



Flora of Espírito Santo, Brazil

Flora of Itaúnas State Park, Espírito Santo, Brazil: Cactaceae

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Abstract

The present work, which is part of a series of taxonomic monographs, aims to provide useful taxonomic features for distinguishing species of Cactaceae from Itaúnas State Park-Brazil. After performing field expeditions and observations, and analysis of herbaria vouchers, a total of five species of Cactaceae is herein recorded: *Brasiliopuntia brasiliensis* (Least Concern), *Cereus fernambucensis* subsp. *fernambucensis* (Least Concern), *Melocactus violaceus* subsp. *violaceus* (Vulnerable), *Pereskia aculeata* (Least Concern), and *Pilosocereus arrabidaei* (Near Threatened). Leaf (when present) and cladodes morphology, and presence or absence of cephalium are the most useful characters to specific delimitation. Key identification, descriptions, photographs, taxonomic comments, geographic distribution and habitat data are herein provided.

Key words: Atlantic Forest, cacti, Caryophyllales, *Restinga*, taxonomy.

Resumo

O presente trabalho, que faz parte de uma série de monografias taxonômicas, visa fornecer características taxonômicas úteis para distinguir espécies de Cactaceae do Parque Estadual de Itaúnas-Brasil. Após a realização de expedições e observações de campo e análise de vouchers herbários, um total de cinco espécies de Cactaceae foram registradas: *Brasiliopuntia brasiliensis* (Pouco Preocupante), *Cereus fernambucensis* subsp. *fernambucensis* (Pouco Preocupante), *Melocactus violaceus* subsp. *violaceus* (Vulnerável), *Pereskia aculeata* (Pouco Preocupante) e *Pilosocereus arrabidaei* (Quase Ameaçado). Morfologia da folha (quando presente) e dos cladódios, e presença ou ausência de cefálio são os caracteres mais úteis para as delimitações específicas. Chave de identificação, descrições, fotografias, comentários taxonômicos, distribuição geográfica e dados de habitat são fornecidos aqui.

Palavras-chave: Mata Atlântica, cactos, Caryophyllales, *Restinga*, taxonomia.

Introduction

Caryophyllales has 13 families sharing, among other synapomorphies, the presence of vessels with simple perforations and similar aminoacid sequences of the cytochrome *c* (Judd *et al.* 2009; APG IV 2016). In the suborder Caryophyllineae, which is considered monophyletic based on morphological and molecular studies (Judd *et al.* 2009), Cactaceae and Portulacaceae are phylogenetically related by sharing loss of internal

phloem and CAM photosynthetic metabolism (Judd *et al.* 2009; Ocampo & Columbus 2010; Hernández-Hernández *et al.* 2011). Cactaceae, one of the most representative and iconic families of the order, has approximately 1,400 species and 100 genera distributed exclusively in the American continent, with Mexico, USA, and Northeastern and Southeastern Brazil bearing its main centers of diversity (Barthlott 1983; Valiente-Banuet *et al.* 1996; Dávila-Aranda *et al.* 2002; Casas *et al.* 2014).

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Cactaceae species are characterized mainly by the reduction of branches, leaves (usually) modified in spines, succulent and photosynthetic stems, superficial and often thorny roots (Duque 1980; Wallace & Gibson 2002; Edwards & Donoghue 2006; Judd *et al.* 2009). Due to their features, many species might be used as human food resource, forage, timber, medicinal and ornamental (Ruedas *et al.* 2006; Santos *et al.* 2007; Lucena *et al.* 2013, 2014; Nunes *et al.* 2015).

In Brazil, Cactaceae is represented by approximately 270 species (193 endemic) and 39 genera (14 endemic), which *Pilosocereus* Byles & Rowley, *Rhipsalis* Gaertn. (29 spp., each) and *Parodia* Speg. (27 spp.) are the most taxonomically diverse genera (BFG 2018). The highest species richness can be found in arid and semi-arid environments, such as those occurring in Northeastern Brazil (Taylor & Zappi 2004). However, many species can be also found in moist environments such as the Atlantic Forest where 102 species belonging to 21 genera are recorded (BFG 2018). Amongst Brazilian states, Rio de Janeiro is the one which bears the highest number of Cactaceae taxa recorded (57 spp.) (BFG 2018).

