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Sistemática de *Drosera* sect. *Drosera* s.s.
(Droseraceae)

Systematics of *Drosera* sect. *Drosera* s.s.
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São Paulo
2017

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**Systematics of *Drosera* sect. *Drosera* s.s.
(Droseraceae)**

Paulo Minatel Gonella

Tese apresentada ao Instituto de
Biociências da Universidade de
São Paulo para a obtenção de
Título de Doutor em Ciências
Biológicas na Área de Botânica.

Orientador

Paulo Takeo Sano (Universidade de São Paulo)

Co-orientador

Andreas Fleischmann (Botanische Staatssammlung München)

São Paulo – 2017

Ficha Catalográfica

Gonella, Paulo Minatel

Sistemática de *Drosera* sect. *Drosera* s.s. (Droseraceae) 159 pg.

Tese (Doutorado) – Instituto de Biociências da Universidade de São Paulo.
Departamento de Botânica.

1. Droseraceae. 2. Sistemática. 3. Diversidade I. Universidade de São Paulo.
Instituto de Biociências. Departamento de Botânica.

Comissão Julgadora

Prof. Dr. Paulo Takeo Sano (Orientador) :

Prof(a). Dr(a). :

Prof(a). Dr(a). :

Prof(a). Dr(a). :

Prof(a). Dr(a). :

Nas muitas curvas sinuosas que a vida dá é certo que encontremos obstáculos, alegrias, tristezas, quiçá até mesmo uma espécie nova no Facebook, mas nenhum desses achados é mais valioso que uma amizade verdadeira.

Aos meus queridos Carol e Baladinha, dedico.

Só a Natureza é divina, e ela não é divina...

Se às vezes falo dela como de um ente
É que para falar dela preciso usar da linguagem dos homens
Que dá personalidade às cousas,
E impõe nome às cousas.

Mas as cousas não têm nome nem personalidade:
Existem, e o céu é grande e a terra larga,
E o nosso coração do tamanho de um punho fechado...

Bendito seja eu por tudo quanto não sei.
É isso tudo que verdadeiramente sou.
Gozo tudo isso como quem sabe que há o sol.

Alberto Caeiro
O Guardador de Rebanhos

Agradecimentos

A construção de um doutor é feita de muito trabalho, dedicação, força de vontade e vários outros sacrifícios individuais. No entanto, o mérito por esse trabalho e pela minha formação pessoal e acadêmica não é só meu, mas de todos que me ajudaram a trilhar esse caminho. Nesses quatro anos, tive apoio e suporte de diversas pessoas e instituições e aproveito esse espaço para agradecê-las.

Agradeço às instituições que ampararam esse doutorado: Instituto de Biociências da Universidade de São Paulo, Ludwig Maximilians Universität München, Botanische Staatssammlung München, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq – Proc. 140135/2013-8) e Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES – PDSE/Proc. 99999.010612/2014-09).

Vou quebrar o protocolo e agradecer em primeiro lugar aos meus orientadores desde sempre, meus pais **Nadir e Sérgio**, que sempre estiveram lá para me guiar, apoiar e dar aquele empurrãozinho quando necessário. Obrigado por tudo!

Ao meu orientador, **Paulo Sano**, que me acompanha desde a graduação, agradeço por todo apoio, aprendizado e orientação não só acadêmica, mas também pessoal ao longo desses anos todos.

Ao meu co-orientador, **Andreas Fleischmann**, pela recepção calorosa em Munique e pelas incontáveis horas de aprendizado, seja no laboratório, no Jardim Botânico, em campo ou num Biergarten.

Aos que contribuíram com o desenvolvimento da minha pesquisa, em especial ao **Fernando Rivadavia** pelas incontáveis horas online e no campo de frutíferas discussões sobre as dróseras. Ao Dr. **David Neill** pela sua contribuição no Capítulo 2. Ao **Carlos Rohrbacher**, que contribuiu com material e importantes observações sobre as plantas em seu excepcional cultivo. Ao **Reginaldo Vasconcelos**, o descobridor da *Drosera magnifica*, por toda sua contribuição para que pudéssemos estudar essa magnífica planta e pelos seus esforços em protegê-la.

Agradeço aos meus amigos e companheiros, atuais e antigos, do Sobre-as-Ondas, **Annelise Frazão, Augusto Giarretta, Beatriz Gomes, Caetano Troncoso, Carolina Siniscalchi, Carolina Agostini, Caroline Andrino, Cíntia Luz, Eric**

Kataoka, Fernanda Calió, Gisele Alves, Guilherme Antar, Gustavo Heiden, Jenifer Carvalho, Juliana Rando, Juliana El Otra, Juliana Lovo, Leonardo Borges, Livia Echternacht, Luiz Henrique Fonseca, Marcelo Devecchi, Marcelo Kubo, Matheus Cota, Pamela Santana, Paulo Baleeiro, Pedro Fiaschi e Rebeca Viana. Um agradecimento especial à **Anne**, à **Beca**, ao **Caqui**, à **Carol** e ao **Kubo** que foram maravilhosos sempre, mas em especial por segurarem a minha barra na reta final dessa fase.

Aos colegas e amigos do AG Heubl em Munique, Prof. **Günther Heubl, Agnes Scheunert, Andrea Brandl, Tanja Ernst, Salvatore Tomasello** e, claro, **Andreas Fleischmann**, pela companhia e aprendizado. Um agradecimento especial ao Prof. **Heubl**, que financiou os custos laboratoriais envolvidos na obtenção dos dados do Capítulo 4.

Aos professores que fizeram parte da minha banca de qualificação, Prof. **José Rubens Pirani** e Profa. **Fernanda Calió**, pelas valiosas sugestões.

Aos técnicos do Herbário SPF, **Viviane Jono, Roberta Figueiredo e Abel Cangussu** pelo zelo com essa preciosa coleção e pelo café de todo dia.

Aos amigos que me receberam na Alemanha, em especial ao **Alexander Schommer, Juilson Jubanski, Jan Zippel, Denison Caldeiron, Tiago de Oliveira, Roberto Goya, Alexander Rockinger e Thomas Wittmann**, que tornaram meu tempo na batatolândia ainda mais memorável.

Aos meus amigos dos tempos de graduação, **Caroline “Cidoca” Araujo, Ivan Dias, Victor Rabelo, Diego Vasques e Yve Magedans**, pelo incentivo e companheirismo.

À minha tia **Vanda**, pela companhia sempre especial. À minha tia **Teresinha**, que sempre me incentivou. À minha avó **Sônia**, pela sua alegria contagiante. À minha avó **Marina**, que me ensinou a ver a beleza das flores e ao meu avô **Guilherme**, que me levou pra vê-las na natureza.

E, mais uma vez porém nunca o suficiente, a essas pessoas lindas que são a **Carol**, a **Sinis**, o **Baladinha** e o **Kubo**, com quem dividi momentos maravilhosos durante esse doutorado e que tornaram esse processo de crescimento acadêmico, mas, sobretudo, pessoal, muito mais fácil e especial.

Muito obrigado! Thank you very much! Danke schön!

Paulo

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Abstract

Drosera is a carnivorous plant genus belonging to the Droseraceae and comprising around 250 species distributed worldwide. A great number of new species and combinations have been published for Brazil and the Neotropics in the past decades; however, a comprehensive taxonomic work dealing with these species was still lacking. Furthermore, previous phylogenetic works on the genus focused on understanding the relationships between the morphological and geographical groups, revealing that all proposed infrageneric classifications were incongruent with the phylogeny and that the Neotropical species belonging to *D.* sect. *Drosera* are divided into two lineages mostly defined by chromosome number. In the present work, a comprehensive taxonomic treatment for the Brazilian *Drosera* is presented, together with a revision of the previously poorly known Andean species, descriptions of new species and a molecular phylogeny focusing on the two Neotropical lineages of *D.* sect. *Drosera*. Although the phylogenetic analyses here performed did not present conclusive results regarding relationships at the species level, they shed light on the importance of some morphological traits for the classification of these species and back up the species circumscriptions adopted in recent works. Combined with data covering all the other lineages in a global phylogeny of *Drosera*, these results will be of crucial importance for the proposition of a new infrageneric classification of the genus.

Resumo

Drosera é um gênero de plantas canívoras pertencente às Droseraceae e compreende cerca de 250 espécies distribuídas no mundo todo. Um grande número de novas espécies e combinações foi publicado para o Brasil e os Neotrópicos nas últimas décadas, no entanto, ainda carecia-se de um compreensivo trabalho taxonômico lidando com tais espécies. Além disso, trabalhos filogenéticos anteriores focaram no entendimento das relações entre os grupos definidos por morfologia e distribuição geográfica, revelando que todas as classificações infragenéricas já propostas eram incongruentes com a filogenia e que as espécies Neotropicais pertencentes a *D. sect. Drosera* se dividiam em duas linhagens definidas, principalmente, por número cromossômico. No presente trabalho, um tratamento taxonômico compreensivo tratando das espécies brasileiras é apresentado, junto com uma revisão taxonômica das antes pouco conhecidas espécies andinas, descrições de novas espécies e uma filogenia molecular focando nas duas linhagens Neotropicais de *D. sect. Drosera*. Embora os resultados das análises filogenéticas não tenham sido conclusivos para o estabelecimento de relações ao nível das espécies, eles apontam para importância de alguns caracteres morfológicos para a classificação dessas espécies e apoiam as circunscrições adotadas em trabalhos recentes. Combinados com dados cobrindo as demais linhagens numa filogenia global de *Drosera*, esses resultados serão de crucial importância para a proposição de uma nova classificação infragenérica para o gênero.

General Introduction

The Droseraceae belong to the non-core Caryophyllales and are comprised by three genera, two of which are monotypic (APG IV, 2016; Meimberg et al., 2000). *Dionaea muscipula* Ellis (the “Venus flytrap”) is a bulbous geophyte restricted to the marshlands of SE United States; *Aldrovanda vesiculosa* L. (the “water-wheel plant”) is an aquatic macrophyte with a disjunct distribution in Africa, Australia, Asia and Europe; and, finally, the species-rich *Drosera* L. is found in all continents but Antarctica and currently comprises around 250 species (Juniper et al., 1989; Meimberg et al., 2000; Gonella et al., 2015).

Despite the contrasting habit and general morphology, *Dionaea* and *Aldrovanda* share the morphologically unique snap traps and strong support is found for a common origin of such feature and the close affinity of both genera (Cameron et al., 2002; Heubl et al., 2006; Gibson & Waller, 2009). Monophyly of *Drosera* is supported by morphology and also *atpB* and 18S sequences, although it was suggested the segregation of the two basal species, *Drosera regia* Stephens and *D. arcturi* Hook., to a genus of their own due to incongruence of its position in the Droseraceae phylogeny when reconstructed from different genomic markers (e.g. *matK* and *rbcL*; Miranda, 2006). Nevertheless, stronger support is found for a monophyletic *Drosera*, sister to the pair *Dionaea-Aldrovanda*.

Drosera is easily recognized by the presence of vascularized and mobile glandular emergences (commonly referred to as tentacles) over the adaxial lamina surface. Such tentacles exude a translucent mucilage with compounds for the attraction (nectar), capture (adhesive compounds - polysaccharides) and digestion (digestive enzymes) of animal prey (Juniper et al., 1989). A vast diversity of enzymes has been described for *Drosera*, including protease, phosphatase, peroxidase, nuclease, carbohydrase, amidase and even chitinase (Juniper et al., 1989; Matusikova et al., 2005; Krol et al., 2012).

Originally described by Linnaeus (1753), the genus' type is *D. rotundifolia* L., a species widely distributed in the temperate zone of the Northern Hemisphere. Nevertheless, the majority of the ca. 250 species are distributed in the tropical areas of the Southern Hemisphere: 165 spp. are found in Australia (Lowrie, 2013), 42 spp. in South America (Gonella et al. in prep. – Chapter 3) and ca. 35 in Africa, mostly in the Cape floristic region (Fleischmann in prep.) – comparatively, only 8 species are

found in North America and 3 species are found in Europe (McPherson, 2010). A few species are also found in continental islands, such as Japan, Madagascar, New Zealand and New Caledonia, and oceanic islands, such as Hawaii (Juniper *et al.*, 1989).

The first systematic revision and infrageneric classification of the genus were proposed by Augustin de Candolle (1824), who divided the 32 species known at that time into two sections, based on the style morphology: *Drosera* sect. *Rorella* DC., with styles entire or bi- or tripartite, and *D.* sect. *Ergaleium* DC., with multipartite styles. Each of the sections was further divided into two series, based on the presence or absence of an elongated stem. Planchon (1848) segregated the genus into 13 sections based on the general morphology and style division. Diels (1906), in what is the latest global monograph of the genus, segregated the then known 84 species into three subgenera and 12 sections: *D.* subg. *Ergaleium* (DC.) Diels, characterized by the multipartite styles, lack of stipules and presence of tubers; *D.* subg. *Ptycnostigma* (Planch.) Diels, characterized by the bipartite styles, lack of stipules and presence of tuberous roots; and *D.* subg. *Rorella* (DC.) Diels, with entire or bipartite styles, stipules present, and tubers or tuberous roots absent. DeBuhr (1977) revised the classification of *D.* subg. *Ergaleium*, dividing it into three sections based on habit, leaf morphology and stem anatomy.

Almost ninety years after Diels' (1906) revision, meanwhile ca. 50 species were described, Seine & Barthlott (1994) proposed a new infrageneric classification based on general morphology, especially on the presence/absence of storage organs (roots or tuberous roots) and stipules, production of gemmae (modified leaves for asexual reproduction), division of styles, pollen features (Takahashi & Sohma, 1982), trichome morphology (Seine & Barthlott, 1993) and chromosome number (Kondo, 1976). The genus was segregated into three subgenera: *D.* subg. *Drosera* (= *D.* subg. *Rorella*), further divided into eight sections; *D.* subg. *Ergaleium*, divided into three sections (the same as DeBuhr, 1977), and the monotypic *D.* subg. *Regiae* Seine & Barthlott, to place the then newly described *D. regia*, which differs from the rest of the genus by the operculate pollen and woody rhizome.

The latest infrageneric classification is that presented by Schlauer (1996), based on morphology, in which the genus is segregated in 11 subgenera, mostly by raising the rank of the sections of Seine & Barthlott (1994).

Williams *et al.* (1994) published the first phylogeny of the genus based on molecular data, by using the *rbcL* region of the chloroplast genome. In spite of the

small number of sampled taxa (12 spp.), they recognized three lineages inside the genus: the early diverging *D. regia*, sister to two clades, one containing only Australian species (including *D. binata* Labill., *D. petiolaris* R.Br. and the so-called “pygmy” and “tuberous” *Drosera*) and another comprised of American and African species.

On the following decades, Rivadavia *et al.* (2003, 2012) expanded the sampling and, using only the *rbcL*, they were able to reconstruct the backbone of the phylogeny and recognize the main clades, however, with very low resolution inside them, possibly due to the recent radiation of the American and African lineages.

Using the topology of the trees obtained for the *rbcL*, Rivadavia *et al.* (2003) postulated that the genus might have originated in southern Africa or in Australia, based on the current distribution of the extant species belonging to the species-poor lineages connected to deeper nodes (*D. regia* and *D. arcturi*, respectively). The genus, then, diverged into two lineages: the “Australian clade” and the “Cosmopolitan clade” (Rivadavia 2003; Veleba *et al.*, 2017).

The lineages of the Australian clade diversified mostly on N and SW Australia, with very few representatives colonizing other areas. It shows great variety of life strategies and morphology, including the “tuberous sundews” (*D.* subg. *Ergaleium*), the “pygmy sundews” (*D.* subg. *D.* sect. *Bryastrum*), the “wooly sundews” (*D.* subg. *D.* sect. *Lasiocephala*), the “forked-leaf sundew” *D. binata* (*D.* subg. *D.* sect. *Phycopsis*) and *D. glanduligera* Lehm. (*D.* subg. *D.* sect. *Coelophylla*) (Rivadavia *et al.*, 2003; classification by Seine & Barthlott, 1994).

Lineages connected to deeper nodes of the Cosmopolitan clade are still found in Australia (*D.* sect. *Arachnopus*, *D.* sect. *Stelogyne*, *D.* sect. *Psychophila*, *D.* sect. *Thelocalyx* – the last two showing an interesting Australia-South America disjunction pattern), while the most speciose lineages, comprising the core of this clade, diversified in the New World and in Africa (*D.* sect. *Drosera* s.s.). A lineage mostly centered in the Neotropics (the “Neotropical diploid clade”), but also with boreal species, is sister to a clade containing two sister clades, the “Brazilian-tetraploid clade” and the “African clade”.

Despite a Gondwanan vicariance could be inferred from this distribution, such hypothesis is not supported by the recent diversification of the genus (Rivadavia *et al.*, 2003; Yesson & Culham, 2006; Ellison & Gotelli, 2009) and a colonization via long distance dispersal seem more likely, as the diminutive seeds could be easily

carried by winds and adhered to feathers and legs of migratory birds (Juniper *et al.*, 1989; Rivadavia *et al.*, 2012).

Altogether, it is estimated that *D.* sect. *Drosera* s.s. contains around 80 species, which are diagnosed by the presence of an intrapetiole stipule, the geniculate leaf veneration (in the immature leaves, the lamina if folded over the petiole) and the styles in a number of three and bifurcated at the base.

The plastidial marker *rbcL*, used by Rivadavia *et al.* (2003, 2012), was important for the recognition of the main lineages inside *Drosera*. However, the resolution inside such lineages was very low, especially inside the three clades of *D.* sect. *Drosera* in the strict sense. Furthermore, none of the presently proposed infrageneric classifications was congruent with the phylogenetic studies (Williams *et al.*, 1994; Rivadavia *et al.*, 2003, 2012). Although *D.* subg. *Ergaleium* and *D.* subg. *Regiae* (*sensu* Seiner & Barthlott, 1994) were found to be monophyletic, the three sections proposed by DeBuhr (1977) for the former group were shown to be polyphyletic. *Drosera* subg. *Drosera* (*sensu* Seiner & Barthlott, 1994) was also found to be polyphyletic, being spread in both Australian and Cosmopolitan clades. Finally, *D.* sect. *Drosera sensu* Seiner & Barthlott (1994) and Schlauer (1996) are clearly artificial and polyphyletic groupings. New studies are necessary for the better comprehension of the affinities between the species and as a source for a new and consistent infrageneric classification, as evidenced by Ellison & Gotelli (2009).

Drosera was the basis for the seminal work of Charles Darwin on carnivorous plants (Darwin, 1875) and attracts the general public attention not only by its curious habit, but also from its peculiar beauty (Gonella *et al.*, 2015). Still, the genus lacks a broad and complete taxonomic study and a robust infrageneric classification that is congruent with the phylogeny. In this context, the present study aims to fill this knowledge gap by bringing new information on the systematics of Brazilian and South American taxa of *Drosera* sect. *Drosera* s.s.

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CHAPTER 1

Drosera magnifica: the largest New World sundew, discovered on Facebook

Paulo Minatel Gonella, Fernando Rivadavia & Andreas Fleischmann

Article published in the periodic **Phytotaxa** in July 2015

***Drosera magnifica* (Droseraceae): the largest New World sundew, discovered on Facebook**

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Abstract

Drosera magnifica, a microendemic sundew discovered on a single mountain top in eastern Minas Gerais (southeastern Brazil), is described here as a new species for science. Regarded as the largest New World sundew and one of the three largest *Drosera* species, it was just recently discovered through photographs posted on the social network Facebook. A detailed description, remarks on ecology, habitat, and conservation, a distribution map, line drawings, and photographs are provided, as well as a comparison between the related taxa (*D. graminifolia* and *D. spiralis*). The species is considered Critically Endangered, according to the IUCN Red List categories and criteria.

Key words: carnivorous plants, Critically Endangered, *Drosera graminifolia*, microendemic, new species

Resumo

Drosera magnifica, uma planta carnívora microendêmica do topo de uma única montanha no leste de Minas Gerais, sudeste do Brasil, é aqui descrita como uma nova espécie para a ciência. Considerada como a maior espécie de *Drosera* no Novo Mundo e uma das três maiores do seu gênero, esta foi recentemente descoberta por meio de fotos publicadas na rede social Facebook. Uma descrição detalhada, comentários sobre ecologia, habitat e conservação, um mapa de distribuição, ilustrações e fotografias são fornecidas, além de uma comparação com os táxons relacionados (*D. graminifolia* e *D. spiralis*). A espécie é considerada Criticamente Ameaçada, de acordo com os critérios e categorias da IUCN Red List.

Palavras-chave: Criticamente Ameaçada, *Drosera graminifolia*, espécie nova, microendêmica, plantas carnívoras

Introduction

Internet based image databases have become an important tool for plant enthusiasts and botanists to share their interest and knowledge of species diversity and taxonomy. Photographs are Publicly shared on internet discussion groups hosted by social networks, forums, and other websites, uniting amateurs and professionals in their common interests of plant identification and taxonomy, frequently resulting in the discovery of new regional records. Although, in most cases, specimens for herbarium are not taken of the plants photographed by amateurs, the geographic location data enables further fieldwork by professional taxonomists, resulting in the formal report of the discovery. This remarkable phenomenon has even led to the discovery of new taxa, such as a species of green lacewing (Insecta: Neuroptera: Chrysopidae) described by Winterton *et al.* (2012). Here, we document the first plant species to be recorded as being discovered through photographs on a social network, a remarkable new species of sundew from Brazil.

The genus *Drosera* Linnaeus (1753a: 281) (Droseraceae Salisb.) presents a worldwide distribution with about 250 species (McPherson 2010, Lowrie 2013, Fleischmann 2014) and is currently considered the largest carnivorous plant genus. Over the past decade, several studies have reviewed, re-established and described new *Drosera* taxa from Brazil, which now includes around 30 species in its native flora (Rivadavia 2003, 2008, 2009, Rivadavia *et al.* 2009, 2014,

Rivadavia & Gonella 2011, Gonella *et al.* 2012, 2014). Despite this high diversity, only fourteen species of *Drosera* are listed in the online database “Lista da Flora do Brasil” (Silva 2015), which requires urgent reconsideration.

Gonella *et al.* (2012) recently recovered *D. spiralis* Saint-Hilaire (1826: 270) from the synonymy of *D. graminifolia* Saint-Hilaire (1826: 269), following the taxonomic species concept originally proposed by Saint-Hilaire (1826). Meanwhile, in October 2012, an orchid enthusiast posted a picture of another thread-leaved sundew on the internet-based social network Facebook (see Acknowledgements). The picture, showing plants at the beginning of anthesis, was picked up by carnivorous plant enthusiasts in September 2013, and examined by the authors. The photographer was contacted and he kindly provided further images and location data. Although the two pictures available were of very low resolution, the broad and seemingly sessile (non-petiolate) leaves, together with the divergent geographic location provided, clearly indicated that this population required further investigation.

Less than three months after first viewing these pictures online, a field trip was carried out, and healthy populations of the plant were successfully located. Peculiar morphological characteristics of the plants led us to describe them as a new species to science.

Material & Methods

Field surveys were carried out by the two first authors (P.M.G. and F.R.) in late November 2013 and mid July 2014, when the type location and two other nearby peaks were also explored. Further field observations were provided by the discoverer of the new sundew, from trips in October 2012 and May 2014 (Reginaldo Vasconcelos, pers. comm.). No preceding herbarium collections of the taxon are known. The collected specimens were examined under stereo dissecting microscope and the description was based on fresh, dried and spirit material.

The distribution map was prepared using georeferenced location data obtained during our field observations and, for *D. graminifolia* and *D. spiralis*, based on the results by Gonella *et al.* (2012), and generated with DIVA-GIS (Hijmans *et al.* 2005).

The herbarium abbreviations cited through the text follow Thiers (2015).

Taxonomic Treatment

Drosera magnifica Rivadavia & Gonella, *sp. nov.* (Figs. 1–4)

Type:—BRAZIL. Minas Gerais: Conselheiro Pena, Pico do Padre Ângelo, 1530 m, 28 November 2013, *Gonella & Rivadavia 645* (holotype SPF!, isotypes BHCBI, MO!, P!, RB!, SPF!).

Diagnosis:—*Drosera magnifica* differs from *D. graminifolia* and *D. spiralis* by the long prostrate or ascending stems up to 123.5 cm long; by the higher number of active leaves per rosette, which are sessile and broader linear-lanceolate in shape, 100–240 × 3–8 mm, with circinate-involute vernation (lateral margins of lamina involute in bud), entirely lacking glandular trichomes, with a raised midrib on the adaxial surface extending from base to $\frac{1}{3}$ – $\frac{1}{2}$ of the leaf length, the adaxial surface with a short, triangular to narrowly triangular tentacle-free zone at the base that is eglandular-pilose, and the mature leaves with revolute margins; by multiple-branched inflorescences (branched scorpioid cymes), covered with stalked glandular trichomes 0.1–0.4(–0.5) mm long; and by the larger fusiform seeds 1–1.2 mm long.

Description:—*Perennial* rosetted herbs, caulescent; *stem* well-developed, up to 123.5 cm long, prostrate or ascending (supported by surrounding vegetation), often apically branching once and with basal sprouts, covered by the persistent dead leaves (70–100 mm between inflorescences from different years). *Roots* succulent, black, sparsely branched, densely covered by root hairs. *Indumentum* consisting of white (drying gold colored) eglandular trichomes up to 4 mm long, occurring on the base of the adaxial leaf surface, whole abaxial leaf surface, scape, bracts, pedicels and sepals; stalked glandular capitate trichomes 0.1–0.4(–0.5) mm long on scapes, bracts, pedicels and sepals; minute sessile glands ca. 0.03 mm in diameter on both leaf surfaces, scapes, bracts, pedicels and sepals. *Leaves* 100–240 × 3–8 mm, active leaves 7–18 per rosette, linear-lanceolate, apex acute, vernation circinate-involute (regular or irregular), lamina of mature leaves with revolute margins, green in color, erect to semi-erect, with a raised midrib on adaxial surface extending from base to approximately $\frac{1}{3}$ – $\frac{1}{2}$ of length (less conspicuous in dried specimens), leaves becoming reflexed and drying curled when old; *petioles* absent in mature plants (leaves sessile), but often distinct in juvenile plantlets; *lamina* comprising the entire leaf length, with the abaxial surface densely eglandular-pubescent, especially

towards the margins, and covered with numerous sessile glands, while the adaxial surface is covered with numerous sessile glands and red, carnivorous, capitate tentacles with radial symmetric gland heads, except for a triangular to narrowly-triangular tentacle-free zone of 7–45 × 2–7 mm at the base, which is densely to sparsely eglandular-pilose, but glabrous at the very base; *stipules* 8–15 mm long, 3.5–9.0 mm wide at the base, triangular, membranaceous, translucent bronze-gold in color (sometimes whitish to reddish), apex acute and fimbriate. *Scapes* 1 per plant (in plants with forked stems, one scape per rosette), terete, hollow, base erect and 2–5 mm in diameter, 165–350 mm in total length (including floriferous part; the peduncle 120–225 mm long), densely pilose, covered with glandular and eglandular trichomes, the indumentum becoming denser towards the apex; *inflorescence* in a multiple-branched scorpioid cyme, with (2–)6–10(–14) branches, green to reddish-green in color, bearing 17–190 flowers, often with 1–4 larger bracts not supporting a flower at the base of the rachis (“sterile bracts”), 7–12 mm long, linear; *floral bracts* caducous, 4–6 mm long, linear-lanceolate to ovate, usually absent, densely glandular and eglandular-pilose on the abaxial surface; *pedicels* 2.5–7.0 mm long, inserted 2–7 mm apart from each other, densely glandular and eglandular-pilose; *sepals* 5, pinkish-red when in bud and during anthesis, greenish when in fruit, 4.5–8.0 mm long, 2.2–3.0 mm wide, oblong-obovate to ovate, united at basal 1/4–1/5 of length, densely glandular-pilose and sparsely eglandular-pilose, apex rounded to broadly acute; *petals* 5, 8–10 mm long, 6–8 mm wide, obovate, light pink; *stamens* 5, ca. 3.5 mm long, filaments white, anthers 1.5–1.8 mm long, bithecate, yellow; *ovary* 1.2–1.5 mm in diameter at anthesis, 3-carpellate, globose, rounded in outline, green; *styles* 3, forked at the base, 4.0–4.8 mm long including stigmas, stigmas simple or bilobed, pinkish-white in color; *fruit* a dry capsule, 1.5–2.5 mm long, globose, 3-valvate. *Seeds* fusiform, 1.0–1.2 × 0.2–0.3 mm, testa reticulate, dark brown.

Etymology:—The epithet “*magnifica*” refers to the magnificent appearance of this new species, which has remained undiscovered until so recently, even though it is one of the three most robust species of the genus and largest sundew in the New World.

Distribution and habitat:—*Drosera magnifica* is a microendemic species, so far only known to occur on the summit of the Pico do Padre Ângelo, in the municipality of Conselheiro Pena, eastern Minas Gerais state, Brazil (Figs. 1, 3A). The new species occurs on sandstone outcrops among herbaceous and shrubby vegetation in a vegetation type intermediate between *campos rupestres* (“rocky fields”) and *campos de altitude* (“highland fields”), in a narrowly defined habitat at elevations around 1500–1530 m (Fig. 3). Plants grew mostly in soil composed of a very loose layer of organic matter mixed with sand over sandstone, or more rarely in cracks of bare sandstone.

On the Pico do Padre Ângelo, *D. magnifica* was observed to occur mostly at a single site on the south slope of the summit, with thousands of plants concentrated in an area of about 50 × 50 m (Fig. 3B). This slope is approximately at a 45-degree angle and receives significant moisture in the form of condensation from uplift winds. Two smaller subpopulations were seen on gentle slopes on the north side of the summit, distant ca. 200 m and 300 m from the main population, and bearing around 10 and 100 individuals, respectively.

Typical members of the altitude vegetation growing together with *D. magnifica* are: the subshrub *Baccharis platypoda* Candolle (1836: 409) (Asteraceae), the bromeliad *Vriesea sanctaparecidae* Leme (2013: 45) (Bromeliaceae), as well as other species belonging to Asteraceae, Bromeliaceae, Melastomataceae, Orchidaceae, Rubiaceae, mosses and lichens (Fig. 3). Although a few pockets of *Sphagnum* Linnaeus (1753b: 1106) moss were observed in the area, *D. magnifica* was not found growing with it, but only next to it.

Because of their proximity and similar elevation, the Pico da Aliança (ca. 1440 m, 10 km to the southwest) and Pico do Pinhão (ca. 1430 m, 5 km to the north) were also explored, but these were found to be comparatively drier and no *D. magnifica* populations were located. The only other peak in the vicinity likely to harbor *D. magnifica* is the Pico do Sossego (ca. 1550 m, 7 km to the north), which is still unexplored botanically.

Phenology:—The available data indicates that the flowering period of *D. magnifica* is comprised between late dry season and early wet season (from October to December), with only a single inflorescence produced per mature rosette. No plants were seen in flower in May or July, when only dry old scapes were observed.

Conservation Status:—Critically Endangered: CR B1ab(iii) + B2ab(iii). *Drosera magnifica* is a microendemic species, currently known to occur on a single mountain summit where it is locally abundant, but restricted to a fragile and isolated habitat.

Habitat degradation was observed along most of the summit trail, caused by coffee and eucalypt plantations (Fig. 3A), cattle ranching, and invasive species of grasses, such as “capim gordura” [*Melinis minutiflora* Palisot de Beauvois (1812: 54)], *Brachiaria* (Trinius 1826: 39) Grisebach (1853: 469) (Poaceae), and the fern *Pteridium arachnoideum* (Kaulfuss 1824: 190) Maxon (1924: 89) (Dennstaedtiaceae). Because of its highly restricted occurrence as well as the observed and projected decline of habitat quality, *D. magnifica* is here listed as Critically Endangered (CR) according to the criteria of IUCN (2012).

FIGURE 1. Distribution area of *D. magnifica* (star), *D. graminifolia* (triangles) and *D. spiralis* (circles).

The Pico do Padre Ângelo and surrounding mountains (including the Serra do Pinhão and Pico da Aliança) should be a priority aim for conservation, as they contain some of the very last remaining areas of eastern Minas Gerais that are not completely degraded, and which harbor a unique and still very poorly-known biodiversity. The surrounding lowlands have been heavily deforested over the past century and only small patches of rainforest remain between cattle ranches and family farms. The species-rich and fragile *campos rupestres* found on these highlands harbor narrowly endemic taxa, such as the recently described bromeliads *Alcantarea nana* Leme (2014: 72), *A. occulta* Leme (2013: 10) and *Vriesea sanctaparecidae* (Leme & Kollmann 2013, Leme *et al.* 2014), as well as the orchid *Cattleya alvarenguensis* (Campacci 2014: 382) Berg (2014: 84), among several other still undescribed species (pers. obs.).

Ecological notes:—All observed specimens of *D. magnifica* show a well-developed stem (Fig. 2A), usually prostrate, but often erect and supported by surrounding shrubby vegetation, reaching 30–40 cm above the soil surface (Fig. 3C–F). Stems were frequently observed to branch once (rarely more), and new growing tips were frequently seen sprouting from the stem bases (Fig. 3F). In some cases, young plantlets were also observed emerging from roots. Not a single seedling was found during either of our visits, which is surprising considering the numerous flowers and the large quantity of seed produced by *D. magnifica*.

