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Original Paper

Climbing plants from Seridó Ecological Station: diversity, interactive key and five new records from Rio Grande do Norte state, Brazil

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Abstract

In Brazil, Seasonally Dry Tropical Forests (SDTFs) are represented by Caatinga, which exhibits one of the greatest species richness and endemisms among the Neotropical SDTFs. However, studies of the flora of this biome remain deficient, especially in scientifically neglected areas, such as the Seridó region. Located between the states of Rio Grande do Norte (RN) and Paraíba, the Seridó region has an underestimated floristic diversity, especially for non-arboreal components such as climbers. Given this scenario, the study aimed to survey the climbers of the Seridó Ecological Station, a federal conservation unit located in the RN state, as well as to provide a multiple access online identification key. Collections were carried out from 2018 to 2019, as well as consultation of material deposited at the UFRN herbarium. In total, 56 species were listed, being 33 herbaceous and 23 woody climbers, respectively, adding 14 species of climbers to the previous checklist of the unit. Five new occurrences were found for the state of Rio Grande do Norte: *Cuscuta globosa*, *Cuscuta partita* (Convolvulaceae), *Macroptilium bracteatum* (Fabaceae), *Heteropterys trichanthera* and *Tetrapterys longibracteata* (Malpighiaceae), being the latest a new occurrence of the genus Tetrapterys for the state. Convolvulaceae is the most representative family (18 spp.), followed by Fabaceae (10 spp.), Apocynaceae (eight spp.) and Cucurbitaceae (five spp.). This is the first study that provides an interactive identification key for the Seridó region and for the RN state. The interactive identification key is published throughout the Xper³ platform, and can be accessed at <xper3.fr/xper3GeneratedFiles/publish/identification/-4505993480748774750/mkey.html>.

Key words: caatinga, seasonally dry tropical forests, lianas, virtual taxonomy.

Resumo

No Brasil, as Florestas Tropicais Sazonalmente Secas (FTSS) são representadas pela Caatinga, que exibe uma das maiores riquezas de espécies e endemismos dentre as FTSS Neotropicais. Contudo, o bioma segue deficiente quanto ao estudo da flora, principalmente em áreas negligenciadas cientificamente, como a região do Seridó. Localizada entre os estados do Rio Grande do Norte (RN) e Paraíba, o Seridó possui uma diversidade florística subestimada, principalmente em componentes não arbóreos, como as trepadeiras. Diante deste cenário, o trabalho teve como objetivo realizar um levantamento das trepadeiras da Estação Ecológica do Seridó, unidade de conservação federal localizada no estado do RN, bem como disponibilizar uma chave de identificação de múltiplo acesso online. Foram realizadas coletas entre 2018 e 2019 nessa unidade, bem como consulta de material depositado no herbário UFRN. Foram listadas 56 espécies de trepadeiras, sendo 33 herbáceas e 23 lenhosas, adicionando 14 espécies de trepadeiras ao checklist anterior da unidade. Cinco novas ocorrências foram encontradas para o estado do RN: *Cuscuta globosa*, *Cuscuta partita* (Convolvulaceae), *Macroptilium bracteatum* (Fabaceae), *Heteropterys trichanthera* e *Tetrapterys longibracteata* (Malpighiaceae), sendo a última nova ocorrência do gênero *Tetrapterys* para o estado. Convolvulaceae é a família mais representativa

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(18 spp.), seguida de Fabaceae (10 spp.), Apocynaceae (oito spp.) e Cucurbitaceae (cinco spp.). Este é o primeiro estudo que fornece uma chave de identificação interativa para a região do Seridó e para o estado do RN. A chave interativa para identificação das espécies está hospedada na plataforma Xper³, e pode ser acessada em <xper3.fr/xper3GeneratedFiles/publish/identification/-4505993480748774750/mkey.html>.
Palavras-chave: caatinga, florestas tropicais sazonalmente secas, lianas, taxonomia virtual.

Introduction

The Seasonally Dry Tropical Forests (SDTF) are formations characterized by the seasonal distribution of rainfall that result in several months of severe drought (Mooney *et al*. 1995). In the Neotropical region it is distributed in dispersed areas, from northwestern Mexico to northern Argentina and the Caribbean region, with 54.2% of its extension present only in South America (Linares-Palomino *et al.* 2011; Miles *et al.* 2006). The Caatinga, located in Northeast Brazil, is the largest fragment of Seasonally Dry Tropical Forests (SDTFs) in the neotropical region, with one of the greatest species richness and endemism among these formations (Prado 2003; Dryflor 2016). Considered to be the most populous semi-arid region in the world, the Caatinga remains neglected by researchers and conservationists and thus vulnerable to the impact of unsustainable use of natural resources (Santana *et al.* 2009). Despite the high level of degradation, the Caatinga still has well-preserved regions and comprises a considerable number of rare and endemic taxa (Giulietti *et al.* 2004).

