

# The Ronaldo Wasum Cactarium at the Botanical Garden of Joinville Region University, Santa Catarina, Brazil

## *O Cactário Ronaldo Wasum do Jardim Botânico da Universidade da Região de Joinville, Santa Catarina, Brasil*

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### ABSTRACT

The Ronaldo Wasum Cactarium (RWC), at the Botanical Garden (BG) of Univille, Santa Catarina, was created on April 19, 2016. Its name is in honor of Professor Ronaldo Adelfo Wasum (*in memoriam*), ex Director of the BG of Caxias do Sul, Rio Grande do Sul State. One of the objectives of the RWC is the *ex situ* conservation of cactus and other succulents species, including rare and endangered ones. In the RWC collection, there are 86 species, four of Apocynaceae, 68 of Cactaceae and 14 of Euphorbiaceae, one endemic to Santa Catarina and 17 to Brazil. 63 species are threatened with extinction: one critically endangered, three endangered, six vulnerable, three near threatened, 48 of least concern and four are data deficient. The RWC is open to the community; visits are monitored by the BG team, the Trails Program and the Visit Program of Univille. Along with the other collections of live plants at the JB and the Herbarium Joinvillea (JOI), the CRW is an important source for scientific research, in addition to providing knowledge about plants and moments of contemplation of nature to visitors. This work aims to present the CRW collection, opening up possibilities for research and interaction with other institutions and professionals who work with these species.

**Keywords:** biodiversity conservation; biological collections; cactus; succulent plants.

### RESUMO

O Cactário Ronaldo Wasum (CRW), do Jardim Botânico (JB) da Univille, Santa Catarina, foi criado em 19/4/2016. Seu nome é homenagem ao professor Ronaldo Adelfo Wasum (*in memoriam*), ex-diretor do JB de Caxias do Sul, Rio Grande do Sul. Um dos objetivos do CRW é a conservação *ex situ* de espécies de cactos e suculentas, incluindo raras e ameaçadas de extinção. Na coleção, há 86 espécies, quatro de Apocynaceae, 68 de Cactaceae e 14 de Euphorbiaceae, sendo uma endêmica de Santa Catarina, 17 endêmicas do Brasil. 63 estão ameaçadas de extinção: uma criticamente ameaçada, três ameaçadas, seis vulneráveis, três quase ameaçadas, 48 em estado menos preocupante e quatro com dados insuficientes. O CRW está aberto à comunidade e recebe visitas monitoradas pelas equipes do JB, do Programa Trilhas e do Programa Visite, da Univille. Juntamente com as demais coleções de plantas vivas do JB e do Herbário Joinvillea (JOI), o CRW é uma importante fonte para pesquisas científicas, além de propiciar conhecimento sobre plantas e momentos de contemplação da natureza aos visitantes. Este trabalho objetiva apresentar a coleção do CRW, abrindo possibilidades de pesquisa e interação com outras instituições e profissionais que trabalham com tais espécies.

**Palavras-chave:** cactos; coleções biológicas; conservação da biodiversidade; plantas suculentas.

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## INTRODUCTION

Brazil is home to the world's largest biodiversity, around 20% (MARINONI & PEIXOTO, 2010), with an estimated of 1.8 million species and 1,173 threatened taxa (ICMBio, 2014). One way of contributing to what is known and recorded about the species diversity of many ecosystems, ecoregions and biomes, is to make biological collections, which are unique sources of information for those who develop activities with living organisms, that can be accessed via databases produced and made available for consultation (MELO JÚNIOR *et al.*, 2014).

Following the promulgation of the Convention on Biological Diversity (CBD), signed in 1992 at the United Nations Conference on Environment and Development (CBD, 1992), different institutions (e.g., museums, universities, botanical gardens) have made zoological, microbiological and herbarium collections more evident to society and governments because, among other reasons, these institutions are responsible for keeping specimens that document biodiversity (MARINONI & PEIXOTO, 2010). Brazil hosts more than 46,000 species of plants, algae and fungi, representing one of the most biodiverse countries on Earth, and plays a key role in the Global Strategy for Plant Conservation (GSPC), which established a series of targets, one of which is to ensure that plant diversity is well understood, so that it can be effectively conserved and used in a sustainable manner (BFG, 2015). Based on this, Brazil defined biological collections as basic components of support for scientific development and technological innovation, affirming that the strengthening of science for the benefit of society depends on promoting broad access to data and information about Brazilian biodiversity (PEIXOTO *et al.*, 2006; FORZZA *et al.*, 2016). Thus, botanical gardens play a fundamental role through their collections of live plants, associated herbaria, research and environmental education activities, that seek to raise awareness of the importance of species preservation (COSTA & PEREIRA, 2008). In Brazil, several botanical gardens (BGs) maintain a cactarium or cactus collection, such as the BG of Rio de Janeiro (RJ), BG of Porto Alegre (RS), BG of Caxias do Sul (RS), BG of Jundiá (SP) (MIRANDA & COLOMBINI, 2009) and, more recently, the BG of São José (SC) (JARDIM BOTÂNICO MUNICIPAL MAX HABLITZEL DE SÃO JOSÉ, 2022).

