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# A review of vascular plant endemisms in Santa Catarina, southern Brazil, highlights critical knowledge gaps and urgent need of conservation efforts[1]

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Hassemer, G. (Programa de Pós-graduação em Biologia Vegetal, Centro de Ciências Biológicas, Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil), P. M. A. Ferreira (Programa de Pós-graduação em Botânica, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil), and R. Trevisan (Departamento de Botânica, Centro de Ciências Biológicas, Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil). A review of vascular plant endemisms in Santa Catarina, southern Brazil, highlights critical knowledge gaps and urgent need of conservation efforts. J. Torrey Bot. Soc. 142: 78–95. 2015.—The State of Santa Catarina, located in southern Brazil, presents great diversity of topography, landscapes and vegetation types. It also harbors a very rich biodiversity, and many species are exclusive to this territory. As a consequence of the destruction of most of its original vegetation, a considerable part of this biodiversity is threatened. This work presents a survey of the vascular flora exclusive to Santa Catarina, based on a thorough literature review. The compilation provides information on the distribution, environments, latest recorded date of collection, and conservation status of these species with bibliographic references. This information has great potential value for biodiversity conservation. More taxonomic and conservation studies are warranted since our results present strong evidence that there are profound knowledge gaps on Neotropical biodiversity, even for allegedly well-studied areas, thwarting the implementation of effective conservation policies.

Key words: conservation status, data deficient species, narrow endemism, Neotropics, threatened taxa.

Tropical and Neotropical areas present impressive biodiversity and encompass widely known hotspots for conservation priorities (Myers et al. 2000, Ribeiro et al. 2011). However, many plant species in the tropics are threatened by habitat loss or degradation, overexploitation, and biological invasions (Sala et al. 2000, Miller et al. 2012, Mouillot et al. 2013). Even though nearly half of the world's vascular plant species are endemic to recognized hotspots, most of these hotspots have less than one third of their original habitats preserved (Brooks et al. 2002). Furthermore, recent work highlights the impact of biodiversity loss on the functioning of ecosystems (Hooper et al. 2012, Mouillot et al. 2013) and on humanity (Cardinale et al. 2012).

Despite conservation efforts by governments and international organizations, the preservation of natural environments is currently insufficient in extension and quality to prevent biodiversity loss (Rands et al. 2010, Dobrovolski et al. 2011). The successful conservation of rare or endangered species, which are almost always the most threatened (Mouillot et al. 2013), depends on the effective incorporation of political, economic, and biological factors in management strategies (Schemske et al. 1994, Werff and Consiglio 2004), and on the availability of reliable biogeographic information on these species (Callmander et al. 2007, Miller

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and Morgan 2011). The lack of comprehensive lists of species at risk of extinction is one of the greatest impediments to future efforts to ensure their survival (Miller et al. 2012). The delineation of priority areas for conservation based on the number of endemic species has been shown to be an effective way to maximize the benefits of the conservation efforts (Ferreira and Boldrini 2011).

Narrow endemism is a kind of rarity, defined by a spatially restricted distribution (Kruckeberg and Rabinowitz 1985, Cowling 2000, Knapp 2002, Ferreira and Boldrini 2011, Werneck et al. 2011). However, the concept of endemism is often used arbitrarily and without standardization (Ferreira and Boldrini 2011, Werneck et al. 2011). An endemic species is restricted to a particular area due to historical, ecological, and/or physiological reasons (Ferreira and Boldrini 2011, Silva 2011, Werneck et al. 2011). As suggested by Ferreira and Boldrini (2011), the term "endemic to" should be used to indicate the restriction to natural boundaries, as in "endemic to Trindade Island" or "endemic to high-elevation grasslands", and not for political boundaries that do not coincide with natural boundaries. In such cases, we recommend the use of "exclusive to", as in "exclusive to the State of Santa Catarina". However, a species exclusive to a political area is still endemic to a narrower natural area included within this larger, artificial area. Because of this, we can refer to "endemisms" as the ensemble of endemic species occurring in a given area, be it natural or artificial. In this sense, both "endemic" and "exclusive" species are restricted to a certain area and do not occur spontaneously (without human cultivation) elsewhere.

Endemic species with very restricted distributions (hereafter referred to as 'endemic') are naturally more vulnerable to genetic impoverishment events and extinction (Ellstrand and Elam 1993), and thus require priority conservation efforts (Versieux 2011). In the tropics, the levels of endemism are generally higher with increasing elevation (Werff and Consiglio 2004). In comparison with more widely distributed species, endemic species have been shown to occur at higher elevations and poorer soils, indicating that these species may be specialists, adapted to stressful environments, and less able to compete in other types of environment and to colonize new areas (Lavergne et al. 2004).

Study Area. Brazil has the richest flora of any country in the world (Giulietti et al. 2005), with 44,034 plant species currently recognized (Lista de Espécies da Flora do Brasil 2014) and is also the country with most vascular plant species exclusive to its territory (Forzza et al. 2012). The area of study of this work is the State of Santa Catarina (SC), which is located in southern Brazil, between the latitudes 25° 57′ and 29° 21′ S, and occupies an area of 95.483 km$^2$ (Santa Catarina 1986). Elevation in SC ranges from sea level to 1827 m asl, and mean temperature is 9.1 °C during winter (with record low of –14° C in Caçador) and 27.4 °C during summer (with record high of 44.6 °C in Orleans; CIRAM 2014). The state has a wide variety of vegetation types, including Atlantic rainforest (dense ombrophilous forest), araucaria forest (mixed ombrophilous forest), deciduous seasonal forest, cloud forest, coastal restingas and mangroves, and high-elevation grasslands. Some species occur in more specialized environments, such as on rocky outcrops, which are present amidst almost all vegetation types in SC, being particularly frequent in the high-elevation grasslands areas, and the rheophytes species, which vegetate in river rapids. This impressive environmental variety is mainly the result of its subtropical climate and the wide variation of elevation within its territory, thus making possible a considerable diversification of its flora, and the development of many specialized species with very restricted distribution, some of which exclusive to its territory.

The Atlantic rainforest is well known to harbor high plant species richness, but other formations in SC also stand out by their species richness and endemism. Worth mentioning are the high-elevation grasslands, a vegetation type that under the current climate occurs at elevations above 800 m asl in SC and, although largely neglected by the public attention in the past, is recently receiving increasing attention because of its high percentage of endemic species (Iganci et al. 2011).

The distribution of forests and grasslands in highlands from southern Brazil followed a dynamic associated with glacial and interglacial periods, in which each vegetation type expanded or retreated according to variations in temperature and humidity (Behling et al. 2004, Lorenz-Lemke et al. 2010). There is evidence that grasslands were the dominant ecosystem in the region during the early and

mid-Holocene, which was followed by a fast (and still ongoing) expansion of Araucaria forest (Behling et al. 2004). In interglacial periods with no marked annual dry season such as we have today, higher elevation areas may serve as refuges for grassland species, which may partially explain the high levels of endemism and overall range restriction of species in the region. Additionally, SC (and southern Brazil as a whole) is inserted in a zone of transition between tropical and temperate ecosystems (Cabrera and Willink 1980), in which one can find taxa from different centers of origin (e.g. Andean, Amazonian, and Atlantic), thus promoting high levels of richness and endemism.