The Caatinga vegetation displays unique adaptations to survive in a hostile environment, with extremely low rainfall and prolonged dry season, contrasting to those found in neighboring regions such as the Amazon and the Atlantic Forest (Queiroz *et al.* 2017). The Caatinga is described by typical features of xerophytic vegetation such as shrubby or arboreal forests, spiny and deciduous trees (Prado 2003; Giulietti *et al.* 2004). Most of the region has precipitation between 600 and 1,200 mm annually, in a warm semi-arid climate, with an average temperature ranging from 25 to 30 °C throughout the year (Andrade *et al.* 2017; Silva *et al.* 2017). Its main physiographic compositions include the frequent rock outcrops, extensive intermittent drainage, and the numerous fields of inselbergs, frequent in different types of formations.

Among the eight ecoregions defined for the Caatinga biome by Velloso *et al.* (2002), the Depressão Sertaneja Setentrional (DSS) is considered the most degraded one, with a small number of protected areas. The DSS includes three regions with very distinct vegetation and soil: Chapada do Apodi, Cariri Paraibano and Seridó (Velloso *et al.* 2002) (Fig. 1). The Seridó region, located whithin a semi-arid area between Rio Grande do Norte and Paraíba states, is distinguished from the other areas of the DSS by having shallow soils derived from precambrian granites, gneisses and schists, with crystalline elevations up to 700 meters (Radam Brasil 1981; Velloso *et al*. 2002; Varela-Freire 2002). The vegetation is classified as with low density and small size, which shows a predominantly open formation, typical of crystalline formations in Northeast Brazil (Radam Brasil 1981; Queiroz *et al.* 2015). However, it is argued that its floristic diversity is underestimated because floristic surveys in the area focused on arboreous species, neglecting the importance of herbaceous and/or annual species, an important component of plant communities in arid regions, like the Caatinga biome (Mott 1972; Nash *et al.* 1999; Costa *et al.* 2007; Queiroz *et al.* 2015).

Climbing plants, subdivided into herbaceous and woody species, are those that need some support to grow (Gentry 1991; Gerwing *et al.* 2006). Plants that have this habit use the stem, tendrils, adventitious roots, or other appendages to stay suspended, ensuring sunlight and moisture necessary for their survival (Gerwing *et al.* 2006; Burnham 2015). The climbing strategy emerged independently on several occasions during plant evolution (Putz 1984; Burnham 2015). According to Gentry (1991), 26 angiosperm families include 85% of all New World climbers, which are of great floristic importance, contributing significantly to the taxonomic diversity of tropical forests. In neotropical region, woody climbing (or liana) plants account for about 25% of overall plant species richness (Schnitzer & Bongers 2002). Climbing species also affects the structure of tropical forests by exerting a strong selective pressure on the trees, which influences their survival rate, individuals with large number of lianas suffer higher mortality rates than liana-free

trees (Putz 1984; Gentry 1991). In contrast, lianas can also provide support to trees by anchoring each other, reducing mechanical stress, induced by wind for example (Putz 1984).

Despite its importance contributing to the diversity and structure of tropical forests, few studies focusing on the diversity of this life form have been carried out in the Caatinga (Araújo 2014; Oliveira *et al.* 2015; Delgado-Junior & Alves 2017; Lucena *et al*. 2017). Given this, detailed studies are still needed to improve our understanding about the diversity of climber species, especially in underexplored areas such as the Seridó. Further studies focusing on the characterization, conservation and management of these species are also required (Ribeiro Neto *et al.* 2018).

The knowledge of a region's flora is a fundamental part of the evaluation and monitoring of its biodiversity, which supports the information used for elaboration of conservation measures and the use of natural resources (Cerqueira 2001). However, such measures should be based on correct species identification (Urbanetz *et al.* 2010). Taxonomy has traditionally used numerous terminologies that are difficult for non-botanists to understand, and taxonomic information is not