Identification of Cactaceae samples in herbaria is difficult due to the different methods of collection and drying specimens. Main reproductive characters of Cactaceae are lost during sampling and drying processes, especially those from fruits. In addition, the number of thorns in the areolas can also be modified depending on processes mentioned above.

Under these considerations, the present work aims to provide a taxonomic treatment for Cactaceae occurring in the State Park of Itaúnas, contributing to the knowledge of the regional and state floras, and delimitation among the species of the group.

Materials and Methods

Itaúnas State Park (ISP) (18°25'S, 39°42'W) (Fig. 1) is located in the municipality of Conceição da Barra, northern coast of Espírito Santo, and has an area of 3,481 ha (Souza *et al.* 2016). The ISP is fully inserted in the geological zone of the trays and has several natural ecosystems, such as *restingas* (predominant vegetation), *tabuleiro* forests, dunes, wetlands and mangroves (Souza *et al.* 2016).

Specimens at VIES and SAMES herbaria

(acronyms according to Thiers, continuously updated) were analyzed, and fieldwork expeditions were performed from August/2018 to May/2019. Samples were processed according to Peixoto & Maia (2013), incorporated mainly to VIES herbarium and duplicates sent to MBML and SAMES herbaria. Identification and geographical distribution comments were performed using specialized literature (Zappi 1994; Taylor & Zappi 2004; Hunt *et al.* 2006; Zappi *et al.* 2007; Menezes *et al.* 2013; Gonzaga *et al.* 2014a,b, 2017).

Terminology for morphological characters followed Harris & Harris (2001) and Taylor & Zappi (2004). Scientific names and their authorship are in agreement with IPNI (2019). Habit and habitat data were based on voucher tags information and field observations.

This work is part of the series of taxonomic and floristic works carried out for Itaúnas State Park, among them Souza *et al.* (2016, 2017) and others which will be published soon.

Results and Discussion

For the Espírito Santo, 46 species of Cactaceae are recorded, of which 22 occur in the *restingas* of the state, of these, five (22%) species are recorded in the ISP (BFG 2018). In addition, of the 13 species of Cactaceae endemic to Brazil that occur in the *capixaba restingas*, four (23%) are registered for study area (BFG 2018).

Initially, Cactaceae at the ISP was represented by six species (Souza *et al.* 2016), however, after the taxonomic treatment presented here, five species are recognized for the family: *Brasiliopuntia brasiliensis* (Willd.) A. Berger, *Cereus fernambucensis* Lem. subsp. *fernambucensis*, *Melocactus violaceus* Pfeiff. subsp. *violaceus*, *Pereskia aculeata* Mill. and *Pilosocereus arrabidaei* (Lem.) Byles & Rowley, being this the first taxonomic treatment considering Cactaceae from Espírito Santo state. Main useful morphological characters for species delimitation were the leaf cladodes morphology and presence or absence of cephalium.

According to the Goettsch *et al.* (2015), *Brasiliopuntia brasiliensis*, *Cereus fernambucensis* subsp. *fernambucensis* and *Pereskia aculeata* are assigned as Least Concern (LC), *Pilosocereus arrabidaei* as Near Threatened (NT), and *Melocactus violaceus* subsp. *violaceus* as Vulnerable (VU).



Figure 1 – a-f. Environments found in the Itaúnas State Park – a. *Almésca* of Trail; b. *Borboleta* of Trail; c-d. *Buraco do Bicho* of Trail; e. *Pescador* of Trail; f. *Restinga* of Trail.