The flora of SC is considered the best known in Brazil (Reis et al. 2011, Sousa-Baena et al. 2014), mainly because of the publication of its regional flora, the 'Flora Ilustrada Catarinense', which is still ongoing, and more recently also the 'Inventário Florístico Florestal de Santa Catarina' (see Vibrans et al. 2010). However, most of the original vegetation of the state was destroyed in the last fifty years, being replaced mainly by monoculture plantations, cultivated pastures and buildings, a process that is still ongoing, threatening with extinction a significant part of its rich plant diversity, even inside environmental protection areas (Dobrovolski et al. 2011).

Knowledge about the plant endemisms in SC, as in most other Neotropical regions, is still deficient (Werneck et al. 2011), a situation that impedes a correct execution of effective conservation efforts (Miller et al. 2012). In the face of this, we present a revision of the information available for the vascular plant species exclusive to SC, including their distribution, types of environment of occurrence, and the most recent collection dates. We also evaluate the conservation status of these species. Furthermore, we present references for these species in order to encourage and facilitate more studies and especially conservation efforts for them.

**Materials and Methods.** In order to compile the list of plant endemisms in SC, we made an initial search for vascular plant species exclusive to SC using the List of Species of the Flora of Brazil (LFB; http://floradobrasil.jbrj.gov.br) and the Catálogo de las Plantas Vasculares del Cono Sur (CCS; http://www2.darwin.edu.ar/proyectos/floraargentina/fa.asp). Afterwards, starting from this list, we revised each species using specialized taxonomic literature, in order to check if the species is exclusive to SC, and also to determine its distribution, habitat, and collection dates. Furthermore, we made a thorough revision through the available taxonomic literature, aiming at correcting possible errors in the list, and to search for plant species exclusive to SC that were absent from the initial list. Because most of the species in the list are very narrowly distributed, scarcely collected, and poorly studied, it was not possible to present phytosociological or ecological information.

The resulting list (Table 1) is arranged alphabetically by botanical family and presents for each species, the most recent year of collection recorded in the literature and/or in the speciesLink database (http://splink.cria.org.br; see Canhos et al. 2004), the types of environment and municipalities of occurrence, the conservation status according to the IUCN criteria (IUCN 2012, 2014), and the references consulted. Despite the great deficiency of the data available on most species in the list, we followed the recommendations of IUCN (2012, 2014) which discourage the assignment of 'Data Deficient' category to species whose distribution and/or habitat deterioration would be enough to classify them for a threatened category. We found the application of the IUCN criterion B2a,b(iii) the most useful to classify the species in the list, considering the deficiency of information available on the species and the current trend of environmental degradation in SC. To apply this criterion, we did our best to make estimates of species' areas of occurrence based on approximations of areas of municipalities and areas of vegetation types. The species and authors names follow IPNI (The International Plant Names Index; http://www.ipni.org). The classification systems used were the APG III (APG 2009) for angiosperms, Christenhusz et al. (2011b) for gymnosperms, and Christenhusz et al. (2011a) for lycophytes and ferns. The types of environments in SC were accepted as in the Phytogeographic Map of Klein (1978).

**Results and Discussion.** The search in the LFB resulted in 4368 species of angiosperms, 6 of gymnosperms, and 420 of lycophytes and ferns that occur in SC, totaling 4794 accepted species of vascular plants occurring in the

Table 1. List of the vascular plant species exclusive to SC, including types of environments of occurrence (Env.): AR, Atlantic rainforest; CV, coastal vegetation; HG, high-elevation grasslands; AF, Araucaria forest; CF, cloud forest; SF, deciduous seasonal forest; RO, rocky outcrops; R, rheophytes; year of the most recent recorded collection of the species (Col.); and conservation status according to IUCN (2014), applying the criterion B2a,b(iii) (IUCN). Information/reference not found is indicated with a question mark (?).