FIGURE 2. *Drosera magnifica* (based on the holotype). **A)** habitus, showing an erect inflorescence at anthesis as well as two prostrate dead ones, the older entangled by the remains of dead leaves. **B)** leaf base, adaxial surface. **C)** leaf base, abaxial surface. **D)** stipule. **E)** immature leaf, with regular circinate-involute vernation. **F)** apex of an inflorescence branch, with a spent flower and a flower bud, the arrow indicating a detail of the indumentum on the pedicel and calyx, composed by eglandular trichomes, long-stalked glandular trichomes and sessile glands. **G)** flower. **H)** gynoecium. **I)** seed (drawing by Rogério Lupo).

FIGURE 3. A) View of the Pico do Padre Ângelo, eastern Minas Gerais state, Brazil, with coffee and eucalypt plantations visible near the base. B) high-montane habitat of *D. magnifica*, among rocks and shrubs, with the Pico da Aliança in the background. C–D) numerous flowering individuals with stems prostrate or ascending; the large specimen on the right side of figure D is the holotype. E) specimen with ascending stem supported by surrounding vegetation. F) group of individuals with long stems, first prostrate then ascending, covered by remains of dead leaves, with smaller rosettes sprouting from the stem bases (bottom right). (A, C–F by P.M. Gonella; B by F. Rivadavia).

Large numbers of insects (mostly from Hymenoptera: Terebrantia, as well as small Coleoptera, Diptera, and Lepidoptera) were observed stuck on the leaves of *D. magnifica* in November and May, but not as many in July. Nutrition obtained from the abundant prey may be an important factor in sustaining the surprising robustness of this new species as well as the fast growth rate (see below), since it grows in very scarce and structured soil over sandstone.

Acephalous dipteran larvae were observed on many specimens of *D. magnifica*, hidden among the young leaves, as were also their pupae on the abaxial leaf surfaces. Similar dipteran larvae have previously also been observed by F.R. to live on the leaves of the related *D. spiralis* (pictured as living on “*D. graminifolia*” in McPherson 2010).

FIGURE 4. *Drosera magnifica*. **A–B)** detail of the center of the rosette, showing the numerous young leaves with both regular and irregular circinate-involute vernation and densely eglandular-pilose abaxially **C)** adaxial surface of a leaf base, with a narrowly triangular tentacle free zone and a prominent midrib; notice the large bronze-gold stipules. **D)** detail of the multiple-branched scorpioid cyme. **E)** flower, flower buds and spent flowers. (A–C, E by P.M. Gonella; D by F. Rivadavia).

Additional specimens examined

***Drosera magnifica* (paratypes)**—BRAZIL. **Minas Gerais:** Conselheiro Pena, Pico do Padre Ângelo, 1530 m, 08 July 2014, *Gonella et al.* 675 (SPF, M).

Drosera graminifolia—BRAZIL. **Minas Gerais:** Crescit in summis montibus dictis Serra-da-Caraça; alt. circiter 6000 ped., February, *Saint-Hilaire B1-448* (P, holotype); Serra do Caraça, December 1830, *Sellow 1300* (B, holotype of *D. graminifolia* var. *major* Eichl. in Mart. & Eichl.).

Drosera spiralis—BRAZIL. **Minas Gerais:** Crescit in montibus dictis Serra de Curumatahy, ad rivulum Corgo Novo, in parte provinciae Minas Geraes dicta Distrito dos Diamantes, *Saint-Hilaire B1-2021bis* (P; holotype); Tejuco (Serro Frio) [currently Diamantina], May, *Martius 1287* (M; original material of *D. brasiliensis*); inter Tejuco et Bandeirinhas, May, *Martius s.n.* (M).

Discussion

Drosera magnifica belongs to the *D. graminifolia* alliance (Gonella *et al.* 2012), which now comprises three species: *D. graminifolia*, *D. spiralis*, and *D. magnifica* (Table 1).

TABLE 1. Comparative diagnostic characters between *D. graminifolia*, *D. spiralis* and *D. magnifica* (data partially based on Gonella *et al.* 2012).

	<i>D. graminifolia</i>	<i>D. spiralis</i>	<i>D. magnifica</i>
Stem length (cm)	Up to 6(–15)	Up to 10	Up to 123.5
Stipule length (mm)	7–14	14–22(–30)	8–15
Number of active leaves per rosette	5–10	2–6	7–18
Eglandular trichomes on the abaxial surface of the leaves (mm in length)	Long, 3–5	Short, 0.5–1.5	Long, up to 4
Glandular trichomes (type and size)	Translucent-yellow short-stalked multicellular globose trichomes, 0.1–0.12 mm in diameter	Long-stalked, 0.1–0.5 mm long and capitate	Long-stalked, 0.1–0.4(–0.5) mm long and capitate
Glandular trichomes on leaves (other than sessile glands)	Present	Present	Absent
Leaf vernation	Regular circinate	Irregular circinate	Regular and irregular circinate-involute
Cross section at leaf base	Very narrowly transversely elliptic (flat)	Semicircular to transversely elliptic	Transversely elliptic in the center, with revolute narrow margins
Petiole length (mm)	30–40(–47)	5–30	Petiole absent
Lamina width (mm)	1.2–3(–3.5)	0.6–2.8	3–8
Number of branches per inflorescence	1–2	1–2(–8)	(2–)6–10(–14)
Tentacles on sepals	Absent	Often sparsely present	Absent
Seed shape and length (mm)	Oblong-fusiform, 0.65–0.8	Ovoid, 0.6–0.65	Fusiform, 1–1.2
Main flowering period	January to April	April to December	October to December
Habitat	High-montane, intermediate between <i>campo rupestre</i> and <i>campo de altitude</i>	<i>Campos rupestres</i> of montane regions	High-montane, intermediate between <i>campo rupestre</i> and <i>campo de altitude</i>
Elevation (m a.s.l.)	(1700–)1800–1950	700–1500	Around 1500–1530
Distribution area	Endemic to Serra do Caraça, southern Espinhaço Range, central Minas Gerais	Widespread from Diamantina to Grão Mogol, central Espinhaço Range, central-northern Minas Gerais	Micro-endemic to the Pico do Padre Ângelo, eastern Minas Gerais

Drosera magnifica is most reminiscent of *D. graminifolia*, sharing a similar narrowly restricted high-montane habitat, as well as the comparatively small stipules (Fig. 2B, D; notably larger in *D. spiralis*), the eglandular indumentum consisting of long and evident white trichomes present on the leaves (Fig. 2C, E), and a fusiform seed shape (Fig. 2I). Morphological similarities with *D. spiralis* are: the reduced petiole (completely absent on the sessile leaves of flowering-size specimens of *D. magnifica*), the presence of stalked glandular trichomes on the inflorescence parts (Fig. 2F; instead of translucent-yellow short-stalked multicellular globose trichomes), and the tendency to have multiple-branched cymes (usually fewer branches in *D. spiralis*).

Drosera magnifica differs from both *D. graminifolia* and *D. spiralis* by the presence of a pronounced, long stem (Fig. 2A) reaching an observed length of 123.5 cm, the rosettes with more numerous active leaves that are broader, sessile (Fig. 2B), linear-lanceolate in shape and 3–8 mm in width [vs. few-leaved rosettes, leaves linear and up to 3(–3.5) mm wide], the circinate-involute leaf vernation (Fig. 2E; vs. circinate vernation), the lack of glandular trichomes on leaves other than sessile glands (translucent-yellow short-stalked multicellular globose trichomes in *D. graminifolia* and stalked trichomes in *D. spiralis*), the revolute leaf margins on mature leaves (Fig. 2C; vs. not revolute), the raised midrib on adaxial leaf surface extending from base to approximately 1/3–1/2 of length (Fig. 4C), the more frequently branched floriferous part of the inflorescence (Figs. 2A, 4D), and the larger seeds 1.0–1.2 mm long (up to 0.8 mm in the two other species).

Among South-American taxa, circinate-involute leaf vernation is a unique characteristic of *D. magnifica*. In this type of vernation, the young leaf is coiled along its entire length and the lateral margins are folded inwards (Figs. 2E, 4A, B). The only other *Drosera* known to present this rare kind of leaf vernation are the Australian *D. adelae* Mueller (1864: 154), and *D. schizandra* Diels (1906: 80), as well as the South-African *D. regia* Stephens (1926: 309). These three species are only distantly related to *D. magnifica*, even though *D. adelae* and *D. regia* possess similarly-shaped leaves. Whereas in *D. graminifolia* the young leaves have regular circination and in *D. spiralis* these are irregularly circinate, in *D. magnifica* both regular and irregular circination were observed on young leaves, even on the same individual.

Drosera magnifica is the largest representative of the genus in the New World, with flowering specimens reaching a total of over 1.5 m in length. In terms of total biomass, it may only be rivaled by the South African relict species *D. regia* and the Australian tuberous sundew *D. gigantea* Lindley (1839: 88).

Reaching at least 123.5 cm in length, the stems of *D. magnifica* are by far the longest of any New World *Drosera* species, followed by *D. chrysolepis* Taubert (1893: 505) at the Serra do Cipó, observed to reach 46 cm. The adult stem growth rate of *D. magnifica* can be estimated at approximately 7–10 cm per year, by measuring the distance between live inflorescences and dead remains of old scapes from previous years still attached to the stems (estimated in 7–8 cm per year in *D. chrysolepis*). This growth rate suggests that the largest observed specimens of *D. magnifica* were around 12–17 years old. However, plants may be older than this, since it is not possible to know whether older parts of the stems were not present due to decomposition. Also, the growth rate of juvenile plants is not known.

The highly branched candelabra-like inflorescences of *D. magnifica* (Figs. 2A, 4D), with up to 190 flowers and 14 branches each are also unique among New World sundews (*D. spiralis* comes closest, with up to 90 flowers and 8 branches). This is only matched by Australian tuberous species of *Drosera* subgenus *Ergaleium* and by *D. binata*, which have all double or multiple scorpioid cymes (Diels 1906, Troll 1964).

During the herbarium study for the current work, two misplaced specimens collected by Martius and belonging to the *D. graminifolia* alliance were located at M, including material that Martius identified with the manuscript name “*Drosera brasiliensis*”. That name was never validly published by Martius, however it was cited later as a synonym of *D. graminifolia* by Eichler (1872) (see Gonella *et al.* 2012). Both specimens are here identified as *D. spiralis* and listed above.

Conclusions

Drosera magnifica brings the current count of *Drosera* species in Brazil to 31 (Gonella *et al.*, unpubl. data), more than twice the number listed in the online checklist of the “Lista da Flora do Brasil” (Silva 2015), which clearly needs an urgent revision. The surprising and rather casual discovery on a social network of a previously uncollected new *Drosera* species which is the largest in the New World and one of the three largest in the genus, from a region which is by no means remote from large cities nor of difficult access, should raise an important conservation alarm about how understudied the native Brazilian flora still is in the XXI century, and how much unknown biodiversity may still be at risk of extinction before it is even discovered.

Acknowledgements

We would like to thank first and foremost Reginaldo Vasconcelos (Governador Valadares, Brazil), the discoverer of the “magnificent sundew”, for posting the original pictures online (<https://goo.gl/C6i5s2>) and for providing location data, contacts, logistical help and field observations, all of which were essential in allowing us to travel to and climb the Pico do Padre Ângelo to perform our field studies, as well as for providing additional information from a follow-up expedition to this peak and for accompanying us on our second expedition. We are also grateful to Ednilson Ribeiro and his son Júlio César Ribeiro (Conselheiro Pena, Brazil) for their hospitality and for being our trail guides during our field trips to the region; to Fabiano Pereira (Campina Grande, Brazil) for bringing to our attention Reginaldo’s pictures posted on Facebook; to Carlos Rohrbacher (Jaraguá do Sul, Brazil) for support during the field work and for providing photos of *D. magnifica* seedlings, which allowed insights into the early development of this species; to Rogério Lupo (Campinas, Brazil) for the magnificent line drawings; to Gustavo Heiden (Pelotas, RS) for identifying the *Baccharis* species growing with *D. magnifica*; to François Mey (Paris, France) for aiding our herbarium studies; and to Dr. Duilio Iamónico and one anonymous reviewer for suggestions to improve the manuscript. This work is part of PMG’s PhD. thesis, financially supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq—Processo 140135/2013-8).

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CHAPTER 2

A revision of *Drosera* (Droseraceae) from the central and northern Andes, including a new species from the Cordillera del Cóndor (Peru and Ecuador)

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Article published in the periodic **Plant Systematics and Evolution** in August 2016

A revision of *Drosera* (Droseraceae) from the central and northern Andes, including a new species from the Cordillera del Cóndor (Peru and Ecuador)

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Received: 10 May 2016 / Accepted: 27 July 2016 / Published online: 30 August 2016
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Abstract The *Drosera* species endemic to the central and northern Andes are revised here, including three species: the Venezuelan *D. cendeensis* as well as *D. peruensis* and *D. condor* **sp. nov.**, from Peru and Ecuador. The latter is a new species endemic to the Cordillera del Cóndor that is here described and illustrated for the first time. The similarities and differences between these three taxa are discussed and the previously poorly known *D. cendeensis* and *D. peruensis* are provided with amended descriptions, illustrations and photographs. New records expand the known distribution range of *D. peruensis* through the sub-Andean cordilleras in Peru and Ecuador.

Keywords Andes · *Drosera cendeensis* · *Drosera condor* · *Drosera peruensis* · New species · Sub-Andean cordilleras

Introduction

Drosera L. (Droseraceae, non-core Caryophyllales) is a carnivorous plant genus that comprises around 250 species distributed worldwide, of which ca. 40 species are

currently recognized to occur in South America (Gonella et al. 2015, Gonella et al. in prep.). In the Neotropics, the genus is usually found in open vegetation types growing in nutrient-poor sandy soils, with two main centers of diversity: the Espinhaço Range in eastern Brazil and the Guiana Highlands on the border between Venezuela, Guiana and Brazil (Duno de Stefano 1995; Gonella et al. 2014; Fleischmann et al. 2007).

Dominated by two regions with low *Drosera* diversity—the Andes and the Amazon—Peru and Ecuador had only two records of this genus: *D. peruensis* T.Silva & M.D.Correa and *D. chrysolepis* Taub. (sensu Correa and Silva 2005), both found in the sub-Andean cordilleras (Duno de Stefano and Silva 2001; Silva and Correa 2002; Correa and Silva 2005). These low-elevation mountain chains scattered from northern Ecuador to southern Peru, between the main Andes chain and the Amazon basin, have attracted the attention of botanists over the past few decades because of their rich, unique, and poorly studied plant diversity. Although uplifted concurrently with the Andean chain several million years ago, these cordilleras differ significantly from the Andes both geologically and floristically (Schulenberg and Awbrey 1997). They consist mostly of sandstones and limestones from Mesozoic and early Cenozoic sediments and present a fascinating biogeographic and floristic connection at the generic level with the more ancient *tepui* highlands of the Guiana Shield (Huber 1995; Neill 2005; Ulloa and Neill 2006; Rodríguez-Rodríguez et al. 2013).

Several new, locally endemic plant species and genera have been recorded and described from these sub-Andean highlands over the past two decades, especially from the Cordillera del Cóndor, on the Peru-Ecuador border (Pruski 1998; Neill 2005; Clark et al. 2010; Neill and Asanza 2012; Neill et al. 2012; Riina et al. 2014; Rodríguez-Rodríguez

Handling editor: Ricarda Riina.

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et al. 2006, 2013; SERNANP 2012; Ulloa and Neill 2006; Ulloa et al. 2012; Vázquez-García et al. 2012; Penneys et al. 2015). The Cordillera del Cóndor extends for 150 km along a north–south axis, rising up to 2900 m and hosting one of the richest floras in the Neotropics (Schulenberg and Awbrey 1997).

The genus *Drosera* is known to present some extreme cases of geographic disjunction, which have been explained by long-distance dispersal. *Drosera meristocaulis* Maguire & Wurdack, endemic to the Neblina Peak at the border between Venezuela and Brazil, belongs to a monophyletic group of sundews endemic to Australia and New Zealand (Rivadavia et al. 2012). The sister pair *D. sessilifolia* A.St.-Hil. (Neotropics) and *D. burmannii* Vahl (Southeast Asia and Australasia) (Rivadavia et al. 2003). Two boreal species, *D. anglica* Huds. and *D. rotundifolia* L., show disjunct populations in subtropics and/or tropics with the former occurring on Kauai Island (Hawai'i chain) and the latter in the Philippines and New Guinea (Coritico and Fleischmann 2016). Furthermore, some Neotropical *Drosera* species, such as *D. brevifolia* Pursh, *D. intermedia* Hayne, and *D. capillaris* Poir, occur in disjunct populations across the American continent along the north–south axis. Finally, *D. montana* A.St.-Hil., a species widely distributed in the highlands of eastern and southern Brazil, presents a disjunct population in the Bolivian Yungas (Rivadavia et al. 2014).

While previous works have confirmed all the above cases, one remained doubtful until now: the disjunct distribution of *D. chrysolepis*. This species has its core distribution in the *campos rupestres* (rupestrian fields—montane savannas with quartzitic and sandstone rock outcrops) along the Espinhaço Range, in the Brazilian states of Minas Gerais and Bahia (Gonella 2012). However, *Drosera chrysolepis* also occur in *restingas* (coastal vegetation, including moist broadleaf forests and herbaceous/shrubby fields over sandy soils) of coastal Bahia, representing an interesting case of geographic and ecological separation (Silva and Giuliatti 1997; Giuliatti and Pirani 1988). Oddly enough, this species had also been reported from the Cordillera del Cóndor, over 4000 km from its Brazilian range (Duno de Stefano and Silva 2001; Silva and Correa 2002; Correa and Silva 2005).

Rivadavia (2003), while describing *D. camporupestris* Rivadavia, a species from central Minas Gerais state (SE Brazil) and formerly treated under *D. chrysolepis* by Silva and Giuliatti (1997), mentioned similarities between the newly described species and a single specimen examined from Ecuador (Gentry 80306). However, the great geographical disjunction and the incomplete specimen examined prevented this author from making a decision regarding the identity of the Ecuadorian specimen (Rivadavia 2003).

During a comprehensive study of the *Drosera* from Brazil and South America, further herbarium specimens from the Cordillera del Cóndor were uncovered, enabling us to conduct a meticulous morphological analysis. Additionally, these studies revealed new records of *D. peruen-sis*, extending its distribution within Peru and to Ecuador.

Materials and methods

Herbarium specimens held at ECUAMZ, F, HUEFS, M, MO, NY, QCNE, SPF, UC, US, USM, and VEN (herbarium acronyms according to Index Herbariorum: Thiers 2016) were personally studied and carefully examined under a stereomicroscope, and the descriptions were based on dried specimens and spirit material. In addition, specimen photographs from MER, MERC, MERF, and PORT were also analyzed. Habitat information was extracted from the specimens' labels and literature, as well as from personal observations in the field. Distribution maps were prepared using georeferenced location data obtained from herbarium records and generated with DIVA-GIS (Hijmans et al. 2005).

Conservation status was assessed using IUCN Red List Categories and Criteria (IUCN 2012). For the estimation of the extent of occurrence (EOO) and area of occupancy (AOO), the CAT tool (available at <http://geocat.kew.org/>) was used as described in Bachman et al. (2011). For the AOO estimation, the standard IUCN cell size of 4 km² was employed.

Results

Based on the analysis of vegetative and generative morphology of the several new specimens from Cordillera del Cóndor, it became evident that the similarities with *D. chrysolepis* and *D. camporupestris* were merely superficial and that the plants from Cordillera del Cóndor actually belonged to a distinct, unnamed species.

The new species belongs to *Drosera* section *Drosera* (sensu Seine and Barthlott 1994), based on the three styles forked at the base, and was found to be more similar to two other little-known species: the Andean *D. cendeensis* Tamayo & Croizat, from the Páramo de Cendé and surrounding areas in northwestern Venezuela and *D. peruen-sis*, previously known only from Cordillera Yanachaga, a sub-Andean cordillera in central Peru (Fig. 1). In light of this morphologically similar new taxon from the Cordillera del Cóndor and the availability of additional specimens of *D. cendeensis* and *D. peruensis*, a close reinvestigation of the two latter taxa became necessary.

The rarely available fertile material of *D. cendeensis*, especially in recent collections, hinders the study of the inner flower organs, such as the stamens and gynoecium, rendering the floral description of this species incomplete in the current work. Seeds were also not observed in the studied material of *D. cendeensis* or *D. peruensis*, but SEM images are available in Correa and Silva (2005) for both species, although the seeds appeared to be unripe. Among the South American representatives of *Drosera* section *Drosera*, floral characters are generally not taxonomically significant to distinguish species, whereas leaf characters are useful for species delimitation (see Gonella et al. 2012, 2014, 2015; Rivadavia et al. 2014).

Discussion

Drosera condor, *D. cendeensis*, and *D. peruensis* share the circinate leaf vernation (Fig. 5b), a somewhat similar (very narrowly spatulate) leaf shape, and the indumentum of scape, pedicels, and sepals consisting exclusively of sessile glands and eglandular trichomes (lacking long-stalked glandular trichomes). *Drosera condor* and *D. peruensis* are further united by the triangular stipules. This combination of characters is not found in any other Neotropical *Drosera*, making it very difficult to phylogenetically place these three species based on morphology only.

The eglandular-pilose inflorescence parts lacking long-stalked glandular trichomes are shared with only a few species in the Neotropics, namely *D. cayennensis* Sagot ex Diels, *D. amazonica* Rivadavia, A.Fleischm. & Vicent., *D. felix* Steyerf. & L.B.Sm., *D. kaieuteurensis* Brumm.-Ding. and *D. solaris* A.Fleischm., and Wistuba & S.McPherson (the last three endemic to the Guiana Shield), which are in turn all easily distinguished from the three Andean species by geniculate-involute leaf vernation and leaves with an obovate to round lamina.

Circinate leaf vernation (Fig. 5c) is a widespread character among South American *Drosera* species, being found in another 17 species of the so-called Brazilian tetraploid clade (Gonella 2012; Gonella et al. 2012, 2014, 2015; Rivadavia et al. 2014). Triangular stipules are also present in six species of this clade. However, all species of the Brazilian tetraploid clade possess some kind of glandular trichomes on the scape. The leaf vernation pattern is a valuable taxonomic character to distinguish between the New World diploid and tetraploid *Drosera* species (Gonella 2012; Rivadavia et al. 2014), yet further cytological and molecular data are still necessary to securely assign the three Andean species to one of these two groups.

Drosera species are mostly missing from the main Andean chain (Fernández-Pérez 1965; Fleischmann and Duno de Stefano 2014; Rivadavia et al. 2014), with the exception of *D. cendeensis* in NW Venezuela, *D. uniflora*

Willd. from the southernmost Andean foothills of Argentinean and Chilean Patagonia, and *D. montana* from the Bolivian Yungas (a disjunction from its core distribution in central and eastern Brazil; Rivadavia et al. 2014). This low diversity may be explained by the Andean geology, which consists mainly of nutrient-rich volcanic soils. In fact, most Neotropical *Drosera* prefers nutrient-poor, quartzitic soils.

If the three Andean *Drosera* species described in this work are revealed to be closely related to the *tepui* species from the Guiana Shield, the occurrence of *Drosera* in the sub-Andean cordilleras could corroborate the hypothesis of a biogeographical connection between the two highland areas, already supported by several disjunct genera (Neill 2005). Nevertheless, further phylogenetic studies are necessary to test this hypothesis in the case of *Drosera*.

Taxonomic treatment

Drosera condor Gonella, A.Fleischm. & Rivadavia, **sp. nov.**—TYPE: Ecuador. Morona-Santiago: Gualaquiza Cantón, Campamento Achupalla, Cordillera del Cóndor, 15 km east of Gualaquiza, 2090 m, 21 Jul 1993, Gentry 80306 (holotype: QCNE-92866!; isotypes: MO-04984889!, MO-04604340!, PMA [n.v.], SPF-109890!) (Figs. 1, 2, 3).

Etymology: The scientific epithet is a noun in apposition referring to the condor, the great vulture that lends its name to the cordillera where this species grows.

Diagnosis: The new species is most similar to *Drosera cendeensis*, but differs from the latter in its isomorphic leaves that are narrower, more pilose, and fewer per rosette; its larger triangular stipules (6.5–10 mm long) with two abaxial longitudinal, sub-parallel ridges along their whole length, each terminally lacinate and dividing the apical third of the stipule into three segments, the lateral segments being lacinate and longer, the central shorter and divided into a few fimbriae.

Description: Perennial rosetted herb, rosettes lax, forming short upright stems up to 15 mm covered by the persistent dead leaves, stems not branching. Roots terete, dark, sparsely branched. Indumentum of white eglandular trichomes (bronze colored when dried) up to 2.5 mm long, on abaxial surfaces of petioles, laminae, and sepals, as well as on scapes and pedicels; and minute sessile glands c. 0.03 mm in diameter on both leaf surfaces, scapes, pedicels, and sepals. Leaves 40–70 mm long, active leaves only 2–4 per plant, with circinate vernation, erect to semierect, very narrowly spatulate, red, apex rounded; petioles 30–55 × 0.4–0.8 mm, linear, margins slightly revolute, adaxial surface glabrous, abaxial surface sparsely eglandular-pilose; lamina 10–20 × 0.7–1.5 mm, narrowly oblanceolate, adaxial

surface covered with numerous red, carnivorous, capitate tentacles of radial symmetry, abaxial surface sparsely eglandular-pilose; stipules $6.5\text{--}10 \times 2\text{--}4$ mm, triangular, membranaceous, reddish in color (drying golden), with two abaxial longitudinal ridges along their whole length, subparallel, each terminating in a lacinia and dividing the apical third into three segments, the lateral segments lacinate and longer, the central segment shorter and divided into a few fimbriae. Scape 1 per plant, $90\text{--}220$ mm long (including floriferous part), terete, $0.4\text{--}1$ mm in diameter at the base, scape erect from the very base, sparsely eglandular-pilose from base to apex, red in color; inflorescence a simple scorpioid cyme, bearing 2–7 flowers; bracts caducous,

$1.5\text{--}2$ mm long, oblong-lanceolate, eglandular-pilose; pedicels $1\text{--}2.5$ mm long, inserted $1.5\text{--}7$ mm apart, sparsely eglandular-pilose; sepals $3.5\text{--}4 \times 1.5\text{--}2.5$ mm, united at basal half of length, elliptic, sparsely eglandular-pilose, apex obtuse to acute; petals $8\text{--}12 \times 5$ mm, obovate, light pink to violet-pink in color; stamens 5, c. 7 mm long, anthers c. 1 mm long, bithecate, yellow; ovary 3-carpellate, fused, ca. 1 mm in diameter, globose, slightly 3-lobed in outline; styles 3, forked at the base, ca. 4 mm long (including stigmata), style arms curved inwards after anthesis, stigmata bilobed or trilobed. Fruit a dry dehiscent capsule, ca. 3 mm long, ellipsoid, 3-valvate; seeds oblong, $0.6\text{--}0.7 \times 0.2\text{--}0.25$ mm, testa reticulate, black.

Fig. 1 Maps showing the distribution of *Drosera cendeensis* (triangles), *D. condor* (stars), and *D. peruensis* (circles)

Phenology: Flower phenology information is very scarce for this species, since there are only four known herbarium collections from two localities, all of which were collected with flowers and fruits in June and July.

Habitats: *Drosera condor* was found at elevations between 2090 and 2500 m. The type collection at the Achupallas site occurred in vegetation characterized as a mosaic of sclerophyllous shrubs and *herbazales*, the latter defined by Schulenberg and Awbrey (1997) as “meadows

dominated by dense and species-rich clumps of bromeliads and orchids, interspersed with an array of other herbs and shrubs including dwarf palms, the insect-eating *Drosera*, and the rare curly grass-fern (*Schizaea pusilla*).”

At the Cerro Machinaza site, *D. condor* grows on outcrops of bare sandstone bedrock (Fig. 3b), in pockets of soil over rock, a habitat it shares with a few other herbaceous plants such as the fern *Pterozonium brevifrons* (A.C.Sm.) Lellinger (Adiantaceae). Between the sandstone

Fig. 2 *Drosera condor* **a** habit, **b** detail of the adaxial petiole surface, **c** detail of the abaxial petiole surface, **d** stipule with leaf base attached, **e** pedicel and calyx, and **f** seed. Based on Gentry 80306 (isotypes: MO, SPF)

Fig. 3 *Drosera condor* **a** habitat in the Cordillera del Cóndor, **b** detail of the leaves and **c** plants growing in cracks of sandstone (Neill & Kajekai 16902). Photos by David Neill

outcrops, the soil is a deep white quartzite sand derived from the parent bedrock with a low, open vegetation of shrubs and herbaceous plants not exceeding 1 m in height. Many of these plants are local endemics known only from the sandstone crest of the Cordillera del Cóndor that have been described in recent years, such as the shrubs *Clethra concordia* D.A.Neill, H.Beltrán & Quizhpe (Clethraceae), *Miconia machinazana* C.Ulloa & D.A.Neill, *Chalybea brevipedunculata* Penneys, C.Ulloa & D.Fernández (Melastomataceae), *Weinmannia condorensis* Z.S.Rogers (Cunoniaceae), and the terrestrial herb *Anthurium achupallense* Croat. (Araceae). The vegetation at the Cerro Machinaza locality also includes shrub species with a wider distribution such as *Purdiaea nutans* Planch. (Clethraceae) and *Arcytophyllum ciliolatum* Standl. (Rubiaceae) (D. Neill personal observation; Fig. 3a).

Distribution area: Peru (Amazonas) and Ecuador (Morona-Santiago and Zamora-Chinchipec); endemic to the Cordillera del Cóndor, along the border between the two

countries (Fig. 1). *Drosera condor* grows on the sandstone mesas (*tepui*-like formations) at two known localities, Achupallas at 2090–2500 m elevation and Cerro Machinaza (Machinaza Plateau) at 2160–2440 m elevation.

Conservation status: Endangered: EN B1ab(iii) + B2a-b(iii). The available data suggest that *D. condor* is endemic to the Cordillera del Cóndor, a remote region that is still very poorly explored botanically. According to Rodríguez-Rodríguez et al. (2013), although deforestation and mining activities have increased in the area over the past decades, the central areas of the sandstone highlands remain mostly intact. However, the expansion of large-scale mining activity in that region poses a major threat to the biodiversity of the Cordillera del Cóndor, resulting in habitat loss and environmental degradation. Based on the estimated extent of occurrence (EOO) of 137.8 km², the area of occupancy (AOO) of 16 km², and the fact that it is restricted to very specific, narrow habitats that can be easily degraded or destroyed by human activities, *D.*

condor is considered Endangered, according to the IUCN Red List (2012) categories and criteria. This new species is known to occur inside the recently created Ichigkat Muja—Cordillera del Cóndor National Park, in Peru, as well as in two protected areas in Ecuador: the El Quimi Biological Reserve and the Cordillera del Cóndor Protection Forest.

Notes: The putative closely related taxa to *D. condor* are the Andean species *D. cendeensis*, from northwestern Venezuela, and *D. peruensis*, from Peru and Ecuador (see below). All three species share a somewhat similar leaf shape and indumentum (considering only the long, erect leaves of the heterophyllous *D. cendeensis*) and similar scape indumentum.

Drosera condor is easily recognized by the stipule morphology (Fig. 2d), which is unique among all Neotropical taxa, except for the only distantly related *D. meristocaulis* from Cerro Neblina on the border between Venezuela and Brazil, which similarly presents two sub-parallel longitudinal ridges along the whole length of the abaxial surface of the stipule. This is a curious case of morphological convergence, since *D. meristocaulis* belongs to a distantly related clade of mostly Australian species, the “pygmy sundews” (*Drosera* section *Bryastrum*; Rivadavia et al. 2012).

Drosera condor and *D. cendeensis* share similar leaf morphology, if one considers only the erect leaves of the latter species. Besides the characteristic stipule morphology, *D. condor* differs from *D. cendeensis* by the isomorphic leaves (vs. dimorphic leaves in *D. cendeensis*, a heterophyllous species which produces smaller rosetted leaves during the dry dormancy periods), the narrower lamina up to 1.5 mm wide (vs. 2–3 mm wide in the erect leaves of *D. cendeensis*), and the abaxial leaf surface with denser indumentum (vs. glabrous to glabrescent abaxial leaf surface).

Although not very similar at a first glance, *D. condor* resembles a lax, long-leaved *D. peruensis*. Both species share similar leaf and scape indumentum, but *D. peruensis* has more compact and dense rosettes with shorter, narrowly oblong leaves (and further differs from the other two, pink-flowered Andean species by its white petal color).

Similarities with *D. chrysolepis* and *D. camporupestris*, both from eastern Brazil, include the overall habit, the narrowly spatulate leaves, the triangular stipules, and the similarly sized oblong seeds. *Drosera condor* further shares with *D. camporupestris* the characteristic lax rosette, each with very few active leaves (usually only 1–3). However, the two Brazilian species are very distinctive in their larger stipules (9–16 mm long in *D. camporupestris*; 8–15 mm in *D. chrysolepis* vs. 6.5–10 mm long in *D. condor*), the acute leaf apex terminating in a single carnivorous tentacle (vs.

rounded leaf apex) and the dense indumentum of long eglandular trichomes and translucent-yellow, short-stalked, globose multicellular glandular trichomes (“TSG trichomes”; Rivadavia and Gonella 2011) that are found on both petiole surfaces, the abaxial surface of the lamina, the scape, pedicels, and sepals.

