

Orchid's diversity at Tepequém's Tepuy, Roraima, Brazil⁽¹⁾

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ABSTRACT

The Orchidaceae family is one of the largest among the angiosperm, with more than 27000 species, 2,500 is endemic to Brazil, 871 species are found in the Brazilian Amazon. In the far north of Brazil, in the state of Roraima, is located the Tepequém Mountains, a *Tepuy* – mountain top with table shape – with relictual vegetation due to prolonged isolation. Historically, Tepequém was a site of diamond exploration, which caused changes in the landscape. However, with mining decay, ecotourism became the main economic activity. About 68% of Roraima's territory is composed of conservation areas and indigenous lands, and the Tepequém Mountain is the only *Tepuy* found outside the protected areas. Thus, this study aims to describe the orchid flora found at Tepequém's *Tepuy*, an area of ecological and economic importance for Roraima's ecotourism. The survey was carried out through expeditions between the years of 2013-2015. The species were photographed, harvested and taken to Embrapa Roraima for identification, exsiccate confection and/or cultivation. The exsiccatae were deposited at Roraima's Integrated Museum (Museu Integrado de Roraima – MIRR) and the Federal University of Roraima (Universidade Federal de Roraima – UFRR). Any orchid species deposited by other collectors was also considered. Thus, 20 genera and 34 species were registered at Tepequém. The genera with largest representation were the *Epidendrum* (7 spp.), *Scaphyglottis* (4 spp.) and *Habenaria* (3 spp.), with 70% of the other genera presenting one species only. 10% of Roraima's orchid's diversity is found at Tepequém. The diversity of habitats – forest, campina and savannah – found at Tepequém's *Tepuy* allows the Orchidaceae species diversity and the unique flora with low similarities to other floristic surveys.

Keywords: Orchidaceae, high altitude vegetation, Amajari, Amazon.

RESUMO

Diversidade de orquídeas no Tepuy do Tepequém, Roraima, Brasil

A família Orchidaceae é uma das maiores dentre as angiospermas com mais de 27.000 espécies, 2.500 dessas são endêmicas do Brasil, sendo que 871 espécies são encontradas na Amazônia brasileira. No extremo norte do Brasil, no estado de Roraima, encontra-se a serra do Tepequém, um *Tepuy* (montanha com o topo em forma de mesa, onde a vegetação é relictual devido ao isolamento prolongado). O Tepequém historicamente foi alvo da exploração de diamante, o que causou mudanças na paisagem; porém, com a decadência da mineração, atualmente a principal atividade econômica desenvolvida é o ecoturismo. Em Roraima cerca de 68% do território são áreas de conservação e terras indígenas, e a serra do Tepequém é o único Tepuy que não se encontra dentro de áreas de proteção. Portanto, o objetivo deste estudo é descrever a flora orquídeofila no *Tepuy* do Tepequém, uma área de importância ecológica e econômica em termos de ecoturismo no estado de Roraima, Brasil. O levantamento das espécies de Orchidaceae foi realizado a partir de expedições entre os anos de 2013 e 2015. As espécies foram fotografadas, coletadas e levadas a sede da Embrapa Roraima para identificação, confecção de exsicatas e/ou cultivo. As exsicatas foram depositadas nos herbários do Museu Integrado de Roraima (MIRR) e da Universidade Federal de Roraima (UFRR), as espécies de orquídeas depositadas por outros coletores nos herbários também foram consideradas. Assim, foram registrados 20 gêneros e 34 espécies de Orchidaceae no Tepequém. Os gêneros com maior representatividade foram *Epidendrum* (7 spp.), *Scaphyglottis* (4 spp.) e *Habenaria* (3 spp.), enquanto 70% dos gêneros apresentaram apenas uma espécie. No Tepequém concentra-se 10% da diversidade de orquídeas de Roraima. Esta diversidade de habitats – floresta, campina e savana, encontrados no *Tepuy* do Tepequém possibilita a diversidade de espécies de Orchidaceae e a flora singular que apresentou pouca similaridade com outros levantamento florístico.