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| **Acanthaceae** | | | | | |
| *Dyschoriste smithii* Leonard | R | Concórdia | 1964 | CR | Wasshausen and Smith 1969 |
| *Ruellia kleinii* C.Ezcurra & Wassh. | AR | Florianópolis | 1967 | EN | Ezcurra 1993 |
| *Ruellia reitzii* Wassh. & L.B.Sm. | AR | Luiz Alves | 1953 | EN | Wasshausen and Smith 1969, Ezcurra 1993 |
| **Amaryllidaceae** | | | | | |
| *Hippeastrum hemographes* (Ravenna) Dutilh | ? | ? | ? | DD | ? |
| *Nothoscordum aparadense* Ravenna | HG | Bom Jardim da Serra | 1998 | EN | Ravenna 2001a |
| *Nothoscordum catharinense* Ravenna | HG | Bom Jardim da Serra | 1986 | EN | Ravenna 1988 |
| *Nothoscordum ibiramense* Ravenna | AR | Ibirama | 1953 | EN | Ravenna 1990 |
| *Zephyranthes lagesiana* Ravenna | ? | ? | 2000 | DD | ? |
| **Anemiaceae** | | | | | |
| *Anemia alfredi-rohrii* Brade | RO | Palhoça | 1957 | EN | Sehnem 1974 |
| **Apiaceae** | | | | | |
| *Eryngium raulinii* Mathias & Constance | RO | Grão Pará, Morro Grande | 2012 | EN | Mathias et al. 1972 |
| **Apocynaceae** | | | | | |
| *Matelea reitzii* Fontella | HG | Curitibanos | 1962 | EN | Pereira et al. 2004 |
| *Oxypetalum kleinii* Fontella & Marquete | CF,RO | 10+ mun. | 2006 | NT | Pereira et al. 2004 |
| *Oxypetalum morilloanum* Fontella | HG | Abelardo Luz | 1963 | EN | Pereira et al. 2004 |
| *Oxypetalum reitzii* Fontella & Marquete | AF | Campo Alegre, Rio do Sul | 1998 | VU | Pereira et al. 2004 |
| **Araceae** | | | | | |
| *Anthurium lacerdae* Reitz | AR | Luiz Alves | ? | EN | Reitz 1957 |
| *Anthurium pilonense* Reitz | AR | Palhoça | ? | EN | Reitz 1957 |
| *Philodendron renauxii* Reitz | RO,AR | Garopaba, Laguna, Palhoça | 2007 | VU | Reitz 1957 |
| **Asteraceae** | | | | | |
| *Baccharis chionolaenoides* D.Falkenberg & Deble | RO | Urubici | 1993 | EN | Falkenberg and Deble 2010 |
| *Baccharis scopulorum* A.A.Schneid. & G.Heiden | RO | Urubici | 2006 | EN | Schneider et al. 2011 |
| *Conyza retirensis* Cabrera | HG | Bom Jardim da Serra, Bom Retiro | 1957 | EN | Cabrera 1959 |
| *Eupatorium laxicephalum* Cabrera | AR | 10+ mun. | 2010 | NT | Cabrera and Klein 1989 |
| *Eupatorium rosengurttii* Cabrera | AR | S. Francisco do Sul | 1938 | EN | Cabrera and Klein 1989 |
| *Heterocondylus reitzii* R.M.King & H.Rob. | HG | 10+ mun. | 2009 | NT | Cabrera and Klein 1989 |
| *Hysterionica matzenbacherii* A.A.Schneid. | RO | Lauro Müller | 1996 | EN | Schneider and Boldrini 2012 |
| *Hysterionica pinnatisecta* Matzenb. & Sobral | RO | Bom Jardim da Serra, Lauro Müller | 2008 | EN | Matzenbacher and Sobral 1996 |
| *Koanophyllon lobatifolium* (Cabrera) R.M.King & H.Rob. | AR | Joinville | 2010 | EN | Cabrera and Klein 1989 |
| *Leptostelma catharinense* (Cabrera) A.M.Teles & Sobral | HG | 10+ mun. | 2007 | NT | Teles et al. 2008 |
| *Lessingianthus ulei* (Hieron.) H.Rob. | CV | 10+ mun. | 2007 | NT | Cabrera and Klein 1980 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| *Macropodina reitzii* R.M.King & H.Rob. | AF | 10+ mun. | 1995 | NT | Cabrera and Klein 1989 |
| *Malmeanthus catharinensis* R.M.King & H.Rob. | HG | S. Joaquim | 1967 | EN | Cabrera and Klein 1989 |
| *Neocabreria catharinensis* (Cabrera) R.M.King & H.Rob. | HG | 4 mun. | 1962 | VU | Cabrera and Klein 1989 |
| *Perezia eryngioides* (Cabrera) Crisci | HG | 10+ mun. | 2000 | NT | Cabrera and Klein 1973, Katinas 2012 |
| *Senecio hilairianus* Cabrera | ? | ? | 1816 | DD | Cabrera and Klein 1975 |
| *Senecio reitzianus* Cabrera | CV | Florianópolis | 1946 | EN | Cabrera and Klein 1975 |
| *Senecio stigophlebius* Baker | AF | 10+ mun. | 2009 | NT | Cabrera and Klein 1975 |
| *Stevia catharinensis* Cabrera & Vittet | HG | 10+ mun. | 1999 | NT | Cabrera and Klein 1989 |
| *Symphyopappus reitzii* (Cabrera) R.M.King & H.Rob. | HG | 10+ mun. | 2010 | NT | Cabrera and Klein 1989 |
| **Begoniaceae** | | | | | |
| *Begonia biguassuensis* Brade | AR,CF | 8 mun. | 2009 | NT | Smith and Smith 1971 |
| *Begonia camposportoana* Brade | AR | Joinville | 1958 | EN | Smith and Smith 1971 |
| *Begonia fuscocaulis* Brade | ? | ? | ? | DD | Smith and Smith 1971 |
| *Begonia garuvae* L.B.Sm. & R.C.Sm. | AR | Garuva, Joinville | 2009 | VU | Smith and Smith 1971 |
| *Begonia hilariana* A.DC. | AR | Timbé do Sul, Siderópolis, Bom Retiro | 1975 | VU | Smith and Smith 1971, Jacques and Mamede 2005 |
| *Begonia insularis* Brade | AR | Florianópolis | 1950 | EN | Smith and Smith 1971 |
| *Begonia konderreisiana* L.B.Sm. & R.C.Sm. | AR | Garuva, Joinville | 2010 | VU | Smith and Smith 1971 |
| *Begonia lineolata* Brade | AR | 10+ mun. | 2005 | NT | Smith and Smith 1971 |
| *Begonia parvistipulata* Irmsch. | AR,CF | Lauro Müller, S. Francisco do Sul | 2010 | VU | Smith and Smith 1971 |
| *Begonia pilgeriana* Irmsch. | AR | 10+ mun. | 2010 | NT | Smith and Smith 1971 |
| *Begonia rupium* Irmsch. | AR | Corupá, Joinville, S. Francisco do Sul | 2002 | VU | Smith and Smith 1971 |
| *Begonia scharffii* Hook. | AR | Florianópolis, Grão Pará | 1997 | VU | Smith and Smith 1971, Jacques and Mamede 2005 |
| *Begonia solitudinis* Brade | CF | Bom Retiro, Grão Pará, Orleans | 1997 | VU | Smith and Smith 1971 |
| *Begonia squamipes* Irmsch. | RO | 4 mun. | 2010 | VU | Smith and Smith 1971 |
| **Bromeliaceae** | | | | | |
| *Aechmea blumenavii* Reitz | AR | 10+ mun. | 2010 | NT | Reitz 1983, Martinelli et al. 2008 |
| *Aechmea leppardii* Philcox | AR | Florianópolis | 1972 | EN | Philcox 1992 |
| *Aechmea pimenti-velosoi* Reitz | AR | Itajaí, Rio do Sul | ? | VU | Reitz 1983, Martinelli et al. 2008 |
| *Aechmea rubroaristata* Leme & Fraga | HG | Campo Alegre, Joinville | 2010 | EN | Leme et al. 2010 |
| *Dyckia ibiramensis* Reitz | R | Ibirama | 1956 | CR | Reitz 1962, Reitz 1983, Martinelli et al. 2008 |
| *Dyckia monticola* L.B.Sm. & Reitz | RO | Campo Alegre | 1957 | EN | Reitz 1962, Reitz 1983, Martinelli et al. 2008 |
| *Nidularium catarinense* Leme | AR | Campo Alegre, Jaraguá do Sul | 2010 | VU | Leme 2000 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| *Tillandsia montana* Reitz | AR | 10+ mun. | 2010 | NT | Reitz 1962, Reitz 1983, Martinelli et al. 2008 |
| *Tillandsia pseudomontana* W.Weber & Ehlers | ? | S. Bento do Sul | 1981 | EN | Weber 1983 |
| *Tillandsia seideliana* E.Pereira | AF | Rio Negrinho, S. Bento do Sul | 1978 | EN | Pereira 1979 |
| *Vriesea biguassuensis* Reitz | AR,CF | Antônio Carlos, Campo Alegre | 1998 | VU | Reitz 1983, Gomes-da-Silva and Costa 2011 |
| *Vriesea declinata* Leme | AR | Florianópolis | ? | EN | Leme 1989 |
| *Vriesea rastrensis* Leme | CF | Benedito Novo, Lauro Müller, Taió | 2010 | VU | Leme 1989 |
| *Vriesea rubens* J.Gomes-da-Silva & A.F.Costa | AR | Antônio Carlos, Orleans, S. Martinho | 2010 | VU | Gomes-da-Silva and Costa 2011 |
| *Vriesea triangularis* Reitz | AR | S. Martinho | ? | EN | Reitz 1983, Gomes-da-Silva and Costa 2011 |
| **Combretaceae** | | | | | |
| *Terminalia uleana* Engl. ex Alwan & Stace | AR | Tubarão | 1889 | CR | Stace 2010 |
| **Cyatheaceae** | | | | | |
| *Cyathea acantha* (Sehnem) Lehnert | AR | Florianópolis | 1948 | CR | Sehnem 1978 |
| **Cyperaceae** | | | | | |
| *Eleocharis pauciglumis* R.Trevis. & D.J.Rosen | CV | Florianópolis, Palhoça | 2012 | VU | Trevisan et al. 2012 |
| *Rhynchospora smithii* W.W.Thomas | HG | Bom Retiro, Curitibanos | 1972 | VU | Thomas 1984 |
| *Schoenus lymansmithii* M.T.Strong | HG | Urubici | 2007 | EN | Strong 1999 |
| **Dioscoreaceae** | | | | | |
| *Dioscorea beecheyi* R.Knuth | ? | ? | ? | DD | Knuth 1924 |
| *Dioscorea commutata* R.Knuth | AR | Itajaí | 1909 | CR | Knuth 1924 |
| **Dryopteridaceae** | | | | | |
| *Ctenitis laetevirens* (Rosenst.) Salino & Morais | AR | 9 mun. | 2013 | NT | Salino and Morais 2003 |
| **Elaeocarpaceae** | | | | | |
| *Crinodendron brasiliense* Reitz & L.B.Sm. | CF | Bom Jardim da Serra, Bom Retiro, Urubici | 1995 | VU | Smith and Smith 1970 |
| **Ericaceae** | | | | | |
| *Gaultheria corvensis* (R.R.Silva & Cervi) G.O.Romão & Kin.-Gouv. | RO | Grão Pará, Urubici | 2012 | EN | Romão and Kinoshita 2010 |
| *Gaultheria ulei* Sleumer | RO | Bom Jardim da Serra, Grão Pará | 1995 | EN | Marques 1975 |
| **Eriocaulaceae** | | | | | |
| *Eriocaulon reitzii* Moldenke & L.B.Sm. | HG | Rancho Queimado | 1957 | EN | Moldenke and Smith 1976 |
| *Eriocaulon ulaei* Ruhland | CV,HG | 10+ mun. | 2005 | NT | Moldenke and Smith 1976 |
| **Escalloniaceae** | | | | | |
| *Escallonia ledifolia* Sleumer | HG | Lages, Urubici | 2008 | VU | Klein and Reitz 1985 |
| **Euphorbiaceae** | | | | | |
| *Acalypha uleana* L.B.Sm. & Downs | HG | Bom Jardim da Serra | 1891 | CR | Smith 1971 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| *Chiropetalum phalacradenium* (J.W.Ingram) L.B.Sm. & Downs | AR | 10+ mun. | 2009 | NT | Smith et al. 1988 |