Additional specimens examined (paratypes): Ecuador. Zamora-Chinchipe: Paquisha Cantón, Cordillera del Cóndor, Machinaza Plateau, precisely on the Ecuador–Peru border, 2440 m, 22 Jun 2009, Neill and Kajekai 16902 (MO, QCNE). Morona-Santiago: Gualaquiza Cantón, crest of Cordillera del Cóndor, ridge top 15 km ENE of Gualaquiza, 2500 m, 26 Jul 1993, Gentry 80462 (MO, QCNE–94752). Peru. Amazonas: Condorcanqui, Cordillera del Condor, la cima del “tepui” Cerro Machinaza, cabeceras del Rio Comainas, tributario al oeste del Rio Cenepa, 2160 m, 31 Jul 1994, Beltrán and Foster 1488 (F, USM).

Drosera cendeensis Tamayo & Croizat. Lilloa 17: 175. 1949.—TYPE: Venezuela. Trujillo/Lara: Páramo de Cendé, 3000 m, 24 Jun 1940, Isabel Venegas Perdomo s.n. [Tamayo 1430] (holotype: VEN!; isotypes: F!, UC!, US–1800890!, US–1800021!) (Figs. 1, 4, 5a–d).

Vernacular names: dítamo, dítamo real, díctamo de venado, yerba de Lucas (Duno de Stefano and Riina 2003).

Etymology: Named after the páramos de Cendé (now in the Dinira National Park) in the Venezuelan Andes, where it was first discovered (Tamayo and Croizat 1949).

Description: Perennial rosetted herbs, acaulescent or forming very short, inconspicuous stem up to 5 mm long. Roots terete, dark, sparsely branched. Indumentum of white eglandular trichomes (bronze colored when old) on scape, pedicels and sepals and eventually on leaves; minute sessile glands c. 0.03 mm in diameter on both leaf surfaces, scape, pedicels, and sepals. Leaves dimorphic, with circinate veneration, lamina adaxial surface covered with numerous red, carnivorous, capitate tentacles with radial symmetry; basal leaves numerous, 10–25 mm long, oblong-spatulate, decumbent to semierect, glabrous, petioles 7.5–17 × 1.5–2 mm, lamina 2.5–5 × 2–2.5 mm, continuous with the petiole, oblong to ellipsoid, apex rounded to obtuse, green with red tentacles; erect leaves 3–5 per plant, 30–140 mm long, very narrowly spatulate, glabrous or with very sparse eglandular trichomes in the abaxial surface, petioles 25–106 × 0.6–2 mm, linear with slightly broader base, narrowing toward apex, lamina 5–34 × 2–3 mm, oblong to narrowly oblanceolate, apex rounded, red to reddish-green; stipules 4–7(–8) × 2–3 mm, rectangular, membranaceous, translucent white to reddish in color (drying gold-colored), the apical third divided in three segments, the two lateral segments simple and lacinate, the central

Fig. 4 *Drosera cendeensis* **a** habit depicting a fertile specimen with basal and erect leaves, **b** habit depicting a specimen at rosette stage only with basal leaves, **c** stipule of an erect leaf with base of leaf attached, **d** detail of the indumentum on the abaxial petiole surface, **e** basal leaf with stipule attached and **f** pedicel and calyx. **a, c–e** based on Riina et al. 722; **b** based on van der Werff and Rivero 7997; **f** based on Tamayo 1430 (isotype UC)

segment broader and shorter, divided into a few fimbriae. Scape 1 per plant, 150–250 mm long (including floriferous part), terete, 1.5 mm in diameter at base, base erect, sparsely eglandular-pilose at the base, becoming densely eglandular-pilose toward apex, red in color. Inflorescence a simple scorpioid cyme, bearing 3–7 flowers; bracts not seen; pedicels 1–4 mm long, sparsely eglandular-pilose; sepals 6–9 × ca. 1.5 mm, united at

basal 1/3–1/4 of length, lanceolate, densely eglandular-pilose, apex acute; petals 7–12 mm long, obovate, pink in color; stamens 5, ca. 5 mm long, anthers ca. 1 mm long, bithecate, yellow; ovary 3-carpellate; styles 3, forked at the base, ca. 3 mm long, stigma bilobed; fruits not seen; seeds not seen [according to Tamayo and Croizat (1949): seeds broadly ellipsoid, 0.75 mm long, testa reticulate, black].

Fig. 5 **a–d** *Drosera cendeensis* at Dinira National Park, Venezuela: **a** habitat at La Lajita, **b** group of individuals at the rosette stage growing among *Sphagnum* sp., **c** collected specimens (Alvarado et al. 3377) presenting early emerging erect leaves, note the circinate leaf veneration, **d** collected fertile specimens (Riina et al. 722). **e–g** *D.*

peruensis **e** collected specimen from Cerro Plateado (Neill et al. 17459), forming a column of dead leaves, **f** plant covered by dew, at Sira Mountain, Peru (Graham 5751) and **g** flower (Graham 6038). **a**, **d** by Ricarda Riina; **b** by Régulo Briceño; **c** by Hipólito Alvarado; **e** by David Neill; **f**, **g** by James G. Graham

Phenology: *Drosera cendeensis* was collected with erect leaves and flowers between May and August, while specimens collected in November presented only basal leaves and no inflorescences. Also, in field studies conducted in September 2006 (Briceño 2009), only immature plants with basal leaves were observed.

The species has a dormancy period in the dry season (R. Duno de Stefano personal comm.), during which shorter and more spatulate-shaped leaves are present (Fig. 4b, e; quite similar to the distantly related *D. stenopetala* Hook.f. from New Zealand). Interestingly, the unrelated

carnivorous plant *Pinguicula elongata* Benj. (Lentibulariaceae, Lamiales), endemic of high Andean páramos of Colombia and Venezuela, also has dimorphic leaves, which enable it to form dormant, bulb-like resting buds during the two annual dry seasons (Fernández-Pérez 1964; Beck et al. 2008; S. Vieira personal comm.).

Habitats: *Drosera cendeensis* grows in montane forest and subpáramo vegetation, where it is usually found associated with riparian vegetation, or open wet areas in peat-rich soils often covered by carpets of *Sphagnum* L. (Fig. 5a, b).

Distribution area: Endemic to the easternmost part of the Venezuelan Andes, in the states of Trujillo and Lara (Fig. 1). *Drosera cendeensis* has been collected in the páramos de Cendé, Las Rosas, Los Nepes and Jabón, at elevations ranging between 2300 and 3200 m. A previous report from the Guaramacal National Park (Duno de Stefano 1995) turned out to be an error, as no *Drosera* species is recorded from this area (Dorr et al. 2000).

Conservation status: Critically Endangered: CR A2d + B1b(v)c(iv). *Drosera cendeensis* is locally considered to be medicinal, reportedly used as an antispasmodic for pertussis, a tonic, and a vasodilator (Duno de Stefano and Riina 2003). The species is collected in large quantities and sold in local markets in Trujillo and Lara, which explains its increasing rarity (Briceño 2009). Also, the flowering period coincides with the time when plants are collected for medicinal use (24 June—Day of Saint Juan, Briceño 2009), which directly affects the number of mature individuals and jeopardizes the reproduction of the species. Given its restricted occurrence (EOO of 20 km²) associated with overexploitation, the species is here signaled as Critically Endangered. *Drosera cendeensis* is found inside the Dinira National Park, but according to Duno de Stefano and Riina (2003), that is not enough to ensure its protection.

Notes: In discordance with Tamayo and Croizat (1949) and Duno de Stefano (1995), who describe the indumentum of the scapes and sepals as being exclusively glandular-pilose, all fertile specimens examined (including the type specimens) presented an exclusively eglandular-pilose indumentum (Fig. 4a, f).

The type specimen of *D. cendeensis* was originally collected by Isabel Venegas Perdomo, but deposited under Tamayo's collection number 1430.

Additional specimens examined: Venezuela. Lara: Morán, Páramo de los Nepes, en sabanas a más de 2000 mts, Nov 1937, *Tamayo* 325 (US, VEN), Lajas del Dítamo, un sector hacia la base de la vertiente oriental del Páramo de Cendé, 2900 m, 10 Jun 1971, *Ruiz-Terán* and *López-Figueiras* 2026 (MERF, US), pica que va desde Buenos Aires a Paramo Las Rosas, 2300–2600 m, 15 Nov 1984, *van der Werff* and *Rivero* 7997 (MO, PORT). Parque Nacional Dinira, ladera del Páramo de Jabón, vertiente hacia el Tocuyo, sector “Los Charquitos,” 2800–2900 m, 15 Aug 1999, *Riina* et al. 704 (VEN), ladera vertiente hacia el Tocuyo, sector “La Lajita,” 2700 m, 15 Aug 1999, *Riina* et al. 722 (M, NY, VEN), turberas del Páramo Cendé, serranía de Barbacoas, 2715 m, *s.d.*, *Alvarado* et al. 3377 (UCOB [image!]). Trujillo: Páramo de las Rosas, 3200 m, Oct 1912, *Jahn* 166 (US); Carache, inmediaciones del

Paramo Cendé, 3000 m, 21 May 1987, *Rivero* 1185 (MO, PORT).

Drosera peruensis T.Silva & M.D.Corréa. Novon 12(4): 543. 2002.—TYPE: Peru. Pasco: Oxapampa, Cordillera Yanachaga, Cerro Pajonal, “chacos” 12 km SE of Oxapampa, 2700–2800 m, 7 Oct 1982, *Foster* 9066 (holotype: PMA [image!]; isotypes: F!, HUEFS!, MO!, US!) (Figs. 5e–g, 6).

Etymology: Named after the country of Peru, where it was first discovered and to which it was believed to be endemic (Silva and Corrêa 2002).

Description: Perennial rosetted herbs, forming upright columns densely covered by the persistent dead leaves, up to 50(–80) mm long, rarely branching. Roots terete, dark, sparsely branched. Indumentum of white eglandular trichomes (bronze colored when old) on abaxial surfaces of petiole and lamina, on scape, pedicels, and sepals; minute sessile glands c. 0.03 mm in diameter on both leaf surfaces, scape, pedicels and sepals. Leaves 7–14(–20–28) mm long, with circinate vernation, semierect, decumbent and persistent when old, narrowly oblong, apex rounded, petiole green to yellowish-green becoming red toward the apex, lamina red; petioles 4.5–8(–14–19) × 0.35–0.7(–1.2) mm, with slightly broader base, narrowing toward apex, margins revolute, adaxial surface glabrous, abaxial surface densely eglandular-pilose; lamina 2.5–6(–9) × 0.5–1(–1.8) mm, oblong to narrowly oblanceolate, adaxial surface covered with numerous red, carnivorous, capitate tentacles with radial symmetry, abaxial surface densely eglandular-pilose; stipules 5–7 × 1.5–3 mm, triangular, membranaceous, white to reddish in color (drying gold-colored), the apical half divided into three segments, the marginal segments narrower, longer, and entire, the central segment broader, shorter and divided into several laciniae. Scape 1 per plant, 50–150(–215) mm long (including floriferous part), terete, 0.6–10 mm in diameter at base, base erect, sparsely eglandular-pilose from base to apex, red in color; inflorescence a simple scorpioid cyme, bearing 1–7(–10) flowers; bracts caducous, 1–2 mm long, linear-lanceolate, eglandular-pilose; pedicels 1–4(–10) mm long, inserted 1–5(–11) mm apart, sparsely eglandular-pilose; sepals 2–5 × 1.7–2.5 mm, united at basal 1/3–1/4 of length, ovate to broadly ovate, densely eglandular-pilose, apex obtuse to rounded (acute); petals 6–7 mm long, obovate, white or tinged light pink; stamens 5, ca. 3.5 mm long, anthers ca. 1 mm long, bithecate, yellow; ovary 3-carpellate, fused, ca. 1.5 mm in diameter, globose, slightly 3-lobed in outline; styles 3, forked at the base, ca. 3 mm long (including stigmata), stigmata bilobed or

Fig. 6 *Drosera peruensis* **a** habit depicting a specimen from Sira Mountains, Peru, **b** habit depicting a specimen from the type location at Oxapampa, Peru, **c** stipule with leaf base attached, **d** leaf with stipule attached, **e** detail of the indumentum of the abaxial petiole surface, **f** pedicel and calyx. **a** based on *Graham 5751*; **b** based on *Foster 9066* (isotype F); **c–f** based on *Graham 6038*

flabellate; fruit a dry dehiscent capsule, 3 mm long, ellipsoid, 3-valvate; seeds ellipsoid, ca. 0.7×0.2 mm wide, testa reticulate, black.

Phenology: *Drosera peruensis* was collected with flowers and fruits in January, August, September, and October, which suggests somewhat continuous flowering throughout the year.

Habitats: *Drosera peruensis* grows in quartzitic sandy soils or in cracks of sandstone in humid areas of dwarf forest (shrubland). At the Cerro Plateado locality in Ecuador, *D. peruensis* occurs in open, herbaceous vegetation on white sandy soil derived from sandstone, together with other low herbaceous plants such as *Gentianella saxifragoides* (Kunth) Fabris (Gentianaceae), *Lysipomia sparrei* Jeppesen (Campanulaceae), and *Pinguicula*

calyptrata Kunth (Lentibulariaceae) (D. Neill personal observation).

Distribution area: Peru (Cajamarca, Pasco, Ucayali) and Ecuador (Zamora-Chinchi). *Drosera peruensis* exhibits a wide, but apparently disjunct distribution along the sub-Andean cordilleras in central and northwestern Peru and southern Ecuador (Fig. 1). Silva and Correa (2002) described the species as being endemic to the Cordillera Yanachaga, in Central Peru (Pasco), but the new records presented here expand its range ca. 150 km further to the northeast on the Sira Mountains (Ucayali) and ca. 750 km to the northwest on the Cerro Picorana (Cajamarca, NW Peru) and on a southern portion of the Cordillera del Cóndor, the Cerro Plateado (S Ecuador, close to the border with Peru), ca. 85 km south from the closest known occurrence of *D. condor*.

Conservation status: Endangered: EN B2ab(iii, iv). *Drosera peruensis* was previously considered as Critically Endangered (Duno de Stefano and Silva 2001) and Endangered (León et al. 2006) based on its restricted occurrence and the state of conservation of the type location. However, the new records presented here expand its distribution considerably, to relatively well-conserved areas. Nevertheless, the conservation status for *D. peruensis* is here maintained as Endangered, meeting the criteria B2a, b(iii, iv). The species has an estimated AOO of 20 km², occurring in narrow and highly fragmented habitats. The conservation status is further aggravated by the known reduction in the population size, at least at the type location, where it is apparently extinct, although the habitat seems to not have suffered from human interference (F. Rivadavia and S. Vieira personal observation). In both countries, *D. peruensis* occurs in protected areas: the Sira Comunal Reserve in Peru and the Cerro Plateado Biological Reserve in Ecuador.

Notes: Silva and Correa (2002) state that the species resembles the Venezuelan *D. arenicola* Steyerl., due to the superficially similar oblong leaves (further similarity comes from the white petal color; Fig. 5g). *Drosera arenicola* is distinguished by the geniculate leaf vernation (vs. circinate), by the entirely red leaves (vs. bicolored), by the oblong-obovate lamina (vs. oblong to narrowly oblanceolate), the shorter and rectangular stipules up to 5 mm long (vs. longer triangular stipules, 5–7 mm long), by the shorter scapes [up to 55 mm long vs. 50–105(–215) mm long], and the exclusively glandular-pilose scapes and sepals (vs. exclusively eglandular-pilose).

The compact, globose rosettes with narrowly oblong, semi-upright, bicolored leaves of *D. peruensis* are superficially reminiscent of those of the Australasian *D. neocaledonica* Raym.-Hamet (species endemic to the island of New Caledonia), but such similarities may not reflect a closer phylogenetic

affinity, as *D. peruensis* is likely to be a derived member in the South American clade of *Drosera* (with triangular stipules and circinate leaf vernation), whereas *D. neocaledonica* (rectangular stipules and geniculate leaf vernation) branches earlier in the generic phylogeny of Rivadavia et al. (2003).

Plants of *D. peruensis* from the Sira Mountains (central Peru) are much larger when compared to specimens from other known populations (compare Figs. 6a with b, 5e with f), usually twice the size. It is currently unknown to us if this size difference is a result of genetic differences, or just the effect of environmental conditions (e.g., elevation or soil), since the Sira Mountains are at lower elevation, around 2000 m (vs. ca. 2800 m for other *D. peruensis* populations).

Additional specimens examined: Ecuador. Zamora-Chinchi: Nangaritza, Cordillera del Cóndor, Reserva Biológica Cerro Plateado, 2790 m, 24 Aug 2012, Neill et al. 17459 (ECUAMZ, MO). Peru. Cajamarca: San Ignacio, San José de Lourdes, cerro Picorana, 2830 m, 17 Aug 1998, Campos et al. 5540 (HUEFS, MO, USM), campamento Zural, base del Cerro Picorana, 2200 m, 23 Jan 1999, Diaz et al. 10466 (HUEFS, MO). Ucayali: Coronel Portillo, Iparia, Alturas del Cerro Ariapo, Reserva Comunal el Sira, 2000 m, 16 Dec 2009, Graham 5751 (F), 20 Sep 2010, Graham 6038 (F, SPF).

Acknowledgments We would like to thank Ricarda Riina (Real Jardín Botánico, Madrid), Hipólito Alvarado Álvarez (UCOB), and Régulo Briceño for information and photos of *D. cendeensis* from Dinira National Park, Venezuela; José Ramón Grande Allende (Universidad Central de Venezuela, Caracas) for photos of *D. cendeensis* specimens from MERF and VEN and information about possible specimens at MER and MERC; Nidia Cuello (Universidad Nacional Experimental de los Llanos Occidentales, Venezuela) for photos of specimens at PORT; James G. Graham (Field Museum, Chicago) for the photos of *D. peruensis* from Sira Mountains, Peru; the curators and staff of the visited herbaria; and two anonymous reviewers for valuable suggestions to the manuscript. DAN thanks the Ministry of Environment of Ecuador for the research permits enabling fieldwork in the Cordillera del Cóndor. This work is part of PMG's Ph.D. thesis, financially supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq – Proc. 140135/2013-8) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES – PDSE/Proc. 99999.010612/2014-09). PTS acknowledges CNPq Research Grant (Proc. 310437/2015-6).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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CHAPTER 3

A synopsis of the genus *Drosera* (Droseraceae) from Brazil

Article prepared for submission to the periodic **Phytotaxa**

A synopsis of the genus *Drosera* (Droseraceae) in Brazil

Abstract. A synopsis of the *Drosera* (Droseraceae) species occurring in Brazil is here presented, providing tools for the identification of its species and synthesizing data as a basis for future studies on diversity and conservation of the genus in the country. Thirty-three taxa, comprising thirty-two species and one variety, are recognized for the Brazilian territory and, for each taxon, a brief diagnosis, notes on distribution, habitat, phenology and conservation status, plus a list of representative specimens are presented, along with an identification key. *Drosera hirtella* var. *lutescens* is raised to species status, lectotypes are designated for *D. capillaris* var. *brasiliensis*, *D. chrysolepis*, *D. hirtella*, *D. hirticalyx*, *D. intermedia* var. *elatior*, and *D. maritima*, and a neotype is designated for *D. intermedia* var. *tenuis*. *Drosera* species are recorded from all Brazilian states, being Minas Gerais the richest state in number of species, with a total of 21 spp.

Key words: carnivorous plants, conservation, lectotypification, Neotropics, taxonomy.

Resumo. Uma sinopse para as espécies de *Drosera* (Droseraceae) ocorrentes no Brasil é aqui apresentada, provendo ferramentas que permitam a identificação de suas espécies e sintetizando dados que sirvam de base para estudos futuros sobre diversidade e conservação do gênero em território nacional. Trinta e três táxons, incluindo trinta e duas espécies e uma variedade, são reconhecidos para o território brasileiro e, para cada táxon, uma breve diagnose, notas sobre distribuição, habitat, fenologia e conservação e uma lista de espécimes representativos são apresentados, junto com uma chave de identificação. *Drosera hirtella* var. *lutescens* é elevada ao status de espécie, lectótipos são designados para *D. chrysolepis*, *D. hirtella*, *D. hirticalyx*, e *D. maritima* e um neótipo é designado para *D. intermedia* var. *tenuis*. Espécies de *Drosera* são reportadas para todos os estados brasileiros, sendo que Minas Gerais é o estado mais rico em número de espécies, com um total de 21 spp.

Palavras-chave: conservação, lectotipificação, Neotrópicos, plantas carnívoras, taxonomia.

Introduction

The carnivorous family Droseraceae (non-core Caryophyllales) comprises three very distinctive genera: the monospecific *Aldrovanda* Linnaeus (1753: 281), the “waterwheel plant”, a free-floating aquatic, widespread in all continents except Antarctica and the Americas; the also monospecific *Dionaea* Sol. ex Ellis (1768: 4), the “Venus flytrap”, endemic to southeastern USA and very popularly cultivated worldwide, including Brazil; and *Drosera* Linnaeus (1753: 281), the “sundews”, a worldwide-distributed genus with an increasing number of species in the last few years, currently comprising around 250 species (Rivadavia *et al.* 2003, Gonella *et al.* 2015).

The greatest species diversity of *Drosera* is found in Australia, where ca. 150 species are native, mostly in southwestern and northern Australia, the main diversity centers of the genus (Lowrie 2013). Further diversity centers are eastern (mountain ranges of E Brazil) and in northern (Guyana Shield) South America (Duno de Stefano & Culham 1995, Fleischmann *et al.* 2007, Gonella *et al.* 2012, 2014, 2015, 2016, Rivadavia 2003, 2008, Rivadavia & Gonella 2011, Rivadavia *et al.* 2009, 2014), and the Cape floristic region in South Africa (Fleischmann *et al.* 2008).

The study of the *Drosera* diversity in Brazil dates back to the French naturalist Auguste de Saint-Hilaire (1824, 1826), who reported 12 species and two varieties for the country, of which 11 species and the two varieties were all newly described in his works.

Eichler (1872) revised the genus in Martius’ *Flora Brasiliensis*, raising the number of taxa to 20 (13 species and seven varieties) by reporting new occurrences and describing new varieties under *D. communis* A.St.-Hil., *D. intermedia* Hayne, *D. montana* A.St.-Hil., and *D. villosa* A.St.-Hil.

Diels (1906), in the last global monograph of the genus, reduced the number of taxa in Brazil to 15 (10 species and five varieties), mostly by synonymizing morphologically similar taxa under a few names (e.g. *D. graminifolia* A.St.-Hil., *D. villosa*), and reducing some species to varieties under *D. montana*.

By the end of the 20th Century, Silva & Giuliatti (1997) reviewed the genus in Brazil, registering 15 taxa (12 species and three varieties), mostly following Diels’ (1906) species circumscriptions.

In the treatment for the Flora Neotropica, Correa & Silva (2005) reported only 14 species and no varieties for Brazil, a taxonomic opinion that is strictly followed by

Silva (2010) in the “Catálogo de Plantas e Fungos do Brasil”, the most comprehensive work on Brazilian flora since the *Flora Brasiliensis*.

In contraposition to the lumping taxonomic view started by Diels (1906) and culminating in the works by Correa & Silva (2005) and Silva (2010), several recent studies based on extensive fieldwork and analysis of herbarium specimens have reviewed, re-established and described new *Drosera* taxa for Brazil, raising considerably the number of accepted taxa (Rivadavia 2003, 2008, 2009, Rivadavia *et al.* 2009, 2014, Rivadavia & Gonella 2011, Gonella *et al.* 2012, 2014, 2015). An extensive historical literature review can be found in Rivadavia (2008), Gonella *et al.* (2014) and Rivadavia *et al.* (2014).

The main goal of this work is to summarize the current knowledge about the taxonomy of the genus *Drosera* in Brazil and provide tools for the correct identification of the species occurring in the country, as well as directions for future research on diversity, conservation and ecology of the Brazilian taxa.

Material and Methods

Extensive literature review related to the genus in the Brazilian territory was undertaken in addition to the study of herbarium specimens held at ALCB, B, BHCB, BM, CEN, CESJ, DIAM, ESA, F, FLOR, HEPH, HUCS, HUEFS, HUFU, IBGE, INPA, IPA, K, M, MAC, MBM, MO, NY, OUPR, P, PAMG, R, RB, RON, SP, SPF, UB, UEC, UFRN, US, VIES and W (herbarium acronyms according to Thiers 2011). Digitized high-resolution images of the type materials held at MPU (<http://hvsh.cria.org.br/>) and WU (<http://herbarium.univie.ac.at/database/search.php>) were also examined. Furthermore, several field studies focusing in areas with great species diversity of the genus were undertaken.

Data about phenology, habitat and geographic distribution were extracted from our own field observations as well as specimens' labels and bibliography. Only the synonyms in the context of the Neotropics are listed here, even for species occurring outside of this area. In the geographic distribution section, countries are listed from North to South, while Brazilian states are divided between the five geographic regions, from North to South, then alphabetically. In the lists of specimens, the states are ordered alphabetically. Standard acronyms are used for Brazilian states (IBGE 2016).

For each species we present a diagnosis containing a combination of characters that allows the identification of said species and, for that reason, the parallel model usually adopted in taxonomic revisions is not followed here.

A list of representative specimens examined that can serve as a reference for comparative identification is presented for each of the species here treated, or, in the case of recently revised taxa, a reference for a complete or extensive listing of specimens is cited. For widely distributed species, at least one specimen for each Brazilian state of occurrence is cited.

When data is available, the occurrence of the species inside National and State Parks is given in the “Conservation Status” section under each species.

Translucent-yellow short-stalked globose trichomes (Rivadavia & Gonella 2011) are present in some species and the abbreviation “TSG trichomes” is used throughout.

Conservation status was assessed using IUCN Red List Categories and Criteria (IUCN 2012). For all geographically restricted species (restricted to a mountain range or to one or two states), we estimated the extent of occurrence (EOO) and area of occupancy (AOO) using the CAT tool described in Bachman *et al.* (2011) and available at <http://geocat.kew.org/>. The standard IUCN cell size of 4 km² was employed for the AOO estimation.

Results and Discussion

A list of 60 names was obtained for Brazil, of which 34 names are accepted here, comprising 32 species, one variety and one nothotaxon (named hybrid). The species here accepted are listed on Table 1, which also presents their distribution in the Brazilian regions and states.

Only one species, *D. sessilifolia*, belongs to *D.* sect. *Thelocalyx* Planchon (1848: 92), characterized by the pentamerous gynoecium, with five undivided styles. All the other 31 species belong to *D.* sect. *Drosera*, recognized by the trimerous gynoecium, with three styles bifurcated from the base.

Brazil exhibits the highest species richness of the genus in South America: from the 42 species found in the sub-continent, 32 occur in Brazil (18 endemics), followed by Venezuela (15 spp., five endemics) and Guiana (7 spp., one endemic) (Table 2). In Brazil, the highest species concentration is found in the state of Minas

Gerais (21 spp., 11 endemics), followed by Bahia (10 spp., one endemic), Amazonas (nine species), and Goiás and Roraima (eight species) (Table 1).

A few species, namely *D. kaieteurensis*, *D. meristocaulis* and *D. solaris*, occur in borderline areas with Venezuela and Guyana, and may occur in the Brazilian territory as well. However, no specimen of these taxa have been recorded from Brazil and, as such, these are not included in this treatment.

The number of species here presented is more than twice the number cited for Brazil by Correa & Silva (2005) and Silva (2010). All the 14 species registered for Brazil in such works are also recognized here, however, only four species have similar circumscriptions in this work (*D. brevifolia*, *D. hirticalyx*, *D. roraimae* and *D. sessilifolia*), while most taxa are here very distinctively circumscribed.

Main changes occurred in the historically neglected and poorly circumscribed *D. montana* (see Rivadavia *et al.* 2014): 6 taxa here accepted were placed under this name by Correa & Silva (2005), as well as synonyms that we place under *D. cayennensis* and *D. communis*. Contrary to the historic classifications, that used scape indumentum as the main character to distinguish between the taxa under this name (and which was the reason used by Correa & Silva (2005) to place all names under synonymy), all taxa historically allied to *D. montana* can be easily distinguished by leaf characters, such as shape, indumentum and vernation, making the identification possible even in the sterile state. The same holds true for the *D. villosa* species alliance, which was also recently split into several taxa, including restablished names and new species (Gonella *et al.* 2014), and for *D. graminifolia* and its long neglected sister species *D. spiralis*, restablished based on numerous morphological characters (Gonella *et al.* 2012).

In the last two decades, 10 new species were published for Brazil, and two varieties were raised to species status, most of them Espinhaço Range and/or *campos rupestres* endemics (e.g. Rivadavia *et al.* 2003, 2008, 2009, 2014, Rivadavia & Gonella 2011, Gonella *et al.* 2014, 2015). The number of Brazilian endemic taxa changed considerably between Correa & Silva (2005) and the current work, from 3 to 18 species, with huge implications for the conservation: of these endemic species, 12 are placed in one of the categories of threat, following IUCN (2012).

In the New World, *Drosera* is especially diverse in the ancient quartzitic formations of the Espinhaço Range in eastern Brazil (18 spp., 11 endemics) and in the Guiana Shield (16 spp., 10 endemics), with interchange of only one species (*D. communis*). Both these regions have in common the prevalence of montane areas

with nutrient-poor sandy soils that host open field physiognomies with sandstone and quartzite outcrops. The *campos rupestres* (rupestrian fields) from the Espinhaço Range and other areas in central-eastern Brazil are the most species-rich vegetation type, with 22 spp., of which 13 spp. are endemic. This vegetation type shares the nutrient-poor sandy soils and the presence of a pronounced dry season with the other hotspots of *Drosera* diversity: the *fynbos* of the Cape floristic region in South Africa, and the *kwongan* sandplains in SW Australia. These three ecoregions differ, however, in the climate: while the *fynbos* and the *kwongan* experience Mediterranean climate, with wet winters and dry summers, the *campos rupestres* experience a sub-humid Tropical climate, with wet summers and dry winters.

Drosera species are usually absent from forested vegetations in the Neotropics, with the exception of a few species that can eventually be found growing in the understory of gallery forests, along the river margins (e.g. *D. chimaera*, *D. latifolia*, *D. riparia* and *D. tomentosa*). In denser forest vegetations, the genus is majorly absent, but often colonizes deforested and perturbed areas, such as in the Atlantic Forest, where the most common habitat of the genus are the high altitude fields (*campos de altitude*), but a few species can also be found as ruderals along trails and roads (eg *D. communis*, *D. latifolia*, *D. montana*). In the Amazon, *Drosera* is not found in the core of the Amazon Forest, being mainly restricted to north of the Rio Negro and south of the Rio Madeira, where it is most commonly found in the amazonic savannas and in the *campinas*, seasonally flooded grasslands with white quartz sand soils.

Among the Brazilian biomes, the Cerrado, with its sandy, acidic and nutrient poor soils, is the most species rich, with 20 species, followed by the Mata Atlântica with 12 spp. and the Amazon with 10 spp. Nine species are found in the Caatinga biome but, of those, eight are restricted to the Chapada Diamantina. Finally, the Pampas, in South Brazil, and the Pantanal, in the Center-West, are poorest biomes in terms of *Drosera* diversity, with only two species each. Sporadic frost may explain the low species diversity in the Pampas, while seasonal floods and edaphic factors may be the reason for the low species diversity in the Pantanal.

We present a key to identify all the 32 species occurring in Brazil. For each species, we also provide a brief diagnosis, a list of illustrations of reference, remarks on distribution, habitat, phenology, conservation status and taxonomic notes, when necessary.

Taxonomy

Drosera Linnaeus (1753: 281).

Type species: *Drosera rotundifolia* Linnaeus (1753: 281).

Perennial, seasonal geophyte perennial or annual, carnivorous herbs, terrestrial or lithophytes. *Stem* restricted to the rosette (acaulescent), often forming short stems densely covered by the remains of dead leaves (columns), or plants caulescent, with stems erect or prostrate, rarely branching. *Roots* capillary to succulent, rarely tuberous, black, scarcely branching, densely covered by root hairs. *Leaves* simple, rosulated, spirally arranged, petiolated or sessile, spatulate, obovate, oblong, lanceolate, or linear (including variations) in shape, densely covered by carnivorous glandular emergences (tentacles) on the adaxial lamina surface, glabrous or glandular- and/or eglandular-pilose on both surfaces, tentacles uniform or snap-tentacles with unifacial gland present in the apical margin of the leaves; leaf vernation circinate, circinate-involute, geniculate, geniculate-involute, or entire-involute; stipules intrapetiolar, membranaceous, or reduced to lateral fimbriae, or absent. *Inflorescence* a scorpioid-cyme, multiple-flowered or single flowered, lateral, terete, usually with very long peduncle (scape), rarely sub-sessile, scape glandular- and/or eglandular-pilose or glabrous; bracts caducous, usually absent in mature inflorescences; pedicels glandular- and/or eglandular-pilose, or glabrous. *Flowers* actinomorphic, bisexual, tetracyclic. *Calyx* 5-merous, sepals united at the base, oblong, ovate, lanceolate, obovate or sub-orbicular, glandular- and/or eglandular-pilose at the abaxial surface, or glabrous, adaxial surface glabrous. *Corolla* 5-merous, petals free, obovate, pink to white in color, persistent. *Androecium* 5-staminate, stamens free, filaments white or pink; anthers extrorse, bithecate, tetrasporangiate, with longitudinal dehiscence; pollen released in tetrads, yellow. *Gynoecium* 3–5-merous, syncarpous, ovary superior, unilocular, with parietal placentation, with numerous ovules; styles 3, forked at the base, or 5, entire. *Fruit* a dehiscent capsule, 3–5-valvate, globose or ellipsoid. *Seeds* numerous, ovoid, oblong, ellipsoid, fusiform or rectangular, testa reticulated, foveolated or papillose.