Among the collections of living plants in botanical gardens, one of the most striking is that of cacti. The family Cactaceae comprises about 128 genera and 1,450 species, in four subfamilies (HUNT *et al.*, 2006). The group is almost exclusively distributed in the Americas, from Canada to Patagonia (except *Rhipsalis bacifera* (JM Muell.) Stearn, which occurs in Africa, Madagascar and Sri Lanka), and has centers of diversity in Mexico, eastern Brazil and in the Andes (Peru and Bolivia) (HUNT *et al.*, 2006; ZAPPI *et al.*, 2010). The Brazil Flora Group (BFG, 2015) recognizes 39 genera, 261 species and 92 subspecies in Brazil, in the subfamilies Pereskioideae, Opuntioideae and Cactoideae, including 14 endemic genera and 188 endemic species (SILVA *et al.*, 2011; GOETTSCHE *et al.*, 2015). Many of the species in Brazil are threatened with extinction (BRASIL, 2014; IUCN, 2021). The family occurs in all states and phytogeographic domains of Brazil, especially in the Caatinga, Cerrado and Atlantic Forest (GONZAGA *et al.*, 2017).

According to Zappi *et al.* (2010), Cactaceae species are perennial and usually have the following characteristics: stem succulent, externally greenish, with photosynthesizing function, often articulated, compressed, cylindrical, flanked or tuberculate, sometimes with mucilaginous, gummiferous or laticiferous cells or canals internally; axillary meristems represented by short stems called areoles, from which trichomes, thorns, flowers or rarely leaves arise; flowers showy, originating from modified or non-modified areoles, symmetry generally actinomorphic (except *Schlumbergera*), receptacular hypanthium (pericarpel) sometimes covered by scales and areoles with trichomes and spines, floral tube present or reduced (*Rhipsalis*); segments of the perianth with strong transition of texture and format, the outermost sepaloid, the innermost petaloid, stamens numerous, forming one or more continuous series in a spiral arrangement, inserted in the interior of the floral tube, anthers basifixed, disciform nectary at the apical portion of the ovary, ovary usually inferior, 1-locular, placentation basal or parietal, stigma lobed, lobe number equal to that of fused carpels; fruit as a type of berry, succulent, dehiscent or indehiscent, globose to conical, with or without remnants of the perianth, pericarp greenish to green, funiculus forming colored, solid (*Pilosocereus*) or mucilaginous (tribe Rhipsalideae) pulp; seeds naked or with sclerified aril (*Brasiliopuntia*, *Nopalea*, *Opuntia*), the hilum-micropylar region with two depressions, embryo straight or curved, endosperm absent, perisperm abundant.

In addition to species of Cactaceae, the place named cactarium usually has other species of succulent plants, mainly those of the families Apocynaceae, Crassulaceae and Euphorbiaceae. Lay people easily confuse these families with Cactaceae, since some species are succulent and leafless (e.g., *Euphorbia tirucalli* L. and *E. canariensis* L.) or succulent and/or with spines (e.g., *E. millii* Des Moulins, *E. horrida* Boiss., *Pachypodium densiflorum* Baker and *P. lamerei* Drake). However, Cactaceae usually have spines concentrated in the areolas; although, some species lack spines or the spines are inconspicuous, as found in, for example, *Rhipsalis*. Also, species of the Cactaceae genus *Pereskia* retain numerous plesiomorphic characters, such as a non-succulent stem, well developed and persistent leaves, determinate inflorescences, many styles and, at least in some species, a superior ovary with basal placentation (JUDD *et al.*, 2009).

With the goal of disseminating information about biological diversity, the Ronaldo Wasum Cactarium (RWC), at the Univille Botanical Garden (BG), was created as a collection of cacti and similar plants, enhancing its role as a source of knowledge about biological diversity.