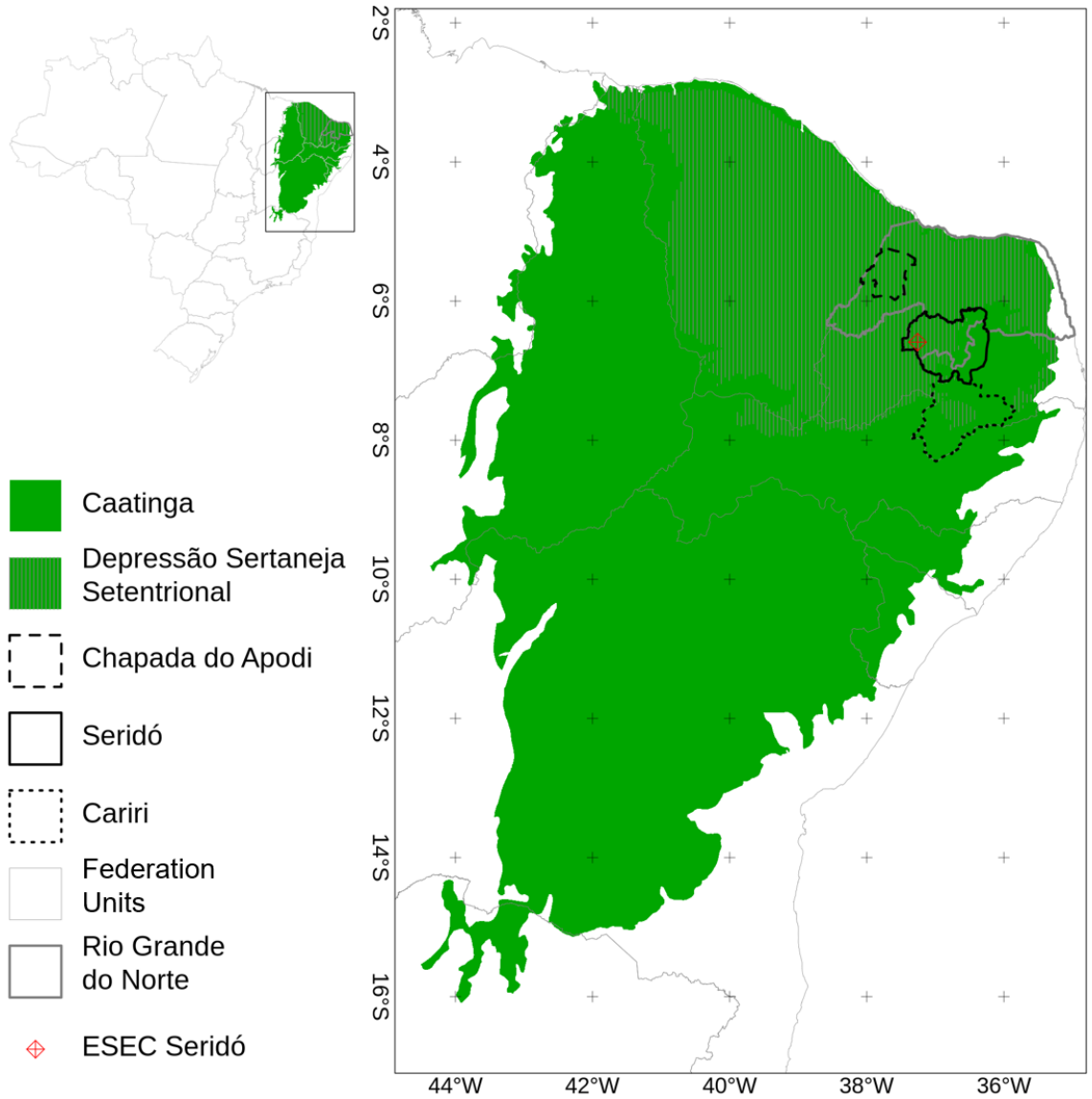

Figure 1 – Location of the study area, the Seridó Ecological Station, a federal conservation unit inserted in the ecoregion of the Depressão Sertaneja Setentrional (DSS), northern portion of the Caatinga biome, Rio Grande do Norte state.

always accessible to the whole society, which makes it difficult to properly identify species. Therefore, the use of modern taxonomic tools can contribute significantly to the adequate dissemination of the knowledge about diversity and, consequently, to the flora maintenance of a specific region, especially in protected areas. One of the tools available today is the interactive identification key, which abandons the dichotomy of traditional identification keys. The interactive keys are relatively friendly platforms that use images in order to illustrate terms and species, besides the fact that are available online and, therefore, facilitate the process of identifying taxa, especially by non-specialists. From this point of view, anyone can learn about biodiversity beyond a collection of taxon names by gathering taxonomic information into a reliable, easily accessible, up-to-date source (Hardisty & Roberts 2013).

Considering the above, the objective of the present work is to list, describe and illustrate the flora of climbing plants in Seridó Ecological Station (ESEC Seridó), one of the few conservation units of the Caatinga in Rio Grande do Norte state. This study aims to make use of virtual taxonomic tools, which combines the basic principles of taxonomy and modern digital resources, facilitating access to data and dissemination of knowledge about the local flora.

Material and Methods

Study site

Seridó Ecological Station (ESEC Seridó) is a conservation unit (CU) located in the municipality of Serra Negra do Norte, state of Rio Grande do Norte, in the Seridó microregion (coordinates: maximum latitude: 06º36'40"S, minimum latitude: 06º33'50"S, west longitude: 37º17'10"W, east longitude: 37º14'20"W). Created in 1982, ESEC Seridó has 11,2361 km² and, although is one of the smallest strict protection areas in the country, is also the second largest CU of Rio Grande do Norte and the first for the Caatinga biome in this state (ICMBio 2019) (Fig. 1).