Table 1. *Drosera* species occurring in Brazil, respective occurrences in the Brazilian states divided by the geographic regions and indication if the species is endemic to Brasil.

#	Taxon	North								AL	BA
		AC	AM	AP	PA	RO	RR	TO			
1	<i>D. amazonica</i> Rivadavia, A.Fleischm. & Vicent.		X				X				
2	<i>D. ascendens</i> A.St.-Hil.										
3	<i>D. biflora</i> Willd. ex Roem. & Schult.		X								
4	<i>D. brevifolia</i> Pursh										
5	<i>D. camporupensis</i> Rivadavia										
6	<i>D. capillaris</i> Poir.		X	X			X				
7	<i>D. cayennensis</i> Sagot ex Diels	X	X	X	X	X	X	X			
8	<i>D. chimaera</i> Gonella & Rivadavia										
9	<i>D. chrysolepis</i> Taub.										X
10	<i>D. communis</i> A.St.-Hil.						X	X			X
11	<i>D. esmeraldae</i> (Steyerm.) Maguire & Wurdack		X								
12	<i>D. graminifolia</i> A.St.-Hil.										
13	<i>D. grantsau</i> Rivadavia							X			X
14	<i>D. graomogolensis</i> T.Silva										
15	<i>D. hirtella</i> A.St.-Hil.							X			X
16	<i>D. hirticalyx</i> R.Duno & Culham		X				X				
17	<i>D. intermedia</i> Hayne			X			X				X
18	<i>D. latifolia</i> (Eichler) Gonella & Rivadavia										
19	<i>D. lutescens</i> (A.St.-Hil.) Gonella & Rivadavia										
20	<i>D. magnifica</i> Rivadavia & Gonella										
21	<i>D. montana</i> A.St.-Hil.										X
22	<i>D. quartzicola</i> Rivadavia & Gonella										
23	<i>D. riparia</i> Rivadavia & Gonella										X
24	<i>D. roraimae</i> (Klotzsch ex Diels) Maguire & J.R.Laundon		X				X				
25	<i>D. schwackei</i> (Diels) Rivadavia										
26	<i>D. sessilifolia</i> A.St.-Hil.		X		X		X	X	X	X	X
27	<i>D. spiralis</i> A.St.-Hil.										
28	<i>D. spirocalyx</i> Rivadavia & Gonella										
29	<i>D. tentaculata</i> Rivadavia										X
30	<i>D. tomentosa</i> A.St.-Hil.										X
31	<i>D. villosa</i> A.St.-Hil.										
32	<i>D. viridis</i> Rivadavia										
TOTAL: 32 spp.		1	8	3	2	1	8	5	1	10	

[illegible]

Table 2. Species occurring in South America, respective occurrences in the countries and indication of endemism in the continent.

Species	Brazil	Colombia	Venezuela	Guiana	Suriname
<i>D. amazonica</i>	X		X		
<i>D. arenicola</i> Steyerl.			X		
<i>D. ascendens</i>	X				
<i>D. biflora</i>	X				
<i>D. brevifolia</i>	X				
<i>D. camporupestris</i>	X				
<i>D. capillaris</i>	X		X	X	X
<i>D. cayennensis</i>	X	X	X	X	X
<i>D. cendeensis</i> Tamayo & Croizat			X		
<i>D. chimaera</i>	X				
<i>D. chrysolepis</i>	X				
<i>D. communis</i>	X	X	X		
<i>D. condor</i> Gonella, Rivadavia & A.Fleischm.					
<i>D. esmeraldae</i>	X	X	X		
<i>D. felix</i> Steyerl. & L.B.Sm.			X		
<i>D. graminifolia</i>	X				
<i>D. grantsau</i>	X				
<i>D. graomogolensis</i>	X				
<i>D. hirtella</i>	X				
<i>D. hirticalyx</i>	X		X		
<i>D. intermedia</i>	X		X	X	X
<i>D. kaeteurensis</i> Brumm.-Ding.			X	X	
<i>D. latifolia</i>	X				
<i>D. lutescens</i>	X				
<i>D. magnifica</i>	X				
<i>D. meristocaulis</i> Maguire & Wurdack			X		
<i>D. montana</i>	X				
<i>D. peruensis</i> T.Silva & M.D.Correa					
<i>D. quartzicola</i>	X				
<i>D. riparia</i>	X				
<i>D. roraimae</i>	X		X	X	
<i>D. schwackei</i>	X				
<i>D. sessilifolia</i>	X	X	X	X	
<i>D. solaris</i> A.Fleischm., Wistuba & S.McPherson				X	
<i>D. spiralis</i>	X				
<i>D. spirocalyx</i>	X				
<i>D. tentaculata</i>	X				
<i>D. tomentosa</i>	X				
<i>D. uniflora</i> Willd.					
<i>D. villosa</i>	X				
<i>D. viridis</i>	X				
<i>D. yutajensis</i> R.Duno & Culham			X		
TOTAL: 42 spp.	32 spp.	4 spp.	15 spp.	7 spp.	3 spp.

Table 2. cont.[illegible]

Key to the *Drosera* species occurring in Brazil

Numbers in parentheses before the names of the species indicate its position in the taxonomic treatment.

Note: for this key, when referring to leaf indumentum (glabrous, glandular- and/or eglandular pilose), the carnivorous tentacles and sessile glands should not be considered.

1. Leaves with glandular trichomes only; leaf vernation entire-involute; gynoecium 5-merous, styles 5, undivided **(26) *D. sessilifolia***
- 1'. Leaves glabrous, or with eglandular trichomes only, or with both glandular and eglandular trichomes; leaf vernation of other type; gynoecium 3-merous, styles 3, bifurcated at the base (six stigmatic tips in total) **2**
2. Stipules absent or reduced to two small setae on the margins of the leaf base **(4) *D. brevifolia***
- 2'. Stipules well developed, conspicuous, intrapetiolar **3**
3. Stipules triangular in outline, usually golden-brownish in living plants **4**
- 3'. Stipules rectangular in outline, or deeply divided from the base, usually papery white or red in living plants **9**
4. Leaves sessile, exclusively eglandular-pilose, lamina linear-lanceolate, with circinate-involute vernation **(20) *D. magnifica***
- 4'. Leaves petiolated, both glandular- and eglandular-pilose, lamina linear, lanceolate or narrowly lanceolate, with circinate vernation **5**
5. Leaves and inflorescence parts with stalked glandular trichomes (0.1–0.5 mm long) **(27) *D. spiralis***
- 5'. Leaves and inflorescence parts with sub-sessile globose glandular trichomes (ca. 0.1 mm in diam.) **6**
6. Leaves linear **(12) *D. graminifolia***
- 6'. Leaves of other shapes **7**
7. Petiole and lamina of similar width **(22) *D. quartzicola***

- 7'. Petiole 2 or 3 times narrower than the lamina 8
8. Plants acaulescent (if stem-forming, then internodes not distinguishable); active leaves only 1–3(–5) in number (5) *D. camporupestris*
- 8'. Plants caulescent (internodes conspicuous), 1–46 cm long; active leaves 3–several
..... (9) *D. chrysolepis*
9. Sub-sessile globose glandular trichomes (ca. 0.1 mm in diam.) present on leaves, scapes and sepals (25) *D. schwackei*
- 9'. Leaves exclusively eglandular-pilose or glabrous, glandular trichomes of scape and sepals, if present, stalked and not as above 10
10. Leaves spatulate with petiole narrower and distinct from the lamina; lamina narrow- to broadly obovate or sub-orbicular 11
- 10'. Leaves of other shapes, if spatulate then with petiole indistinct and gradually broadening into the lamina; lamina cuneate, ellipsoid, lanceolate, oblanceolate, oblong or obovate 21
11. Leaves entirely glabrous; petioles 3 times longer than the lamina or longer; seeds with papillose testa, papillae randomly distributed (17) *D. intermedia*
- 11'. Leaves with eglandular hairs present (at least on abaxial surface and/or margins); petioles equal to the lamina in length or up to 2 times longer; seeds with reticulate, foveolate or papillose testa, if papillose then papillae not distributed as above 12
12. Flowers sub-sessile (entire inflorescence shorter than the leaves) and solitary; pedicel erect in flower, but bent down in fruit (1) *D. amazonica*
- 12'. Flowers on a long conspicuous scape (longer than the leaves), inflorescence usually with more than one flower (rarely scapes uniflorous), peduncle erect in flower and in fruit 13
13. Scape with a slight to pronounced curve at the base 14
- 13'. Scape conspicuously erect at the base 18

14. Scapes densely eglandular-pilose in the basal third 15
- 14'. Scapes glabrous at the base, or only sparsely eglandular-pilose 16
15. Scape red; eglandular trichomes of scape red (15) *D. hirtella*
- 15'. Scape yellowish-green; eglandular trichomes of scape white ..(19) *D. lutescens*
16. Plants usually forming a conspicuous erect column of dead leaves; abaxial leaf surface densely eglandular-pilose; seeds ellipsoid to rectangular; only in uplands and highlands of Amazonas and Roraima (24) *D. roraimae*
- 16'. Plants acaulescent (eventually forming etiolated stems when growing in waterlogged places); abaxial leaf surface only sparsely eglandular-pilose (abaxial lamina surface often glabrous); seeds rectangular or fusiform; plants widespread, in Amazonas and Roraima only at lower elevations 17
17. Leaves entirely green or with reddish petiole and greener lamina (even if growing in sunny habitats); seeds rectangular (scapes often with curve not pronounced at the base) (32) *D. viridis*
- 17'. Leaves red (greener only in shaded habitats or if growing waterlogged); seeds fusiform (10) *D. communis*
- 18'. Scapes and sepals exclusively eglandular-pilose or both glandular- and eglandular-pilose; sepals lanceolate (7) *D. cayennensis*
18. Scapes and sepals completely glabrous or, if glandular hairs present, then restricted to the sepals; sepals of other shapes 19
19. Sepals united only at the very base, reflexed in fruit (3) *D. biflora*
19. Sepals united up to half length, erect in fruit 20
20. Pedicels equal to or longer than the sepals; sepals with acute to cuspidate apex; seeds with foveolate testa (11) *D. esmeraldae*
- 20'. Pedicels shorter than the sepals; sepals with rounded apex; seeds with papillose testa (6) *D. capillaris*
21. Lamina oblong, lanceolate, or ellipsoid in outline (apex narrower or of similar width than the base) 22

- 21'. Lamina obovate, oblanceolate, spatulate, or cuneate in outline (apex distinctly broader than the base) **30**
22. Internodes of the stem well-developed, at least as long as the stipules; stems long and slender, flexuose; flower scapes thin and capillary **(13) *D. grantsau***
- 22'. Internodes of the plant very short, leaves rosetted; plants acaulescent or, if with long stem, then plants forming stiff columns covered with dead leaves (except for etiolated plants by growing semi-submerged in water); flower scapes usually robust **23**
- 23'. Petiole shorter than or equal to one third of total leaf length **24**
23. Petiole longer than one third of total leaf length **27**
24. Basal third of scape exclusively eglandular-pilose or glabrous (glandular trichomes, if present, very sparse) **25**
- 24'. Basal third of scape densely glandular-pilose (glandular trichomes, if present, then sparse) **26**
25. Basal third of scape densely eglandular-pilose; seeds ovoid, 0.4 mm long **(8) *D. chimaera***
- 25'. Basal third of scape glabrous, or with sparse eglandular trichomes; seeds fusiform, 0.8–1.0 mm long **(18) *D. latifolia***
26. Plants acaulescent, delicate, root geophyte (dormant in the dry season); leaves decumbent; petiole $\leq 0.5(-1)$ mm wide; styles up to 3 mm long **(21) *D. montana***
- 26'. Plants robust, forming stiff columns of dead leaves, perennial; leaves semi-erect; petiole width ≥ 1.5 mm; styles 4–5 mm long **(14) *D. graomogolensis***
27. Both petiole surfaces densely eglandular-pilose; scapes densely eglandular-pilose on basal third of length **(31) *D. villosa***
- 27'. Abaxial petiole surface glabrescent to densely eglandular-pilose, adaxial surface glabrous to glabrescent; scapes lacking eglandular trichomes or, if present, then very sparse **28**

28. Base of scape arcuately curved (ascending); entire scape densely covered by long (up to 1.8 mm) glandular trichomes decreasing in size towards the apex; seeds ellipsoid(2) *D. ascendens*
- 28'. Base of scape erect; lower half of scape glabrous to glabrescent, glandular trichomes increasing in density towards the apex; seeds fusiform or obconical 29
29. Petiole equal to or longer than the lamina, as well as distinct from it, narrower; seeds obconical; endemic to the Chapada Diamantina, Bahia (23) *D. riparia*
- 29'. Petiole shorter than the lamina, grading into it and of near equal width; seeds fusiform; from South and Southeastern Brazil(18) *D. latifolia*
30. Stipule divided into multiple acicular segments from the base; petals white; plants drying black; from montane elevations in Amazonas and Roraima (16) *D. hirticalyx*
- 30'. Stipule entire up to ca. half length, then divided into multiple lacinate segments, or into 3 segments, the lateral longer and lacinate and the central shorter and fimbriate; petals pink; plants drying brown; from south of the Amazon 31
31. Leaves obovate-cuneate to cuneate, with geniculate vernation; apical tentacles conspicuously distinct, in number of 7–12, 4–9 mm long, with rectangular head
..... (29) *D. tentaculata*
- 31'. Leaves obovate, oblanceolate or oblong-spatulate, with circinate vernation; apical tentacles inconspicuously distinct, up to 5 mm long, with ellipsoid or globose head
..... 32
32. Adaxial petiole surface densely eglandular-pilose; sepals ovate to sub-orbicular with rounded (subobtuse) apex, in bud forming a pyramidal projection at the fusion point between adjacent sepals (28) *D. spirocalyx*
- 32'. Adaxial petiole surface glabrous or only sparsely eglandular-pilose; sepals oblong-ovate to narrowly-ovate with acute apex, not forming pyramidal projections as described above 33

33. Leaves oblong, oblong-spatulate or spatulate; petiole 0.2–0.5(–1) mm wide; glandular trichomes of similar length present throughout the scape; generally flowering from December to March, winter dormant (21) *D. montana*
- 33'. Leaves obovate to oblong-obovate; petiole 0.4–3.0 mm wide; glandular trichomes absent in the basal third of scape, but dense and larger towards the apex; generally flowering from June to September, growing throughout the year
..... (30) *D. tomentosa*

***Drosera* species occurring in Brazil**

Species ordered in alphabetical order

1. *Drosera amazonica* Rivadavia, A.Fleischm. & Vicent. in Rivadavia *et al.* (2009: 13). Figure 1A.

Type:—BRAZIL. AMAZONAS: Rio Cueiras, igarapé de Cachoeira, 15 November 1964, *Rodrigues 6042* (holotype INPA!).

Perennial, column forming, stem short, up to 100 mm long; leaves semi-erect, with geniculate-involute vernation, distinctly petiolated spatulate, lamina spatulate to obovate, adaxial petiole surface glabrous, abaxial leaf surface glabrescent; flowers solitary, sub-sessile, pedicel erect in flower and reflexed in fruit; flowers sweetly perfumed; seeds ovoid to subglobose, testa foveolate.

Illustrations:—Rivadavia *et al.* (2009: 14, fig. 1 – habit and details).

Distribution:—Brazil (North: AM, RR) and Venezuela. In Brazil, it is known from two localities distant ca. 450 km in the northern Amazon Basin. It is here first recorded for Venezuela, however, the old collection from this country presents a vague locality information.

Habitat:—Lowland open habitats in seasonally flooded white quartz sand savannas, around 50 m a.s.l.

Phenology:—Collected with flowers in April, June, November and December.

Conservation status:—Data Deficient (DD). Native to remote areas in the northern Amazon Basin, *D. amazonica* is sub-sampled and may be much more widespread than currently reported. Given the low sampling and the large availability of favorable habitats between the known localities, it is here assumed that there is not enough information about the geographic distribution and population size of this species to

properly evaluate its conservation status, thus, it is here considered as Data Deficient (DD). *Drosera amazonica* occurs inside the Viruá National Park (RR) and Parque Estadual do Rio Negro Setor Sul (AM).

Representative specimens examined:—BRAZIL. AMAZONAS: Manaus, Rio Cuieiras, Igarapé Cachoeira, 16 December 2006, *Rivadavia & Azevedo 2458* (INPA, SPF), *2460* (SPF), *2461* (INPA, SPF); Rio Negro, Rio Cuieiras, Igarapé da Cachoeira, 22 June 1992, *Mori & Gracie 22444* (INPA, NY). RORAIMA: Caracaraí, Parque Nacional do Viruá, 5 December 2006, *Carvalho & Nascimento 1129* (INPA). VENEZUELA. Without further location data, 7 April 1921, *Grisol s.n.* (P-4962855).

2. ***Drosera ascendens*** Saint-Hilaire (1826: 268). Figure 2B, C.

Type:—BRAZIL. MINAS GERAIS: Crescit in sabuletis humidis montium dictorum Serra de Curumatahy, parte boreali provinciae Minas Geraes dicta Distrito dos Diamantes; alt. circiter 3700 ped., September 1817, *Saint-Hilaire B1-1988* (holotype P-578094!, isotypes P-578098!, B!).

Perennial, column forming, stems short, up to 125 mm long; leaves semi-erect, with circinate vernation, lanceolate, abaxial leaf surface densely covered by white eglandular trichomes; petioles only slightly shorter than the lamina, adaxial petiole surface glabrous, margins revolute; scape with curved base (ascending); scape, pedicels and sepals densely covered by long (up to 1.8 mm long) red glandular trichomes, increasing in size and density towards the base of the scape; flowers large, petals ca. 8 mm long; styles ca. 4 mm long; seeds ellipsoid, testa reticulate.

Illustrations:—Gonella *et al.* (2014: 14, fig. 6 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Found in central Minas Gerais state, the species was previously only known from the northern portion of the Diamantina Plateau (Gonella *et al.* 2014), but new records extended its distribution further North along the Espinhaço Range, in the municipalities of Olhos D'Água and Itacambira (A. Peres, pers. comm.).

Habitat:—Wet areas in *campo rupestre* vegetation, in sandy soils, between 730–1300 m a.s.l.

Phenology:—Collected with flowers between July to September.

Conservation status:—Endangered: EN B1ab(iii) + B2ab(iii). *Drosera ascendens* presents a restrict occurrence (EOO=931 km²; AOO=32 km²), and although it can be

found inside the recently created Sempre-Vivas National Park, it is threatened by reduction of habitat quality and habitat loss by cattle farming, invasive grasses and anthropic fires. It was previously considered Data Deficient (DD) by Gonella *et al.* (2014).

Notes:—The name *D. ascendens* was mistakenly adopted by previous works (Rivadavia *et al.* 2003; Rivadavia 2005, 2009) and carnivorous plant enthusiasts to designate the morphologically similar *D. latifolia*. The species was considered a synonym of *D. villosa* by Diels (1906) and all subsequent taxonomic treatments, and only recently re-established by Gonella *et al.* (2014).

Specimens examined:—BRAZIL. MINAS GERAIS: Diamantina, Inhaí, July 2010, Peres Júnior 27 (UB), 05 September 2011, Gonella *et al.* 462 (SPF, BHCB). Buenópolis, Parque Nacional das Sempre Vivas, 04 September 2011, Gonella *et al.* 454 (SPF, BHCB, P, RB), Gonella *et al.* 455 (SPF), Gonella *et al.* 460 (M, MO, RB, SPF), 08 March 2013, Gonella *et al.* 603 (SPF), Gonella *et al.* 607 (SPF), Gonella *et al.* 612 (SPF), 03 September 2014, Gonella *et al.* 734 (SPF), Gonella *et al.* 742 (SPF), Gonella *et al.* 746 (SPF), 04 September 2014, Gonella *et al.* 752 (SPF), Gonella *et al.* 753 (SPF).

3. *Drosera biflora* Willd. ex Roemer & Schultes (1820: 763).

Type:—VENEZUELA. AMAZONAS: in arenosis humidis Rio Atabapo (Orinoco), Humboldt & Bonpland 1100 (holotype B-W06247-010!; isotypes B!, P!).

Supposedly perennial, acaulescent or forming short etiolated stems in aquatic habitats; leaves semi-erect, with geniculate-involute vernation, distinctly petiolated spatulate, adaxial petiole glabrous, abaxial petiole sparsely eglandular-pilose, lamina obovate; stipules divided into several laciniae from near the base; scape erect at the base, glabrous, 15–30 mm long, 1–3(–7) flowered; pedicels usually exceeding half length of the sepals, 1.7–3(–4) mm long; sepals oblong-ellipsoid (narrowly obovate), free (united only at the very base), glabrous or sparsely glandular-pilose mostly at the base, apex rounded (obtuse), reflexed in the fruit, 3–5 x 1.7–2 mm; seeds ovoid, testa foveolate.

Illustrations:—Kunth (1823: Tab. 490, Fig. 1 – habit and details, as *D. pusilla*).

Distribution:—Venezuela and Brazil (North: AM).

Habitat:—Found in wet areas of savanna vegetation, in sandy soils. Data about altitudinal range is not available.

Phenology:—Collected with flowers in March, October and November.

Conservation status:—Data Deficient (DD). *Drosera biflora* grows in remote areas and the most recent collected specimen in Brazil dates from 1987. Based on the scarce available data, it is not possible to properly evaluate its conservation status, and it is, thus, considered as Data Deficient. It is not known to occur inside any protected area.

Discussion:—We here adopt a more strict concept of *D. biflora*, different of that broad circumscription presented by Correa & Silva (2005), which included *D. esmeraldae* under its synonymy. *Drosera biflora*, *D. capillaris* and *D. esmeraldae* present very similar vegetative morphology, and can be mostly distinguished by reproductive characters such as pedicel length, sepals shape and indumentum, as well as seed ornamentation (Table 3). Furthermore, in Brazil, *D. biflora* is also distinct from the other two species by the upright leaves (vs. decumbent). From *D. biflora*, *D. capillaris* is distinguished by the pedicels that are shorter than half sepal length, smaller glabrous sepals and seeds with papillose testa. *Drosera esmeraldae* shares the long pedicels and foveolate seed testa with *D. biflora*, but is easily distinguished by the longer and usually multiple-flowered scapes, and shorter sepals with acute to cuspidate apex.

The sepals reflexed in the fruit constitute a character never cited before for this taxon. It was observed in all fruiting specimens of *D. biflora* and is a good character for distinguishing it from similar species.

Kunth (1823) described *D. pusilla* Kunth in Humboldt *et al.* (1823: 390) based on a different duplicate of the same type specimen of *D. biflora*, and further mention this latter name under its synonymy, rendering *D. pusilla* the status of illegitimate and superfluous name (Art. 52.1; McNeill *et al.* 2012).

Correa & Silva (2005) misspelled the collection number for the type of *D. biflora* (1110 instead of 1100), which is corrected here.

Specimens examined:—BRAZIL. AMAZONAS: Rio Içana, Tunuí, 24 October 1947, Pires 713 (INPA, NY). Igarapé Tibuiari, afluente do rio Uaupés perto do local chamado Monte Cristo e próximo da confluência com o rio Negro, 22 November 1987, Kawazaki 246 (INPA, NY). Prope San Carlos, ad Rio Negro, April/May 1853, Spruce 2997 (K, W).

Additional specimen examined:—VENEZUELA. AMAZONAS: Rio Negro, at base of Cerro Cucuy, 2 March 1944, *Baldwin Jr. 3205* (F, K, NY, P, US).

Table 3. Differences between *D. biflora*, *D. capillaris* and *D. esmeraldae*.

Character/Species	<i>D. biflora</i>	<i>D. capillaris</i>	<i>D. esmeraldae</i>
<i>Pedice</i> l relative to the sepals	Longer than half sepal length	Equal to or shorter than half sepal length	Longer than sepal length
<i>Sepal shape</i>	Oblong-ellipsoid, apex rounded	Ovate, apex rounded	Ovate, apex acute to cuspidate
<i>Sepals in fruit</i>	Reflexed	Erect	Erect
<i>Sepal indumentum</i>	Glabrous or sparsely glandular-pilose mostly towards the base	Glabrous	Glabrous or sparsely glandular-pilose mostly towards the base
<i>Seed testa ornamentation</i>	Foveolate	Papillose, papillae disposed in longitudinal rows	Foveolate

4. ***Drosera brevifolia*** Pursh (1813: 211). Figure 1D–F.

Lectotype (designated by Wood 1966):—USA. GEORGIA, *Eslen s.n.* (PH).

=*Drosera chiapasensis* Matuda (1957: 362–364).

Type:—MEXICO. Chiapas: en orilla de lago, en camino del Rancho de San José del Arco, 22 January 1952, *Rzedowski 729* (holotype MEXU image!; isotype ENCB).

=*Drosera maritima* Saint-Hilaire (1826: 264).

Type:—URUGUAY. Pão de Assucar [Cerro Pan de Azúcar] dans la Provincia Cisplatina, *Saint-Hilaire C2-2153bis* [lectotype P-00749142!, first-step lectotype designated by Correa & Silva (2005: 29), second-step lectotype designated here; isolectotypes P-00749141!, P-00749143!, MPU-012265 image!] —Remaining syntype: BRAZIL. SANTA CATARINA: “Araranguá, sur les confins de prov. de St. Catherine et Rio Grande”, *Saint-Hilaire C2-1804* (P-00749144!).

Supposedly seasonal geophyte perennial or biannual, rosetted, acaulescent; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, lamina broadly obovate to cuneate, snap tentacles (bilaterally symmetrical tentacles) very conspicuous at the leaf apex; both glandular and eglandular trichomes present on leaves; stipules absent or reduced to setae at the margin of the leaf base; scape

erect at the base, glandular-pilose towards apex; seeds ovoid to ellipsoid, testa reticulate.

Illustrations:—Silva & Giuliatti (1997: 103, fig. 14 – habit and details).

Distribution:—*Drosera brevifolia* presents a disjunct distribution in the Americas, occurring in North America in southern and eastern United States and in Mexico; in Central America and Antilles, it occurs in Belize and in Cuba; and, in South America, in Brazil (Northeast: PE, SE; South: PR, RS, SC), in Argentina, and in Uruguay. The species was very recently first recorded for northeastern Brazil, in Sergipe (Carregosa *et al.* 2015), and is here first recorded for Pernambuco.

Habitat:—In southern Brazil, it is found in coastal open areas on sandy soils (*restingas*) at sea level, and in more inland elevated areas in field physiognomies with sandy soil, up to 1200 m. In northeastern Brazil, the species was found in wet areas in the highlands of Serra de Itabaiana (around 220 m a.s.l.), in the state of Sergipe, and over wet rock in an inselberg, around 830 m a.s.l., in Pernambuco state.

Phenology:—*Drosera brevifolia* can be found with flowers from August to April, with a peak between September and November, corresponding to early wet season.

Conservation status:—Least Concern (LC). *Drosera brevifolia* is a widespread species, frequently found in abundant and large populations in its southern range in Brazil, where it can often be found as a ruderal species in disturbed areas. However, its distribution in Northeast Brazil seems to be very restricted to fragile environments, where further data is necessary to evaluate if it can be categorized in some degree of threat locally. It is found inside the Aparados da Serra (RS) and Serra de Itabaiana (SE) National Parks.

Notes:—*Drosera maritima* was described by Saint-Hilaire (1826) based on two different specimens, from different locations (*C2-1804* and *C2-2153bis*). Correa & Silva (2005) designated the specimen *C2-2153* [sic] as the lectotype; however, a close inspection of Saint-Hilaire's field notebook and the specimen's labels revealed that the labels with the location data for the two specimens are switched. According to Saint-Hilaire's notebook, the specimen *C2-1804* was collected in Araranguá (Santa Catarina state, S Brazil), while the specimen *C2-2153bis* (written only "C2-2153" in the specimen's main label, but correctly written in the small labels attached to the plants) was collected in the "Pão de Assucar, prov. Cisplatina [Uruguay]". Finally, many duplicates of the specimen *C2-2153bis* are found at P, making it

necessary to select a single one as the lectotype; we select the specimen to which Saint-Hilaire's handwritten description is attached as the lectotype.

Representative specimens examined:—BRAZIL. PARANÁ: Palmeira, Rio das Pombas, 25 November 2006, *Rivadavia & Rohrbacher 2445* (SPF). PERNAMBUCO: Agrestina, iselbergue Pedra Cabeça de Velho, 832 m, no date, *Gomes et al. 446* (IPA, RB, UFP). SERGIPE: Areia Branca, Serra de Itabaiana, 220 m, 12 October 2007, *Amorim et al. 144* (ASE, RB, UFP). SANTA CATARINA: Laguna, terreno baldio beirando estrada de terra para o norte da cidade, 6 September 2004, *Rivadavia 1857* (SPF). RIO GRANDE DO SUL: São Leopoldo, October 1941, *Leite 541* (NY).

5. *Drosera camporupensis* Rivadavia (2003: 85). Figure 1G–I.

Type:—BRAZIL. MINAS GERAIS: Jaboticatubas, Serra do Cipó, em campos rupestres dentro da Fazenda da Serra do Cipó, 1215 m, 06 July 1995, *Rivadavia-Lopes 447* (holotype SPF!; isotypes K!, NY!, R!, SP!).

Perennial, rosetted, acaulescent; leaves in a lax rosette, active leaves in number of 1–3 (rarely 4 or 5), erect to semi-erect, with circinate vernation, petioles linear, (30–)40–105 mm long, 2–3 times narrower than the lamina, lamina narrowly lanceolate; stipules narrowly triangular, large (9–16 mm long), undivided, bronze-gold colored, apex fimbriate; dense indumentum of long white eglandular trichomes and TSG trichomes on leaves, scapes, pedicels and sepals; narrowly obovate petals that do not overlap when in full anthesis; seeds oblong-fusiform or ellipsoid, testa reticulate.

Illustrations:—Silva & Giulietti (1997: 10, fig. 13B – habit, as *D. chrysolepis*); Rivadavia (2003: 86, fig. 3.1A–F – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Found in the Serra do Cipó and Diamantina Plateau, in the central Espinhaço Range in Minas Gerais state.

Habitat:—Wet areas with sandy soils in *campo rupestre* vegetation, between 1100–1400 m a.s.l.

Phenology:—*Drosera camporupensis* flowers mainly between May to September, which corresponds to the dry season, but flowering specimens were also collected in February.

Conservation Status:—Vulnerable: VU B1ab(iii). The calculated extent of occurrence (EOO=5397.4 km²) would lead to Vulnerable, while the area of

occurrence (AOO=64 km²) would lead to Endangered. It is here chosen to place it in a less severe category of threat due to the occurrence of the species in large populations inside two National Parks (Sempre-Vivas and Serra do Cipó) and at least one State Park (Rio Preto). The species is threatened by habitat destruction for agriculture and cattle farming purposes, and by reduction of habitat quality by invasive grasses and anthropic fires.

Discussion:—The species is closely related to *D. chrysolepis* with which it shares a similar leaf shape and general indumentum, but is easily distinguished by the lack of a conspicuous stem and the fewer leaves per rosette (usually 1–3 vs. 3-numerous). It is further distinguished by the usually longer petioles and leaves, and by the narrowly obovate petals that do not overlap during anthesis (vs. obovate to broadly obovate, overlapping in anthesis). Silva & Giulletti (1997) and Correa & Silva (2005) placed specimens of *D. camporupestris* under *D. chrysolepis*.

Specimens examined:—For an extensive listing, see Rivadavia (2003: 87).

Additional specimens examined:—BRAZIL. MINAS GERAIS: Diamantina, Parque Nacional das Sempre Vivas, 3 March 2013, *Gonella et al. 606* (SPF). Santana do Riacho, Serra do Cipó, km 112-113 da MG-10, 16 May 2008, *Gonella et al. 98* (SPF). Santana do Pirapama, Serra do Cipó, trilha da Senhorinha, 27 Julho 2009, *Zappi & Taylor 2259* (SPF). Serro, Milho Verde, cachoeira do Arco-Íris, 13 January 1998, *Chaves s.n.* (BHCB-42737).

Figure 1. **A**, *Drosera amazonica*. **B**, **C**, *D. ascendens*. **D–F**, *D. brevifolia*. **G–I**, *D. camporupensis*. **J–L**, *D. capillaris*.

6. ***Drosera capillaris*** Poirét (1804: 299). Figure 1J–L.

Type:—USA. Carolina, no date, *M. Bosc s.n.* (holotype P!).

=*Drosera communis* var. *breviscapa* C.Wright ex Grisebach (1866: 12).

Lectotype (designated by Correa & Silva 2005):—CUBA. *C. Wright 1902* (US!; isoelectotypes BM!, G, GH, K!, MO!, NY!).

=*Drosera tenella* Willd. ex Roemer & Schultes (1820: 783).

Type:—VENEZUELA. ANZOÁTEGUI: Caripe, *Bonpland 216* (holotype B! (Herb. Willdenow); isotype B!, P!).

