAC	NEO	INPA 280899, 280990
<i>Vanilla bicolor</i> Lindl.	Hem	DFC	NEO	INPA 280959, 280960
Rubiaceae				
<i>Hillia illustris</i> (Vell.) K.Schum.	Acc	OFC	NEO	INPA 288699
Urticaceae				
<i>Coussapoa asperifolia</i> Trécul	Hem	OFC	NEO	INPA 148153