Inside the ESEC Seridó, the hyperxerophilous Caatinga, typical vegetation of the region that develops on a shallow and stony soil, presents distinct physiognomies related to soil type, presence of water and relief (Fig. 2) (Moreira 1990; IBAMA 2004). The unit has three main terrestrial habitats, as mentioned by Queiroz *et al.* (2015): Open caatinga (Fig. 2a), with sparse deciduous woody plants and herbaceous plants that cover the soil during the rainy season; closed Caatinga (Fig. 2b), which is a dense scrubland or woodland, being the most widespread habitat in the unit; finally, the rocky outcrops (Fig. 2c), including inselbergs and lagedos, with the presence of rupicolous vegetation. In addition to these habitats, aquatic environments can be observed, such as the artificial reservoir (Fig. 2d) and temporary ponds during the rainy season. According to the Köppen-Geiger classification, ESEC Seridó has a Bsh type climate (warm semi-arid), with the rainy season concentrated from January to May (Alvares *et al.* 2013). The CU is inserted in the morphodynamic domains of the Depressão Sertaneja, Jucurutu Formation, where it presents luvisols, organosols and neosols soils (the latter two being less frequent) (IBAMA 2004). In the buffer zone of the CU there are isolated communities, mostly family farmers.

Floristic study

A preliminary list of species was initially generated by accessing public repositories (SpeciesLink, <http://splink.cria.org.br/>; BFG (2018); and GBIF, <https://www.gbif.org/>). The names have been updated and the data were managed to remove errors and duplicates using BRAHMS software (<https://herbaria.plants.ox.ac.uk/bol/>). Thereafter, periodic expeditions were carried out to obtain botanical samples, from April 2018 until December 2019, covering both wet and dry seasons. The specimens were georeferenced using a GPS (Garmin Gpsmap 78s). Individuals in reproductive stage were collected and photographed using a Nikon Coolpix P600 digital camera.

The botanical material was processed according to the usual techniques for vascular plants (Fidalgo & Bononi 1989). Taxonomic identification was accomplished by means of specialized taxonomic literature, herborized collections and, when necessary, consultation with specialists. Additionally, the collection of the UFRN herbarium, which concentrates a large volume of botanical material from ESEC Seridó including those from Queiroz *et al.* (2015), was consulted and served as the basis for coding of morphological characteristics used in the determinations and in the interactive identification key.

For the determination of new occurrences and endemism, we consulted BFG (2018) and previous studies about the flora of Rio Grande do Norte that cited some of the listed species: Versieux *et al*. (2017), Soares (2018), Medeiros

Figure 2 – a-d. Overview of distinct habitats in Seridó Ecological Station, a federal conservation unit located in the Caatinga biome, Rio Grande do Norte state – a. open caatinga at the beginning of the dry season; b. closed caatinga in rainy season; c. rock outcrop during the dry season; d. artificial reservoir during the rainy season. Photographs: a-d by L.F.A. de Paula.

et al. (2010), Roque *et al.* (2010), Amorim *et al.* (2016) and Santos *et al.* (2019). Species cited in previous studies that are not yet in BFG (2018) were highlighted (Tab. 1).

Interactive key

The interactive identification key for woody and herbaceous climber species in ESEC Seridó was developed using the open access software Xper², version 2.3.2 (<http://www.infosyslab.fr/>). The software was developed in Java language and is compatible with the major operating systems (*i.e.* Windows, MacOS and Linux), is free and has a user-friendly interface available in several languages, including Portuguese (Ung *et al.* 2010). Therefore, the key was later transferred to the online platform Xper³ (<http://www.xper3.fr>), facilitating access for the public.

The organization of characters and character states, as well as their description, was based on specialized literature (Vidal & Vidal 2000; Gonçalves & Lorenzi 2011). The characters used in the key were grouped into four main sections: "Leaf", "Flower", "Other Vegetative Characters", "Fruits and Seeds". In Xper³, these characters are ordered according to their respective discriminating power, based on the efficiency indices of the Xper (Ung *et al.* 2010), Jaccard (1901) and Sokal & Michener (1958) descriptors. All images are from species found in the study site, being used to illustrate the species, the characters and character states. In some cases, it was not possible to acquire images of the species in the field; therefore, we used photographs of public domain. All images were properly referenced with the photographer's name and/or link that gave permission to use them.

The discriminatory power of the key descriptors was evaluated using analytical tools of Xper², which include three indexes that quantitatively evaluate the efficiency of each descriptor in distinguishing species. Analyses of these indexes were helpful to check the efficiency of each character, allowing us to review the key in order to keep only the most useful characters.

Results

Climber diversity in the study area

We recorded a total of 56 climbing species in the study area, belonging to 13 families and 34 genera (Tab. 1; Fig. 3). Only two species belonged to monocotyledons (*Dioscorea campestris*, Dioscoreaceae and *Aristolochia birostris*, Aristolochiaceae). Among the eudicotyledons, Convolvulaceae is the most representative family (18 species; five genera), followed by Fabaceae (10 species; six genera), Apocynaceae (eight species; six genera) and Cucurbitaceae (five species; five genera) (see Fig. 4). Within the species, 33 were classified as herbaceous climbers or vines (about 58,9%), and most of them belonged to the Convolvulaceae family (18 species). The remaining 23 species (41,1% of the total species number) were classified as woody climbers or lianas, with the Apocynaceae family being the most representative (totaling eight species) (Fig. 4).