Perennial, rosetted, acaulescent; leaves decumbent, with geniculate-involute veneration, distinctly petiolated spatulate, sparsely eglandular-pilose mostly on abaxial leaf surface and petiole margins, petioles winged, lamina sub-orbicular to obovate; scapes with erect base; scapes, pedicels and sepals glabrous (covered by minute sessile glands only); pedicels very short, usually shorter than half sepals length; sepals ovate, apex rounded, fused up to half length; seeds ovoid, testa papillose, papillae disposed in longitudinal rows.

Illustrations:—Silva & Giuliatti (1997: 97, fig. 11A–I – habit and details).

Distribution:—Widespread in the Americas, this species occurs in North America: in southern United States and Mexico; Central America and Antilles: Belize, Honduras, Costa Rica, Panama, Cuba, Jamaica, Porto Rico, Trinidad & Tobago; South America: Venezuela, Guiana, Suriname, French Guiana, Brazil (North: AM, AP, RR; Southeast: SP; South: PR, RS, SC), and Uruguay. A previous record for Paraguay (Correa & Silva 2005) corresponds to *D. communis* (specimen *Hassler 6807* seen at MO and NY).

Habitat:—In South and Southeast Brazil, it is found in coastal open plain areas in sandy soils (*restingas*) at sea level, while in North Brazil it can be found in lowland open savannas, also in sandy soils. Often found as ruderal in disturbed areas within its range.

Phenology:—Found with flowers year-round.

Conservation status:—Least Concern (LC). *Drosera capillaris* is widespread and common, and also often observed growing in disturbed areas as a ruderal species, being thus asserted as of Least Concern. Found inside the National Parks of Viruá (RR) and Superagui (PR), and the Ilha do Cardoso State Park (São Paulo), and several other protection areas along the SE and S coast.

Discussion:—*Drosera capillaris* presents a wide variation regarding overall plant size, leaf position and length throughout its entire distribution across the Americas. Two main morphotypes can be recognized: one with upright leaves and long petioles, found only in the northern range of the species, in the USA, Central America and Antilles (fitting the type specimen); and another with compact rosettes, with

decumbent leaves and shorter petioles, found more or less throughout the species' range (fitting *D. tenella*). Intermediates between the two morphotypes are often found, however. Nevertheless, in Brazil, the plants from both the northern and southern distribution ranges are somewhat uniform and fit *D. tenella* description and type. Further studies are necessary to evaluate if these two morphotypes represent different taxa or just a single, variable species.

Representative specimens examined:—BRAZIL. AMAPÁ: Oiapoque, Airfield, 25 April 1960, *Egler 1418* (NY). RORAIMA: Pacaraima, km 685 da BR-174, 25 May 2007, *Rivadavia 2563* (SPF). SÃO PAULO: Bertioga, praia de Guaratuba, 5 November 2008, *Gonella 176* (SPF). Cananeia, Ilha Comprida, 15 April 1987, *Falkenberg & Souza 4913* (FLOR). Juréia, 11 October 1988, *Simão-Bianchini 58* (SPF). PARANÁ: Guaratuba, Brajatuba, 26 October 2013, *Barboza 4079* (MBM). Guaraqueçaba, PARNA do Superagui, 16 November 2013, *Brotto et al. 1437* (MBM). SANTA CATARINA: Insel St. Catharina, February 1887, *Ule 603* (US); Florianópolis, 11 September 2004, *Rivadavia 1866* (SPF). RIO GRANDE DO SUL: Butiazal de Tapes, Fazenda São Miguel, 28 November 2011, *Marchi et al. 3249* (HECT, SPF).

7. ***Drosera cayennensis*** Sagot ex Diels (1906: 86). Figure 2A, B.

Type:—FRENCH GUIANA. Bei Cayenne in der Savana, 1859, (Herb. Sagot N° 1228) *Leprieur s.n.* (holotype P-749149!; isotypes B!, K!, P-749150!).

=*Drosera colombiana* A.Fernández (1965: 226).

Type:—COLOMBIA. META: Llanos de San Martín, en sabana, July 1948, *Dryander 3019* (holotype US!; isotype COL fragm. image!).

=*Drosera panamensis* Correa & Taylor (1976: 390).

Type:—PANAMA. VERAGUAS: La Yegunda, Altos de Baltazar y el Veladero, 650 m, 4 August 1976, *Correa et al. 2215* (holotype PMA image!; isotypes CHR, COL image!, DUKE, FI, KI, MEXU image!, MO!, NSW, U image!, US!).

=*Drosera pumilla* E.Santos (1986: 305).

Type:—BRAZIL. MATO GROSSO: Cataqui-lamain, Campos dos Urupás, December 1918, *Kuhlmann 1987* (holotype R!).

=*Drosera sanariapoana* Steyermark (1952: 243).

Type:—VENEZUELA. AMAZONAS: wet savanna, vicinity of Sanariapo, near Río Sanariapo, tributary of Orinoco, 8 September 1944, *Steyermark 58472* (holotype F!).

Seasonal geophyte perennial, rosetted, acaulescent; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, lamina obovate to obovate-cuneate; scape erect at the base, short, 2.5–8.0 cm long, 1–4(–8) flowered, densely to sparsely eglandular-pilose from base to apex, eventually also sparsely glandular-pilose towards the apex; sepals lanceolate, exclusively eglandular-pilose, or both glandular- and eglandular-pilose, the glandular trichomes shorter and sparser than the eglandular, reflexed in the fruit; seeds ovoid, testa foveolate.

Illustrations:—Duno de Stefano (1995: 81, fig. 1h–m – habit and details); Silva & Giulietti (1997: 97, fig. 11J–S – habit and details).

Distribution:—Central-America: Costa Rica, Panamá; South America: Colombia, Venezuela, Guiana, Suriname, French Guiana, Peru, Brazil (North: AC, AM, AP, PA, RO, RR, TO; Center-West: DF, GO, MT), and Bolivia.

The distribution here presented for *D. cayennensis* in Brazil is much broader than previously reported for this species as it was only recorded to the states of Amazonas, Pará and Rondônia (Correa & Silva 2005, Silva 2010). It is here also first reported for Costa Rica.

Habitat:—Found in areas between 0–1600 m a.s.l. growing in sandy and clay soils in seasonally wet areas of savanna in the Cerrado and Amazon Domains, and also in *campo rupestre* vegetation in sandy-clayish soils with quartz gravel.

Phenology:—In Brazil, *D. cayennensis* has been found with flowers between December and March, which corresponds to the wet season. The species is dormant during the dry season, usually from April to September, when its presence is completely imperceptible.

Conservation status:—Least Concern (LC). *Drosera cayennensis* is a widespread species found in large populations across its distribution. The species is, however, threatened by the expansion of the agriculture frontier and habitat transformation for cattle farming. In Brazil, it is protected by the National Parks of the Chapada dos Guimarães (MT), Chapada dos Veadeiros (GO) and Viruá (RR), and the State Park of Xingu (MT).

Discussion:—*Drosera cayennensis* shows a high variability regarding the indumentum of the scape, from densely and exclusively eglandular-pilose to sparsely eglandular-pilose at the base, becoming densely (and sometimes exclusively) glandular-pilose at the apex. Such variability is especially visible in the southern range of this species, in Center-West Brazil (GO, DF, MT), and can be a result of

introgression between this species and *D. lutescens*, and eventually *D. hirtella*. Hybrids between *D. cayennensis* and the two species are common in mixed populations, but it is unknown if these hybrids are fertile.

The inclusion of *D. pumilla* under synonymy of *D. cayennensis* was first suggested by Rivadavia (2005) and further supported by the morphological studies of Rivadavia *et al.* (2014). For the present work, the holotype of *D. pumilla* was analyzed and no difference was observed between this taxon and the exclusively eglandular-pilose (type) morphotype of *D. cayennensis*. In discordance with Correa & Silva (2005), the holotype of *D. pumilla* was found and personally studied (at the year of 2013), making unnecessary the lectotypification of the illustration present in Santos (1986).

Contrary to Fernández (1965) and based on the analysis of the type specimens of both *D. colombiana* and *D. cayennensis*, it was here found that these two taxa share the same scape and sepal indumentum and sepal shape, thus, *D. colombiana* is considered a synonym of *D. cayennensis*.

The record of *D. kaieurensis* to the Viruá National Park by Costa *et al.* (2016) actually represents a misidentified specimen of *D. cayennensis*.

Representative specimens examined:—BRAZIL. ACRE: Cruzeiro do Sul, Estrada Alemanha, 27 May 1971, *Fittkau P13311* (INPA). AMAPÁ: Coastal Region, between Rios Cujubim and Flechal, 8 August 1962, *Pires & Cavalcante 52401* (K, NY). AMAZONAS: “Estrada do Estanho” road to Igarapé Preto, ca. 60 km SE of Transamazon Highway, 2 July 1979, *Calderon et al. 2744* (US). Canutama, BR-319, savanna a 80 km de Porto Velho, 23 March 2013, *Bigio et al. 613* (RON). DISTRITO FEDERAL: Fazenda Água Limpa, divisa com Reserva Ecológica do IBGE, 14 March 2009, *Meneguzzo et al. 84* (UB). GOIÁS: Alto Paraíso de Goiás, limite nordeste do Parque Nacional da Chapada dos Veadeiros, 14 April 1995, *Rivadavia & Ogassavara 384* (SPF). Pirenópolis, lado esquerdo da estrada que sobe a serra para as cachoeiras, 7 January 2001, *Rivadavia 1242* (SPF). MATO GROSSO: Chapada dos Guimarães, nascente ao lado do córrego da Mata Fria, 23 February 1994, *Rivadavia & Cardoso 255* (SPF). São Felix do Araguaia, próximo à cidade, 28 March 2008, *Cardoso 107* (SPF). PARÁ: Vigia, Campina do Palha, 20 January 1950, *Black 50-8639* (US); direita da PA-140, 17 March 2001, *Rivadavia 1247* (SPF). RONDÔNIA: Basin of Rio Madeira, Margin of Mutumparaná airstrip, 25 November 1968, *Prance et al. 8860* (INPA, K, NY, US). RORAIMA: Boa Vista, lado leste do km 570 da BR-174, 27 May 2007, *Rivadavia 2583* (SPF). Caracarái, PARNA Viruá, 23

July 2010, *Barbosa 1284* (INPA, UEC). TOCANTINS: Mateiros, APA Jalapão, 11 June 2006, *Rivadavia 2192* (SPF).

Additional specimen examined:—COSTA RICA. SAN JOSÉ: Turrubares, Cuenca del Tárcoles, 10 October 2009, *Hammel et al. 25428* (MO).

Specimens examined (*D. cayennensis* × *D. hirtella*):—BRAZIL. GOIÁS: Cristalina, norte da BR-40, 24 April 2010, *Gonella et al. 301* (SPF), *Gonella et al. 305* (SPF).

8. ***Drosera chimaera*** Gonella & Rivadavia in Gonella *et al.* (2014: 34). Figure 2C.

Type:—BRAZIL. MINAS GERAIS: Cristália, em afloramento de arenito ao lado de banco de areia na margem direita do Rio Itacambiruçu, 695 m alt., 07 September 2011, *Gonella et al. 500* (holotype SPF!; isotypes BHCBI, P!, RBI!).

Perennial, rosetted, acaulescent; leaves semi-erect, with circinate vernation, narrowly to broadly oblong-lanceolate, petioles much shorter than the lamina (less than 1/3 of leaf length), adaxial petiole surface glabrous, abaxial leaf surface sparsely eglandular-pilose; scape erect at the base and densely eglandular-pilose (especially on basal third), becoming densely glandular-pilose towards apex, often bifurcating, bearing small flowers (petals up to 6 mm long); seeds ovoid, 0.4 × 0.2 mm, testa reticulate.

Illustrations:—Gonella *et al.* (2014: 36, fig. 16 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Restricted to the northern portion of the Espinhaço Range in Minas Gerais, in the municipalities of Grão-Mogol and Cristália.

Habitat:—Sandy soils or cracks on sandstone at river margins, sometimes shaded by riparian vegetation, around 700 m a.s.l.

Phenology:—Found with flowers in July, September and October.

Conservation status:—Endangered: EN B1a, b(iii) + B2a, b(iii). With an estimated EOO of 2.4 km² and AOO of 8km², the occurrence range completely out of any protected area and the fragile habitat that is highly susceptible to disturbance, *D. chimaera* is here considered Endangered. The species is known only from three or four small populations that are highly susceptible to habitat changes due to deforestation for charcoal and sand removal for construction.

Discussion:—Sterile rosettes of *D. chimaera* are reminiscent of small-sized *D.*

latifolia, but are readily distinguished when fertile by the scape densely eglandular-pilose at the basal half and by the smaller ovoid seeds. Inflorescence indumentum, flower morphology and seed shape are very similar to those of *D. tomentosa* var. *tomentosa*, but *D. chimaera* is easily distinguished by the longer narrowly to broadly oblong-lanceolate semi-erect leaves (see Gonella *et al.* 2014).

Specimens examined:—BRAZIL. MINAS GERAIS: Cristália, margem direita do Rio Itacambiruçu (type location), July 2010, *Peres Júnior 26* (UB), 12 August 2010, *Gonella 359* (SPF). Grão Mogol, Serra de Grão-Mogol, August 1960, *Mendes Magalhães 18091* (UB); estrada para Francisco Sá, 15 October 1988, *Harley et al. 25067* (K, SPF); Capim Puba, 727 m alt, 13 August 2010, *Gonella 360* (SPF), 07 Sep 2011, *Gonella et al. 489* (BHCB, RB, SPF).

9. ***Drosera chrysolepis*** Taubert (1893: 505). Figure 2D, E.

Lectotype (here designated):—BRAZIL. MINAS GERAIS: Serra do Cipó, 1891/92, *Glaziou 18857* (B!; isoelectotypes K!, P!).

Perennial, caulescent, stem conspicuous (1 to 46 cm in length) with distinct internodes; active growing leaves few to numerous (3–13), with circinate vernation, petiole linear, 2–3 times narrower than the lamina, lamina lanceolate; stipules triangular to narrowly triangular, divided into few to several laciniae on the apical 1/2–1/3, bronze-gold, often with white margins; dense indumentum of long white eglandular trichomes and TSG trichomes on leaves, scapes, pedicels and sepals; petals obovate to broadly obovate, pink, overlapping in anthesis; seeds oblong, testa reticulate.

Illustrations:—Silva & Giulietti (1997: 101, fig. 13A, C–M – habit and details); Rivadavia (2003: 86, fig. 3.2A–F – habit and details).

Distribution:—Brazil (Northeast: BA; Southeast: MG), endemic. Found in the *campos rupestres* of the Espinhaço Range from the municipality of Caeté (central Minas Gerais) to the Chapada Diamantina (in Bahia), and disjunctly on coastal sandy plains (*restingas*) in central coastal Bahia.

Habitat:—In the Espinhaço Range it is found in wet areas of *campo rupestre* vegetation on sandy to peat-sandy soils, or on drier areas in sandy soil with white quartz gravel, at elevations around 1200–1800 m. At the coastal *restingas* it is found just a few meter above sea level on wet sandy plain areas.

Phenology:—*Drosera chrysolepis* produces flowers from April to September, corresponding to the end of the wet season and middle of the dry season.

Conservation status:—Least Concern (LC). *Drosera chrysolepis* is widely distributed, and, although relatively uncommon along its range, it is protected by National Parks (Chapada Diamantina and Serra do Cipó) and State Parks (Rio Preto and Serra Nova), among other protection areas, being here considered as of Least Concern.

Discussion:—Previous records of *D. chrysolepis* from Ecuador and Peru (Correa & Silva 2005), and assigned as possibly being *D. camporupestris* by Rivadavia (2003), turned out to be a new species, *D. condor* Gonella *et al.* (2016: 1421), closely related to the Venezuelan *D. cendeensis* Tamayo & Croizat (1949: 175) and the Peruvian *D. peruensis* Silva & Correa (2002: 543) (Gonella *et al.* 2016).

Drosera chrysolepis was described by Taubert (1893) based on the specimen *Glaziou 18857* from the Serra do Cipó, but the author did not cite the herbarium where this material was analyzed, which configures all known duplicates of this specimen as syntypes. Silva & Giulietti (1997) cite the specimen deposited at K as an isotype, and Correa & Silva (2005) cite the specimen from P as the holotype. According to the International Code of Nomenclature, Arts. 9.9 and 9.23 (McNeill *et al.* 2012), the name is not correctly typified, and a lectotype must be designated. Of the three syntypes, the only specimen personally annotated by Taubert is the one held at B, thus, it is here designated as the lectotype.

Representative specimens examined:—BRAZIL. BAHIA: Abaíra, Cachoeira das Anáguas, 1600 m, 24 February 1992, *Stannard et al. H 51558* (SPF, NY, MBM, SP). Ituberá, km 15 da Estrada para a Praia de Pratigi, 8 October 2005, *Rivadavia 2112* (SPF). MINAS GERAIS: Itacambira, estrada para Montes Claros (MG 308), 1314 m, 22 April 2010, *Gonella et al. 288* (SPF). Rio Pardo de Minas, Parque Estadual da Serra Nova, 13 March 2007, *Salino et al. 11740* (BHCB). Santana do Pirapama, Serra do Cipó, Fazenda Inhame (Serra Mineira), 23 March 1982, *Cordeiro et al. CFSC 8185* (SP, SPF). Santana do Riacho, Serra do Cipó, bifurcação da Estrada para Morro do Pilar e Conceição do Mato Dentro, 25 February 1997, *Rivadavia & Pinheiro 558* (SPF).

Figure 2. A, B, *Drosera cayennensis*. C, *D. chimaera*. D, E, *D. chrysolepis*. F-K, *D. communis*.

10. ***Drosera communis*** Saint-Hilaire (1824: t. XV(1)). Figure 2F–K.

Lectotype (designated by Correa & Silva 2005):—BRAZIL. SÃO PAULO: “Mogy das Cruzes” [Mogi das Cruzes], *Saint-Hilaire D-722bis* (P-00631824!). —Remaining syntypes: BRAZIL. MINAS GERAIS: “Marais pres Capueirinha”, *Saint-Hilaire D-414* (P-00631821!, P-00631823*partel* [mixed with *Saint-Hilaire 695*], MPU-011030 image!). “Marais pres S. Miguel de Mato Dentro”, *Saint-Hilaire B1-695* (P-00631822!,

P-00635417!). “Marais dans le prov. de Minas et de St. Paul”, *Saint-Hilaire s.n.* (B-10 0272050!, K-000432545!).

=*Drosera communis* var. *alba* Hoehne (1915: 28, t. 124, f. 3).

Lectotype (designated by Correa & Silva 2005):—BRAZIL. MATO GROSSO DO SUL: Coxim, June 1911, *Hoehne 3358* (SP!; isoelectotypes R!, US!).

=*Drosera intermedia* var. *americana* Willdenow (1809: 340) De Candolle (1824: 318) *sensu* Eichler (1872), *pro parte*.

=*Drosera intermedia* var. *tenuis* Eichl. in Martius & Eichler (1872: 392).

Neotype (here designated):—BRAZIL. SÃO PAULO: Itirapina, Morro Pellado, January 1901, *Edwall 697* (SP!).

=*Drosera parvifolia* Saint-Hilaire (1826: 263).

Type:—BRAZIL. MINAS GERAIS: São João del Rey, *Saint-Hilaire D-377* (holotype P-00749170!; isotype P-00706171!).

=*Drosera montana* f. *parviflora* Chodat (1903: 539).

Type:—PARAGUAY. Iter ad “Yerbales” montium “Sierra de Maracayú”, November, *Hassler 5271* (holotype G; isotypes BM-590380!, K *partel*!, P-749152!, P-749153!, UC!).

Perennial, rosetted, acaulescent or forming etiolated stems when growing semi-aquatically; leaves semi-erect or decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, red to reddish (greenish when growing in shaded or waterlogged habitats), petioles narrow, abruptly broadening into the broadly to narrowly obovate to sub-orbicular lamina, petioles sparsely eglandular pilose on the abaxial surface and glabrous to glabrescent on the adaxial surface; stipules rectangular in outline, divided into several laciniae from the base; scapes arcuately curved at the base, base glabrous to very sparsely eglandular-pilose; sepals usually exclusively glandular-pilose, but rarely with sparse eglandular trichomes; seeds fusiform, testa reticulate.

Illustrations:—Hoehne (1915: t. 124, fig. 3 – habit and details, as *D. communis* var. *alba*); Rivadavia (2003: 89, fig. 4.2A-E, 4.1F, G – habit and details).

Distribution:—Colombia, Venezuela, Brazil (North: RR, TO; Northeast: BA, PB, PE, RN; Center-West: DF, GO, MS, MT; Southeast: MG, RJ, SP; South: PR, RS, SC), Bolivia, Paraguay, and Argentina.

Habitat:—*Drosera communis* can be found in a wide range of habitats and soil types. In the Cerrado and Amazônia domains it is found in savannic vegetations in year-round wet areas among sparse to dense grasses in sandy soils, such as the in the *veredas*. In the Cerrado, it is also found in perennially wet areas of *campos rupestres* vegetation. In the Mata Atlântica domain, it is found in highland field vegetations in wet areas in sandy and clayish soils, often in disturbed areas such as road and trail sides. It can also be found at sea level in *restinga* vegetation in NE Brazil. Found between 0–1500 m a.s.l.

Phenology:—Found with flowers year-round.

Conservation status:—Least Concern (LC). *Drosera communis* is one of the most widespread and common *Drosera* species across South America, being assigned as of Least Concern. In Brazil, it is protected by several National Parks (Brasília, Chapada dos Guimarães, Chapada dos Veadeiros, Emas, Sempre-Vivas, and Serra do Cipó), State Parks (Biri-Biri, Pirineus, Rio Preto, Serra Nova, Serra do Cabral), and other protected areas.

Discussion:—*Drosera communis* presents some morphological variation across its wide distributional range, mostly regarding leaf shape, pilosity and position, but also in the pilosity of the scape. Several characteristics, however, were commonly observed varying inside populations, such as size, color, shape, pilosity and position of the leaves, as well as flower color (from white to pink), all of which may be mostly associated with habitat gradients, such as water availability and luminosity. That way, *D. communis* is here interpreted as a variable and plastic species, as it would be expected for such a widely distributed species.

Neither the type specimen of *D. intermedia* var. *tenuis* [SÃO PAULO: in humidis ad Batataes, June, *Riedel s.n.*] nor any duplicates of the type collection could be located in any of the visited or contacted herbaria, including the collections where most of Riedel's collections were sent to (e.g. BM, LE, R). However, based on the original description [slender than the type, leaves smaller, petioles ciliate-pubescent and scape sub-flexuose (curved)] and geographic distribution (Batatais, SP) provided by Eichler (1872), this taxon is undoubtedly conspecific with *D. communis*, the only species from that area that fits the description. The only other species known to occur in the same area are *D. lutescens* (easily distinguishable by the densely eglandular-pilose scapes) and *D. grantsau* (caulescent, with oblong leaves and scapes with erect base). Since no original material is known, a neotype is

to be designated. We selected a specimen from the same region and fitting the description as the neotype.

Drosera intermedia var. *americana* was described by De Candolle (1824; as *D. americana*) based on American specimens of *D. intermedia*, a species originally described from Europe. However, in the treatment for the *Flora Brasiliensis*, Eichler (1872) expanded its circumscription and included some specimens here identified as *D. communis* (e.g. *Martius* 476) under this name. Furthermore, the illustration plate of this taxon includes drawings of both *D. communis* and *D. intermedia*. In Tab. 90, figure II, the habit in the left and flower parts (2, 2II, and 4) clearly represent *D. communis* due to characteristics such as the long scapes with larger flowers and glandular calyx, while the habit in the right and seed drawings represent *D. intermedia* (glabrous calyx and ovoid seeds with papillose testa).

The type specimens of *D. parvifolia* represent dwarfed individuals of *D. communis* (Rivadavia *et al.* 2014). Such difference in the plant size could be explained by the fact that these plants were found growing in clayish soil (*Saint-Hilaire* D-377 specimen's label), but could also be linked to hydric stress. This taxon has been historically associated with *D. montana* (Diels 1906, Correa & Silva 2005) possibly due to the presence of eglandular hairs at the base of the scape (a character present in the holotype of *D. parvifolia*, but not in the isotype). Such feature was found to be somewhat common among *D. communis*, and can even be found in some of the individuals in the remaining syntypes (but not in the lectotype).

Drosera communis is known to form natural hybrids with *D. hirtella* and *D. lutescens* when growing sympatrically, the hybrids presenting intermediate leaf shape and position, as well as the eglandular hairs on the scape with the same color as those of the parent species, red (*D. hirtella*) or white (*D. lutescens*). The hybrid population is always smaller than the parent species and is unknown if it is fertile. Introgression with *D. lutescens* may explain the presence of eglandular hairs in the scape in some *D. communis* populations (including *D. parvifolia*) in areas where the distribution of both species overlaps.

Representative specimens examined:—BRAZIL. BAHIA: Abaíra, Catolés, 26 July 1995, *Rivadavia-Lopes* 478 (SPF). Camaçari, Estrada Salvador-Camaçari-Dias D'Ávila. 14 August 2003, *Rivadavia* 1690 (SPF). DISTRITO FEDERAL: Planaltina, Estação Ecológica de Águas Emendadas, 20 February 2009, *Meneguzzo & Somavilla* 122 (UB). GOIÁS: Chapada dos Veadeiros, 14 February 1966, *Irwin et al.* 12792 (NY, UB). MATO GROSSO: Nova Xavantina, Fazenda Brasil, 28 March 1997,

Árbocz et al. 3711 (ESA, MT). MATO GROSSO DO SUL: Costa Rica, Estrada para Alcinópolis, 28 October 2001, *Rivadavia-Lopes* 1304 (SPF). MINAS GERAIS: Moeda, Serra da Moeda, 8 March 2007, *Batista* 1988 (BHCB). Prata, ao longo da BR-153, 4 March 2006, *Rivadavia & Demets* 2154 (SPF). Santa Rita de Jacutinga, cachoeira às margens da BR-494, 26 December 2009, *Gonella et al.* 251 (SPF). PARAÍBA: Km 78 estr. Recife-João Pessoa, 30 June 1967, *Lima* 67-5049 (IPA). PARANÁ: Ponta Grossa, 26 December 1984, *Krieger* 20043 (CESJ, SPF). PERNAMBUCO: Goiana, January 1988, *Pereira s.n.* (IPA-49830). RIO DE JANEIRO: Nova Friburgo, início da Estrada para Macaé de Cima, 20 January 2007, *Rivadavia et al.* 2465 (SPF). RIO GRANDE DO NORTE: Rio do Fogo, Lagoa da Cotia, 11 October 2015, *Garcia & Gonçalves* 52 (UFRN). RIO GRANDE DO SUL: Caxias do Sul, Fazenda Pedro Hoffmann, 15 December 2012, *Grizzon* 119 (FLOR, HUCCS). RORAIMA: Pacaraima, BR-174, 26 May 2007, *Rivadavia* 2573 (SPF). Rio Branco, Surumu, September 1909, *Ule* 8392 (K). SÃO PAULO: São Paulo, Parelheiros, 11 February 2006, *Rivadavia & Miranda* 2145 (SPF); in paludosis ad S. Paulo, December, *Martius* 476 (M). SANTA CATARINA: Alfredo Wagner, km 111 da rodovia BR-282, 27 April 2007, *Rivadavia* 2505 (SPF). TOCANTINS: Mateiros, margem esquerda do Rio Novo, 8 May 2001, *Proença et al.* 2521 (UB).

Specimen examined (*D. communis* × *D. hirtella*):—BRAZIL. GOIÁS: Cavalcante, PARNA Chapada dos Veadeiros, 26 February 2014, *Gonella & Andrino* 657 (SPF).

11. ***Drosera esmeraldae*** (Steyermark 1952: 244) Maguire & Wurdack (1957: 335).

Figure 3A, B.

≡ *Drosera tenella* var. *esmeraldae* Steyermark.

Type:—VENEZUELA. AMAZONAS: between Esmeralda Savanna & SE base of Cerro Duida, 22 August 1944, *Steyermark* 57850 (holotype F!; isotypes NY!, US!, VEN).

Perennial, rosetted, acaulescent or forming short columns densely covered by remains of dead leaves; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, petiole abruptly broadening into lamina, lamina obovate to sub-orbicular; scape erect at the base, glabrous, (3–)7–15 cm long, (2–)4–12 flowered; pedicels about the same length as the sepals or longer (always longer than half sepal length), 2–4(–6) mm long; sepals 2.5–4.5 mm long, ovate,

apex acute to cuspidate, glabrous or sparsely to densely glandular-pilose, mostly at the base; seeds ovoid, testa foveolate.

Illustrations: Duno de Stefano (1995: 84, fig. 2a–f); Duno de Stefano & Culham (1998: 701, fig. 555 – habit and leaf).

Distribution:—Colombia, Venezuela, and Brazil (North: AM).

Habitat:—Lowland savanna and highland rock outcrops in sandy soils or cracks of sandstone in wet areas, between 80–1700 m a.s.l.

Phenology:—Collected with flowers in January, February, July and August.

Conservation status:—Least Concern (LC). *Drosera esmeraldae* is widespread in a relatively remote and conserved area. In Brazil, it is found inside the Serra do Aracá State Park (AM).

Discussion:—*Drosera esmeraldae* is here considered distinct from *D. biflora* based on sepal morphology (Table 3).

The species is reminiscent of *D. roraimae*, but easily distinguished by the acaulescent habit, the decumbent leaves, the overall smaller size and the ovoid seeds with foveolate testa (vs. ellipsoid to rectangular, with reticulate testa). Introgression between the two species may occur in areas where both are sympatric, resulting in plants with intermediate features (such as the specimen *Rivadavia et al.* 784, below).

Specimens examined:—BRAZIL. AMAZONAS: Barcelos, Serra do Aracá, platô, 28 August 2011, *Vicentini et al.* 1899 (INPA, MO); margin of Rio Aracá near Serrinha, 25 July 1985, *Prance et al.* 29800 (INPA, MO, NY); alto da Serra do Aracá, 14 January 1999, *Rivadavia et al.* 784 (SPF). Plateau of northern massif of Serra Aracá, South side of North Mountain, 12 February 1984, *Prance et al.* 28997 (NY). Summit of Central Massif of Serra Aracá, 16 July 1985, *Prance & Guedes* 29604 (K, NY, US). Without attribution to administrative area, quadrante K6, na saída da trilha acampamento-campina, 3 September 1998, *Vicentini et al.* 1371 (INPA, SPF).

12. ***Drosera graminifolia*** Saint-Hilaire (1826: 269). Figure 3C.

Type:—BRAZIL. MINAS GERAIS: Crescit in summis montibus dictis Serra-da-Caraça, alt. circiter 6000 ped., February, *Saint-Hilaire* B1-448 (holotype P!).

=*Drosera graminifolia* var. *major* Eichler in Martius & Eichler (1872: 396).

Type:—BRAZIL. MINAS GERAIS: Serra do Caraça, December 1830, *Sellow* 1300 (holotype B!; isotype K!).

Perennial, rosetted, acaulescent or forming short columns up to 6(–15) cm long; leaves erect to semi-erect, with regular circinate vernation, linear, petioles 30–45(–50) × 1.5–2.4 mm; stipules 7–14 × 6.5–10 mm, triangular, bronze-gold in color; glandular trichomes of the TSG type and eglandular hairs present on leaves, scapes, pedicels and sepals; seeds oblong-fusiform 0.65–0.80 × 0.2 mm, testa reticulate.

Illustrations:—Saint-Hilaire (1826; t. XXV – habit); Gonella *et al.* (2012: 46, fig. 2 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Restricted to the high-montane areas around the summit of the four highest peaks of the Serra do Caraça (Canjerana, Carapuça, Inficionado and Sol), in the southern portion of the Espinhaço Range in Minas Gerais.

Habitat:—Sandy soils or islands of vegetation over sandstone in high-montane areas in a vegetation intermediate between *campos rupestres* and *campos de altitude*. Found between 1700–1950 m a.s.l.

Phenology:—Found with flowers between January to April, with a second minor flowering period in September.

Conservation status:—Critically Endangered: CR B1b(iii)c(iv). Gonella *et al.* (2012) asserted this species as Critically Endangered, based on the restrict occurrence (EOO=17.6 km²), the observed decline in the know populations during the last decades probably due to pollution from mining activities around the Serra do Caraça, and also the threat caused by invasive grasses in the very fragile habitats occupied by this species. Found inside the protection area of the RPPN Santuário do Caraça.

Specimens examined:—For an extensive listing, see Gonella *et al.* (2012: 49).

Additional specimens examined:—BRAZIL. MINAS GERAIS: Santa Bárbara, Parque Natural do Caraça, 05 March 1992, *Rivadavia 122* (K, SPF). Environs de Rio de Janeiro et d'Ouro Preto, 1883-84, *Glaziov 14485* (K).

Figure 3. A, B, *Drosera esmeraldae*. C, *D. graminifolia*. D-F, *D. grantsauí*. G, H, *D. graomogolensis*.

13. ***Drosera grantsauí*** Rivadavia (2003: 82). Figure 3 D–F.

Type:—BRAZIL. MINAS GERAIS: Grão-Mogol, morro do Jambreiro, nascente brejosa na base do morro, c. 7 km da cidade pela estrada para Montes Claros, 700 m alt., 8 September 1994, *Rivadavia 299* (holotype SPF!; isotypes K!, MBM!).