| *Croton bresolinii* L.B.Sm. & Downs | AR | Florianópolis | 1987 | EN | Smith et al. 1988, Ahumada 1991 |
| *Croton catharinensis* L.B.Sm. & Downs | HG | Bom Jardim da Serra | 1958 | EN | Smith et al. 1988 |
| *Croton confinis* L.B.Sm. & Downs | HG | 10+ mun. | 1987 | NT | Smith et al. 1988 |
| *Croton dusenii* Croizat | HG | 10+ mun. | 2006 | NT | Smith et al. 1988 |
| *Croton kleinii* L.B.Sm. & Downs | HG | Lages | 1957 | EN | Smith et al. 1988 |
| *Croton patrum* L.B.Sm. & Downs | HG | 10+ mun. | 2006 | NT | Smith et al. 1988 |
| *Croton polygonoides* L.B.Sm. & Downs | AF | 10+ mun. | 2005 | NT | Smith et al. 1988 |
| *Croton serratus* (Klotzsch) Müll.Arg. | CV | S. João do Sul | ? | EN | Smith et al. 1988 |
| *Dalechampia riparia* L.B.Sm. & Downs | R | 10+ mun. | 1968 | NT | Smith et al. 1988 |
| **Fabaceae** | | | | | |
| *Adesmia reitziana* Burkart | HG | Grão Pará, Urubici | 2008 | EN | Miotto and Leitão Filho 1993 |
| *Lonchocarpus grazielae* M.J.Silva & A.M.G.Azevedo | CV | 5 mun. | 2010 | NT | Silva and Tozzi 2008 |
| *Mimosa catharinensis* Burkart | CV | Florianópolis, Gov. Celso Ramos | 2013 | VU | Burkart 1979 |
| *Mimosa chaetosphaera* Barneby | CF | 10+ mun. | 2003 | NT | Burkart 1979 |
| *Mimosa lepidorepens* Burkart | HG | Campo Alegre, Garuva, Joinville | 2008 | VU | Savassi-Coutinho 2009 |
| *Mimosa murex* Barneby | HG | 10+ mun. | 2006 | NT | Barneby 1993 |
| *Mimosa pseudolepidota* (Burkart) Barneby | HG | S. José do Cerrito | ? | EN | Burkart 1979 |
| *Mimosa ramentacea* Burkart | HG | Bom Retiro, Campo Alegre, Garuva | 2006 | VU | Burkart 1979 |
| *Senegalia catharinensis* (Burkart) Seigler & Ebinger | AR | Rancho Queimado, S. Amaro da Imperatriz | 1957 | VU | Burkart 1979 |
| **Gesneriaceae** | | | | | |
| *Sinningia bullata* Chautems & M.Peixoto | RO | Florianópolis | 2006 | EN | Chautems et al. 2010 |
| *Sinningia leopoldii* (Scheidw. ex Planch.) Chautems | ? | Florianópolis, Itapema | 2008 | VU | Chautems 2012 |
| **Iridaceae** | | | | | |
| *Cypella catharinensis* Ravenna | HG | São Joaquim | 1971 | EN | Ravenna 2005 |
| *Sisyrinchium albilapidense* Ravenna | HG | Lages | 1988 | EN | Ravenna 2001b |
| *Sisyrinchium coalitum* Ravenna | HG | Curitibanos, Santa Cecília | 1962 | VU | Ravenna 2000 |
| **Isoëtaceae** | | | | | |
| *Isoëtes spannagelii* H.P.Fuchs | R | Lages, Urubici | 2010 | EN | Fuchs-Eckert 1986 |
| **Lamiaceae** | | | | | |
| *Aegiphila australis* Moldenke | CV,SF | 4 mun. | 1995 | NT | França 2003 |
| *Cunila tenuifolia* Epling | HG | Caçador, Urubici | ? | VU | Epling and Mathias 1957, Epling 1960, Bordignon 1997 |
| *Hesperozygis dimidiata* Epling & Mathias | HG,AF | Campo Alegre, Rancho Queimado | 1956 | VU | Epling and Mathias 1957, Epling 1960 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| *Hesperozygis kleinii* Epling & Játiva | RO | Bom Jardim da Serra, Grão Pará, Urubici | 2004 | VU | Epling and Játiva 1963 |
| *Salvia tenuiflora* Epling | HG,AR | 4 mun. | 1964 | VU | Epling 1960 |
| **Loganiaceae** | | | | | |
| *Spigelia catarinensis* E.F.Guim. & Fontella | AR | Blumenau | 1884 | CR | Smith et al. 1976 |
| **Lycopodiaceae** | | | | | |
| *Huperzia catharinae* (Christ) Holub | ? | "Serra do Oratório" | ? | CR | Øllgaard and Windisch 1987 |
| **Malpighiaceae** | | | | | |
| *Peixotoa catarinensis* C.E.Anderson | CV | 6 mun. | 2013 | NT | Anderson 1982 |
| **Malvaceae** | | | | | |
| *Callianthe muelleri-friderici* (Gürke & K.Schum.) Donnell | AR | 10+ mun. | 2008 | NT | Schumann 1891 |
| *Calyptraemalva catharinensis* Krapov. | HG | Bom Jardim da Serra, Grão Pará | 1991 | EN | Krapovickas 1965 |
| *Monteiroa catharinensis* Krapov. | R | 10+ mun. | 1990 | NT | Krapovickas 1962 |
| *Pavonia reitzii* Krapov. & Cristóbal | HG | Bom Retiro | ? | EN | Fryxell 1999 |
| *Sida parva* Krapov. | HG | Bom Jardim da Serra | 2009 | EN | Krapovickas 2012 |
| *Sida reitzii* Krapov. | AR | 5 mun. | 2005 | NT | Krapovickas 2003 |
| **Marantaceae** | | | | | |
| *Saranthe ustulata* Petersen | AR | Blumenau | ? | CR | Petersen 1890 |
| **Melastomataceae** | | | | | |
| *Leandra luctatoris* Wurdack | AR,CF | 4 mun. | 1995 | NT | Wurdack 1962 |
| *Leandra ulaei* Cogn. | AR | 10 mun. | 2010 | NT | Wurdack 1962 |
| *Leandra urbaniana* Cogn. | ? | Florianópolis | ? | CR | Wurdack 1962 |
| *Miconia lagunensis* Ule | CV,HG | 10+ mun. | 2009 | NT | Wurdack 1962 |
| **Monimiaceae** | | | | | |
| *Mollinedia eugeniifolia* Perkins | AR | Angelina, Blumenau | 2010 | VU | Peixoto et al. 2001 |
| *Mollinedia howeana* Perkins | AR | 10+ mun. | 2002 | NT | Peixoto et al. 2001 |
| **Myrtaceae** | | | | | |
| *Eugenia angelyana* Mattos | AR | Palhoça | 1971 | EN | Mattos 1989 |
| *Eugenia mattosii* D.Legrand | AR | 5 mun. | 2004 | NT | Legrand and Klein 1969 |
| *Eugenia pachyclada* D.Legrand | AR | 10+ mun. | 2004 | NT | Legrand and Klein 1969 |
| *Eugenia pseudomalacantha* D.Legrand | AR | 10+ mun. | 2008 | NT | Legrand and Klein 1969 |
| *Eugenia reitziana* D.Legrand | HG | Campo Erê | ? | EN | Legrand and Klein 1969 |
| *Myrceugenia hamoniana* (Mattos) Sobral | AR | Ibirama | 1902 | CR | Mattos 1963 |
| **Ochnaceae** | | | | | |
| *Ouratea australis* Ule | CV | Laguna | 1889 | CR | Ule 1915 |
| *Ouratea pulchella* (Planch.) Engl. | ? | Florianópolis | ? | CR | Engler 1876 |
| **Onagraceae** | | | | | |
| *Oenothera catharinensis* Cambess. | CV | 5 mun. | 2010 | NT | Dietrich 1984 |
| **Orchidaceae** | | | | | |
| *Acianthera asaroides* (Kraenzl.) Pridgeon & M.W.Chase | ? | ? | ? | DD | Kränzlin 1907 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| *Acianthera murexoidea* (Pabst) Pridgeon & M.W.Chase | ? | Bom Retiro, Palhoça, São José | 2012 | VU | Pabst 1956 |
| *Anathallis globifera* (Pabst) F.Barros & Barberena | ? | Florianópolis | 1951 | EN | Barros and Barberena 2010 |
| *Brachystele bicrinita* Szlach. | ? | ? | 1891 | DD | Szlachetko 1996 |
| *Constantia australis* (Cogn.) Porto & Brade | RO | Florianópolis | 1861 | CR | Cogniaux 1898 |
| *Diskyphogyne scabrilingua* (Szlach.) Szlach. & R.González | ? | ? | ? | DD | ? |
| *Grobya guieselii* F.Barros & Lourenço | AR | Joinville | 1991 | EN | Barros and Lourenço 2004 |
| *Habenaria ulei* Cogn. | ? | ? | 1891 | DD | Batista et al. 2011 |
| *Maxillaria binotii* De Wild. | ? | ? | 1880 | DD | Wildeman 1906 |
| *Octomeria rohrii* Pabst | AR | Florianópolis | 1970 | EN | Pabst 1952 |
| *Promenaea acuminata* Schltr. | ? | ? | ? | DD | Schlechter 1919 |
| *Promenaea catharinensis* Schltr. | ? | ? | ? | DD | Schlechter 1921 |
| *Stelis reitzii* Garay | ? | Imaruí, Sombrio | 1973 | VU | Garay 1953 |
| *Veyretia undulata* Szlach. | HG | Santa Cecília | 1962 | EN | Szlachetko 1996 |
| **Oxalidaceae** | | | | | |
| *Oxalis odonellii* Lourteig | RO | Bom Retiro | 1956 | EN | Lourteig 1983, Lourteig 2000 |
| **Passifloraceae** | | | | | |
| *Passiflora reitzii* Sacco | AR | Garuva | 1957 | EN | Sacco 1980 |
| **Piperaceae** | | | | | |
| *Peperomia pseudobcordata* Yunck. | CF | 10+ mun. | 2009 | NT | Yuncker 1974, Guimarães et al. 1984 |
| *Peperomia schenkiana* Dahlst. | AR | Blumenau | 1886 | CR | Yuncker 1974 |
| *Piper kleinii* Yunck. | AR,CF | 4 mun. | 2010 | NT | Guimarães and Valente 2001 |
| *Piper ulei* C.DC. | AR | 10+ mun. | 2013 | NT | Guimarães and Valente 2001 |
| **Plantaginaceae** | | | | | |
| *Plantago rahniana* Hassemer & R.Trevis. | HG | Bom Jardim da Serra, Urubici | 2013 | EN | Hassemer et al. 2014 |
| **Poaceae** | | | | | |
| *Calamagrostis reitzii* Swallen | HG | Bom Retiro, Urubici | 2007 | VU | Smith et al. 1982 |
| *Chusquea hatschbachii* L.G.Clark & A.Blong | RO | Urubici | 1995 | EN | Clark and Blong 2009 |
| *Chusquea nudiramea* L.G.Clark | R | S. Amaro da Imperatriz | 1992 | CR | Clark 1992 |
| *Chusquea windischii* L.G.Clark | HG | Bom Jardim da Serra, Urubici | 2010 | VU | Clark 1992 |
| *Cortaderia vaginata* Swallen | HG,RO | Bom Retiro, Urubici | 2011 | VU | Smith et al. 1981 |
| *Digitaria myriostachya* (Hack.) Henrard | ? | Tubarão | 1889 | CR | Canto-Dorow 2001 |
| *Merostachys kleinii* Send. | AF,AR | 7 mun. | 1974 | NT | Sendulsky 1995 |
| *Merostachys vestita* McClure & L.B.Sm. | AF | Caçador | 1947 | EN | Smith et al. 1981 |
| *Panicum bresolinii* L.B.Sm. & Wassh. | AR | 10+ mun. | 1999 | NT | Smith et al. 1982 |
| *Panicum magnispicula* Zuloaga et al. | HG | Água Doce | 1987 | EN | Zuloaga and Morrone 1996, Guglieri et al. 2004 |
| *Piptochaetium palustre* Muj.-Sall. & Longhi-Wagner | HG | Urubici, Urupema | 2010 | VU | Cialdella and Arriaga 1998 |
| **Portulacaceae** | | | | | |
| *Portulaca diegoi* Mattos | HG | 4 mun. | 1960 | NT | Mattos 1984 |