Five new occurrences were found for the state of Rio Grande do Norte (Tab. 1): *Cuscuta globosa*, *Cuscuta partita*, (Convolvulaceae), *Macroptilium bracteatum* (Fabaceae), *Heteropterys trichanthera* and *Tetrapterys longibracteata* (Malpighiaceae), being the latest a new occurrence of the genus *Tetrapterys* for the state. Five other species, although mentioned in previous studies, are not cited for the state of Rio Grande do Norte in BFG (2018): *Ancistrotropis peduncularis* (Versieux *et al*. 2017), *Ipomoea cynanchifolia* (Soares 2018), *Cucumis anguria* (Medeiros *et al.* 2010), *Luffa operculata* (Roque *et al.* 2010) and *Tragia cearensis* (Santos *et al*. 2019). Some listed species have economic, medicinal and ornamental importance: *Cucumis anguria*, popularly known as maxixe, is widely consumed and cultivated in the region; *Momodica charantia* and *Luffa operculata* have several uses in traditional medicine (Silva & Freire 2010) as in the pharmaceutical industry (Champney *et al.* 1978); and *Alamanda blanchetti* (Fig. 3e) stands out for its ornamental use because its flowers are very showy.

Interactive key

The interactive key database includes 16 reproductive characters and 29 vegetative characters, totaling 45 characters and 209 character states. In total, 281 images were used to illustrate the key. To illustrate the species, 88 photos were used, including habit, main structures and exsiccates used in the description. The key was later transferred to the online platform Xper³ [<http://www.xper3.fr> (Fig. 5)], where it is published and freely accessible to the public through the link: <http://www.xper3.fr/xper3GeneratedFiles/publish/identification/-4505993480748774750/mkey.html>.

Table 1 – Climbers from Seridó Ecological Station, Rio Grande do Norte, Brazil. Habit: H (Herbaceous), W (Woody). Endemic from Brasil (End). Habitat: Ro (Rock outcrop), Oc (Open Caatinga), Cc (Closed Caatinga), Unk (Unknown). Distribution (Distrib.): N (Native), E (exotic). Collectors: M = Moreira VP; Mo = Moura EO; Ma = Marinho AM; Me = Melo JI; N = Nascimento MB; Q = Queiroz RT. Voucher = Collector Number / Catalog Number. First records for the Rio Grande do Norte state are in bold. Names preceeded by "*" were previously cited in the literature, but not on the BFG (2018). Ancistrotropis peduncularis is cited by Versieux *et al.* (2017) Ipomoea cynanchifolia by Soares (2018), Cucumis anguria by Medeiros *et al.* (2010), Luffa operculata by Roque *et al.* (2010) and Tragia cearensis by Santos *et al.* (2019).

Família / Espécie	Habit	End.	Habitat	Dist.	Voucher
Apocynaceae					
Allamanda blanchetii A.DC.	W	X	Oc, Cc	N	Q 760 (UFRN3524)
Ditassa hastata Decne.	W	X	Ro	N	Q 454 (UFRN3260)
Funastrum clausum (Jacq.) Schltr.	W		As	N	Q 396 (UFRN-3327)
Ibatia ganglinosa (Vell.) Morillo	W	X	Unk	N	Q 539 (UFRN3773)
Ibatia harleyi (Fontella & Morillo) Morillo	W	X	Oc	N	N 367 (UFRN26142)
Ibatia nigra (Decne.) Morillo	W	X	Oc	N	M 266 (UFRN26525)
Petalostelma cearense Malme.	W	X	Oc, Cc	N	N 379 (UFRN26154)
Ruehssia megalantha (Goyder & Morillo) F. Esp. Santo & Rapini	W	X	Oc	N	N 456 (UFRN26637)
Aristolochiaceae					
Aristolochia birostris Duch.	W	X	Cc	N	Q 703 (UFRN3942)
Bignoniaceae					
Amphilophium crucigerum (L.) L.G.Lohmann	W	X	Cc	N	N 377 (UFRN26152)
Cuspidaria cratensis (J.C. Gomes) A.H. Gentry ex L.G. Lohmann	W	X	Oc		N 467 (UFRN26639)
Fridericia dichotoma (Jacq.) L.G.Lohmann	W		Oc	N	Mo 76 (UFRN12799)
Boraginaceae					
Myriopus rubicundus (Salzm. *ex* DC.) Luebert.	W	X	Oc, Cc	N	Me 594 (UFRN8430)
Convolvulaceae					
Cuscuta partita Choisy.	H		Oc	N	Q 287 (UFRN3444)
Cuscuta globosa Ridl.	H		Oc	N	N 173 (UFRN26055)
Distimake aegyptius (L.) A.R. Simões & Staples	H		Ro, Oc	N	Me 596 (UFRN8426)
Ipomoea acanthocarpa Hochst. *ex* Choisy	H		Oc	N	Q 267 (UFRN3449)
Ipomoea bahiensis Willd.	H	X	Oc, Cc	N	N 239 (UFRN26099)
Ipomoea blanchetii Choisy	H	X	Unk	N	Q 754 (UFRN4139)
**Ipomoea cynanchifolia* Meisn.	H		Oc	N	N 76 (UFRN12799)
Ipomoea hederifolia L.	H		Oc	N	Q 389 (UFRN3273)
Ipomoea heptaphylla Sweet.	H		Oc	N	Q 791 (UFRN3340)
Ipomoea longeramosa Choisy.	H		Oc	N	Q 215 (UFRN3082)
Ipomoea marcellia Meisn.	H	X	Oc		N 257 (UFRN26117)
Ipomoea muricata (L.) Jacq.	H		Unk	N	Q 1070 (UFRN3750)
Ipomoea nil (L.) Roth.	H		Oc	N	Ma 58 (UFRN7170)