Perennial, caulescent, stem developed with conspicuous internodes, delicate, erect or supporting in the surrounding vegetation, 1–28 cm long; leaves semi-erect, with circinate vernation, petiole distinct, narrower than the lamina and about the same length, lamina oblong to narrowly oblong-spatulate; stipules rectangular, the upper

half divided into several laciniae; scape slender, with erect base, delicate, glabrescent; sepals glandular-pilose; seeds fusiform, testa reticulate, translucent golden-brown.

Illustrations:—Silva (1994: 82, fig. 15N – leaf as *D. communis*); Rivadavia (2003: 80, fig. 2 – habit and details).

Distribution:—Brazil (North: TO; Northeast: BA; Center-West: DF, GO, MS, MT; Southeast: MG, SP; South: PR, SC) and Paraguay (Caaguazu). It is here first recorded to Santa Catarina state, the southernmost record of the species.

Habitat:—*Drosera grantsau* can be found growing in sandy soils in humid areas of *cerrado* vegetation, such as the *veredas*, and along river margins, usually among tall and somewhat dense grasses, but also in more open areas. In the *campos rupestres* (BA, GO, and MG) and in the *campos gerais* (PR and SC) vegetation types, the species grows on year-round wet springs in sandy soil. Found between 600–1600 m a.s.l.

Phenology:—*Drosera grantsau* seems to have no defined flowering season, being found with flowers and fruits year-round. However, a flowering peak can be observed in the end of the dry season, between August and November as reported by Rivadavia (2003).

Conservation status:—Least Concern (LC). *Drosera grantsau* is widely distributed and protected by several National Parks, being considered as of Least Concern. Found inside the Serra do Cipó, Sempre-Vivas, Serra da Canastra, Emas, Chapada dos Veadeiros National Parks.

Discussion:—*Drosera grantsau* was described by Rivadavia (2003), where is presented a very complete treatment, distinguishing it from *D. communis*. Nevertheless, Silva (2007) argues that Rivadavia (2003) states that the presence of a developed stem in *D. grantsau* is the only difference between the two taxa, and places this species under the synonymy of *D. communis*. Indeed, one of the diagnostic characters of *D. grantsau* is the short to long aerial stem 1–28 cm long, but the species can be promptly distinguished from *D. communis* by several other characters indicated on Table 4, most already cited by Rivadavia (2003).

Drosera grantsau often hybridizes with *D. tomentosa* in areas where both species are found sympatric, forming the hybrid *D. × fontinalis* Rivadavia (2009: 121; more under this nothotaxon below).

Specimens examined:—For an extensive listing, see Rivadavia (2003: 84–85).

Additional specimens examined:—BRAZIL. Location not indicated: *Sellow 128* (B). TOCANTINS: Ponte Alta, Jalapão, 17 June 2006, *Rivadavia 2262* (SPF). BAHIA: Piatã, alto da serra, 29 April 2010, *Gonella & Fleischmann 331* (SPF). DISTRITO FEDERAL: Brasília, Parque Municipal do Gama, 03 September 1964, *Irwin & Soderstrom 5900* (MO, NY, UB). GOIÁS: Alto Paraíso de Goiás, Chapada dos Veadeiros, 23 June 2007, *Rivadavia & Batista 2624* (SPF). MATO GROSSO: Chapada dos Guimarães, 29 April, 1995, *Rivadavia & Cardoso 422* (SPF). Vila Bela da Santíssima Trindade, Chapada dos Parecis, 27 July 1986, *Emmerich et al. 6044* (R). MATO GROSSO DO SUL: Costa Rica, salto da Rapadura, 28 October 2001, *Rivadavia 1300* (SPF). MINAS GERAIS: Diamantina, estrada para a Gruta do Salitre, 13 May 2007, *Rivadavia 2539* (SPF). Itacambira, km 91 da estrada para Montes Claros, 22 April 2010, *Gonella et al. 289* (SPF). Joaquim Felício, estrada da ‘Serra do Cabral Agro Indústria S.A.’ entre Joaquim Felício e Francisco Dumont, 3 July 2003, *Rivadavia 1665* (SPF). SÃO PAULO: Itararé, estrada Itararé-Itapeva (SP-258), Rio Verde, 24 April 1995, *Rivadavia 418* (SPF). São Paulo, Butantan, 03 October 1917, *Hoehne 660* (SP). PARANÁ: Jaguariaíva, estrada Ponta Grossa-Sengés (PR-151), Rio Cajuru, 24 April 1995, *Rivadavia 410* (SPF). SANTA CATARINA: Campo Alegre, Serra do Quiriri, 20 May 2016, *Dolsan 43* (RB).

Table 4. Diagnostic characters distinguishing *D. communis* and *D. grantsau*.

Character/Species	<i>D. communis</i>	<i>D. grantsau</i>
<i>Aerial stem</i>	Absent	Present, 1–28 cm long
<i>Leaf lamina shape</i>	Broadly to narrowly obovate to sub-orbicular	Oblong to narrowly oblong-spatulate
<i>Leaf vernation</i>	Geniculate-involute	Circinate
<i>Stipule division</i>	Divided into several laciniae from the base	Lower half fused, upper half divided into several laciniae
<i>Base of the scape</i>	Arcuately curved	Erect
<i>Chromosome number (from Rivadavia 2005)</i>	$2n=x=20$	$2n=2x=40$

14. ***Drosera graomogolensis*** T.Silva (1997: 85). Figure 3G, H.

Type:—BRAZIL. MINAS GERAIS: Grão-Mogol, Córrego da Bonita, subida para o Morro Jambreiro, 800 m, 07 September 1990, *Silva et al. CFCR 13506* (holotype SPF!; isotype RB!).

Perennial, robust, rosetted, column forming, stems up to 27 cm long, densely covered by remains of dead leaves; leaves semi-erect, with circinate vernation, lanceolate to oblong-lanceolate, petioles much shorter than the lamina (lamina 2.5 to 5 times longer than petiole), adaxial petiole surface glabrous, abaxial leaf surface densely eglandular-pilose; scape erect (slightly curved) at the base, densely glandular-pilose from base to apex, trichomes short, up to 0.4(–0.5) mm long; flowers large (petals 7.5–11 mm long) with long styles (4–4.5 mm long); seeds oblong-ovoid to ellipsoid, 0.5–0.6 mm long, testa reticulate.

Illustrations:—Silva (1997: 86, fig. 1 – habit and details); Gonella *et al.* (2014: 18, fig. 8 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Restricted to the Espinhaço Range in northern Minas Gerais state, in the municipalities of Grão-Mogol, Botumirim and Itacambira.

Habitat:—Sandy soils in seasonally wet areas of *cerrado* vegetation, including *campos rupestres* vegetation, usually around the edges of seasonal springs in sandy soil with coarse quartz gravel, shallow sand overlying rocks, and in cracks of quartzite. It can also be found along the margins of perennial rivers and perennially boggy areas, where it forms large and dense populations. Found between 700–1420 m a.s.l.

Phenology:—Found with flowers from July to October.

Conservation status:—Endangered: EN B1ab(iii) + B2ab(iii). Both measurements of occurrence (EOO=1137.9 km², AOO=60 km²) indicate towards the placement of this species in this category of threat, in accordance with Silva *et al.* (2013). Although found inside the Grão-Mogol State Park, *D. graomogolensis* is widely threatened by habitat destruction for agriculture and cattle farming purposes and invasive grasses.

Discussion:—The species was previously considered endemic to Grão-Mogol (Silva 1997, Silva *et al.* 2013), but in the revision of Gonella *et al.* (2014) it was found to be more widespread, also occurring further south in the municipalities of Botumirim and Itacambira.

Specimens examined:—For a complete list, see Gonella *et al.* (2014: 20–21).

15. ***Drosera hirtella*** Saint-Hilaire (1826: 262). Figure 4A–F.

Lectotype (designated here):—BRAZIL. MINAS GERAIS: Marais desséchés près Formigas, Certao Cap de Mines et dans la Serra dos Pyrineos Cap de Goyaz, *Saint-Hilaire B1-1762bis* (P-749158, second specimen from right to left).

≡ *D. montana* var. *hirtella* (A.St.-Hil.) Diels (1906: 89).

Seasonal geophyte perennial, rosetted, acaulescent; roots succulent, sometimes tuberous; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, lamina obovate to round-obovate, red (greenish in shaded environments); scapes arcuately curved (often decumbent and ascending out of the rosette) at the base, red in color (greenish in shaded environments), densely eglandular-pilose on the basal half, reducing in density towards apex, eglandular trichomes red, 1–2 mm long, scape becoming densely glandular-pilose towards the apical half; sepals exclusively glandular-pilose or also with sparse eglandular hairs; seeds ovoid, testa reticulate.

Illustrations:—Here, Figure 5A–E.

Distribution:—Brazil (North: TO; Northeast: BA; Center-West: DF, GO; Southeast: MG), endemic. *Drosera hirtella* occurs in two main disjunct areas, one along the Espinhaço Range, in Minas Gerais and Bahia, and another in central-northern Goiás (including the Distrito Federal), western Minas Gerais and Bahia, and eastern Tocantins (Fig. 6).

Habitat:—*Drosera hirtella* is found growing in sandy soils in seasonally wet areas of the *campos rupestres*, and also along the margins of *veredas* and springs in the *cerrado* vegetation. Found at elevations between 600–1600 m.

Phenology:—*Drosera hirtella* was collected with flowers from March to July, corresponding to late wet season to mid dry season. From late July to November (mid dry season to early wet season) the plants are usually dormant, and only dry leaves and scapes can be seen. Succulent roots were observed in the species (F.Rivadavia pers. obs.).

Conservation status:—Least Concern (LC). *Drosera hirtella* is widespread and common, and is here considered as of Least Concern. It can be found inside the National Parks of Brasília (DF), Chapada Diamantina (BA), Chapada dos Veadeiros (GO), Grande Sertão Veredas, Sempre-Vivas and Serra do Cipó (MG), and the State Parks of Biribiri, Rio Preto, Serra do Cabral, and Serra Nova (all in Minas Gerais), and Serra dos Pirineus (GO).

Discussion:—*Drosera hirtella* and the variety *D. hirtella* var. *lutescens* were described by Saint-Hilaire (1826), the latter differing from the autonym variety, according to him, by the smaller leaves, the obovate lamina (vs. obovate to round-obovate) that is more frequently glabrous abaxially, and the hairs of the scape more rigid and yellowish (vs. hairs more flexuous and red).

Latter taxonomists working in the genus, however, historically overlooked both taxa. In addition to the superficial overlap in leaf shape between several small rosetted Brazilian sundews, the color of the hairs of the scape, although very conspicuous in living specimens, is often very difficult to discern in old dried specimens. For that reason, *D. hirtella* has been reduced to a synonym under a broadly circumscribed *D. montana*, following a lumping taxonomic view. Starting with Eichler (1872), that placed *D. hirtella* var. *lutescens* under synonymy of *D. hirtella*, and followed by Diels (1906), who reduced *D. hirtella* to a variety of *D. montana*, as *D. montana* var. *hirtella*. The latter taxonomic opinion was followed by all subsequent taxonomic works of the 20th Century, with the exception of Santos (1989), that corroborated with further morphological data the original circumscription of both the species and the variety as described by Saint-Hilaire (1826). Finally, Correa & Silva (2005) placed both taxa, along with several others, under synonymy of *D. montana*, with no varieties.

Such broad concept of *D. montana*, however, was already found to be polyphyletic in the phylogenetic study by Rivadavia *et al.* (2003), with *D. hirtella* belonging to a clade of diploid, mostly Neotropical species, while *D. montana* was found to be closely allied to tetraploid, mostly Brazilian species. This led Rivadavia *et al.* (2014) to remove *D. hirtella* from the *D. montana* complex, but a detailed treatment for this species was still lacking.

Based on extensive field and herbarium studies, both *D. hirtella* and *D. hirtella* var. *lutescens* are here considered very distinctive from each other and from all other *Drosera* species, being re-established following several previous works that already pointed out the necessity of recovering the names (e.g. Santos 1989, Rivadavia *et al.*

2003, 2014, Rivadavia 2008, Rivadavia & Gonella 2011, Gonella *et al.* 2012, 2014). We further elevate *D. hirtella* var. *lutescens* to species rank (see below).

The first step was to identify and circumscribe *D. hirtella*, as the type specimen was found to be a mixed gathering of different plants from at least two different locations distant over 650 km (Formiga, in SW Minas Gerais, and Serra dos Pirineus, in central Goiás). As a matter of fact, plants matching the description of *D. hirtella* were never again collected in the region around Formiga (MG), where only *D. lutescens* can be found, while in the Serra dos Pirineus, both taxa are found growing sympatric and even hybridizing.

Correa & Silva (2005) designated the specimen “*Saint-Hilaire B1-1762*” as the lectotype, but not only the collection number is wrong (this number refers to a Melastomataceae specimen, according to Saint-Hilaire’s field notebook), but the specimen which they probably intended to select as the lectotype (*B1-1762bis*) is a mixed gathering of *Drosera* and a grass (Poaceae) specimen.

Therefore, the selection of a new lectotype was necessary in order to establish a circumscription of *D. hirtella*, since the referred specimen is also a mixed collection of the two morphotypes of *D. hirtella* recognized here:

i. type morphotype (as here designated): leaves with round-obovate lamina, scapes strongly curved at the base (usually decumbent at the base, ascending outside the rosette), and densely covered with shorter and more flexuous eglandular hairs.

We selected a specimen with the round-obovate leaf lamina as the lectotype, as this is the most widespread morphotype, being the only one found in the eastern range of the species (along the Espinhaço Range), and is also found growing sympatric with the other morphotype (and *D. lutescens*) in the western range of the species, in Goiás.

ii. “Western morphotype”: leaves with narrowly obovate lamina, scapes conspicuously curved, but not as in the type morphotype (scape ascending within the rosette), with slightly longer and more rigid eglandular hairs.

This morphotype occurs only in the western range of the species, from central Goiás to the Jalapão, in Tocantins. On its southern and central range, this morphotype often occurs sympatric or near the type morphotype and *D. lutescens*, while in the northern range it occurs alone. Based on its intermediate morphology between the type morphotype of *D. hirtella* and *D. lutescens*, one could argue that this morphotype is likely to be of hybrid origin between the two taxa, but further

studies are necessary to confirm that hypothesis. Although it forms large and stable populations, the differences between this morphotype and the type are very subtle and intermediates are often found. For that reason, it is here chosen to consider it within the natural variation of a single species, and not at subspecific rank.

The circumscriptions here adopted for *D. hirtella* and *D. lutescens* mostly follow that of Saint-Hilaire (1826), with the main distinctive characters between both taxa being the color of both the scape and eglandular trichomes of the scape, but leaf shape and curvature of the scape are also diagnostic: *D. hirtella* presents red or reddish-green leaves with round-obovate to narrowly obovate lamina, red to greenish scapes with a very pronounced curve at the base (often with prostrated base running at ground level, ascending outside the rosette) and with red eglandular trichomes, while *D. lutescens* has wine-red leaves with narrowly obovate to obovate-spatulate lamina, yellowish-green scapes with the base only slightly curved and with white eglandular trichomes.

Hybrids between *D. hirtella* and *D. communis* have been observed in mixed populations of both species, the hybrids presenting intermediate leaf morphology and scapes with red eglandular trichomes at the base. *Drosera hirtella* can also hybridize with *D. cayennensis* when both species are found sympatric, resulting in intermediate plants, with leaves shorter than *D. hirtella*, with scapes less curved, covered by red eglandular hairs at the basal half, and seeds with reticulate testa (e.g. *Gonella et al.* 305).

Representative specimens examined:—BRAZIL. TOCANTINS: Mateiros, Jalapão, 11 June 2006, *Rivadavia* 2193 (SPF). Ponte Alta do Tocantins, Jalapão, 6 August 2012, *Gonella et al.* 568 (SPF). GOIÁS: Alto Paraíso de Goiás, Jardim de Maytrea, 25 February 2014, *Gonella & Andrino* 650 (M, SPF). Cristalina, BR-050 para Brasília, 30 April 1999, *Rivadavia-Lopes & Sato* 981 (SPF). Pirenópolis, Serra dos Pirineus, 21 March 1997, *Rivadavia* 670 (SPF), 23 April 1999, *Rivadavia & Sato* 927 (SPF). DISTRITO FEDERAL: Brasília, estrada Brasília-Buritis (DF-250), 18 March 1997, *Rivadavia-Lopes* 641 (SPF). Brasília, Fazenda Sucupira, 9 February 2007, *Fontes et al.* 25 (CEN, UB). BAHIA: Abaíra, subindo a Serra do Barbado, 14 July 2005, *Rivadavia et al.* 2008 (SPF). Drainage of the Rio Corrente, western Bahia, near Rio Piau, ca. 150 km SW of Barreiras, 14 April 1966, *Irwin et al.* 14845 (NY, UB). MINAS GERAIS: Arinos, estrada para Chapada Gaúcha, 29 April 1999, *Rivadavia-Lopes & Sato* 964 (SPF). Diamantina, ao sul da cidade, 20 April 2010, *Gonella et al.* 275 (SPF). Itacambira, estrada para Montes Claros, 5 March 1997, *Rivadavia* 613 (SPF).

Monte Azul, estrada para Sucuruí/Riacho Grande/Brejo Grande, 9 September 2011, *Gonella et al. 507* (SPF). Ouro Branco, Serra do Ouro Branco, 1 October 2009, *N.G. Silva et al. 376* (R). Santa Bárbara, Serra do Caraça, 22 May 1997, *Mello-Silva et al. 1332* (MBM, SPF). Santana do Riacho, Serra do Cipó, 15 May 2008, *Gonella et al. 82* (SPF).

Figure 4. A-F, *Drosera hirtella*. G-I, *D. hirticalyx*.

Figure 5. A-E, *Drosera hirtella*: A, habit; B, C, leaf, adaxial surface; D, detail of the base of the scape; E, detail of the apex of the scape. F-I, *D. lutescens*: F, habit; G, leaf, adaxial surface; H, detail of the base of the scape; I, detail of the apex of the scape. A, C-E from the lectotype. B, from original material on the same sheet as the lectotype. F-I from the holotype.

Figure 6. Distribution map of *Drosera hirtella* (circles) and *D. lutescens* (triangles) in central-eastern South America.

16. ***Drosera hirticalyx*** Duno & Culham (1995: 241). Figure 4G–I.

Lectotype (here designated):—VENEZUELA. AMAZONAS: Atabapo, Cerro Marahuaca, summit on undulating plateau with islands of shrubs and *Marahuacaea* with stream branch leading to Salto de Monos and southwestern edge to Caño Iguapo, south and southeast of Summit Camp, 2520–2650 m alt., 26–27 February 1985, *Steyermark & Holst 130701* (VEN!; isoelectotype MO!).

Perennial, rosetted, acaulescent or often forming short erect columns densely covered by remains of dead leaves; leaves decumbent, with geniculate vernation, spatulate, petiole short and discreet, gradually broadening into the obovate lamina, leaves drying black; stipules rectangular in outline, divided into multiple acicular segments from the base; scape erect at the base, glandular-pilose towards the apex, sepals glandular-pilose mostly towards the base; petals white; seeds ovoid, testa reticulate.

Illustrations:—Duno de Stefano & Culham (1995: 242, fig. 1A–E – habit and details).

Distribution:—Venezuela and Brazil (North: AM, RR), possibly also in Guyana. In Brazil the species is only known from borderline areas in the highlands of the Neblina Peak (AM) and Mt. Roraima (RR).

Habitat:—Rock outcrops in sandy soil or cracks of sandstone in wet places, at elevations between 1200–2700 m.

Phenology:—Found with flowers year round.

Conservation status:—Least Concern (LC). *Drosera hirticalyx* is found in remote areas and is not likely to face reduction in the population size in the near future. In Brazil, it is found inside the Monte Roraima and Pico da Neblina National Parks.

Notes:—The holotype of *D. hirticalyx* is referred to NY, however, after exhaustive search it was not located in this herbarium. The same holds true for the isotype at VEN (J.R.G. Allende, pers. comm.). The authors of the species were contacted, but the whereabouts of the type collections are unknown (Duno de Stefano & Culham, pers. comm.). Given the absence of the type specimens or any duplicates of the type, a lectotype is here selected from the paratypes list.

Drosera hirticalyx is reminiscent of the species of the *D. montana* alliance (also including *D. tentaculata*, *D. tomentosa* and *D. spirocalyx*), due to its leaves with the petiole gradually broadening into an obovate lamina. The species is very easily

distinguished from the species of this complex by the stipule divided from the base into acicular segments (vs. stipule entire up to half length, then divided in lacinate segments), the absence of differentiated tentacles (snap-tentacles) in the apical leaf margin (vs. present in all four species of the *D. montana* alliance at some degree), the white petals (vs. pink), the geniculate leaf vernation (circinate in all but *D. tentaculata*, which also presents geniculate vernation) and the fact that the plants turn black when dried (vs. brown). It is further distinguished by the robust glandular trichomes on the calyx, in contrast to smaller trichomes in the pedicel and scape, while in the *D. montana* alliance, the trichomes of the scape, pedicels and sepals present a constant, similar size.

Specimens examined:—BRAZIL. AMAZONAS: São Gabriel da Cachoeira, Serra da Neblina, trilha para o Pico da Neblina, 31 December 1998, *Rivadavia* 770 (SPF). Ridge line on Venezuela-Brazil border, Cerro Neblina, 1900-2100 m, 17 April 1984, *Gentry & Stein* 46710 (MO). RORAIMA: Setor brasileiro do Monte Roraima, 1 January 2003, *Rivadavia-Lopes et al.* 1488 (SPF).

17. ***Drosera intermedia*** Hayne (1801: 37). Figure 7A.

Type:—GERMANY. Hamburg near Eppendorf, s.d., *Hayne s.n.* (holotype B!).

=*Drosera americana* Willdenow (1809: 340). (≡*Drosera intermedia* var. *americana* (Willd.) De Candolle (1824: 318). **Type:**—Habitat in America boreali, s.d., *Kinn s.n.* (holotype B-W06261-010!).

=*Drosera capillaris* var. *brasiliensis* Diels (1906: 87). **Lectotype (designated here):**—BRAZIL. RIO DE JANEIRO: Sitio de Paulistas, *Saint-Hilaire* B2-204bis (P-00749146!; isolectotype P-00749160!).

=*Drosera foliosa* Elliot (1817: 376) [non auct. *Drosera foliosa* Hook. f. ex Planchon (1848: 298)] **Type:**—USA. SOUTH CAROLINA: Chersterfield Co., s.d., *Macbride s.n.* [holotype CHARL-BY2508 *parte* (specimen at the bottom right) image!].

=*Drosera intermedia* var. *elatior* Planchon (1848: 199). **Lectotype (designated here):**—GUIANA. Demerara, s.d., *Dr. Hancock* 63 (K! – ex herb. Hookerianum).

Perennial, acaulescent or forming etiolated stems sparsely covered by remains of dead leaves (in semi-aquatic habitats); leaves semi-erect, with geniculate-involute vernation, glabrous (covered by minute sessile glands only), distinctly petiolated spatulate, with narrow long petioles (at least 3 times longer than the lamina) and obovate lamina; scape with base curved or erect; scapes, pedicels and sepals

glabrous (covered by minute sessile glands only); petals white; seeds ovoid, testa papillose, papillae randomly distributed.

Distribution:—Widely distributed in central and western Europe, Canada, United States, Cuba, Venezuela, Trinidad & Tobago, Guiana, Suriname, and Brazil (North: AP, RR; Northeast: BA; Southeast: ES, RJ). It is here first recorded to Northern Brazil in the states of Amapá and Roraima and to the state of Espírito Santo, in Southeast Brazil.

Habitat:—In Brazil, *D. intermedia* occurs in wet areas of *restingas* vegetation type and in open savannas in the Northern Amazon, in sandy and wet soils just above sea level.

Phenology:—Specimens of *D. intermedia* were collected with flowers in the Brazilian territory in March, June, July, August, November and December, suggesting a somewhat continuous flowering throughout the year.

Conservation status:—Least Concern (LC). *Drosera intermedia* is widely distributed and found in abundant populations, being considered as of Least Concern. In Brazil, the species is found in the Restinga de Jurubatiba National Park (RJ) and the Itaúnas State Park (ES).

Discussion:—*Drosera capillaris* var. *brasiliensis* was described based on specimens of both *D. capillaris* and *D. intermedia*, however, the type specimen selected by Diels (1906), *Saint-Hilaire B2-201bis*, is here identified as *D. intermedia* following Saint-Hilaire (1826). Therefore, this name is here placed under synonymy of *D. intermedia*, in discordance with Correa & Silva (2005). Diels (1906) described *D. capillaris* var. *brasiliensis* based on the specimen *Saint-Hilaire B2-204bis* at P, but two duplicates of this specimen are found at this herbarium, being necessary to select a lectotype among them.

Drosera intermedia var. *elator* was described by Planchon (1848) based on many different specimens (syntypes). It is here selected the specimen *Dr. Hancock 63* (K) as the lectotype.

Representative specimens examined:—BRAZIL. AMAPÁ: Inselberg Talouaken – Massif des Tumuc-Humac, 14 August 1993, *Grainville et al. 12290* (US), *Grainville et al. 12291* (P, US). BAHIA: Porto Seguro, Estrada para Cabralia, 26 March 2005, *Rivadavia 1968* (SPF). ESPÍRITO SANTO: Conceição da Barra, Parque Estadual de Itaúnas, 24 August 2002, *Pereira et al. 6997* (VIES). Vitória, área da C.V.R.D.: lagoas artificiais, 15 August 2007, *Pereira & Lübe 7517* (VIES). RIO DE JANEIRO:

Carapebus, Parque Nacional da Restinga de Jurubatiba, 18 November 2000, *Rivadavia-Lopes 1212* (SPF); Restinga de Carapebus, Praia de Carapebus, 14 September 1995, *Santos et al. 441* (RB). RORAIMA: Uiramutã, Balneário Paiuá, 27 December 2000, *Kinupp 1518* (INPA).

18. ***Drosera latifolia*** (Eichler in Martius & Eichler 1872: 395) Gonella & Rivadavia in Gonella *et al.* (2014: 21). $\equiv$ *D. villosa* var. *latifolia* Eichler in Martius & Eichler. Figure 7B–D.

Lectotype (designated by Silva & Giuliatti 1997):—BRAZIL. RIO DE JANEIRO: Serra dos Órgãos, 13 December 1869, *Glaziov 3868* (R!; isoelectotypes K-000432551!, P-00706179!, P-05113030!). —Remaining syntypes: BRAZIL. RIO DE JANEIRO: Serra dos Órgãos, 12 October 1867, *Glaziov 1605* (P-00706180!, P-05113029!).

$\equiv$ *Drosera villosa* var. *bifurca* Buxbaum (1924: 119).

Type:—BRAZIL. SÃO PAULO: prope Campo Grande inter Santos et urben S. Paulo, 750 m, 1902, *M. Wacket s.n.* (holotype WU image!; isotype W-4935!).

Perennial, rosetted, acaulescent, rarely with short upright columns up to 100 mm long; leaves semi-erect, with circinate vernation, petioles much to slightly shorter than the lamina, transversely flat and 1–3(–4) mm wide, adaxial petiole surface glabrous to glabrescent, lamina lanceolate, oblong, or broad to narrowly oblong-lanceolate (oblong-elliptic); scape erect at the base, base glabrous to sparsely eglandular-pilose, apex glandular-pilose; flowers relatively small to medium sized (petals 5–8.5 mm long); seeds fusiform, 0.8–1 mm long, testa reticulate.

Illustrations:—Gonella *et al.* (2014: 23, 24, figs. 11, 12 – habit and details).

Distribution:—Brazil (Southeast: ES, MG, RJ, SP; South: PR, SC), endemic. Found in the Serra do Mar, Serra da Mantiqueira and Espinhaço Range mountain complexes.

Habitat:—At the Serra do Mar and Serra da Mantiqueira it can be found growing in *campos de altitude* vegetation and in highland disturbed areas, usually on thin layers of organic matter over rocks or on red clayish soils, while in the Espinhaço Range it grows in the *campos rupestres* vegetation, along river margins or on islands of vegetation, on sandy soils. *Drosera latifolia* is one of the few Brazilian species that

can also be eventually found growing along river margins inside riparian forests, growing in shade. Found between 700–2550 m a.s.l.

Phenology:—Flowering period varies across the range of the species: September to February at the Serra do Mar and Serra da Mantiqueira, and June to September with a secondary flowering peak in February–March (Espinhaço Range).

Conservation status:—Least Concern (LC). The species is widely distributed (EOO=478427.7 km²) and common, and is found inside several National Parks (Caparaó, Itatiaia, Sempre-Vivas, Serra da Bocaina, Serra dos Órgãos) and State Parks (Minas Gerais: Pico do Itambé, Rio Preto and Serra do Cabral; São Paulo: Ilha do Cardoso and Serra do Mar).

Discussion:—*Drosera latifolia* is highly variable regarding leaf shape and indumentum and six morphotypes are recognized by Gonella *et al.* (2014). The species was observed to form apparently sterile hybrids with *D. tomentosa* at the Espinhaço Range (Gonella *et al.* 2014).

Specimens examined:—For a complete list, see Gonella *et al.* (2014: 28–30).

Figure 7. A, *Drosera intermedia*. B-D, *D. latifolia*. E-I, *D. lutescens*.

19. ***Drosera lutescens*** (Saint-Hilaire 1826: 263) **comb. et stat. nov.** Figure 7E–I.

≡ *Drosera hirtella* var. *lutescens* (Saint-Hilaire 1826: 263)

Type:—BRAZIL. GOIÁS: Dans la Serra dos Pyreneos Cap de Goyas, *Saint-Hilaire C1-720bis* (holotype P-00749157!; isotypes P-00749159!, MPU-009951 image!).

Seasonal geophyte perennial, rosetted, acaulescent; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, lamina narrowly obovate to obovate-spatulate, wine red (greenish in shaded environments); scapes slightly arcuately curved at the base, yellowish-green in color, densely eglandular-pilose on the basal half, reducing in density towards apex (eglandular trichomes white, 1.5–2

mm long), becoming densely glandular-pilose towards the apical half; sepals exclusively glandular-pilose or also with sparse eglandular hairs; seeds ovoid, testa reticulate.

Illustrations:—Hoehne (1915: t. 124, fig. 2 – habit and details, as *D. montana* var. *schwackei*); here, Figure 5F–I (habit and details).

Distribution:—Brazil (Center-West: GO, MS, MT; Southeast: MG, SP) and Bolivia (Santa Cruz) (Fig. 6). The taxon was recently first recorded for Bolivia as *D. hirtella* var. *lutescens* by Fleischmann & Duno de Stefano (2014).

Phenology:—*Drosera lutescens* was collected with flowers from January to July, corresponding to mid wet season to mid dry season. From July to November (mid dry season to early wet season) the plants are usually dormant, and only dry leaves and scapes can be seen.

Habitat:—*Drosera lutescens* is widespread in the western Cerrado domain, where it is found in seasonally wet areas with sandy soils, such as the margins of *veredas* and springs, more rarely also found growing in clayish soils. It is also found in wet areas of *campo rupestre* vegetation in Goiás, Minas Gerais and São Paulo. Found at elevations between 600–1600 m.

Conservation status:—Least Concern (LC). *Drosera lutescens* is widespread and common, being found in the National Parks of the Chapada dos Guimarães (MT), Emas (GO), and Serra da Canastra (MG), and the State Parks of Serra de Caldas Novas and Serra dos Pirineus (GO), and Furnas do Bom Jesus (SP).

Notes:—Although the collection number written in the specimen's label reads "C1-1762", the correct number for the type specimen of *D. hirtella* var. *lutescens* is C1-720bis, as written in the tags attached to the specimens and in Saint-Hilaire's field notebook.

Discussion:—*Drosera lutescens* is here raised to species status, being considered as distinct from *D. hirtella* based on morphological characters, as well as a distinct and mostly allopatric distribution (see under *D. hirtella*).

Possibly due to the dense indumentum of eglandular hairs on the scape, specimens of *D. lutescens* have been mistaken by *D. montana* var. *schwackei* (here *D. schwackei*) by Hoehne (1915) and Silva & Giuliatti (1997).

Drosera lutescens often hybridizes with *D. communis* when both species are growing sympatric (see under that species).

Representative specimens examined:—BRAZIL. GOIÁS: Corumbá de Goiás, entre a cachoeira Corumbá e Cocalzinho de Goiás, 1 July 2007, *Rivadavia & Batista 2669* (SPF). Cristalina, c. 5 km ao noroeste de Cristalina, 30 June 2007, *Rivadavia & Batista 2650* (SPF). Mossâmedes, Reserva Biológica da Serra Dourada, 1 May 1999, *Rivadavia-Lopes & Sato 989* (SPF). Serra dos Pirineus, ca. 15 km (straight line) N of Corumbá de Goiás, 16 May 1973, *Anderson 10396* (NY, UB). MATO GROSSO: Chapada dos Guimarães, Parque Nacional da Chapada dos Guimarães, 30 April 1995, *Rivadavia-Lopes 424* (SPF); estrada Cuiabá-Chapada dos Guimarães, 18 March 2007, *Rivadavia & Cardoso 2476* (SPF). MATO GROSSO DO SUL: Corumbá, Serra do Amolar, entre Parque Nacional do Pantanal e Fazenda Mandioré, 10 May 2003, *Pott et al. 6293* (HMS, HUEFS). MINAS GERAIS: Delfinópolis, estrada para Condomínio de Pedras, 17 May 2003, *Pacheco et al. 648* (HUFU). Ibiraci, estrada de Cristais Paulistas para Lage e Ibiraci, 11 March 2006, *Rivadavia 2175* (SPF). Tiradentes, Serra de São José, 2 May 2008, *N.G. Silva 267* (R). SÃO PAULO: Estreito, estrada de Cristais Paulistas para Lage e Ibiraci, 11 March 2006, *Rivadavia 2170* (SPF). Pedregulho, Parque Estadual das Furnas do Bom Jesus, 16 March 2003, *Sasaki et al. 167* (SPF).