## THE UNIVILLE BOTANICAL GARDEN

The Univille BG was founded on April 19, 2007, at the Joinville Region University, in Joinville, in Santa Catarina State, as the first botanical garden of the state. It occupies 19,160 m<sup>2</sup> and includes dense ombrophilous lowland forest in an advanced state of regeneration, which serves as a shelter for native species and protects the local flora and fauna. It was created to be a study center for the development of scientific and academic research, as well as a place of knowledge and leisure for the Joinville community and region. Furthermore, Univille BG works on the *ex situ* and *in situ* conservation of biodiversity and public awareness of the usefulness and value of plant resources for life on Earth, which are fundamental roles of botanical gardens (COSTA & PEREIRA, 2008; PEREIRA & COSTA, 2010).

Univille BG has several collections of live plants, such as gymnosperms, palm trees, orchids, bromeliads, and the Ronaldo Wasum Cactarium. It also has an arboretum, the Agroforestry System (AFS), the Vertical Garden, the Women's Garden, the Epiphytarium, the Seeds House, the Bees House, the Kohn Sawmill and a trail of about 300 m in the forest, among other attractions. Visitors, in groups guided by BG scholarship holders, by the Trails Program and by the Visit Program, can see the great diversity that the BG houses, in its relatively small but representative area, due to its location in the urban area of the municipality. Since it is a university garden, it promotes scientific research by students and professors/ researchers of several courses at institutions that study environmental issues (e.g., Biological Sciences, Environmental and Sanitary Engineering, Pharmacy, Gastronomy, Naturology, Pedagogy), as well as environmental education, which is included in the curriculum of the Biological Sciences and Environment and Biodiversity undergraduate degree programs.

## THE RONALDO WASUM CACTARIUM

In commemoration of the nine years of the Univille BG, on April 19, 2016, the Ronaldo Wasum Cactarium (RWC) was inaugurated (figure 1). It was named after Dr. Ronaldo Adelfo Wasum (*in memoriam*), who was the Director of the Botanical Garden of the city of Caxias do Sul, in Rio Grande do Sul State, a botany professor and curator of the UCS Herbarium, at the University of Caxias do Sul (UCS). He devoted himself to the preservation of the cacti in his state, was a great promoter of botanical gardens as a way of knowing, respecting and preserving biodiversity, and conducted environmental education projects in his city and in other regions in Brazil and abroad.

The high degree of endemic species in Brazil, in relation to the Americas as a whole, is the main reason to support the conservation of Brazilian Cactaceae (SILVA *et al.*, 2011). Thus, one of the objectives of the RWC is the *ex situ* conservation of some species, including those that are rare and endangered, taking into account Article 9 of the Convention on Biological Diversity (CBD, 1992), which emphasizes the importance of using *ex situ* conservation strategies as complementary actions

to *in situ* conservation, as noted by Costa & Pereira (2008), Pereira & Costa (2010) and Costa et al. (2016).



**Figure 1** – The Ronaldo Wasum Cactarium at the Univille Botanical Garden. Source: primary.



**Figure 2** – A: Overview of the Ronaldo Wasum Cactarium; B: Nameplate; C: Flowering of *Pilosocereus leucocephalus*. Source: primary.

The installed structure to maintain the RWC collection is an area of 28 m<sup>2</sup>, built with PVC pipes and wood, covered with plastic film of (3.0 mm thick), and environmentally protected by hexagonal

galvanized screen (0.71 mm). Benches, concrete posts and welded wire mesh were used to prevent the accumulation of water. On the floor, there are pebbles, which are smaller in the aisles, to facilitate walking and drainage (figure 2).

The specimens of the collection were purchased from producer Paulo Roberto Winckler, of Lua Cheia Cactus, established in the city of São Francisco do Sul, Santa Catarina State, and also through donations from private collectors.

Presently, the RWC collection comprises a total of 135 specimens from 86 species, being four of Apocynaceae, 68 of Cactaceae and 14 of Euphorbiaceae (table 1), of which 17 species are endemic to Brazil (FLORA E FUNGA DO BRASIL, 2022).

According to Ordinance n. 443 of December 17, 2014, of the Ministry of the Environment (BRASIL, 2014) and IUCN (2021), 61 species of the RWC collection are threatened with extinction: one critically endangered (*Mammillaria carmenae*), three endangered, six vulnerable, three near threatened and 48 least concern. Four species are with data deficient (table 1, figure 3).