Table 1. Continued.

| Taxon | Env. | Distribution | Col. | IUCN | References |
|---|---|---|---|---|---|
| **Proteaceae** | | | | | |
| *Roupala pallida* K.Schum. | AR | 4 mun. | 2000 | NT | Rodriguez 1992 |
| **Rosaceae** | | | | | |
| *Prunus ulei* Koehne | CV | 10+ mun. | 1999 | NT | Reitz 1996 |
| **Ranunculaceae** | | | | | |
| *Ranunculus catharinensis* Lourteig | HG | Bom Jardim da Serra, Urubici | 1992 | VU | Lourteig 1974 |
| **Rubiaceae** | | | | | |
| *Galianthe reitzii* E.L.Cabral | RO | Bom Jardim da Serra, Grão Pará, Urubici | 1996 | VU | Cabral 2009 |
| *Galium ramboi* Dempster | HG | Lages, Mafra | ? | VU | Delprete et al. 2004 |
| *Galium smithreitzii* Dempster | HG | 10+ mun. | 2010 | NT | Delprete et al. 2004 |
| *Psychotria fractistipula* L.B.Sm. et al. | R | 10+ mun. | 2012 | NT | Delprete et al. 2005 |
| **Rutaceae** | | | | | |
| *Raulinoa echinata* R.S.Cowan | R | 4 mun. | 2011 | VU | Cowan and Smith 1973 |
| **Solanaceae** | | | | | |
| *Calibrachoa eglandulata* Stehmann & Semir | RO | Bom Jardim da Serra, S. Joaquim, Urubici | 2007 | VU | Stehmann and Semir 1997 |
| *Calibrachoa sendtneriana* (R.E.Fr.) Stehmann & Semir | HG | Bom Jardim da Serra | 2007 | EN | Smith and Downs 1966 |
| *Calibrachoa serrulata* (L.B.Sm. & Downs) Stehmann & Semir | HG | Bom Jardim da Serra | 2007 | EN | Smith and Downs 1966 |
| *Nicotiana azambujae* L.B.Sm. & Downs | AR | Brusque | 1948 | EN | Smith and Downs 1966 |
| *Petunia reitzii* L.B.Sm. & Downs | HG | Bom Retiro, Urupema | 2007 | VU | Smith and Downs 1966, Stehmann et al. 2009 |
| *Petunia saxicola* L.B.Sm. & Downs | RO | Otacílio Costa, Petrolândia | 2005 | VU | Smith and Downs 1966, Stehmann et al. 2009 |
| *Solanum matadori* L.B.Sm. & Downs | AF | Rio do Sul, S. Cecília, S. Terezinha | 2010 | VU | Smith and Downs 1966, Mentz and Oliveira 2004 |
| *Solanum subhastatum* L.B.Sm. & Downs | AF | 10+ mun. | 2000 | NT | Smith and Downs 1966, Mentz and Oliveira 2004 |
| **Thymelaeaceae** | | | | | |
| *Daphnopsis pseudosalix* Domke | AR,AF | 4 mun. | 2010 | NT | Nevling and Reitz 1968 |
| **Tropaeolaceae** | | | | | |
| *Tropaeolum sanctae-catharinae* Sparre | AR | 4 mun. | 1958 | VU | Sparre 1972 |