Taxonomic treatment

Identification key for the Cactaceae species of Itaúnas State Park

1. Leaves well developed and functional present; pedicellate flowers and gathered in florescences.....
..... 4. *Pereskia aculeata*
- 1'. Leaves reduced or transformed into spines; sessile flowers and lonely.
 2. Arborescent; glochids present, cladodes dimorphics, reduced leaves (in young shoots)
..... 1. *Brasiliopuntia brasiliensis*
 - 2'. Shrubs; glochids absent, cladodes monomorphics, leaves transformed into spines.
 3. Subglobose cladodes; present cephalium, flowers 1.5–2.5 × 0.6–1.3 cm, berry 10–16 × 8–10 mm.....
..... 3. *Melocactus violaceus* subsp. *violaceus*
 - 3'. Cylindrical cladodes; absent cephalium, flowers 6–20 × 4–5 cm, berry 3–7 × 3.5–5.8 cm.
 4. Articulated cladodes, areoles well-spaced along the ribs.....
..... 2. *Cereus fernambucensis* subsp. *fernambucensis*
 - 4'. Non-articulated cladodes, areoles congested along the ribs.....
..... 5. *Pilosocereus arrabidaei*

1. *Brasiliopuntia brasiliensis* (Willd.) A. Berger.

Fig. 2a-b

Arborescent 4–5 m tall. Cladodes cylindrical, branched, articulated, ribs absent, intermediate segments 22–54 cm long, cylindrical, terminal segments 5–12 × 3–5 cm, compresses, obovate, deciduous, distal areolas 10–30 mm between each other, spinescent, spines 1–2, 5–20 mm long, glabrous. Glochids present. Leaves reduced (young branches) or absent (mature branches). Flowers appearing at the apex of the cladodes. Flowers 3–5 × 4–6 cm, sessile, near to terminal segments, filaments and anthers glabrous, ovary ovate, style 1.2–1.5 mm long, stigmatic branches 3–6, 3–6 mm long. Berry 3–6 cm diam., spinescent, globose, yellow-greenish pericarp, smooth, areolated. Seeds 8–10 × 7–9 mm, subgloboids.

Examined material: Trilha da Restinga, 7.VII.2012, fr., *L.F.T. Menezes et al.* 2037 (SAMES); 12.II.2014, fr., *J.O. Machado et al.* 200 (VIES); 2.IV.2019, fr., *A. Nepomuceno et al.* 795 (VIES).

Additional examined material: BRASIL. ESPÍRITO SANTO: Conceição da Barra, Área 126 da Aracruz Celulose, 26.II.1992, fr., *O.J. Pereira et al.* 2879 (VIES); Área 213 da Aracruz Celulose, 25.II.1992, fl., *O.J. Pereira et al.* 3099 (VIES).

Brasiliopuntia (K. Schum) A. Berger is a monospecific genus belonging to the tribe Opuntieae of the subfamily Opuntioideae, occurring from Bolivia to Paraguay and Argentina (Taylor & Zappi 2004; Hunt *et al.* 2006). In Brazil, *B. brasiliensis* occurs in all phytogeographical domains, in Deciduous

Seasonal Forest, Semideciduous Seasonal Forest, Ombrophilous Forest, Mixed Ombrophylous Forest, *restinga* and *rocky outcrops* (BFG 2018). It is characterized by having dimorphic branches, compressed at the top and cylindrical at the base. The species is categorized as Least Concern (LC) according to Goettsch *et al.* (2015). In the study area, it is considered as rare where it can be found only on the edges of *restinga* forest.

2. *Cereus fernambucensis* Lem. subsp. *fernambucensis*.

Fig. 2c-d

Shrubs 1–2 m tall. Cladodes cylindrical, branched, articulate, 4–5 ribbed, ribs 1–2 cm high, oblique transverse folds, distal areolas 7–22 mm between each other, spinescent, spines 4–8, 5–30 mm long. Glochids absent. Leaves transformed in spines. Absent cephalium. Flowers 15–20 cm long, sessile, filaments and anthers glabrous, ovary ovate, style 16–18 cm long, stigmatic branches 12, 5–10 mm long. Berry 5–7 × 3.5–5.5 cm, glabrous, ovoid, pericarp pinkish to reddish, smooth. Seeds 2–3 × 1.8–2 mm, suborbicular.

Examined material: Trilha da Borboleta, 2.VI.2019, fl., *A. Nepomuceno et al.* 788, 789 (VIES); Trilha do Pescador, 21.I.2013, fl., *R. Coelho* 255 (SAMES); 7.II.2013, fl., *A.O. Giaretta* 448 (VIES); 15.VIII.2013, fl., *J.O. Machado et al.* 133 (VIES).