Palavras-chave: Orchidaceae, vegetação de altitude, Amajari, Amazônia

1. INTRODUCTION

The Orchidaceae family is one of the largest among the angiosperm, with more than 27000 species (THE PLANT LIST, 2016). A privileged orchid flora can be found in Brazil, with yearly reports of new species been

publish in understudied places. Thus, floristic surveys covering this family are important to enlarge the available knowledge on orchid's diversity.

The Guiana Highlands can be found in northern South America, an area comprised by Brazil, Venezuela and Guyana, in which a great number of table-shaped

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mountains, regionally called "*Tepuy*", can be found. A few are located at Roraima (RR), such as: the Roraima Mount (RR), the Tepequém Mountains (RR), Urutanim (RR), Uafaranda (RR) and Surucucus (RR). These areas remained isolated for a long time, resulting in a unique floristic unit (ALVES et al., 2007). With this in mind, Haffer (1992) pointed that studies were necessary to understand how this unique landscape came to be at the Amazon portion.

Throughout the 30-70 decades, the Tepequém was a site of diamond mining (BARROS, 1995). Due to dynamite usage several environmental changes occurred during this time, such as riverbed alterations and watercourse's silting (MAFRA and MARMOS, 2014). Nowadays, after mining prohibition, tourism became the main economic activity, showing the region's natural beauty and its unique natural resources. Interestingly, few studies were conducted in the area, and the floral surveys necessary for both tourism activities and environmental preservation remain to be done.

Studies carried out by Alves et al. (2007) point that soil drainage and poverty of nutrients, common features between the *Tepuy* and rupestrian fields, probably contributed to species' distribution pattern and similarity occurrence between these two landscapes. The authors reported great species' diversity for the Xyridaceae and Eriocaulaceae families at the *Tepuy* and rupestrian fields. On the other hand, the Rapateaceae family encompasses more than 100 species in the *Tepuy*, but is represented by the single endemic species *Cephalostemon riedelianus* Koern in the rupestrian fields (ALVES et al., 2007). However, this study did not include the monocotyledons. Thus, the Orchidaceae family was not compared. In order to contribute to the floristic inventory of the Amazon, especially regarding its mountainous areas, this study aimed to describe the Orchidaceae species found in Tepequém's *Tepuy*, an area with distinctive vegetation, of high ecological and economic importance for the Amazon region.

2. MATERIAL AND METHODS

Study site

The Tepequém Mountain is located in a border area of Roraima, between Brazil and Venezuela, 50 km away

from the municipality of Amajari. The mountain covers an area of 12000 Km², located in the center of a closed basin (03°45'54,6" N, 61°41'17,5" W). The altitude ranges from 550 to 1100 m, with humid tropical climate type Am (KÖPPEN CLASSIFICATION, 1948) and annual average temperatures between 22 and 24° C. During the rainy season, temperature below 20° C have been registered for the areas above 700 meters and at the mountain peak, with annual average rainfall of 2000 mm (BARBOSA, 1997).

The vegetation that comprises study site is made of a dense forest area, with arboreal species such as *Micranda lopessi* R. E. Schultes., *Sextonia rubra* (Mez.) van der Werff, *Elizabetha* sp., *Eschweilera odora* Miers., *Cariniana micrantha* Ducke e (Meisn.), *Mezilaurus itauba* Taub. ex Mez., among others (BRASIL, 1975). Whereas, according to Silva (1997), the open and campestre vegetation is characterized as a steppe savanna composed mainly by Poaceae and Cyperaceae, in special species as: *Brachiaria mutica* Stapf, *Panicum maximum* Jacq., *Cynodon dactylon* L. Pers. and some Asteraceae (Figure 1). According to Brasil et al. (1975), been composed by an autochthonous flora makes this vegetation an ecological refuge. A riparian vegetation can be found in areas near drainages, with the formation of small alleys buriti (*Mauritia flexuosa* L.f.) (Figure 1).