state. The search for vascular plant species exclusive to SC in the LFB resulted in 194 accepted species, or 4.05% of the total species occurring in the state. To this result we added the seven species referred to in the LFB as occurring only in Santa Catarina but with "unknown endemism" in Brazil (*Glechon discolor*, *Linum smithii*, *Nothoscordum aparadense*, *N. catharinense*, *N. ibiramense*, *Sisyrinchium albilapidense*, and *S. coalitum*), totaling 201 species. To this total we then added 16 more species that were confirmed as exclusive to SC by the bibliography consulted, resulting in a total of 217 species. Of this total, 30 species were rejected from the condition of being exclusive to SC (see Supplementary Material), having been reported outside SC in the bibliography, or for being a synonym or an invalid name. Thus, from a conservation perspective, the 187 species presented in Table 1 should be treated as exclusive to SC until evidence of the contrary is presented in specialized taxonomic works.

From these results, it became clear that there is still much uncertainty about the distribution of numerous species, and for three species (*Diskyphogyne scabrilingua*, *Hippeastrum hemographes*, and *Zephyranthes lagesiana*) it was not possible to access any references at all. For other species, existing references are very old (prior to 1965, the starting year of publication of the FIC), and may be taxonomically and biogeographically outdated. Twenty-seven species (14.439%) have references only in works prior to 1965, and four (*Callianthe muelleri-friderici*, *Constantia australis*, *Ouratea pulchella*, and *Saranthe ustulata*) (2.139%), prior to 1900 (Table 1). Also, six species are absent from LFB: *Cortaderia vaginata*, *Eupatorium laxicephalum*, *E. rosengurttii*, *Portulaca diegoi*, *Ranunculus catharinensis*, and *Senecio hilairianus*. We must note the great difficulties we faced during the two steps of literature review: first, to determine which references to search for each species, and second (and most difficult), to gain access to these works, because most of them are not available online, and the greater part of them is rather old and very difficult to find.

The families with most species exclusive to SC were Asteraceae, Bromeliaceae, Begoniaceae, and Orchidaceae (Fig. 1). The families most urgently needing further studies are Orchidaceae, Amaryllidaceae, and Iridaceae, although Araceae, Lamiaceae, Melastomataceae, and the genera *Callianthe* (Malvaceae), *Croton* (Euphorbiaceae), *Dioscorea* (Dioscoreaceae), *Galium* (Rubiaceae), *Ouratea* (Ochnaceae), *Peperomia* (Piperaceae), and *Saranthe* (Marantaceae) also need revision because of uncertainties in their taxonomy and species' distribution, and/or because they were reviewed only in old works (prior to 1965).