Additional examined material: BRASIL. ESPÍRITO SANTO: Conceição da Barra, Área 126 da Aracruz Celulose, 3.XII.1992, fl., *O.J. Pereira et al.* 4343 (VIES); Área 213 da Aracruz Celulose, 4.XI.1992, fl., *O.J. Pereira et al.* 4102 (VIES).

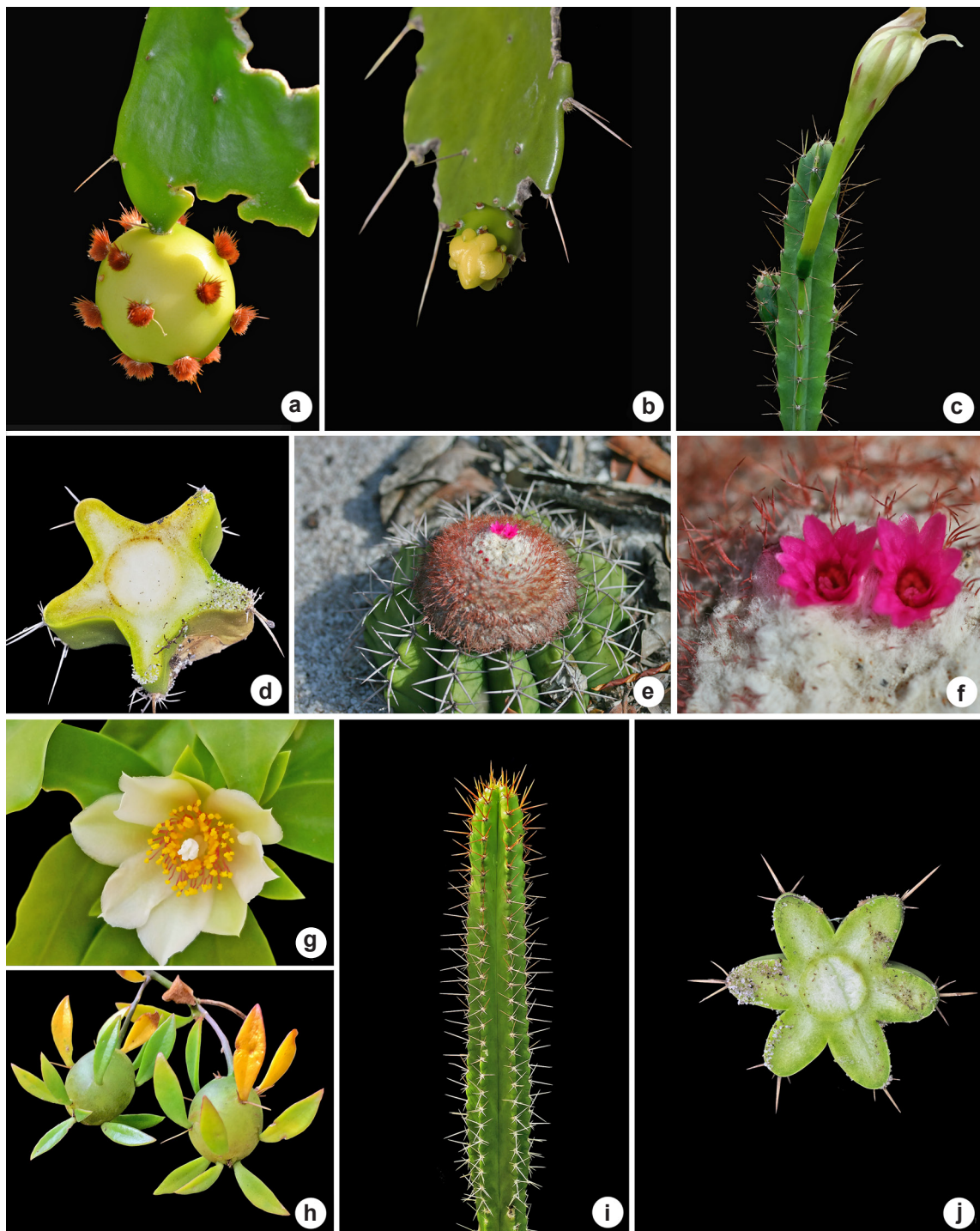


Figure 2 – a-j. Morphological characteristics of native Cactaceae from Itaúnas State Park – a-b. *Brasiliopuntia brasiliensis* – a. berry; b. floral bud; c-d. *Cereus fernambucensis* subsp. *fernambucensis* – c. cladode with flower; d. cross section of cladode; e-f. *Melocactus violaceus* subsp. *violaceus* – e. apical cephalium; f. flowers; g-h. *Pereskia aculeata* – g. flower; h. berry; i-j. *Pilosocereus arrabidaei* – i. cladode; j. cross section of cladode. Photographs: a-c. SGV files; d-e. Rafael Mathielo; f. SGV files; g-h. Maria Ana Farinaccio; i. SGV files; j. Rafael Mathielo.

Cereus Mill. belongs to the Cereeae tribe of the subfamily Cactoideae and has ca. of 20 species distributed throughout South America (Taylor & Zappi 2004). *Cereus fernambucensis* subsp. *fernambucensis* is endemic to Brazil and can be found Caatinga and Atlantic forest domains, in *restingas* and rocky outcrops (BFG 2018). The species differs from *C. fernambucensis* subsp. *sericifer* (Ritter) N.P. Taylor & Zappi for presenting red fruits (*vs.* yellow) (Taylor & Zappi 2004). In addition, it is assigned as Least Concern (LC) according to Goettsch *et al.* (2015). It can be found throughout study area, especially in open areas and forest edges.

3. *Melocactus violaceus* Pfeiff. subsp. *violaceus*.

Fig. 2e-f