Additional specimen examined:—BOLIVIA. SANTA CRUZ: Chiquitos, sobre la meseta de Motacu, 11 April 2008, *Wood et al. 24397* (UB, USZ).

20. ***Drosera magnifica*** Rivadavia & Gonella in Gonella *et al.* (2015: 258). Figure 8A.

Type:—BRAZIL. MINAS GERAIS: Conselheiro Pena, Pico do Padre Ângelo, 1530 m, 28 November 2013, *Gonella & Rivadavia 645* (holotype SPF!, isotypes BHCB!, MO!, P!, RB!, SPF!).

Perennial, rosetted, caulescent, stems long, prostrate or ascending, up to 1.23 m long; leaves semi-erect, with circinate-involute vernation, sessile, linear-lanceolate, 100–240 × 3–8 mm, exclusively eglandular-pilose, with a raised midrib on the adaxial surface, the adaxial surface with a short, triangular to narrowly triangular tentacle-free zone at the base, and the mature leaves with revolute margins; scape erect at the base, highly branched inflorescences (branched scorpioid cymes), covered with stalked glandular trichomes 0.1–0.4(–0.5) mm long and eglandular trichomes; seeds fusiform, 1–1.2 mm long, testa reticulate.

Illustrations:—Gonella *et al.* (2015: 261, fig. 2 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic to the Pico do Padre Ângelo, in eastern Minas Gerais.

Habitat:—High-montane rock outcrops in loose organic matter over sandstone in a vegetation type intermediate between *campos rupestres* and *campos de altitude*, around 1500–1530 m.

Phenology:—*Drosera magnifica* flowers between October to December.

Conservation status:—Critically Endangered: CR B1ab(iii) + B2ab(iii). *Drosera magnifica* is only known to occur in a fragile environment at a single mountain summit, and may face risk of extinction in a near future by habitat degradation from anthropic interference and invasion of exotic grasses.

Notes:—The largest representative of the genus in the American continent, *D. magnifica* belongs to the *D. graminifolia* alliance (Gonella *et al.* 2015), but is easily distinguished from both *D. graminifolia* and *D. spiralis* by the long and conspicuous stem, the sessile leaves with circinate-involute vernation, the absence of glandular trichomes on leaves, the multiple-branched inflorescences and the larger fusiform seeds.

Additional specimen examined:—BRAZIL. MINAS GERAIS: Conselheiro Pena, Pico do Padre Ângelo, 08 July 2014, *Gonella et al.* 675 (SPF, M).

21. ***Drosera montana*** Saint-Hilaire (1826: 260). Figure 8B, C.

Type:—BRAZIL. MINAS GERAIS: “Inverni in jugis altioribus montium dictorum Serra do Papagayo in parte australi provinciae Minas Geraes”, *Saint-Hilaire D542* (holotype P-00749164!; isotypes P-00749165!, K-000432535!, MPU-012261 image!).

=*Drosera communis* var. *pauciflora* Eichler in Martius & Eichler (1872: 394).

Type:—BRAZIL. MINAS GERAIS: Santa Bárbara, Serra do Caraça, January 1825, *Riedel 1463* (holotype B!; isotypes P!, K!).

Seasonal geophyte perennial, rosetted, acaulescent; leaves decumbent, with circinate vernation, oblong, oblong-spatulate or more rarely spatulate, petioles up to 0.5 mm wide (rarely reaching 1 mm wide in Southern populations); scapes erect at the base, densely glandular-pilose from base to apex (eventually also sparsely eglandular-pilose at the very base), glandular trichomes uniformly sized along the whole scape; sepals oblong-ovate, 2–6 × 0.8–2 mm; styles 1.5–3 mm long; seeds ovoid to ellipsoid, testa reticulate.

Illustrations:—Silva & Giuliatti (1997: 93, fig. 9A–C, F, G, L, O, Q–U); Ferrero & Mello-Silva (2011: 17, fig. 2D–F); Rivadavia *et al.* (2014: 149, fig. 3).

Distribution:—Brazil (Northeast: BA; Center-West: DF, GO; Southeast: MG, SP, RJ; South: PR, RS, SC) and disjunctly in Bolivia (Chuquisaca, La Paz, Tarija, Santa Cruz).

Habitat:—Found in a wide range of habitats in sandy soils, but also observed in white and red clayish soils, in seasonally wet areas of *cerrado*, *campos rupestres* and *campos de altitude* vegetations, between 800–2500 m a.s.l. Often observed growing as a ruderal species, occupying disturbed areas, such as trail sides, road banks and freshly exposed habitats.

Phenology:—In Brazil, *D. montana* is found with flowers in the wet season, from December to March, with a few individuals flowering until June. Dormant between May to November.

Conservation status:—Least Concern (LC). *Drosera montana* is a widespread species and is found in several environmental protection areas, including several National Parks (Caparaó, Chapada dos Veadeiros, Itatiaia, Sempre-Vivas, Serra da Bocaina, Serra da Canastra, Serra do Cipó, Serra dos Órgãos), sometimes even growing as a ruderal species in disturbed areas.

Notes:—Historically circumscribed in a broad sense, including many other taxa under its synonymy, *D. montana* was recently recircumscribed by Rivadavia *et al.* (2014). The species is easily distinguished from the other species of its alliance by the fact that it flowers during the wet season and enters dormancy during the dry season, while the other three species are active year-round and flower during the dry season. For further morphological diagnosis, see Rivadavia *et al.* (2014).

Specimens examined:—For a complete listing, see Rivadavia *et al.* (2014: 152–154).

Additional specimen examined:—BRAZIL. RIO GRANDE DO SUL: Cambará do Sul, Fortaleza, 27 September 1992, Barbieri *s.n.* (HUCS-12629).

Figure 8. A, *Drosera magnifica*. B, C, *D. montana*. D, E, *D. quartzicola*. F, G, *D. riparia*. H-I, *D. roraimae*.

22. ***Drosera quartzicola*** Rivadavia & Gonella (2011: 34). Figure 8D, E.

Type:—BRAZIL. MINAS GERAIS: Santana do Riacho, km 112-113 da estrada para Conceição do Mato Dentro (MG-10), em morro após bifurcação da trilha para o Travessão e cachoeira Congonhas, seguindo à esquerda, 1360 m, 19 April 2010, *Gonella et al.* 264 (holotype SPF!).

Perennial, rosetted, acaulescent or forming short stocky stems up to 40 mm long; glandular trichomes of TSG type present on both leaf surfaces, scapes, pedicels and sepals; leaves semi-erect, with circinate vernation, lanceolate, petioles about as long and as wide as the lamina and lacking eglandular trichomes in the adaxial surface, abaxial leaf surface densely eglandular-pilose; stipules triangular, 6–8 mm long, bronze-gold; scapes short, base erect to sub-erect, 17–115 mm long; seeds narrowly oblong-ovate, 0.7–0.8 mm long, testa reticulate.

Illustrations:—Rivadavia & Gonella (2011: 35, fig. 1 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic to the central portion of Serra do Cipó, in central Minas Gerais.

Habitat:—*Drosera quartzicola* occurs in relatively dry areas of *campo rupestre* vegetation, in fine silica sand mixed with white quartz gravel. Found between 1100–1360 m a.s.l.

Phenology:—Found with flowers from November to April.

Conservation status:—Critically Endangered: CR B1ab(iii, iv). Rivadavia & Gonella (2011) asserted this species as CR based on the restricted occurrence, fragile habitat, and small number of known populations (only four were known by the time it was published and two new were discovered since then), all with very few individuals (usually less than 100). Considering all the six currently known populations, the calculated EOO of 9.1 km² supports the classification in the Critically Endangered category, while the AOO of 12 km² would lead to the Endangered category. It is here chosen to keep it in the most severe category of threat, given the small size and area of the known populations. Of the six currently known populations, two are found inside the Serra do Cipó National Park, and the remaining in the APA Morro da Pedreira.

Notes:—*Drosera quartzicola* is closely allied to *D. chrysolepis*, with which it co-occurs and hybridizes (Rivadavia & Gonella 2011).

Specimens examined:—For an extensive listing, see Rivadavia & Gonella (2011: 39).

Additional specimens examined:—BRAZIL. MINAS GERAIS: Santana do Riacho, Serra do Cipó, km 114 da MG-10, trilha para o Canyon do Travessão, 10 November 2013, *Gonella et al. 633* (SPF, BHCB, RB). Santana do Riacho, APA Morro da Pedreira, km 110 da MG-10, 6 July 2014, *Gonella & Rohrbacher 669* (SPF), *670* (SPF).

23. ***Drosera riparia*** Rivadavia & Gonella in Gonella *et al.* (2014: 31). Figure 8F, G.

Type:—BRAZIL. BAHIA: Miguel Calmon, Parque Estadual das Sete Passagens, Cachoeira do Coração, 850 m, 03 August 2012, *Gonella et al.* 543 (holotype SPFI; isotypes ALCB!, HUEFS!, MO!, P!, RB!).

Perennial, rosetted, acaulescent, rarely with decumbent stems up to few cm long; leaves semi-erect, with circinate vernation, with long and narrow petioles that are equal to or longer than the lamina (up to two times longer), petiole glabrous in the adaxial surface, lamina oblong to narrowly oblong; scapes erect at the base, base glabrous or glabrescent, becoming sparsely glandular-pilose towards apex; flowers very small (petals 4–5 mm long); seeds obconic, 0.7–0.9 mm long.

Illustrations:—Gonella *et al.* (2014: 32, fig. 14 – habit and details).

Distribution:—Brazil (Northeast: BA), endemic to the Chapada Diamantina.

Habitat:—Found along the margins of perennial rivers, often shaded by riparian vegetation, but also found in open seepages, in sandy soils or on cracks of sandstone, between 850–1850 m a.s.l.

Phenology:—*Drosera riparia* was found with flowers throughout the year.

Conservation status:—Vulnerable: VU B1ab(iii). *Drosera riparia* is known from only few populations, found in fragile environments along the Chapada Diamantina. Gonella *et al.* (2014) considered this species as Vulnerable (VU), a category that is further supported by the calculated EOO of 5998 km². It is found inside the Chapada Diamantina National Park and Sete Passagens State Park.

Specimens examined:—For a complete list, see Gonella *et al.* (2014: 34).

24. ***Drosera roraimae*** (Klotzsch ex Diels 1906: 90) Maguire & J.R.Laundon in Maguire & Wurdack (1957: 333). Figure 8H, I.

≡*D. montana* var. *roraimae* Klotzsch ex Diels.

Type:—GUYANA. Cisäquatoriale Savannen-Provinz: Britisch-Guiana auf dem Roraima, November 1842, *Schomburgk 1034* (holotype B!; isotype K not found).

≡*Drosera montana* var. *robusta* Diels (1914: 136).

Type:—GUYANA. Auf dem Roraima, in der oberen Felsregion, 2500 m, December 1909, *Ule 8610* (holotype B!; isotype K!).

Perennial, rosetted, caulescent, forming short columns of remains of dead leaves, up to 10 cm high; leaves semi-erect, with geniculate-involute veneration, distinctly petiolate spatulate, petiole adaxial surface glabrous, abaxial surface densely eglandular-pilose, lamina obovate to sub-orbicular, stipule divided into several acicular segments from the base; scape curved or erect at the base, glabrous at the base and becoming glandular-pilose towards apex; sepals glandular-pilose; seeds ellipsoid to rectangular, with reticulate testa.

Illustrations:—Duno de Stefano (1995: 90, fig. 3g–n – habit and details); Silva & Giulietti (1997: 99, fig. 12N–T – habit and details).

Distribution:—Guyana, Venezuela, and Brazil (North: AM, RR).

Habitat:—In Brazilian territory, *D. roraimae* is only found in the highlands of the tepuis and other Amazonic mountain ranges, growing on sandy soils or cracks of sandstone or quartzite. In Venezuela, *D. roraimae* is also found at lower elevations growing in sandy soils in wet areas of the Gran Sabana. Found between 470–2800 m a.s.l.

Phenology:—Found with flowers year round.

Conservation status:—Least Concern (LC). *Drosera roraimae* is widespread in a relatively remote area. In Brazil, it is found inside the Pico da Neblina (AM) and Monte Roraima (RR) National Parks and Serra do Aracá State Park (AM).

Notes:—*Drosera roraimae* superficially resembles *D. communis*, that also occurs in the lowlands of some areas of the Guiana Shield, but never sympatrically. The *D. communis* from north of the Amazon can be easily distinguished from *D. roraimae* by the acaulescent habit, the laxer rosettes with glabrescent leaves, and by the narrowly obovate lamina.

Although all specimens examined from Brazil present glandular trichomes on the inflorescences, a few specimens of *D. roraimae* with completely glabrous scapes, pedicels and sepals were studied from Venezuela. Even with completely glabrous inflorescences, *D. roraimae* can be distinguished from *D. esmeraldae* by the more robust habit, usually stem forming, the semi-erect leaves and the ellipsoid to rectangular seed with reticulate testa.

Drosera montana var. *robusta* was described based on the specimen *Ule 8610*, of which two duplicates are known in two different herbaria: B and K. Although Correa & Silva (2005) indicated the specimen at K as the holotype, Diels (1914) does not indicate the herbarium where the original material was studied, what would make

both specimens syntypes. However, the only specimen annotated by Diels is the one held at B, where he originally worked at the time he published the species, making this, undoubtedly, the original material and the holotype of the name.

Representative specimens examined:—BRAZIL. AMAZONAS: Barcelos, 03 km ao sul da parte central da Serra do Aracá, 1,5 horas leste do Rio Jaurari, 10 February 1984, *do Amaral 1497* (INPA, NY); sandstone tepui 200 km N of Barcelos, Serra do Aracá, 27 December 1989, *Nelson et al. 1706* (MO, NY). Rio Negro, Rio Cauaburí, 2 December 1965, *Maguire et al. 60524* (NY). Santa Isabel do Rio Negro, Serra da Anta, cume, comunidade Yanomami Xamantá-Pohoro, 29 November 2003, *Vicentini et al. 2100* (INPA, MO). São Gabriel da Cachoeira, Serra da Neblina, 30 December 1998, *Rivadavia 768* (SPF). RORAIMA: Roraima 2850 m, October 1927, *Luetzelburg 21625* (M). Upper slopes of Serra Parima, S. of Auaris, 10 February 1969, *Prance et al. 9811* (NY, P, US). Near summit of Serra Parima, south of Auaris airstrip, 30 July 1974, *Prance et al. 21563* (INPA, MO, NY). Setor brasileiro no alto do Monte Roraima, 1 January 2003, *Rivadavia 1491* (SPF).

25. ***Drosera schwackei*** (Diels 1906: 89) *Rivadavia* (2008: 39). Figure 9A.

≡ *Drosera montana* var. *schwackei* Diels.

Lectotype (designated by Silva & Giuliatti 1997):—BRAZIL. MINAS GERAIS: Serra do Cipó, 1892, *Schwacke 8234* (OUPR!; isoelectotype RB!). —Remaining syntypes: BRAZIL. MINAS GERAIS: Diamantina, Biribiri, 6 April 1892, *Schwacke 8235* (B!). Serra do Cipó, 23 April 1892, *Glaziou 18858* (K-001204936!, P!, R *partel*!).

Perennial rosetted herbs, acaulescent or often forming very short stocky stems densely covered by remains of dead leaves; glandular trichomes of TSG type present on both leaf surfaces, scapes, pedicels and sepals, dense eglandular indumentum present on the abaxial leaf surface, adaxial petiole surface, scape (from base to apex), pedicels and sepals; leaves oblong-lanceolate to ovate, semi-erect, yellowish-green to orangish-green; petioles much shorter than the lamina (petiole:lamina ratio of ca. 1/2); stipules rectangular, translucent white, 2.2–2.5(–3) × 1–2 mm; scape with erect base; seeds narrowly oblong, 0.7–0.8 mm long, with reticulate testa.

Illustrations:—*Rivadavia* (2008: 40, fig. 3 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Restricted to the northern Serra do Cipó (Congonhas do Norte and Santana do Pirapama) and the Diamantina Plateau in the Espinhaço Range of Minas Gerais.

Habitat:—*Drosera schwackei* occurs in relatively dry areas of *campo rupestre* vegetation, in fine silica sand mixed with white quartz gravel at elevations between 1200–1370 m.

Phenology:—*Drosera schwackei* flowers from mid to late wet season, from February to April, with some sparse individuals producing flowers until July.

Conservation status:—Endangered: EN B1ab(iii, iv) + B2ab(iii, iv). *Drosera schwackei* presents a restricted occurrence (EOO=1015.2 km², AOO=24 km²), where it usually forms small and very sparse populations in a very specific habitat. The region that harbor the largest number of known sub-populations of this species has been focus of urban expansion of the town of Diamantina over the last decade, and may be completely destroyed in a very near future. The species is here considered Endangered based on the very restricted EOO and AOO and an observed and projected continuing decline of both area and quality of the habitat. The species is found inside the Biribiri State Park.

Notes:—*Drosera schwackei* is the smallest member of the Brazilian species possessing TSG trichomes, but is distinguished from the others by having short, whitish rectangular stipules (vs. large, golden triangular stipules in all other species).

Specimens examined:—For an extensive listing, see Rivadavia (2009).

Additional specimens examined:—BRAZIL. MINAS GERAIS: Congonhas do Norte, Serra Talhada, 23 June 2013, *Gonella et al.* 630 (SPF). Diamantina, estrada que sai do Bairro Arraiola, 24 July 2008, *Gonella et al.* 163 (SPF), 25 July 2008, *Gonella et al.* 175 (SPF), 8 February 2009, *Gonella & Viana* 217 (SPF); estrada vicinal em frente ao clube de campo do Banco do Brasil, 13 April 2011, *Mello-Silva et al.* 3407 (SPF); sul da cidade, estrada das Bicas, 9 March 2013, *Gonella* 617 (SPF).

Figure 9. A, *Drosera schwackei*. B-D, *D. sessilifolia*. E-G, *D. spiralis*. H-I, *D. spirocalyx*.

26. ***Drosera sessilifolia*** Saint-Hilaire (1826: 259). Figure 9B–D.

Type:—BRAZIL. MINAS GERAIS: Marais prans Tapura dans le desert du Rio de St Francisco, *Saint-Hilaire B1-1805bis* (holotype P-706174!; isotype P-706175!).

=*Drosera dentata* Benthams in Hooker (1842: 105).

Type:—GUYANA. 1836, *Schomburgk 102* (holotype K!; isotypes G, P!, US!).

Annual, rosetted, acaulescent; leaves semi-erect or decumbent, with entire-involute veneration, petiole gradually broadening into lamina, lamina obovate, with

conspicuous snap-tentacles in the marginal apex, and densely minutely glandular-pilose on both surfaces; scapes erect at the base, glabrous, with a ceraceous appearance; sepals glandular-pilose; ovary 5-merous, styles 5, entire, stigma with long papillae; seeds ovoid, testa reticulate.

Illustrations:—Hoehne (1915: t. 124, fig. 1 – habit and details); Silva & Giulietti (1997: 84, fig. 5).

Distribution:—Widely distributed across northern South America: Venezuela, Guiana, Colombia, Brazil (North: AM, PA, RR, TO; Northeast: AL, BA, CE, MA, PB, PE, PI, RN, SE; Center-West: GO, MS, MT; Southeast: MG), and Bolivia.

Habitat:—Seasonally wet areas in savanna vegetation, such as marginal areas of *veredas* and springs, and also on the coastal sandy plains (*restingas*), always in sandy soils. Found from sea level up to ca. 900 m a.s.l.

Phenology:—*Drosera sessilifolia* presents different flowering periods across its distribution range, usually flowering from October to February in the northern range (Guiana Shield) and from (April) June to October in northeastern and central Brazil. The species usually flowers during the dry season, dying from exhaustion after multiple flowering scapes or from drought, leaving numerous seeds that germinate early in the following wet season.

Conservation status:—Least Concern (LC). One of the most common and widespread species of the genus in Brazil and South America, *D. sessilifolia* is considered as of Least Concern. It has been recorded from numerous National Parks across Brazil: Chapada dos Veadeiros (GO), Grande Sertão Veredas (MG/BA), Lençóis Maranhenses (MA), Pantanal (MS), Serra da Capivada (PI), Sete Cidades (PI); and State Parks: Araguaia (MT), Jalapão (TO).

Notes:—One of the most widespread species in Brazil, *D. sessilifolia* is highly conserved morphologically, varying mostly in rosette size and leaf color depending on environmental conditions. In South America, it is the only true annual species and also the only one not belonging to *Drosera* sect. *Drosera*, but to *Drosera* sect. *Thelocalyx*, characterized by the 5-merous gymnoecium with undivided styles (*sensu* Seine & Barthlott 1994).

Selected specimens examined:—BRAZIL. ALAGOAS: Piaçabuçu, 20 August 2006, *Rodrigues 2018* (MAC). AMAZONAS: Humaitá, 500 m ao norte da BR-230, km 2, Janssen 156 (INPA, RB). BAHIA: Coribe, 16 June 2006, *Rivadavia 2223* (SPF). CEARÁ: 4 km north of Soure (Caucaia), July 1945, *Cutler 8388* (NY). GOIÁS: Serra

do Morcego, córrego Estrema, ca. 38 km NE of Formosa, 21 April 1966, *Irwin et al.* 15189 (NY, UB). MARANHÃO: Barreirinhas, Lençóis Maranhenses, 30 March 2007, *Rivadavia* 2494 (SPF). MATO GROSSO: Giráu-Caceres, August 1908, *Hoehne* 149 (R, US); Novo Santo Antônio, Parque Estadual do Araguaia, 8 June 2005, *Jacobski et al.* 199 (UB). MATO GROSSO DO SUL: Corumbá, Baía Bonita, Pantanal, 28 July 1992, *Rivadavia* 142 (SPF). MINAS GERAIS: Arinos, 29 April 1999, *Rivadavia & Sato* 965 (SPF). Brazilândia de Minas, fazenda Brejão, 14 July 2000, *Lombardi* 4018 (BHCB). PARÁ: Without attribution to administrative area, 22 July 1916, *Duck* 16311 (US). PARAÍBA: Mamanguape, Reserva Biológica Guaribas, 26 October 2012, *Silva* 26 (JPB). Pedras de Fogo, Fontainha, depois de Sta. Emília, 1 October 1962, *Tavares* 1060 (US). PERNAMBUCO: Goiana, Eng. Calingi, 5 September 1967, *Lima s.n.* (IPA-16608). PIAUÍ: Piracuruca, Parque Nacional de Sete Cidades, 27 July 2009, *Mendes & Annunziata* 583 (UB, TEPB); Without attribution to administrative area, s.d., *Gardner* 2480 (US). RIO GRANDE DO NORTE: Rio do Fogo, Lagoa da Cotia, 11 October 2015, *Garcia & Gonçalves* 53 (UFRN). RORAIMA: Estrada Manaus-Boa Vista, between Mucajai & Boa Vista, 21 November 1977, *Steward et al.* 145 (INPA, NY). SERGIPE: Pirambu, June 2013, *Carregosa & Santos* 402 (ASE). TOCANTINS: Santa Rosa do Tocantins, Folha SC-23-Y-C, 7 July 2009, *Oliveira et al.* 1589 (HUEFS, IBGE, UB).

27. ***Drosera spiralis*** Saint-Hilaire (1826: 270). Figure 9 E–G.

Type:—BRAZIL. MINAS GERAIS: Crescit in montibus dictis Serra de Curumatahy, ad rivulum Corgo Novo, in parte provinciae Minas Geraes dicta Distrito dos Diamantes, September, *Saint-Hilaire B1-2021bis* (holotype P!).

Perennial, rosetted, acaulescent or forming short upright stocky columns up to 10 cm long; glandular capitate trichomes 0.1–0.5 mm long present on leaves, scapes, pedicels and calyx; leaves erect, with irregular circinate vernation, linear, densely glandular- and eglandular-pilose abaxially, petioles short, 5–30 mm long, often hidden by the large stipules; stipules triangular, 14–22(–30) × 8–22 mm, bronze-gold in color; scapes erect at the base, densely glandular- and eglandular-pilose throughout; sepals densely glandular- and eglandular-pilose, often bearing 1–several tentacles; seeds ovoid, 0.6–0.65 × 0.25–0.3 mm, with reticulate testa.

Illustrations:—Eichler (1872: t. 91, II – as *D. graminifolia*); Silva & Giuliatti (1997: 86, fig. 6 – as *D. graminifolia*); Gonella *et al.* (2012: 50, fig. 4 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic. Restricted to the central and northern Espinhaço Range in Minas Gerais state, in the Diamantina Plateau and the highlands between Itacambira and Grão-Mogol.

Habitat:—Open springs and river margins, in sandy soils and cracks of sandstone in *campos rupestres* vegetation, between 700–1500 m a.s.l.

Phenology:—Flowering mainly between April to December, with sparse individuals found with flower year round.

Conservation status:—Vulnerable: VU B1ab(iii). *Drosera spiralis* was asserted as of Least Concern (LC) by Gonella *et al.* (2012), however, based on the new evidence of the calculated extent of occurrence (EOO=10534 km²) that would lead to Vulnerable and area of occurrence (AOO=252 km²) that would lead to Endangered, the species is here considered Vulnerable, a less severe category of threat since it is relatively common along its range and is found inside the Sempre-Vivas National Park and in the Biribiri, Rio Preto and Grão-Mogol State Parks. The new classification is further justified by the increase of habitat loss for agriculture, cattle farming and urban expansion, as well as the common occurrence of anthropic fires along the whole distribution of the species, reducing the quality of the habitat and facilitating the invasion by exotic grasses.

Discussion:—*Drosera spiralis* was placed under synonymy of *D. graminifolia* by Diels (1906), which was followed by all subsequent works, until it was re-established by Gonella *et al.* (2012). Despite the superficially similar leaf morphology, *D. spiralis* is readily distinguished from *D. graminifolia* by general indumentum type and morphology, stipule and petiole sizes, leaf vernation pattern, and seed shape and size (Gonella *et al.* 2012).

Specimens examined:—For a complete list, see Gonella *et al.* (2012: 53–54).

Additional specimens examined:—BRAZIL. Minas Gerais: no date, Gardner 4417 [W(3)].

28. ***Drosera spirocalyx*** Rivadavia & Gonella *in* Rivadavia *et al.* (2014: 155). Figure 9 H, I.

Type:—BRAZIL. MINAS GERAIS: Santana do Riacho, trilha para velózias gigantes, 12 September 1999, *Rivadavia 1165* (holotype SPFI; isotypes BHCB!, P!).

Perennial, rosetted, acaulescent or often forming very short columns of dead leaves; leaves decumbent, with circinate vernation, oblanceolate to narrowly obovate, densely eglandular-pilose on the adaxial petiole surface and whole abaxial leaf surface; scapes erect at the base, minutely glandular-pilose, trichomes becoming denser towards the apex; sepals sub-orbicular to broadly ovate with rounded (rarely subobtusely) apex, overlapping (torsive or spirally contorted aestivation) when in bud and the lateral margins of adjacent sepals forming a pyramidal projection where fused at their bases, glandular pilose; seeds ellipsoid to oblong, testa reticulate.

Illustrations:—Rivadavia *et al.* (2014: 157, fig. 6 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic to the Serra do Cipó, central Minas Gerais.

Habitat:—*Drosera spirocalyx* grows in relatively dry areas of *campo rupestre* vegetation in sandy soils, often with white quartz gravel. Found between 1000–1350 m a.s.l.

Phenology:—Flowering individuals can be found between July to November.

Conservation status:—Endangered: EN B1ab(iii) + B2ab(iii). Based on the restricted distribution and fragile habitats occupied by this species, Rivadavia *et al.* (2014) asserted it as Vulnerable (VU), however, both the calculated extent and area of occurrence (EOO=110 km², AOO=24 km²) suggest a more concerning scenario of threat, and the species is here considered Endangered. It occurs inside the Serra do Cipó National Park and in the Parque Natural Municipal do Ribeirão do Campo.

Discussion:—Specimens of *D. spirocalyx* have been historically identified as *D. montana*, based on the similar leaf morphology. The species belongs to the revised *D. montana* species alliance, but is easily distinguished from the similar species by the leaf indumentum and sepal shape (for more see Rivadavia *et al.* 2014).

Specimens examined:—For an extensive listing, see Rivadavia *et al.* (2014: 158–159).

Additional specimen examined:—BRAZIL. MINAS GERAIS: Santana do Pirapama, Serra do Cipó, Capela de São José, 25 November 2009, *Zappi 2605* (K).

29. ***Drosera tentaculata*** Rivadavia (2003: 79). Figure 10A–C.

Type:—BRAZIL. MINAS GERAIS: Diamantina, no alto da cachoeira dos Cristais, estrada para Biribiri, c. 1000 m alt., 31 July 2002, *Rivadavia-Lopes & Gibson 1376* (holotype SPF!).

Perennial, rosetted, acaulescent or often forming short columns of dead leaves; leaves decumbent, with geniculate vernation, obovate, obovate-cuneate or cuneate, apex with 7–9(–12) large bilaterally-symmetrical tentacles 4–9 mm long, 0.4–0.5(0.6) mm wide at the base, each with a narrowly-obcuneiform stalk and a linearly-rectangular head 0.7–1.2(–1.5) mm long; scapes erect at the base, glandular-pilose from base to apex, eventually sparsely eglandular-pilose at the base; seeds ovoid-ellipsoid, testa reticulate.

Illustrations:—Rivadavia (2003: 80, fig. 1 – habit and details); Rivadavia *et al.* (2014: 159, fig. 8 – habit and details).

Distribution:—Brazil (Northeast: BA; Southeast: MG), endemic. Restricted to the Espinhaço Range where it presents a disjunct distribution between the southern portion, from the Serra do Cipó to Itacambira in Minas Gerais, and the northern portion, in south-western Chapada Diamantina in Bahia.

Habitat:—*Drosera tentaculata* can be observed in a wide range of habitats in *campo rupestre* vegetation. It usually grows in the margins of seasonal springs, or on drier hilltops with fine white sand with quartz gravel, in cracks on sandstone, or over a thin layer of soil over sandstone. More rarely, the species is found in perennially waterlogged areas with peaty-sandy soil. Found between 800–1600 m a.s.l.

Conservation status:—Least Concern (LC). *Drosera tentaculata* is widespread (EOO=48509 km²), common and is protected by several parks (including Serra do Cipó and Sempre Vivas National Parks and Biribiri, Rio Preto and Serra do Cabral State Parks, all in Minas Gerais), being considered as of Least Concern.

Specimens examined:—For a complete listing, see Rivadavia *et al.* (2014: 162–163).

30. ***Drosera tomentosa*** Saint-Hilaire (1826: 261). Figure 10D–F.

Lectotype (designated by Rivadavia *et al.* 2014):—BRAZIL. MINAS GERAIS: Crescit in paludosis montium propè Itambé, *Saint-Hilaire M378* (lectotype P-749166!, fifth specimen from left; isoelectotypes P-00749166! (individual plants indicated on sheet), P-00749167!, P-04962569!, K-000432538! (the two plants on the top right),

MPU-012262 image!).

≡ *D. montana* var. *tomentosa* (A.St.-Hil.) Diels

Perennial rosetted herbs, acaulescent or forming short prostrated columns up to 2 cm long; leaves decumbent, with circinate vernation, obovate to oblong-obovate (rarely oblong), with wide petioles (0.4–3.0 mm in width), apical tentacles usually inconspicuously distinct and in number of 5–9, up to 5 mm long, stalk up to 0.3 mm wide at base, with rectangular-linear head up to 0.6 mm long; scape erect at the base, glandular trichomes absent in the basal third of scape and increasing in density towards apex; sepals narrowly ovate to oblong-ovate (1.5–3×0.6–1.3 mm); seeds ovoid to ellipsoid, testa reticulate.

Illustrations:—Rivadavia *et al.* (2014: 169, 170, figs. 11, 12 – habit and details, both varieties); Ferrero & Mello-Silva (2011: 15, fig. 1D–F – habit and details, *D. tomentosa* var. *glabrata*).

Distribution:—Brazil (Northeast: BA, SE; Center-West: GO; Southeast: MG), endemic. *Drosera tomentosa* has its core distribution along the Espinhaço Range in Minas Gerais and Bahia, extending further south and southwest to the northern tip of the Serra da Mantiqueira and Serra da Canastra (MG), respectively, further west to the Chapada dos Veadeiros (GO), further east to the Pico da Aliança (MG) and coastal Bahia, and northeast to the Serra de Itabaiana highlands (SE).

Habitat:—*Drosera tomentosa* is found in a wide range of habitats in wet areas of *campos rupestres* vegetation where it is found at elevations between 700–2050 m, in sandy or peaty-sandy soils, and also in cracks of sandstone. It also occurs in the *restinga* vegetation in coastal Bahia at sea level in sandy soils. *Drosera tomentosa* is one of the few Brazilian species that can also be found along river margins inside riparian forests, growing in shade.

Phenology:—Found with flowers between June and September, with very sparse individuals flowering year round.