Some species presented a very old date of the last collection, indicating that they could be at a high risk of extinction or even already extinct. For conservation purposes, these species should receive priority attention in the form of urgent studies and the protection of their known sites of occurrence (when such information is available). Eleven species (*Acalypha uleana*, *Brachystele bicrinita*, *Constantia australis*, *Digitaria myriostachya*, *Habenaria ulei*, *Maxillaria binotii*, *Ouratea australis*, *Peperomia schenkiana*, *Senecio hilairianus*, *Spigelia catarinensis*, and *Terminalia uleana*; 5.882%) have the last registered collection prior to 1900, 43 species (22.995%) prior to 1965, and 83 (44.385%) prior to 2000 (Table 1), demonstrating the need for a more continuous monitoring of the flora of SC. Even worse, there are 22 species (11.765%) whose last collection date could not be determined, most of them because the only collection known, the type, has no date information. These species require urgent collection efforts and studies, because they represent the most critical gap of knowledge about the flora of SC and most certainly are critically endangered or even already extinct.

The Atlantic rainforest and the high-elevation grasslands include the majority of the endemic species (Fig. 2). The absence of species endemic to deciduous seasonal forest in SC could tentatively be explained by the relatively small area occupied by this formation in the state and by the high rate of devastation it has suffered. Also noteworthy is that 67 species (35.829%) are unique to a single municipality (Table 1). The municipalities with the highest number of exclusive species are the state capital Florianópolis (13), Bom Jardim da Serra (7), and Urubici (4). Based on Table 1, we can point the Santa Catarina Island and Serra do Tabuleiro in eastern SC, the Aparados da Serra Geral in southern SC, and the Joinville region in northeastern SC as the most critical regions for biodiversity conservation in SC (Fig. 3).

The application of the IUCN criteria showed that no species in the list is of conservation least

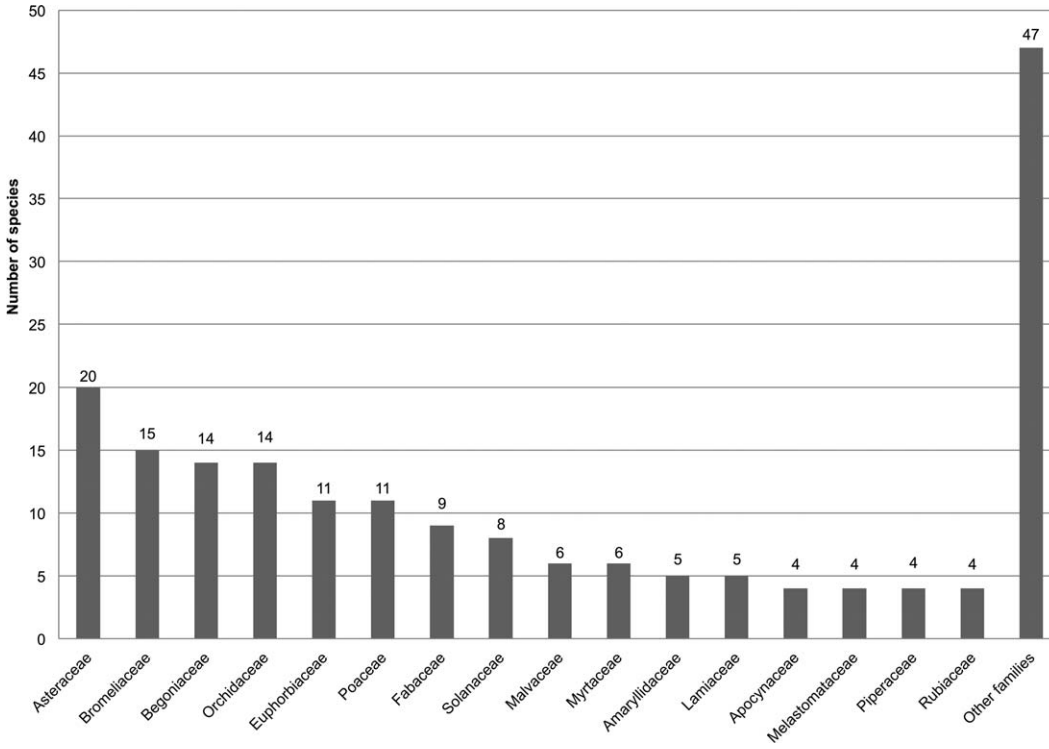


FIG. 1. Vascular plant species exclusive to SC, by botanical family.

concern (LC); 51 (27.273%) species are near threatened (NT), 46 (24.599%) are vulnerable (VU), 61 (32.620%) are endangered (EN), 17 (9.091%) are critically endangered (CR), and 12 (6.417%) could absolutely be not classified and are data deficient (DD). These results highlight the critical and urgent conservation importance of this survey, even more so because the areas of occurrence of most of these species are currently not environmentally protected, and

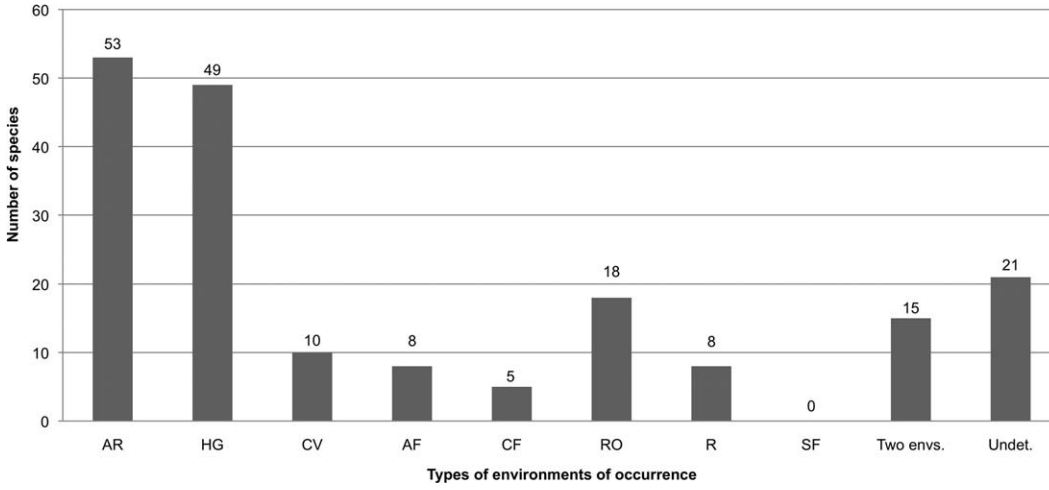


FIG. 2. Vascular plant species exclusive to SC, by types of environments of occurrence. Legend: **AR**, Atlantic rainforest; **HG**, high-elevation grasslands; **CV**, coastal vegetation; **AF**, araucaria forest; **CF**, cloud forest; **RO**, rocky outcrops; **R**, rheophytes; **SF**, deciduous seasonal forest; **Two envs.**, two types of environments; **Undet.**, undetermined.