The Orchidaceae species' survey was carried out through expeditions between the years of 2013-2015, covering both the dry and rainy seasons. The species were photographed, harvested and taken to Embrapa Roraima headquarters for identification, exsiccate confection and/or cultivation. Specimen's identification was performed based on specialized bibliography (COGNIAUX, 1893-1896; 1898-1902; 1904-1906; MIRANDA, 1996; LUZ and FRANCO, 2012). The exsiccatae were deposited at Roraima's Integrated Museum (MIRR) and at the Federal University of Roraima (UFRR). Orchid species deposited by other collectors were also considered. The species' geographic distribution was verified using the website Brazil's Flora (FLORA DO BRASIL 2020, 2016). Sorensen similarity index (SI) was calculated using the following formula: $SI = 2a/2a+b+c$, in which *a* represents the number of species in common, *b* and *c* represent the number of exclusive species in each area (MUELLER-DUMBOIS and ELLENBERG, 1974).



Figure 1. Landscapes that form the Tepequém. A - Tepequém Mountain Plateau; B - Forest on the banks of Igarapé do Paiva; C - Steppe savannah; D - Savannah near the watercourse of a semi-perennial water; E - Rocky outcroppings; and F- Buritis' Vereda and artificial lakes resulting from the mining activity.

3. RESULTS

Orchidaceae species from 20 genera and 35 were found (Figure 2). The genera with largest representation were the *Epidendrum* (7 spp.), *Habenaria* (4 spp.) and *Scaphyglottis* (4 spp.), with 70% of the other genera presenting one species only. Forty-seven percent of the species found at Tepequém have a wide geographical distribution, even been found in other countries, been well disseminated in

Brazil. Of the 35 species, 12 occur only in Brazil's north region, with no reports with five of them been found in any other federation state - *Encyclia auyantepuiensis* Carnevali & I.Ramírez, *Epistephium hernandii* Garay, *Koellensteinia kellnereana* Rchb.f., *Mapinguari auyantepuensis* (Foldats) Carnevali & R.B.Singer and *Scaphyglottis bidentata* (Lindl.) Dressler. Among them, *Scaphyglottis sickii* Pabst is endemic to Brazil, been widely distributed in the whole country (FLORA DO BRASIL 2020, 2016).



Figure 2. Orchidaceae species found at Tepequém Mountain, Roraima.

A species distribution in four main physiognomies was observed: forest – with eight species of epiphytic habit; campina – 17 species with variable habit among rupicolous or terrestrial; savannah – four species of terrestrial habit; and rocky hillside – five species of exclusive rupicolous habit (Table 1)

Table 1. List of Orchidaceae species found at Tepequém Mountain, Roraima, predominant habit and vegetation in which the species were found.

Species	Habit	Vegetation
<i>Bulbophyllum exaltatum</i> Lindl.	Rupicolous	Rocky hillside
<i>B. manarae</i> Foldats	Epiphyte	Forest
<i>Catasetum discolor</i> (Lindl.) Lindl.	Rupicolous	Campina
<i>C. planiceps</i> Lindl.	Rupicolous	Campina
<i>Cleistes rosea</i> Lindl.	Terrestrial	Savannah
<i>Cyrtopodium andersonii</i> (Lamb. ex Andrews) R.br.	Rupicolous	Campina
<i>Encyclia auyantepuiensis</i> Carnevali & I.Ramírez	Rupicolous	Campina
<i>Epidendrum carpophorum</i> Barb. Rodr.	Epiphyte	Forest
<i>E. ibaguense</i> Kunt.	Rupicolous	Campina
<i>E. micronoctrurnum</i> Carnevali & G.A.Romero	Epiphyte	Forest
<i>E. nocturnum</i> Jacq.	Terrestrial	Campina
<i>E. orchidiflorum</i> (Salzm.) Lindl.	Terrestrial	Campina
<i>E. ramosum</i> Jacq.	Epiphyte	Campina
<i>E. strobiliferum</i> Rchb.f.	Epiphyte	Forest
<i>Epistephium duckei</i> Huber	Terrestrial	Campina
<i>E. hernandii</i> Garay	Terrestrial	Campina
<i>Habenaria mitomorpha</i> aff. Kraenzl.	Terrestrial	Savannah
<i>H. obtusa</i> Lindl.	Terrestrial	Campina
<i>H. seticauda</i> Lindl. ex Benth.	Terrestrial	Campina
<i>Habenaria</i> . sp.	Terrestrial	Campina
<i>Jacquiiniella globosa</i> (Jacq.) Schltr.	Rupicolous	Rocky hillside
<i>Koellensteinia kellnereana</i> Rchb.f.	Terrestrial	Savannah
<i>Mapinguari auyantepuensis</i> (Foldats) Carnevali & R.B.Singer	Rupicolous	Campina
<i>Nohawilliamsia pirarensis</i> (Rchb.f.) M.W.Chase & Whitten	Rupicolous	Campina
<i>Notilia</i> sp.	Epiphyte	Forest
<i>Oeceoclades maculata</i> (Lindl.) Lindl.	Terrestrial	Forest
<i>Polystachya concreta</i> (Jacq.) Garay & Sweet	Epiphyte	Mata
<i>Prostechea vespa</i> (Vell.) W.E.Higgins.	Terrestrial	Campina
<i>Sacoila</i> sp.	Terrestrial	Savanna
<i>Scaphyglottis bidentata</i> (Lindl.) Dressler	Rupicolous/ Epiphyte	Rocky hillside/ Campina
<i>S. sickii</i> Pabst	Epiphyte	Forest
<i>S. stellata</i> Lodd. ex Lindl.	Epiphyte	Campina
<i>Scaphyglottis</i> . sp.	Epiphyte	Rocky hillside
<i>Sobralia granitica</i> G.A.Romero & Carnevali	Terrestrial	Campina
<i>Trigonidium acuminatum</i> Bateman ex Lindl.	Rupicolous	Rocky hillside