**Table 1** – List of species of the Ronaldo Wasum Cactarium collection. Status: **EnB** – endemic in Brazil. Threatened with extinction: **CR** – critically endangered; **EN** – endangered; **VU** – vulnerable; **NT** – near threatened; **LC** – least concern; **DD** – data deficient.

Family	Specie	Status
Apocynaceae	<i>Pachypodium densiflorum</i> Baker	
	<i>Pachypodium geayi</i> Baker	LC
	<i>Pachypodium lamerei</i> Drake	LC
	<i>Pachypodium saundersii</i> N.E.Br.	
Cactaceae	<i>Arthroceus campos-portoi</i> (Werderm.) Backeb.	
	<i>Austrocylindropuntia subulata</i> (Muehlenpf.) Backeb.	LC
	<i>Browningia hertlingiana</i> (Backeb.) Buxb.	
	<i>Carnegiea gigantea</i> (Engelm.) Britton & Rose	LC
	<i>Cephalocereus senilis</i> (Haw.) Pfeiff.	EN
	<i>Cereus forbesii</i> C.F.Först.	LC
	<i>Cereus hildmannianus</i> K.Schum. ( <i>C. peruvianus</i> (L.) Mill.	LC
	<i>Cereus spegazzinii</i> F.A.C.Weber	LC
	<i>Cereus</i> sp.	
	<i>Cleistocactus ritteri</i> Backeb.	LC
	<i>Cleistocactus straussii</i> (Heese) Backeb.	
	<i>Consolea rubescens</i> (Salm-Dyck ex DC.) Lem.	LC
	<i>Copiapoa marginata</i> (Salm-Dyck) Britton & Rose	NT
	<i>Echinocereus pentalophus</i> (DC.) Lem.	LC
	<i>Echinocereus rigidissimus</i> (Engelm.) F.Haage	LC
	<i>Echinopsis arebaloi</i> Cárdenas	
	<i>Echinopsis oxygona</i> (Link) Zucc. ex Pfeiff. & Otto	LC
	<i>Echinopsis pachanoi</i> (Britton & Rose) Friedrich & G.D.Rowley	LC
	<i>Echinopsis subdenudata</i> Cárdenas	
	<i>Espostoa lanata</i> (Kunth) Britton & Rose	LC
<i>Ferocactus glaucescens</i> (DC.) Britton & Rose	LC	
<i>Ferocactus herrerae</i> J.G.Ortega	VU	
<i>Ferocactus recurvus</i> (Mill.) Borg		
<i>Gymnocalycium anisitsii</i> (K.Schum.) Britton & Rose	LC	