Shrubs solitary 8–13 cm tall. Cladodes subglobose, non-branched, 9–13 ribbed, ribs 2–3.5 cm high, oblique transverse folds, distal areolas 5–10 mm between each other, spinescent, spines 10–12, 15–25 mm long. Glochids absent. Leaves transformed in spines. Apical cephalium with white trichomes and spinning brown bristles. Flowers 1.5–2.5 × 0.6–1.3 cm; sessile, ovary ovate. Berry 10–16 × 8–10 mm, glabrous, claviforme, pericarp pink to off-white at the base, smooth. Seeds 1–1.5 × 0.8–1 mm, ellipsoids.

Examined material: Trilha da Borboleta, 28.III.2009, fr., *M.M. Monteiro 150* (SAMES), 14.IV.2014, fl., *J.O. Machado et al. 307* (VIES).

Additional examined material: BRASIL. ESPÍRITO SANTO: Conceição da Barra, Área 213 da Aracruz Celulose, 25.II.1992, fl., *O.J. Pereira 3099* (VIES); São Mateus, Bairro Litorâneo, 28.VIII.2008, fl., *A.O. Giaretta et al. 322* (SAMES).

Melocactus (L.) Link. & Otto belongs to the Cereeae tribe of the subfamily Cactoideae and has 34 species distributed from Mexico to the east of Brazil, with limit distribution in Rio de Janeiro (Taylor & Zappi 2004). *Melocactus violaceus* is endemic in Brazil, occurring in the phytogeographic domains of Caatinga and Mata Atlântica, in *carrasco* and *restinga* vegetation (BFG 2018). It is distinguished from *Melocactus violaceus* subsp. *margaritaceus* N.P. Taylor for presenting fruits pink to purple (*vs.* white) and *Melocactus violaceus* subsp. *ritteri* N.P. Taylor due to occur in the coastal region of Brazil, mainly in *restinga* (*vs.* occurrence restricted to the *rocky outcrops* of the interior of the Bahia state). The species is classified as vulnerable (VU) according to Goettsch *et al.* (2015). In the study area, the species is often found in open areas.