The Orchidaceae species registered at Tepequém Mountain were compared to the flora found at Chapada Diamantina, Bahia (BA), at Caxiuanã National Forest, Pará (PA), and at Viruá National Park, Roraima (RR) using Sorensen similarity

index. Results showed similarities of 5%, 4.6% and 20% between communities, respectively. This indicates that Tepequém's *Tepuy* orchidophilic flora has greater similarity to Viruá's, with only 20% of similar species.

4. DISCUSSION

Silva et al. (1995) registered the occurrence of 378 species in an inventory regarding the Amazon orchids, in which 18 occur at the Tepequém Mountain. However, by the time in which the study was conducted, the occurrence of two species had not been recorded at Roraima: *Cyrtopodium andersonii* (Lamb. ex Andrews) R.br. and *Cleisthes rosea* Lindl. After two decades, the number of Orchidaceae species found at Brazilian Amazon increased more than twofold, for a total of 871 species (FLORA DO BRASIL 2020, 2016), in which all 35 species found at Tepequém Mountain are included.

There are records of 309 species distributed in 110 genera at Roraima, in which nine are endemic to the state and 26 are endemic to Brazil. This great variety of orchids' species results from the diversity in vegetation and terrain found in the state. This way, Roraima is considered the third state in diversity of the Brazilian Amazon, with 10% of the orchids' variety occurring at Tepequém mountaintop (FLORA DO BRASIL 2020, 2016).

As previously mentioned, the diamond mining that occurred during the 30-70 decades at Tepequém resulted in environmental alterations and degradation, possibly resulting in loss of biodiversity. However, nowadays, tourism is the main economic activity. The landscape diversity favored ecotourism, mainly through hikings to Paiva's, Barata's and Funil's waterfalls, in addition to Platô's trail (FERNANDES and SENHORAS, 2010; MAFRA and MARMOS, 20014), that becomes a true natural garden during the *Epidendrum ibaguense* Kunt. and *Sobralia granitica* G.A.Romero & Carnevali floriation period.

Regarding the similarity between communities, Conceição and Pinari (2007) point that the common characteristics between the *Tepuy* and the rupestrian fields result in similar distribution patterns for the Xyridaceae and Eriocaulaceae families, which could indicate a high level of similarity among the Orchidaceae in both phytophysognomies. However, when species found at Tepequém were compared to those found at Chapada Diamantina, only two were found in both areas, *Epidendrum ramosum* Jacq. and *Oeceoclades maculata* (Lindl.) Lindl.