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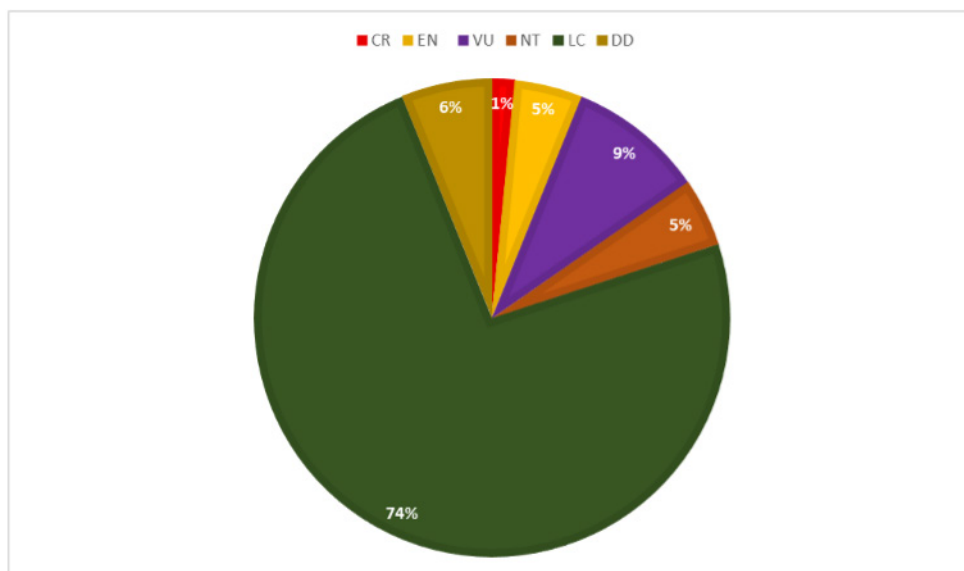
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Family	Specie	Status
	<i>Gymnocalycium calochlorum</i> (Boed.) Y.Itô	LC
	<i>Gymnocalycium horstii</i> Buining	EnB EN
	<i>Gymnocalycium mihanovichii</i> (Frič ex Gürke) Britton & Rose	LC
	<i>Isolatocereus dumortieri</i> (Scheidw.) Backeb.	LC
	<i>Mammillaria bocasana</i> Poselger	LC
	<i>Mammillaria bombycina</i> Quehl	VU
	<i>Mammillaria carmenae</i> Castañeda	CR
	<i>Mammillaria columbiana</i> Salm-Dyck	LC
	<i>Mammillaria compressa</i> DC.	LC
	<i>Mammillaria decipiens</i> Scheidw.	LC
	<i>Mammillaria elongata</i> DC.	LC
	<i>Mammillaria haageana</i> Pfeiff.	LC
	<i>Mammillaria hahniana</i> Werderm.	NT
	<i>Mammillaria marksiana</i> Krainz	LC
	<i>Mammillaria matudae</i> Bravo	DD
	<i>Mammillaria nivosa</i> Link ex Pfeiff.	LC
	<i>Mammillaria plumosa</i> F.A.C.Weber	NT
	<i>Mammillaria spinosissima</i> Lem.	DD
	<i>Melocactus bahiensis</i> (Britton & Rose) Luetzelb.	EnB LC
	<i>Melocactus ernestii</i> Vaupel	EnB LC
	<i>Micranthocereus estevesii</i> (Buining & Brederoo) F.Ritter	LC
	<i>Opuntia cochenillifera</i> DC.	DD
	<i>Opuntia durangensis</i> Britton & Rose	
	<i>Opuntia erinacea</i> Engelm. & J.M.Bigelow	
	<i>Opuntia ficus-indica</i> (L.) Mill.	DD
	<i>Opuntia microdasys</i> (Lehm.) Pfeiff.	LC
	<i>Opuntia microdasys</i> subsp. <i>rufida</i> (Engelm.) U. Guzmán & Mandujano	LC
	<i>Oreocereus trollii</i> Kupper	LC
	<i>Parodia haselbergii</i> (F.Haage) F.H.Brandt	EnB VU
	<i>Parodia leninghausii</i> (Haage) F.H.Brandt	EN
	<i>Parodia magnifica</i> (F.Ritter) F.H.Brandt	EnB EN
	<i>Parodia mamulosa</i> (Lem.) P.N.Taylor	EN
	<i>Parodia ottonis</i> (Lehm.) N.P.Taylor	EnB VU
	<i>Parodia schumanniana</i> (Nicolai) F.H.Brandt	EnB VU
	<i>Parodia</i> sp.	
	<i>Pilosocereus aureispinus</i> (Buining & Brederoo) F.Ritter.	EnB VU
	<i>Pilosocereus glaucochrous</i> (Werderm.) Byles & G.D.Rowley	EnB LC
	<i>Pilosocereus gounellei</i> (F.A.C.Weber ex K.Schum.) Byles & G.D.Rowley	EnB LC
	<i>Pilosocereus leucocephalus</i> (Poselger) Byles & G.D.Rowley	LC
	<i>Pilosocereus pachycladus</i> F.Ritter	EnB LC
	<i>Stenocereus pruinosus</i> (Otto ex Pfeiff.) Buxb.	LC
	<i>Stetsonia coryne</i> (Salm-Dyck) Britton & Rose	LC
	<i>Tacinga inamoena</i> (K.Schum.) N.P.Taylor & Stuppy	EnB LC
	<i>Tephrocactus articulatus</i> (Pfeiff.) Backeb.	LC