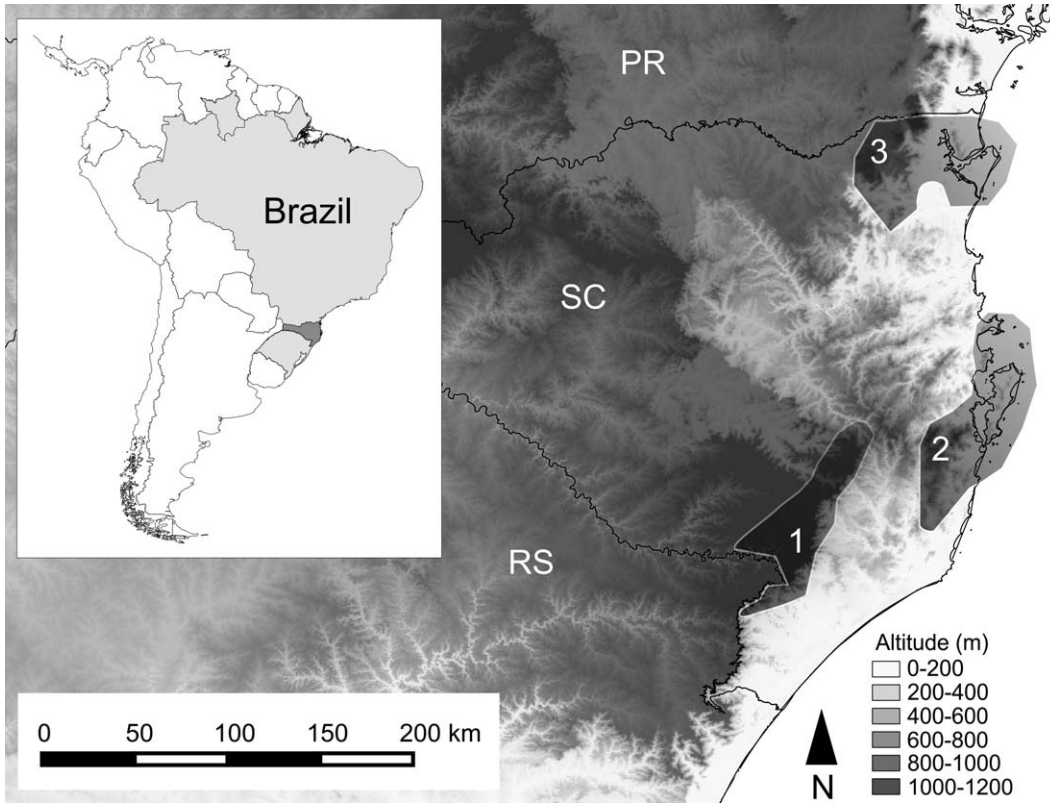


FIG. 3. The three most critical areas for biodiversity conservation in SC, according to the results in Table 1 and the literature review. Legend: (1) Aparados da Serra Geral in southern SC; (2) Santa Catarina Island and Serra do Tabuleiro; (3) Joinville region in northeastern SC.

some protection areas in SC are poorly and incompletely implemented, failing at the task of protecting threatened species.

CONSERVATION RECOMMENDATIONS. The Aparados da Serra Geral (area 1 in Fig. 3) is a region of high elevation (over 1000 m) bordering cliffs and canyons, extending from the northeast of the state of Rio Grande do Sul to the south of SC, including environments such as high-elevation grasslands, cloud forest, araucaria forest, and rocky outcrops (Falkenberg 2003). The advance of monocultures in this region, particularly of exotic pines (*Pinus* spp.), threatens many species endemic to this area. Therefore, we strongly suggest the creation of a conservation area around the top of the Serra do Rio do Rastro, in the municipality of Bom Jardim da Serra, a region which was recognized as extremely important for biodiversity conservation by MMA (2002) and Boldrini (2009). Other areas of high-elevation grasslands in the Aparados that deserve special attention for conservation are the Campos de Santa Bárbara (partially included in the National Park of São Joaquim) and the Campo dos Padres (in the municipality of Bom Retiro).

The Santa Catarina Island (where lies Florianópolis, the capital of SC) and the State Park of the Serra do Tabuleiro (area 2 in Fig. 3) contain the largest protected extent of Atlantic rainforest in SC. This area mainly includes Atlantic rainforest, restingas and mangroves, and its beaches attract many tourists, which is vital to the local economy. This region is suffering increasing environmental threats due to the rising land value, real estate speculation, the creation of new allotments (legal urban advance), the advance of slums (although largely tolerated by Brazilian authorities, this kind of irregular occupation is completely illegal under Brazilian Law), and the lack of political will to prevent new constructions and to compensate the existing

properties in the Park. Currently circulating proposals intend to further reduce the area of the Park and have the support of major contractors and local politicians interested in profiting from the new allotments; these changes constitute a critical threat to the rich biodiversity of the area. Better urban planning is needed to minimize environmental impacts and provide a better quality of life for city dwellers (Miller 2005, Sushinsky et al. 2012).

The Joinville region (area 3 in Fig. 3) is an environmentally very diverse area, including coastal vegetation, Atlantic rainforest, cloud forest, and high-elevation grasslands. Joinville, with ca. 555,000 habitants, is also the biggest city in SC. This region harbors one of the few expressive remnants of low-lying Atlantic forest (mainly in Itapoá), which is severely threatened by urban and rural growth. Also, there is an important area for biodiversity in the high-elevation grasslands and cloud forest of Campos do Quiriri, with endemic species and potential for new species to be found, owing to the deficiency of collection samplings in the area.

Although SC is the state with its flora best studied in Brazil, there are still considerable knowledge gaps regarding its biodiversity (Table 1). This poses a particularly dramatic challenge to the conservation of this rich biodiversity, in face of increasing environmental degradation, even inside protected areas (Dobrovolski et al. 2011). Our results suggest that, if applied to other Neotropical areas, the results would most probably be similar or even more disturbing, as most Neotropical areas have their floras less studied than SC. We recommend the urgent inclusion of the species presented in Table 1 in the ''Red Book of the Flora of Brazil'' (Martinelli and Moraes 2013).

**Conclusions.** This work presents a comprehensive and unprecedented revision of the plant endemisms in SC, summarizing information contained in a great many taxonomic works, most of which are not easily accessible. Extensive revisions like this have great potential for application in environmental conservation as they can guide policies and conservation efforts, can direct studies for the species most critically endangered, and maximize environmental benefits in the delimitation of conservation areas. To prevent the irreversible loss of biodiversity, more studies and conservation efforts are urgently needed. It is unquestionable that the Neotropics has a very rich flora, and many regions are also species rich with endemic plants. In order to protect this biodiversity, we must do the best we can.

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