On the other hand, when compared to the floristic survey carried out by Bastos and Berg (2012) at Morro do Chapéu (Chapada Diamantina micro-region), four species were found in common: *Bulbophyllum exaltatum* Lindl., *B. manarae* Foldats, *Epidendrum orchidiflorum* (Salzm.) Lindl. and *O. maculata*, for a total of 5 common species between the Tepequém Mountain and Chapada Diamantina.

Considering the lack of floral surveys regarding Roraima's *Tepuy* orchidophilic flora, it is only possible to compare the Tepequém Mountain and the Viruá National Park, in which 65 orchid species were registered (PESSOA, 2013), 10 occurring in both areas, been mainly found in *campina* areas. They are: *Catasetum discolor* Lindl., *C. rosea*, *E. carpophorum*, *E. nocturnum* Jacq., *E. orchidiflorum*, *E. strobiliferum* Rchb. f., *Nohawilliamsia pirarensis* (Richb.f.) M.W. Chase & Whitten ex. M.W.

Chase & Whitten, *Prostechea vespa* (Vell.) W.E. Higgins., *Scaphyglottis sickii* Pabst and *Trigonidium acuminatum* Batem. ex Lindl.

Three species can be found at both Tepequém and the National Forest of Caxiuanã (Pará), based on a floral survey performed by Koch et al. (2014) encompassing holoepiphytes and hemiepiphytes Orchidaceae. They are: *Encyclia auyantepuiensis* Carnevali & I. Ramirez, *E. carpophorum* Barb. Rodr. and *E. nocturnum* Jacq. This way, 11 species found at Tepequém were compared in Pessoa et al. (2014) study, been included at the Guyana Endemism Center.

Comparisons between the floral surveys resulted in low species similarity when areas were compared, probably due the prolonged floral isolation in the *Tepuy*. The lack of floral surveys including monocotyledons in these environments impairs more specific comparisons, which in turn could point the ecological relationships that result in the local flora. Furthermore, Krahl et al. (2015) point the need of more studies regarding the pollination and reproduction processes of the orchids found at Brazil's north region.

Despite the technological advances in environmental sciences, it is still impossible to recover the lost biodiversity. When one species goes extinct, it is impossible to recover, or even repair, the lost environmental services. Thus, due to Tepequém's *Tepuy* orchidophilic flora uniqueness, the conservation of the area is of utmost importance.

5. CONCLUSIONS

The habitats diversity (forest, *campina* and savannah) found at the Tepequém's mountaintop is related to the Orchidaceae diversity found in the area. The Tepequém's *Tepuy* showed no similar flora when compared to the floral surveys carried out at the rupestrian fields, nor to the Chapada Diamantina or even the National Park of Viruá. The orchids flora found 20 genres and 35 species at Tepequém's Mountain confirms that the *Tepuys* have autochthonous vegetation.

REFERENCES

- ALVES, R.J.V.; CARDIN, L.; KROPF, M.S. Angiospermdisjunction "Camposrupestres - restingas": a re-evaluation. **Acta Botanica Brasílica**, v.21, n.3, p.675-685, 2007.
- BARBOSA, R.I. Distribuição das Chuvas em Roraima. In: BARBOSA, R.I.; FERREIRA, E.J.G.; CASTELLÓN, E.G. (eds.). **Homem, Ambiente e Ecologia no Estado de Roraima**. Manaus: Ed. INPA, 1997. pp.325-335.
- BARROS, N.C.C. **Roraima paisagens e tempo da Amazônia Setentrional**. Recife: UFPE, 1995. 142p.
- BASTOS, C.A.; VAN DER BERG, C. A família Orchidaceae no município de Morro do Chapéu, Bahia, Brasil. **Rodriguésia**, v.63, n.4, p.883-927. 2012.