Família / Espécie	Habit	End.	Habitat	Dist.	Voucher
Ipomoea tenera Meisn.	H	X	Oc	N	Q 327 (UFRN3408)
Jacquemontia evolvuloides (Moric.) Meisn.	H		Ro, Oc	N	Q 175 (UFRN3309)
Jacquemontia corymbulosa Benth.	H		Ro	N	Q 224 (UFRN3105)
Jacquemontia gracillima (Choisy) Hallier f.	H	X	Oc	N	Q 327 (UFRN3408)
Operculina macrocarpa (L.) Urb.	H		Oc	N	N 382 (UFRN26157)
Cucurbitaceae					
Cayaponia tayuya (Vell.) Cogn.	W	X	Oc	N	Q 971 (UFRN3540)
Ceratosanthes palmata Urb.	H		Oc, Cc	N	N 384 (UFRN26159)
**Cucumis anguria* L.	H		Oc	E	Q 277 (UFRN3394)
**Luffa operculata* (L.) Cogn.	H		Oc	N	N 191 (UFRN26070)
Momordica charantia L.	H		Oc, Cc	E	Q 276 (UFRN3280)
Dioscoreaceae					
Dioscorea campestris Griseb.	H		Cc	N	Q 757 (UFRN3498)
Euphorbiaceae					
**Tragia cearensis* Pax & K.Hoffm.	W		Oc, Cc	N	N 381 (UFRN26156)
Fabaceae					
**Ancistrotropis peduncularis* (Fawc. & Rendle) A.Delgado	H		Ro, Oc	N	N 209 (UFRN26086)
Canavalia brasiliensis Mart. *ex* Benth.	H		Oc, Cc	N	Q 972 (UFRN3647)
Centrosema brasilianum (L.) Benth	H		Ro, Oc	N	Q 252 (UFRN3649)
Centrosema macranthum Hoehne	H		Oc	N	N 356 (UFRN26132)
Centrosema pascuorum Mart. *ex* Benth.	H		Oc	N	N 368 (UFRN26143)
Galactia striata (Jacq.) Urb.	H		Oc	N	Q 902 (UFRN3721)
Macroptilium atropurpureum (DC.) Urb.	H		Unk		Q 1080 (UFRN3752)
Macroptilium bracteatum (Nees & Mart.) Maréchal & Baudet	H		Oc	N	Q 345 (UFRN3401)
Macroptilium martii (Benth.) Maréchal & Baudet	H		Ro, Oc	N	F 176 (UFRN8541)
Rhynchosia minima (L.) DC.	W		Oc	N	N 366 (UFRN26141)
Malpighiaceae					
Diplopterys lutea (Griseb.) W.R.Anderson & C.C.	W	X	Oc	N	N 471 (UFRN26641)
Heteropterys trichanthera A. Juss.	W	X	Oc, Cc	N	N 186 (UFRN26067)
Tetrapterys longibracteata A. Juss.	W	X	Unk	N	Mo 71(UFRN12794)
Passifloraceae					
Passiflora cincinnata Mast.	W		Oc	N	Q 988 (UFRN3865)
Passiflora foetida L.	H		Oc	N	N 231 (UFRN26091)
Sapindaceae					
Cardiospermum corindum L.	W		Oc	N	N 358 (UFRN26134)
Vitaceae					
Clematicissus simsiana (Roem. & Schult.) Lombardi	W		Ro	N	Q 704 (UFRN3462)
Cissus verticillata (L.) Nicolson & C.E.Jarvis	W		Oc	N	Q 784 (UFRN3497)

Figure 3 – a-h. Some climbers of the Seridó Ecological Station, a federal conservation unit located in the Caatinga biome, Rio Grande do Norte state – a. *Canavalia brasiliensis*, flower; b-c. *Allamanda blanchetii*, flower and fruit; d. *Ibatia harleyi*, flower; e. *Jacquemontia evolvuloides*, flower; f. *Myruopus rubicundus*, flower; g. *Cardiospermum corundum*, fruit and seed; h. *Passiflora foetida*, flower. Photographs: a, b by V.P. Moreira; c, d, e, h by M.B. Nascimento; f, g by F.G.L. Moreira.