4. *Pereskia aculeata* Mill. Fig. 2g-h

Climbing shrub. Cladodes cylindrical, branched, not articulated, ribs absent, spines 1–10 central, 10–30 mm long, 6–20 radial, 7–40 mm long, cylindrical. Leaves well-developed and functional, alternate, petiole 3–5 mm long, glabrous, lamina 2.5–7 × 0.5–3 cm, elliptic to narrow-elliptic, glabrous. Glochids absent. Inflorescences in panicles terminal and axillary. Flowers 2.5–5 × 2–4 cm, pedicels 5–20 mm long, ovary ovate, style 10–11 mm long, stigmatic branches 4–7, 3–5 mm long. Berry 1–2 cm diam, glabrous, globose, pericarp yellowish, smooth, spines 3–8 mm long, glabrous, cylindrical, bracts 8–15 × 1–4 mm, narrow-elliptic, glabrous. Seeds 4.5–5 × 4–4.2 mm, obovate to elliptical.

Examined material: Trilha da Restinga, 11.IV.2010, fr., *M. Ribeiro 123* (SAMES, VIES); 22.III.2014, fl., *B.S. Amorim et al. 1966* (VIES); 19.V.2014, fl., *N.T.L. Pena 96* (VIES); 2.VI.2019, *A. Nepomuceno et al. 794* (VIES). **Additional examined material:** BRASIL. ESPÍRITO SANTO: São Mateus, Bairro da Liberdade, 6.III.2008, fr., *O.J. Pereira* (SAMES); 5.IV.2008, fr., *M.B. Faria et al. 157* (SAMES).

Pereskia Mill. belongs to the subfamily Pereskioideae and has 17 species distributed throughout the neotropics (Taylor & Zappi 2004). In Brazil, *Pereskia aculeata* occurs in the various phytogeographical domains of the Caatinga, Cerrado, and Atlantic Forest domains (BFG 2018). It can be distinguished from other species by presenting climbing habit. The species is classified as of Least Concern (LC) according to Goettsch *et al.* (2015). In the study area, the species is rare, being found in the canopy and at the edges of forest.

5. *Pilosocereus arrabidaei* (Lem.) Byles & Romley. Fig. 2i-j

Shrubs ca. 2m tall. Cladodes cylindrical, branched, non-articulated, 6 ribbed, ribs 1.5–2.5 mm high, oblique transverse folds, distal areolas 10–15 mm apart, spinescent, spines 4–10, 5–15 mm long, glabrous. Glochids absent. Leaves transformed in spines. Absent cephalium. Flowers 6–7 × 4–5 cm, sessile, filaments and anthers glabrous, ovary obovate, stylet 45–50 mm long, stigmatic branches 9, 6–10 mm long. Berry 3–5 × 5–5.8 cm, glabrous, subglobose, green pericarp to light red, smooth to slightly rough. Seeds 1.5–2 × 1–1.3 mm, ellipsoids.

Examined material: Trilha da Borboleta, 7.II.2009, fl., *A.O. Giaretta 448* (SAMES); 27.IX.2009, fl., *A.O. Giaretta 638* (VIES); 21.I.2013, fr., *R. Coelho 254* (SAMES); 2.IV.2019, fl. and fr., *A. Nepomuceno et al. 786* (VIES). Trilha da Restinga, 2.IV.2019, fr., *A. Nepomuceno et al. 796* (VIES).

Additional examined material: BRASIL. ESPÍRITO SANTO: Conceição da Barra, Área 126 da Aracruz Celulose, 3.XII.1992, fl., *O.J. Pereira et al. 4342* (VIES); Área 213 da Aracruz Celulose, 25.III.1992, fl., *O.J. Pereira et al. 3081* (VIES).

Pilosocereus Byles & G.D. Rowley belongs to the Cereeae tribe of the subfamily Cactoideae and has 37 species distributed from Mexico to Paraguay (Taylor & Zappi 2004). *Pilosocereus arrabidaei* is endemic to the Brazilian Atlantic Forest domain, in *restinga* vegetation and *rocky outcrops* (BFG 2018). According to Taylor & Zappi (2004), it is morphologically related to *Pilosocereus brasiliensis* (Britton & Rose) Backeb. subsp. *brasiliensis*, a sympatric species in Espírito Santo state, especially due to morphology of the areolas and the color of the epidermis. However, it can be distinguished by presenting acute floral buds (*vs.* obtuse in *Pilosocereus brasiliensis* subsp. *brasiliensis*). The species is classified as almost threatened (NT) (Goettsch *et al.* 2015). It can be found throughout study area, especially in open areas and forest edges.

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