- BRASIL. Departamento Nacional da Produção Mineral. Projeto Radam. **Folha NA-20 Boa Vista e parte das folhas NA-21 Tumucumaque, NB-20 Roraima e NB-21**: geologia, geomorfologia, pedologia, vegetação e uso potencial da terra. Rio de Janeiro: DNP, 1975.
- COGNIAUX, A. Orchidaceae. In: MARTIUS, C.F.P.; Eichler, A.G.; Urban, I. (eds.). **Flora brasiliensis**, v.3, n.4, 1893-1896. pp.1-672.
- COGNIAUX, A. Orchidaceae. In: MARTIUS, C.F.P.; Eichler, A.G.; Urban, I. (eds.). **Flora brasiliensis**, v.3, n.5, 1898-1902. pp.1-664.
- COGNIAUX, A. Orchidaceae. In: MARTIUS, C.F.P.; Eichler, A.G.; Urban, I. (eds.). **Flora brasiliensis**, v.3, n.6, 1904-1906. pp.1-604.
- CONCEIÇÃO, A.A.; PIRANI, J.R. Diversidade em quatro áreas de campos rupestres na Chapada Diamantina, Bahia, Brasil: espécies distintas, mas riquezas similares. **Rodriguésia**, v.58, n.1, p.193-206. 2007.
- FERNANDES, R.B.; SENHORAS, E.M. Geografia do turismo e o Tepequém diante das redes internacionais de ecoturismo. **Textos & Debates**, v.18, p.251-268. 2010.
- FLORA DO BRASIL 2020 em construção. **Orchidaceae**. Jardim Botânico do Rio de Janeiro. Available at: <<http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB179>>. Accessed on: 21 July 2016.
- HAFFER, J. Ciclos de tempo e indicadores de tempo na história da Amazônia. **Estudos Avançados USP**, v.6, n.15, p.7-40. 1992.
- KOCH, A.K.; SANTOS, J.U.M.; ILKIU-BORGES, A.L. Sinopse das Orchidaceae holoepífitas e hemiepífitas da Floresta Nacional de Caxiuanã, PA, Brasil. **Hoehnea**, v.41, n.1, p.129-148. 2014.
- KÖPPEN, W. **Climatologia**. México, Buenos Aires: Ed. Fundo de Cultura Econômica, 1948.
- KRAHL, A.H.; KRAHL, D.R.P.; VALSKO, J.J.; HOLANDA, A.S.S.; ETRINGER-JÚNIOR, H.; NASCIMENTO, J.W. Polinização em orquídeas brasileiras. **Natureza On Line**, v.13, n.3, p.128-133. 2015.
- LUZ, J.; FRANCO, J. **Orquídeas de Roraima**. Brasília: Embrapa, 2012. 184p.
- MAFRA, L.C.A.M.; MARMOS, J.L. Atrativos Geoturísticos. In: HOLANDA, J.L.R.; MARMOS, J.L.; MAIA, M.A.M. (orgs.). **Geodiversidade do estado de Roraima**. Manaus: CPRM, 2014. p.212.
- MIRANDA, F.E.L.F. **Orquídeas da Amazônia brasileira**. Rio de Janeiro: Expressão e Cultura, 1996. 191p.
- MUELLER-DUMBOIS, D.; ELLENBERG, H. **Aims and methods of vegetation ecology**. New York, John Wiley & Sons, 1974. p.574.
- PESSOA, E.M. Orchidaceae no Parque Nacional do Viruá, RR, Brasil: aspectos taxonômicos e biogeográficos. Dissertation, Federal University of Pernambuco, 2013.
- PESSOA, E.M.; SILVA, I.A.A.; ALVES, M. Aspects of Orchidaceae distribution in Costa Rica and northwestern South America: a study on similarity with emphasis on the Amazonian Region. **Hoehnea**, v.41, n.4, p.623-630. 2014.
- SILVA, E.L.S. A vegetação de Roraima. In: BARBOSA, R.I.; FERREIRA, E.J.G.; CASTELLÓN, E.G. (eds.). **Homem, ambiente e ecologia no estado de Roraima**. Manaus: INPA, 1997. p.400-415.
- SILVA, M.F.F.; SILVA, J.B.F.; ROCHA, A.E.S.; OLIVEIRA, F.P.M.; GONÇALVES, L.S.B.; SILVA, M.F.; QUEIROZ, O.H.A. Inventário da Família Orchidaceae na Amazônia Brasileira. Parte I. **Acta Botanica Brasílica**. v.9, n.1. 1995.
- THE PLANT LIST. Available at: <www.theplantlist.org>. Accessed on 27 September 2016.