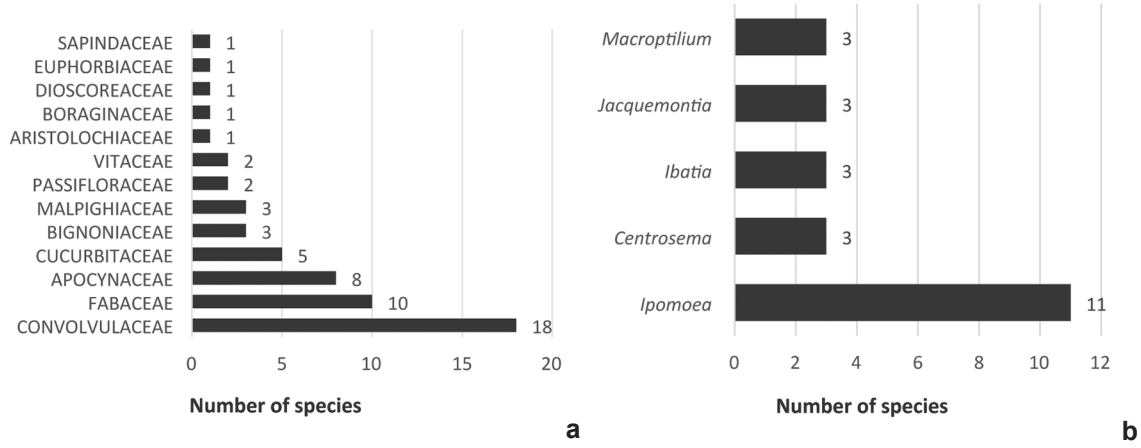

Figure 4 – Richest families (a) and genera (b) of the Seridó Ecological Station, a federal conservation unit located in the Caatinga biome, Rio Grande do Norte state.

Discussion

This study added 14 species of climbers to the previous checklist of ESEC Seridó made by Queiroz *et al.* (2015). It also contributes to a reassessment of the knowledge about the diversity of Caatinga climbing plants, which is an understudied life form group, especially in this region. The insufficient biodiversity knowledge of an area, especially of a CU, hinders several measures that would enable the preservation and sustainable use of the natural resources, and prevents society from having access to correct estimates of species numbers. This work is the first to cover climbers in the CU and throughout the Seridó region, as well as in the state of Rio Grande do Norte. This is also the first online interactive key publication for the flora of Seridó.

None of the climbing plants have any degree of threat according to the Oficial List of Endangered Species of the Brazilian Flora (MMA 2014). However, conservation status is unknown for most of the species as they have not been evaluated due to the absence of data or because are negleted groups. The three most representative families in the study area (Convolvulaceae, Fabaceae and Apocynaceae, respectively) are also the most characteristic families found in a previous survey in ESEC Seridó (Queiroz *et al*. 2015). These families were also reported as the most representative for the Caatinga in general, as seen in Araújo (2014). Although Convolvulaceae is the most representative family, not only in the study area but also in the whole Caatinga biome, the knowledge about its environmental and ecological importance is insufficient (Simão-Bianchini & Pirani 2005).

Previous studies carried out at ESEC Seridó have determined the zoning of the area, identifying rock outcrops, temporary pounds, preserved vegetation and degraded areas (Borges 1989; Moreira 1990). Later, other studies performed more detailed floristic, ethnobotanical, phytosociological and/or phytogeographic surveys (Camacho 2001; Camacho & Baptista 2005; Lacerda & Kageyama 2003; Santana & Souto 2006; Santana *et al.* 2009; Silva & Freire 2010; Queiroz 2006; Queiroz *et al.* 2015). Most of these studies focused on trees and shrubs or concentrated on phytotherapic species. More specifically, one investigation in the ESEC Seridó focused on the family Poaceae, in which a taxonomic treatment accepted 57 species of grasses in the area (Ferreira *et al.* 2009). The management plan of ESEC Seridó was implemented only in 2004 (22 years after its creation), displaying a floristic survey with 164 species (IBAMA, 2004). More thorough surveys were performed by Queiroz (2006) and Queiroz *et al.* (2015). The first comprised 300 species of angiosperms in the area, including woody and herbaceous species, while the latter recorded 335 angiosperm species. In a comprehensive analysis of the life forms found in ESEC Seridó, Queiroz *et al.* (2015) showed that herbaceous species constituted over 80% of the reserve's flora, suggesting that the richness estimates in the Seridó region are underestimated by the lack of studies focusing on non-arboreal species. In addition to the herbaceous species (which comprise 209 species), 16 trees, 39 shrubs/

sub-shrubs and 42 woody/herbaceous climbers were cataloged in the respective study (Queiroz *et al.* 2015). Our study cataloged 56 species of woody and herbaceous climbers, emphasizing the need for longer inventories in different areas of the Seridó region.

As taxonomy is a gateway to all biological knowledge, and it has become increasingly essential for taxonomic information to be organized, up-to-date, and readily available to society at large by electronic means (Bisby *et al.* 2002; Carvalho *et al.* 2015). The use of interactive keys meets this need, as they allow constant updating in addition to the large-scale dissemination provided by the internet, allowing the access of diverse audiences. The interactive key of the climbers in ESEC Seridó favors not only researchers in the area, but also managers of the conservation units, local communities (including schools) and visitors, which may have access to species identification, spreading, therefore, the knowledge about the region's flora. In addition, the key allows the users to obtain information about the flora during the dry season, which must be considered in the context of the Caatinga vegetation, where many plants are annual or deciduous.