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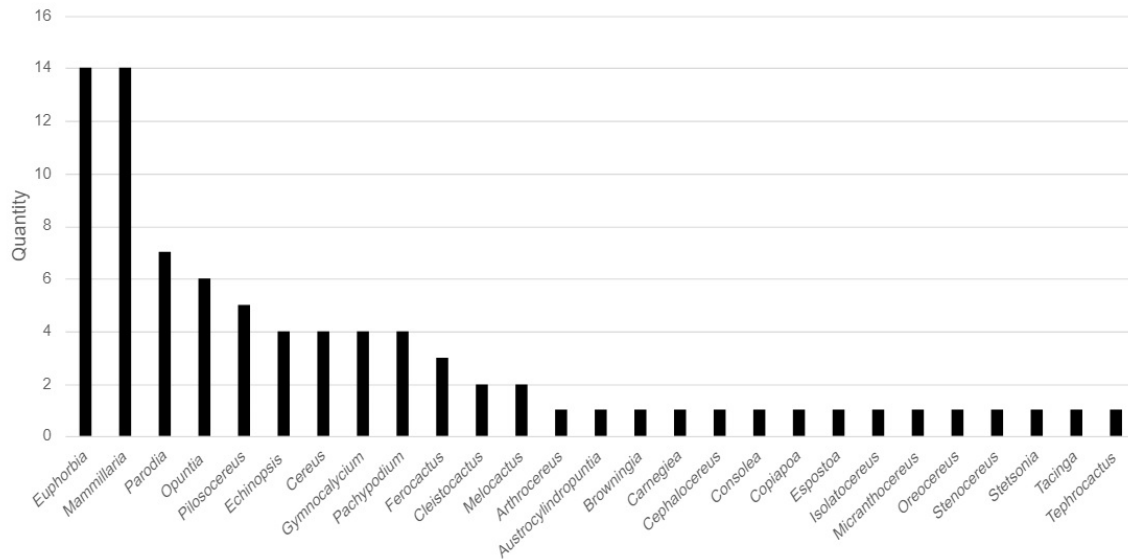
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Family	Specie	Status
Euphorbiaceae	<i>Euphorbia canariensis</i> L.	LC
	<i>Euphorbia cooperi</i> N.E.Br. ex A.Berger	LC
	<i>Euphorbia enterophora</i> Drake	LC
	<i>Euphorbia grandicornis</i> Goebel ex N.E.Br.	LC
	<i>Euphorbia horrida</i> Boiss.	
	<i>Euphorbia ingens</i> E.Mey. ex Boiss.	LC
	<i>Euphorbia lactea</i> Haw.	
	<i>Euphorbia mammillaris</i> L.	
	<i>Euphorbia neriifolia</i> L.	LC
	<i>Euphorbia phosphorea</i> Mart.	EnB
	<i>Euphorbia resinifera</i> O.Berg	
	<i>Euphorbia</i> sp.	
	<i>Euphorbia tetragona</i> Haw.	LC
	<i>Euphorbia trigona</i> Mill.	



**Figure 3** – Distribution of species of the Ronaldo Wasum Cactarium collection threatened with extinction: **CR** – critically endangered; **EN** – endangered; **VU** – vulnerable; **NT** – near threatened; **LC** – least concern; **DD** – data deficient. Source: primary.

Most species of the RWC are *Euphorbia* and *Mammillaria* (14 each), followed by *Parodia* (seven), *Opuntia* (six) and *Pilosocereus* (five) (figure 4).



**Figure 4** – Distribution of species per genus with highest species diversity of the Ronaldo Wasum Cactarium collection. Source: primary.

The names of the species follow the list of species of the Brazilian flora (INCT, 2019) and the names of the authors are cited according to the International Plant Name Index (IPNI, 2015) database. The RWC database uses the program created for registering the BG plants and is available online at <http://jardimbotanico.univille.br>. Accession records include as much information as possible, such as registration number, family, genus, species (subspecies or variety), author, common name (if any), place of origin, geographical coordinates, municipality, state, phytogeographic region, environment, habitat, date of entry, collector/donor and plant dimensions, among other relevant morphological aspects. An image of the plant is also taken and attached to the record. To study the taxonomy of each specimen, whenever possible, depending on flowering and the production of seedlings, a voucher is made at the Joinvillea Herbarium and incorporated into the JOI collection.

Research about pollinators and pollen was already conducted at the RWC with several species (MOUGA *et al.*, 2019), which is of great value, since studies related to the reproductive biology of Cactaceae in Brazil include less than 10% of the species in the country. The great variety of Cactaceae floral characters, such as shape, color, size, odor, floral position and duration of anthesis, indicate pollination by several biotic agents (HUNT & TAYLOR, 1990; VOGEL, 1990; LOCATELLI *et al.*, 1997; AONA *et al.*, 2006; ROCHA *et al.*, 2007). Several cacti of the RWC have already produced fruits and the seeds were collected and stored in the BG seed bank, to ensure future production of seedlings and new plants.

The RWC is open to the community and visits are monitored. As with the collections in the JOI Herbarium and other live plants at the BG, it is an important resource for scientific research and environmental education activities and provides information and the opportunity to be surrounded by nature. Since it was created, the RWC has received more than 14,000 visitors, including adults and children from the local community, students and researchers. During visits, the collection is presented, and some information is provided about recognizing, identifying, caring for and the importance of preserving these plants.

### ACKNOWLEDGMENTS

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