Although there are already published interactive keys for the Atlantic Forest (Carmo & Simões 2017), Cerrado (Peres & Fagg 2011; Zanatta *et al.* 2015) and Amazon (Zuquim *et al.* 2017; Bittrich *et al*. 2012), the Caatinga so far has no exclusive interactive keys for its flora, as well as the state of Rio Grande do Norte. There is only an available interactive key for Bignoniaceae species occurring in the Caatinga biome within the state of Bahia (Espirito Santo *et al.* 2013). This deficiency of studies that includes new taxonomic tools obstructs the process of disseminating the knowledge of Caatinga biodiversity. By contrast, making interactive keys available online

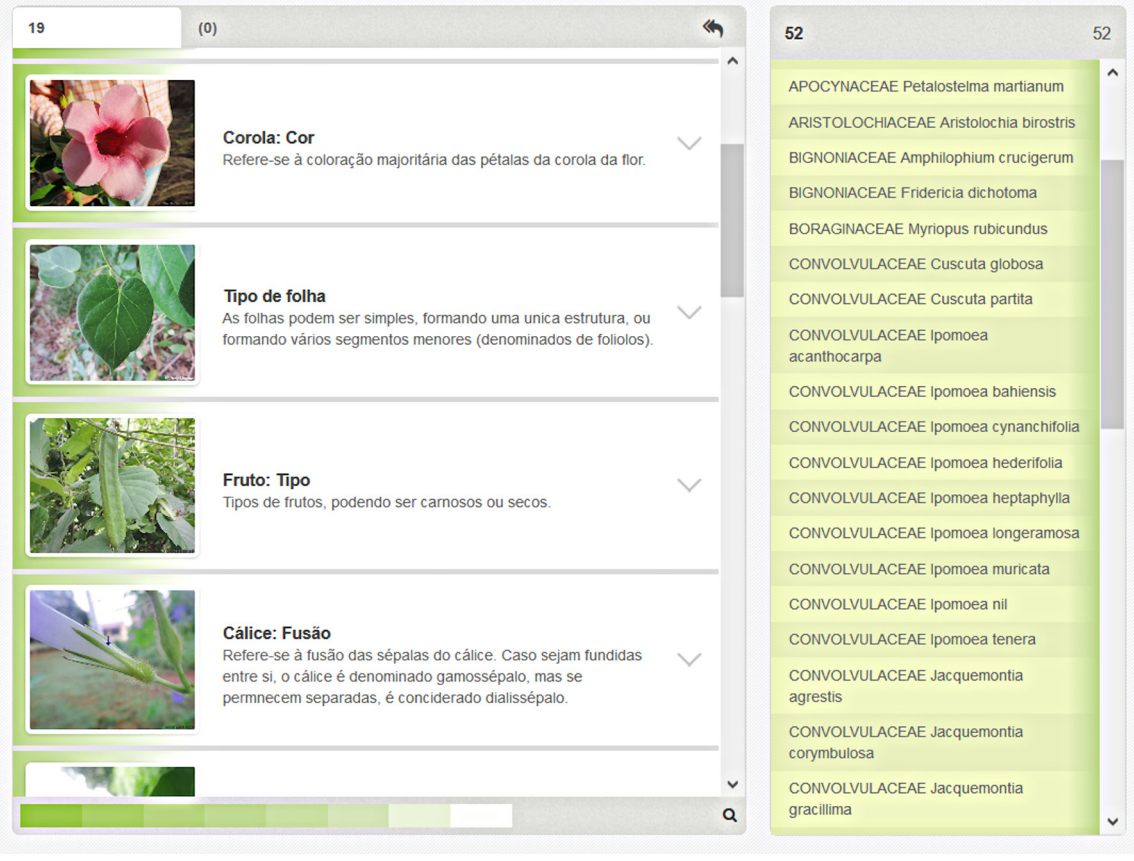

Figure 5 – Interactive Key for climbers species of the Seridó Ecological Station, Rio Grande do Norte, Brazil. The left column presents the characters and their respective states, and the right column presents the species and their respective families.

facilitates the identification process, making it more accessible not only to researchers but also to the general public, especially in more remote areas such as the Seridó region (Brach & Boufford 2011).

The results here support previous studies (Queiroz 2006; Queiroz *et al*. 2015), which emphasized that the Seridó region is still neglected concerning basic floristic knowledge, especially about non-arboreal species. Besides the updated checklist including new records for the Rio Grande do Norte state, we also provided an interactive key for identification of climbing plants. ESEC Seridó is suffering with historical antropic actions such as huntering and farming sourrounding it (Caldas *et al.* 2016). Besides the use by the academic community, the detailed information and images used in the virtual identication key may be used for educational purposes showing schools and sourrounding communities the importance the ESEC Seridó has for the conservartion of the floristic diversity of the region.

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