Conservation status:—Least Concern (LC). *Drosera tomentosa* is widespread and common along the *campos rupestres* of eastern Brazil, where it is found in several National Parks (Chapada Diamantina, Chapada dos Veadeiros, Sempre-Vivas, Serra da Canastra, Serra do Cipó) and State Parks (Minas Gerais: Biribiri, Grão-Mogol, Ibitipoca, Pico do Itambé, Rio Preto, Serra do Cabral, Serra Nova; Bahia: Sete Passagens).

Notes:—*Drosera tomentosa* and its two varieties were re-establishment and removed from synonymy of *D. montana* by Rivadavia *et al.* (2014).

The species is known to form natural hybrids with *D. grantsau* (namely *D. × fontinalis*, Rivadavia 2009), and with *D. latifolia* and *D. villosa* (Gonella *et al.* 2014).

Key to the varieties of *Drosera tomentosa*:

1. Scapes densely eglandular-pilose (villous) at the basal half, decreasing in density towards apex [BA, MG, SE] *D. tomentosa* var. *tomentosa*
- 1'. Scapes exclusively glandular-pilose from base to apex, without notable eglandular indumentum, occasionally also sparsely eglandular-pilose mostly towards the basal third [BA, GO, MG] *D. tomentosa* var. *glabrata*

30.a. ***Drosera tomentosa*** var. ***tomentosa*** (Figure 10F)

Distribution:—Brazil (Northeast: BA, SE; Southeast: MG), endemic.

Specimens examined:—For an extensive listing, see Rivadavia *et al.* (2014: 166–167).

Additional specimens examined:—BRAZIL. MINAS GERAIS: in altis pratis arenosis ad Serra de Grão-Mogol, s.d., *Martius s.n.* (M). Alvarenga, Pico da Aliança, 9 July 2014, *Gonella et al.* 689 (SPF).

30.b. ***Drosera tomentosa*** var. ***glabrata*** Saint-Hilaire (1826: 262). Figure 10E.

Type:—BRAZIL. Minas Gerais: Milho Verde, *Saint-Hilaire M-476* (holotype P-749168!; isotypes MPU image!, P-749169!).

Distribution:—Brazil (Northeast: BA; Center-West: GO; Southeast: MG), endemic.

Specimens examined:—For a complete listing, see Rivadavia *et al.* (2014: 167–168).

Figure 10. A-C, *Drosera tentaculata*. D-F, *D. tomentosa*. E, *D. tomentosa* var. *glabrata*. F, *D. tomentosa* var. *tomentosa*. G-I, *D. villosa*.

31. ***Drosera villosa*** Saint-Hilaire (1826: 267). Figure 10G–I.

Type:—BRAZIL. MINAS GERAIS: Crescit in sabuletis humidis montis dicti Serra Negra in provinciae Minas Geraes, haud longè à finibus provinciae Rio de Janeiro, January/February 1817, *Saint-Hilaire* C1-75 (holotype P-578095!, isotypes K-000432549! (single plant on the top center), P-578097!, P-578099!).

Perennial, rosetted, acaulescent; leaves semi-erect, with circinate veneration, petioles often as long as the lamina and always exceeding 50% of the lamina length (petiole:lamina ratio higher than 1/2), transversely elliptic in cross section and densely eglandular pilose on both surfaces, lamina narrowly oblong to narrowly lanceolate; scape erect at the base, basal third densely eglandular-pilose; flowers

relatively small to medium-sized (petals 5–8 mm long) with short styles (2.5–3 mm long); seeds fusiform, 0.7–0.8 × 0.2 mm, with reticulate testa.

Illustrations:—Ferrero & Mello-Silva (2011: 17, fig. 2A–C – habit and details); Gonella *et al.* (2014: 9, fig. 3 – habit and details).

Distribution:—Brazil (Southeast: MG), endemic to the neighbor highlands of the Serra Negra and Serra do Ibitipoca, part of the Serra da Mantiqueira highlands in SE Minas Gerais state.

Habitat:—River margins, seepages, and springs in *campo rupestre* and *campo de altitude* vegetations, between 1200–1750 m a.s.l. Often found growing in *Sphagnum* spp. mats.

Phenology:—Found with flowers from October to February.

Conservation status:—Endangered: EN B2ab(iii). Gonella *et al.* (2014) asserted this species as Vulnerable (VU), due to its restricted geographical distribution and the fragility of the habitat it is found. However, the calculated EOO of 33.3 km² would lead to Critically Endangered, while the AOO of 16 km² would lead to Endangered, both more severe categories. Since the largest number of populations is found inside the Serra do Ibitipoca State Park and it occurs in more than one location, we have chosen here to assign it to Endangered, a less severe category.

Discussion:—Since Diels (1906), the name *D. villosa* was adopted in a broad circumscription that also included *D. ascendens* and *D. villosa* var. *latifolia* (here *D. latifolia*). The taxon was re-circumscribed by Gonella *et al.* (2014), following the original description by Saint-Hilaire (1826), including only plants from a small area in southeast Minas Gerais. Gonella *et al.* (2014) also reports hybrids between *D. villosa* and *D. tomentosa* var. *glabrata* at Serra do Ibitipoca.

Specimens examined:—For a complete listing, see Gonella *et al.* (2014: 12).

32. ***Drosera viridis*** Rivadavia (2003: 87). Figure 11A, B.

Type:—BRAZIL. SÃO PAULO: Paranapiacaba, Estrada de terra para Paranapiacaba, paralela aos trilhos do trem, c. 2 km antes da cidade, 2 February 1996, Rivadavia-Lopes & Cardoso 510 (holotype SPFI, isotypes MBM!, NY!, R!).

Perennial, rosetted, acaulescent; leaves decumbent, with geniculate-involute vernation, distinctly petiolated spatulate, entirely green or with reddish base and green apex, lamina obovate to sub-orbicular, tentacles with translucent stalk and red

head; stipule rectangular in outline, divided into multiple acicular segments from the base; scapes sub-erect to arcuately curved at the base, base glabrous, apex, pedicels and sepals glandular-pilose; seeds rectangular, testa reticulate.

Illustrations:—Rivadavia (2003: 89, fig. 4.1A-E; 4.2F, G – habit and details).

Distribution:—Brazil (Southeast: SP; South: PR, RS, SC), endemic.

Habitat:—Found in humid to waterlogged habitats on stream sides and seepages, usually in sandy soils, but also on red and white clayish soils, between 550–1400 m a.s.l.

Phenology:—*Drosera viridis* presents a flowering peak between December and March, but flowering individuals can be observed year-round.

Conservation status:—Near Threatened (NT). Although relatively well distributed, *D. viridis* occupies very specific and fragile habitats and may face some risk of extinction in the near future. As an example, the type location was recently revisited in 2011 and no plants were localized at the site, where it may have gone extinct by human interference. The calculated EOO of 75614.9 km² would lead to Least Concern, while the AOO of 68 km² would lead to Endangered. Given such discrepancy that may result from undercollection of this species, it is here assumed that the data is not enough to assert it under a category of threat, and it is here tentatively considered Near Threatened (NT). It is not known to occur inside any National or State Parks.

Discussion:—*Drosera viridis* is closely allied to *D. communis*, with which it often co-occurs, and may hybridize naturally, although no clear hybrids have ever been observed. When occurring sympatric, *D. viridis* is easily distinguished by the overall larger size, the greenish leaves with tentacles with translucent stalk and red head (vs. reddish leaves with tentacles with red stalk and head), the less evident curvature of the scape and the rectangular seeds (vs. fusiform). Although easily distinguishable in living specimens, *D. viridis* is not very easy to distinguish from *D. communis* in herbarized specimens, since most of the cited differences are lost during the herbarium preparations. The differences in leaf indumentum cited by Rivadavia (2003) are not reliable, as *D. communis* is widely variable regarding such characteristic.

Specimens examined:—For an extensive listing, see Rivadavia (2003: 88–89).

Representative specimens examined:—BRAZIL. SÃO PAULO: Embu-Guaçu, distrito de Cipó, 11 February 2006, *Rivadavia & Miranda 2143* (SPF). PARANÁ:

Campo Largo, Serra de São Luís, próximo a São Luís do Purunã, 25 November 2006, *Rivadavia & Rohrbacher 2443* (SPF). Palmeira, Rio das Pombas, 25 November 2006, *Rivadavia & Rohrbacher 2448* (SPF). RIO GRANDE DO SUL: Cambará do Sul, Fortaleza, 27 September 1992, *Barbieri s.n.* (HUCS 12638; mixed specimen with *D. brevifolia*). SANTA CATARINA: Campo Alegre, Campos do Quiriri, 17 November 2012, *Silva 24* (JPB). Mafra, campo São Lourenço, 18 January 2014, *Antunes Filho 1* (SPF). Santa Cecília, Serra do Espigão, 22 February 2014, *Antunes Filho 2* (SPF).

Natural hybrids

Several natural hybrids are reported for Brazil, but only one is named. *Drosera* × *fontinalis* Rivadavia (2009: 121) was the first natural hybrid reported from South America, and is a result of the natural cross between *D. tomentosa* and *D. grantsau*, forming abundant populations sympatric with the parental species (Rivadavia 2009).

Other natural hybrids were also reported, but represented by only a few scattered individuals found alongside with the parental species: *D. chrysolepis* × *D. quartzicola* (reported by Rivadavia & Gonella 2011), *D. tomentosa* × *D. latifolia* and *D. tomentosa* × *D. villosa* (reported by Gonella *et al.* 2014), and the hybrids first recorded here (see under *D. cayennensis*, *D. communis* and *D. hirtella*).

Drosera* × *fontinalis Rivadavia (2009: 121) (*D. tomentosa* × *D. grantsau*). Figure 11C, D.

Type:—BRAZIL MINAS GERAIS: Grão-Mogol, 9 September 1994, *Rivadavia 302* (holotype SPF).

Perennial, rosetted, acaulescent; leaves semi-erect, with circinate veneration, oblong; stipule rectangular, apical 1/2–1/3 divided into laciniate segments; scape erect at the base, base glabrous to sparsely eglandular-pilose, apex, pedicels and sepals glandular-pilose; seeds usually aborted, but, if present then obconical, testa reticulate.

Illustrations:—Rivadavia (2009: 122, fig. 1 – habit and details).

Distribution:—Brazil (Northeast: BA; Center-West: GO; Southeast: MG), endemic. Always found sympatric with both the parental species.

Habitat:—Found in waterlogged habitats on stream sides and seepages in *campo rupestre* vegetation, in sandy to peat-sandy soils.

Phenology:—Found with flowers from June to November, usually coinciding with the flowering period of *D. tomentosa*.

Specimens examined:—For an extensive list, see Rivadavia (2009: 123).

Additional specimens examined:—BRAZIL. MINAS GERAIS: Grão-Mogol, estrada para Montes Claros, 7 September 2011, *Gonella et al.* 483 (SPF). Itacambira, km 91 da estrada para Montes Claros, 22 April 2010, *Gonella et al.* 291 (SPF), 7 March 2013, *Gonella et al.* 597 (SPF).

Figure 11. A, *Drosera viridis* (bottom) growing sympatrically with *D. communis* (top). B, *D. viridis*, flower. C, D, *D. x fontinalis*. E, natural occurring hybrid between *D. hirtella* and *D. communis*. F, natural occurring hybrids between *D. lutescens* and *D. communis*.

Excluded names

Drosera brasiliensis Mart. ex Eichler (1872: 396) *nom. inval.* – The name was published by Eichler (1872) based on notes by Martius, however, Eichler lists it as a synonym of *D. graminifolia*, rendering it the name the status of invalid (Art. 36.c; McNeill *et al.* 2012). The taxon is conspecific with *D. spiralis* (Gonella *et al.* 2012, 2015).

Drosera sessilifolia var. β Planchon (1848: 189) *nom. inval.* and *D. sessilifolia* var. γ Planchon (1848: 190) *nom. inval.* – both names are invalid since they do not meet Art. 32(b) (McNeill *et al.* 2012), as they are written in Greek letters. Both are conspecific with *D. sessilifolia*.

Drosera ferruginea Larrañaga *nom. nud.* – The name is a *nomen nudum* since no type or original material is mentioned by Larrañaga (1923). Based on the poor diagnosis, the name could refer either to *D. brevifolia* or *D. capillaris*, both occurring in Uruguay.

Drosera pusilla Humb. ex Kunth in Humboldt, Bonpland & Kunth (1823: 390) *nom. illeg. superfl.* – Used by Humboldt in notes and in the herbarium specimen at P and published by Kunth (1823), the name is illegitimate and superfluous since it breaks the principle of priority by placing *D. biflora* (published three years before) as a synonym of the new name (Art. 52.1; McNeill *et al.* 2012).

Drosera tenella Kunth in Humboldt, Bonpland & Kunth (1823: 390) *nom. illeg. superfl.* – Kunth's *D. tenella* is a latter homonym, based on a duplicate from a different herbarium of the same specimen as *Drosera tenella* Willd. ex Roem. & Schult.. Furthermore, Kunth (1823) cites the later name under synonymy of the new name, rendering it the status of illegitimate and superfluous (Arts. 52.1, 53.1; McNeill *et al.* 2012).

Acknowledgements

We would like to thank Dr. José Rubens Pirani and Dra. Rafaela Forzza whom suggested the elaboration of this synopsis, so that the taxonomy of Droseraceae in

Brazil could be updated; Caroline Andrino and Guilherme Antar for testing the key and for giving priceless suggestions for its improvement; all curators and staff of the visited herbaria; the managers and staff of the Chapada dos Veadeiros, Sempre-Vivas and Serra do Cipó National Parks for the collection permits and aid in field trips; Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) for the collection permits; Jan Schlauer and Caroline Andrino for aiding with literature; Rita Pereira, Alcina Viana, Paulo Baleeiro, Marcelo Devecchi, Johnathan Santos, Luciana Thomaz, Weverson Cardoso, Felipe Gonzatti, Pedro Fiaschi and Eduardo Michelena for sending images of herbarium specimens; Vladimir Dorofeyev for specimen information from LE.

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APPENDIX 1: Numerical list of accepted taxa and respective synonyms

Accepted taxa in **bold** typeface; synonyms in regular typeface.

1. ***Drosera amazonica*** Rivadavia, A.Fleischm. & Vicent.
2. ***Drosera ascendens*** A.St.-Hil.
3. ***Drosera biflora*** Willd. ex Roem. & Schult.
=*Drosera pusilla* Humb. ex Kunth in Humboldt, Bonpland & Kunth *nom. illeg. superfl.*
4. ***Drosera brevifolia*** Pursh
=*Drosera chiapasensis* Matuda
=*Drosera maritima* A.St.-Hil.
5. ***Drosera camporupestris*** Rivadavia
6. ***Drosera capillaris*** Poir.
=*Drosera communis* var. *breviscapa* C.Wright ex Griseb.
=*Drosera tenella* Willd. ex Roem. & Schult.
7. ***Drosera cayennensis*** Sagot ex Diels
=*Drosera colombiana* A.Fernández
=*Drosera panamensis* M.D.Correa & A.S.Taylor
=*Drosera pumilla* E.Santos
=*Drosera sanariapoana* Steyerm.
8. ***Drosera chimaera*** Gonella & Rivadavia
9. ***Drosera chrysolepis*** Taub.
10. ***Drosera communis*** A.St.-Hil.
=*Drosera communis* var. *alba* Hoehne
=*Drosera intermedia* var. *tenuis* Eichl.
=*Drosera montana* fo. *parviflora* Chodat
=*Drosera parvifolia* A.St.-Hil.
11. ***Drosera esmeraldae*** (Steyerm.) Maguire & Wurdack
≡*Drosera biflora* var. *esmeraldae* Steyerm.
12. ***Drosera graminifolia*** A.St.-Hil.
=*Drosera graminifolia* var. *major* Eichler
13. ***Drosera grantsau*** Rivadavia
14. ***Drosera graomogolensis*** T.Silva
15. ***Drosera hirtella*** A.St.-Hil.
≡*Drosera montana* var. *hirtella* (A.St.-Hil.) Diels
16. ***Drosera hirticalyx*** R.Duno & Culham

17. ***Drosera intermedia*** Hayne
 =*Drosera americana* Willd.
 =*Drosera capillaris* var. *brasiliensis* Diels
 =*Drosera foliosa* Elliot.
 =*Drosera intermedia* var. *americana* (Willd.) DC.
 =*Drosera intermedia* var. *elator* Planch.
18. ***Drosera latifolia*** (Eichl.) Gonella & Rivadavia
 =*Drosera villosa* var. *bifurca* Buxb.
 =*Drosera villosa* var. *latifolia* Eichl.
19. ***Drosera lutescens*** (A.St.-Hil.) Gonella & Rivadavia
 =*Drosera hirtella* var. *lutescens* A.St.-Hil.
20. ***Drosera magnifica*** Rivadavia & Gonella
21. ***Drosera montana*** A.St.-Hil.
 =*Drosera communis* var. *pauciflora* Eichl.
22. ***Drosera quartzicola*** Rivadavia & Gonella
23. ***Drosera riparia*** Rivadavia & Gonella
24. ***Drosera roraimae*** (Klotzsch ex Diels) Maguire & J.R.Laundon
 =*Drosera montana* var. *robusta* Diels
 =*Drosera montana* var. *roraimae* Diels
25. ***Drosera schwackei*** (Diels) Rivadavia
 =*Drosera montana* var. *schwackei* Diels
26. ***Drosera sesilifolia*** A.St.-Hil.
 =*Drosera dentata* Benth.
27. ***Drosera spiralis*** A.St.-Hil.
28. ***Drosera spirocalyx*** Rivadavia & Gonella
29. ***Drosera tentaculata*** Rivadavia
30. ***Drosera tomentosa*** A.St.-Hil.
 =*Drosera montana* var. *tomentosa* (A.St.-Hil.) Diels
- 30.a. ***Drosera tomentosa*** A.St.Hil. var. ***tomentosa***
- 30.b. ***Drosera tomentosa*** var. ***glabrata*** A.St.-Hil.
31. ***Drosera villosa*** A.St.-Hil.
32. ***Drosera viridis*** Rivadavia

CHAPTER 4

Phylogenetic analyses of Neotropical *Drosera* (Droseraceae)

Article prepared for submission to the periodic **Plant Systematics and
Evolution**

Phylogenetic Analyses of Neotropical *Drosera* (Droseraceae)

Abstract. *Drosera* (Droseraceae) is a genus of carnivorous herbs, comprising ca. 250 species worldwide distributed. Previous phylogenetic works on the genus focused on understanding the relationships between the morphological and geographical groups. Here, we attempted to reconstruct the phylogenetic relationships between the species belonging to the two Neotropics-centered clades of *Drosera* sect. *Drosera* s.s. using *rbcL*, ITS, and *rps16* sequences. Although useful for other species groups inside *Drosera*, the *rps16* primers used didn't result in sequences for the Neotropical species. The marker *rbcL* was useful to reconstruct the backbone of the phylogeny, while the ITS retrieved the relationship between some of the species inside the focal groups, with varying degrees of support. Our densely sampled phylogenetic analysis highlighted leaf vernation as a morphological synapomorphy for the Brazilian tetraploid clade. Although our results refined the resolution inside the two Neotropical clades, we acknowledge the limitation of the used markers to the inference of relationship at the species level in the *Drosera* phylogeny.

Keywords: carnivorous plants, ITS, leaf vernation, phylogeny, *rbcL*, sundews.

Introduction

Droseraceae is a family of carnivorous herbs, comprised by three genera: the monospecific *Aldrovanda* (the water-wheel plant) and *Dionaea* (the Venus flytrap), and the species-rich *Drosera* (the sundews). The last is a worldwide-distributed genus, currently comprising around 250 species (Meimberg et al. 2000, Gonella et al. 2015). *Drosera*'s greatest centers of diversity are southwestern and northern Australia, which are home to ca. 150 species (Lowrie 2013), but the genus is also well represented in Southern Africa and South America (ca. 35 and 40 species, respectively; Fleischmann, unpubl.; Gonella et al., unpubl. – Chapter 3 of the current thesis).

Previous phylogenetic studies based on combined data from morphology and/or different molecular markers (Williams et al. 1994; Meimberg et al. 2000, Cameron et al. 2002; Rivadavia et al. 2003, 2012; Yesson & Culham 2005; Heubl et al. 2006; Veleba et al. 2017) support *Drosera* as a monophyletic group, sister to the clade including *Dionaea* and *Aldrovanda*. The South-African *Drosera regia* Stephens and the Australian-New Zealander *D. arcturi* Hook. form a grade and are consecutive sisters to all the rest of the genus, that further splits in two highly-diversified lineages: the “Australian clade” comprising taxa mostly endemic to the Australian continent and surrounding islands, and an “out of Australia” clade (or “Cosmopolitan clade”; Veleba et al. 2017). Some taxa belonging to the later clade, indeed occur exclusively in Australia, and commonly belong to groups connected to deeper nodes, while taxa occurring in all other continents, except for Antarctica, are usually concentrated in shallower nodes (Williams et al. 1994; Rivadavia et al. 2003, 2012).

Although phylogenetic studies confirmed most of the infrageneric classification previously proposed for *Drosera* by Seine & Barthlott (1994) and Schlauer (1996), both *Drosera* subg. *Drosera* and *D.* sect. *Drosera* in these classification systems were found to be polyphyletic, revealing the need for a new classification. That is further evidenced by the fact that the last monograph dealing with the whole genus was published over a century ago, when only 84 species were recognized (Diels 1906).

Among the “Cosmopolitan” lineage, a clade mainly composed by Neotropical and diploid taxa ($2n=20$) and including the genus' type species, *Drosera rotundifolia* L., is sister to a group comprising two clades, the African clade and the “Brazilian tetraploid” clade (with $2n=40$; Rivadavia et al. 2003, 2012; Gonella 2012). The clade

comprising these three lineages is here treated as *D. sect. Drosera* in a strict sense, but further work on the infrageneric classification is clearly necessary. Altogether, it is estimated that *D. sect. Drosera s.s.* contains around 80 species, and its diagnostic characters are the presence of an intrapetiolar stipule (lost or reduced in some taxa), the geniculate leaf vernation (in the immature leaves, the lamina if folded over the petiole) and the styles in number of three and bifurcated at the base, some of the characters used by Seine & Barthlott (1994) in their classification.

The plastidial marker *rbcL*, used by Rivadavia *et al.* (2003, 2012), was important for the recognition of the main lineages inside *Drosera*. However, the resolution inside such lineages was very low, especially inside the three clades of *D. sect. Drosera s.s.* Furthermore, Rivadavia *et al.* (2003, 2012) sampled a total of 17 Neotropical species in their studies and the support for the monophyly of said clades was very weak.

For the current work, we expanded the sampling to 36 Neotropical taxa, expanding the coverage for the Neotropical diploid clade and also including all but two of the putative members of the Brazilian tetraploid clade. Our goal was to infer the phylogeny of *Drosera* focusing on Neotropical taxa, test the monophyly of the two Neotropical clades of *Drosera sect. Drosera s.s.*, and attempt to understand the relationships between the taxa inside said clades using sequences of two genetic markers, the plastidial *rbcL*, and the nuclear ITS. Furthermore, we inferred the evolution of some of the characters historically used in the infrageneric classification of the genus to find morphological synapomorphies for the studied groups.

Material & Methods

Taxonomic and molecular sampling

The dataset comprises 110 accessions representing 68 out of the currently (ca.) 250 accepted *Drosera* species, plus two putative new species and three natural hybrids, as well as *Dionaea* as the outgroup. Sequences available on GenBank of *Drosera* taxa representing the main clades recognized by Rivadavia *et al.* (2003, 2012) were included in the analysis to show the backbone of the phylogeny. The two undiagnosed taxa are identified according to the putative closest relative based on morphology alone (e.g. *D. aff. cayennensis* and *D. aff. hirtella*). The samples collected originated mainly from fieldwork developed by the first author, but also from herbarium material (vouchers were deposited at the SPF herbarium collection –

University of São Paulo, Brazil). Freshly collected leaf (petioles) and flower (petals) tissues were preserved in silica gel.

Table 1 lists species names, sampling location, sequences obtained (*rbcL* and/or ITS), vouchers and the labels used in the trees for all the dataset generated in the current work, while Tables 2 and 3 show species names, GenBank accession numbers, labels and continental distribution for the included taxa with sequences obtained from GenBank for the *rbcL* and ITS, respectively.

DNA extraction and purification

Drosera shows high concentrations of different types of secondary metabolites, such as pigments, polysaccharides (mucilage) and phenolic compounds – all of these are well known to interfere both with DNA extraction and amplification, by reducing the activity and affinity of the Taq polymerase (Fleischmann & Heubl, 2009; Kovacik et al. 2012; Egan & van der Kooy, 2013). To overcome this, we used very small amounts of dried material (10–30 mg), preferably petals or petioles, and used the extraction protocol described by Fleischmann & Heubl (2009), with modifications as follows: in the first step, 120 µl of 10% PVP is added to the suspension (instead of 60 µl); furthermore, the phenol: chloroform step is skipped, proceeding directly to the chloroform: isoamyl alcohol step.

Efforts were made to remove PCR-inhibiting substances from the eluted DNA after DNA extraction, by using a specially designed commercial kit for DNA purification (One-step PCR inhibitor removal kit, Zymo Research). However, in many cases, the so purified DNA could also not be amplified by PCR techniques, which indicates that the PCR interfering substances did bind strongly to the DNA already during early steps of the extraction. This is likely, as oxidized polyphenolic compounds are known to bind covalently and thus irreversibly to DNA molecules – the *Drosera* polyphenolics get oxidized during the cell lysis step of DNA extraction and will immediately attach to the free DNA molecules, which are therefore unsuitable for PCR amplification (see Fleischmann & Heubl, 2009).

DNA amplification and sequencing

Amplification of the plastid molecular marker *rbcL* was performed using the primer *rbcLaF* and protocol of Kress & Erickson (2007). The nuclear internal transcribed spacer (ITS) region was amplified using the PCR primers Leu1 (Walker

and Sytsma, 2007) and ITS4 (White et al., 1990), following the PCR protocol published in White et al. (1990). Primers and PCR protocols for amplification and sequencing of the *rps16* intron followed Oxelman et al. (1997).

The cycle sequencing reaction (using BigDye Terminator v3.1), cleanup and electrophoresis were performed at LMU Biozentrum on an ABI 3730 DNA Analyzer (Applied Biosystems).

Phylogenetic analyses

Sequences were aligned using MAFFT online, version 7 (Kato and Toh 2008), with subsequent manual adjustments. Initial and terminal regions with ambiguous, doubtful, or with high number of missing data were excluded.

Incongruence among data partitions was tested using the incongruence length difference test (ILD) (Farris et al. 1994 as implemented in PAUP* v.4.0b10 (Swofford 2002)). The ILD test was performed between the separate partitions, *rbcL* and ITS, using a heuristic search with 1000 homogeneity replicates, excluding invariant characters previously the analyses. We assumed $p \leq 0.01$ as evidence of significant incongruence (Cunningham 1997, Leigh et al. 2011). The individual gene alignments were concatenated using Sequence Matrix (Vaidya et al. 2010).

Subsequently, the best-fit models of nucleotide substitution for the individual data partitions were determined with jModelTest 2 program (Darriba et al. 2012, Guindon and Gascuel 2003) using the Akaike Information Criterion (AIC). GTR+G+I was identified as the most appropriate model for the *rbcL* and ITS datasets.

For both, Maximum likelihood (ML) and Bayesian inferences (BI), we used the versions available online through the CIPRES project (Miller et al. 2010). ML analyses were run in RaxML, version 8.2.9 (Stamatakis 2014), using the rapid bootstrap algorithm with 1,000 non-parametric bootstrap replicates (BS) and the thorough ML search option (Stamatakis et al. 2008). Bayesian inferences (BI) were performed with MrBayes 3.2.6 (Ronquist and Huelsenbeck, 2003). In BI, two independent MCMC runs were conducted, each composed of four linked chains that ran for 10,000,000 generations with sampling every 1000 generations. Likelihood values were monitored graphically to detect stationarity with Tracer 1.6 (Rambaut et al. 2013). Posterior probabilities (PP) were used to assess clade support. Clades with BS higher than 75% (ML) or PP higher than 0.95 (BI) were considered strongly supported (Cummings et al. 2003). Final trees were visualized and graphically edited using FigTree 1.4.0 (Rambaut 2010).

Parsimony analysis (Maximum Parsimony - MP) was performed in TNT version 1.1 (Goloboff et al. 2000). Heuristic searches were carried on a combination of the random addition of sequences algorithm followed of rearrangement of branches through tree bisection-reconnection (TBR), parsimony ratchet (Nixon 1999), tree fusing (Goloboff 1999), and sectorial searches (Goloboff 1999) under driven searches. The best solution was reached 200 times before the search was stopped. In cases where more than one equally parsimonious MP tree was found, support values were plotted over a semi-strict consensus tree summarizing competing hypotheses.

Morphological character states reconstruction

Optimization of all morphological characters was performed in Mesquite v. 2.75 (Maddison & Maddison 2011) using the Parsimony Ancestral States reconstruction method to investigate occurrence of synapomorphies and to understand evolution of six particular characters: intrapetiolar stipules, snap tentacles, glandular indumentum on leaves, style number and division, and leaf vernation. The tree obtained in the Bayesian Inference analysis was used for this procedure.

Results

Molecular datasets and congruence between datasets

We obtained 54 sequences of *rbcL* and 43 of ITS (Table 1), which were combined with 51 sequences of *rbcL* (Table 2) and 32 of ITS (Table 3) available on GenBank (Benson 2005) totalizing 110 different accessions. The alignment for *rbcL* and ITS was 536 and 877 bp in length, respectively. The total length of the final alignment contained 1,413 bp. The ILD test showed that the *rbcL* and ITS datasets are not incongruent ($p = 0.01$) at the level of $p \geq 0.01$ as suggested in the literature (Cunningham 1997, Leigh et al. 2011).

No *rps16* sequence was obtained using the described primers, so this marker was excluded from the analyses.

Phylogenetic inference

Both markers alone as well as the concatenated datasets in the three analytic approaches corroborated both the “Brazilian tetraploid clade” (BTC) as well as the

“Neotropical diploid clade” (NDC) as monophyletic groups, with the NDC being sister to a clade with the BTC and the African clade. Main differences were observed in the resolution inside the clades, with the MP analysis resulting in clades less resolved and supported, and the ML and BI showing better resolution and support. The trees obtained in the Bayesian Inference and Maximum Likelihood analyses from the concatenated datasets are shown in Figures 1 and 2, respectively.

Both the concatenated MP and ML analysis showed low bootstrap values (BP and BL, respectively) for both BTC (40 BP, 51 BL) and NDC (27 BP, 64 BL) clades, while the BI analysis showed high posterior probability (PP) for both clades (100 PP and 95 PP, respectively).

rbcL tree

The BTC and NDC are both weakly resolved in the isolated *rbcL* tree in all three analytic approaches. The NDC is monophyletic (100 BP, 68 BL, 93 PP), with all the accessions generated here grouping together with relatively high support (100 BP, 85 BL, 94 PP), but collapsed in a polytomy, with the exception of *D. aff. hirtella*, of which both accessions group together (100 BP, 94 BL, 100 PP). The former clade is sister to a clade containing *D. capillaris*, *D. esmeraldae*, *D. filiformis* and *D. intermedia* (100 BP, 66 BL, 99 PP). The basal nodes inside the NDC are less resolved in all analyses, with disagreements regarding on the most inclusive node: in the MP consensus tree, *D. neocaledonica* is sister to the group with all other species, while in the ML and BI trees, a basal polytomy is formed with *D. brevifolia*, *D. rotundifolia* and the clade with the remaining species.

In the BTC, a basal polytomy is also formed, but a few clades can be recognized, with medium to high support. One of the clades comprises *D. camporupestris*, most of *D. chrysolepis* accessions (the exception being the one from Chapada Diamantina), *D. quartzicola* and its hybrid with *D. chrysolepis*, *D. graminifolia* and one of the three accessions of *D. spiralis* (100 BP, 65 BL, 91 PP). Another clade was retrieved in all analyses, although more inclusive in the MP analysis. In the ML and BI analyses, a clade containing *D. chimaera*, *D. grantsau*, *D. peruensis*, *D. latifolia*, *D. tomentosa* and the hybrid with *D. latifolia*, *D. villosa*, and a single accession of *D. montana*, from Serra do Ibitipoca presents only medium support (52 BL, 76 PP). In the MP it is only weakly supported (<50 BP) and further includes all *D. montana* accessions and *D. riparia* from the type location. This clade is poorly resolved and all clades inside it are only weakly supported. Finally, two of

the *D. montana* accessions group together with high support at the basal polytomy in the ML and BI analyses (89 BL, 100 PP), while in the MP it falls within the above-mentioned clade (100 BP).

ITS tree

A great discrepancy was observed between the trees obtained in each analytic approach when using the isolated ITS dataset.

The BTC is retrieved as monophyletic only in the BI analyses, with strong support (98 PP), but not in the MP and ML analyses. Both in the MP and ML trees, all of the accessions newly generated for this study group together with strong support (94 BP, 94 BL), but in the MP tree the accessions obtained from the Genbank fall within a basal polytomy containing the remaining of the BTC, the NDC, and the African species. In the ML tree, *D. capensis* falls within the clade containing all of the BTC species, but it is only weakly supported (<50 BL), and the remaining of the African species are sister to a clade containing most of the NDC species, but also very weakly supported (<50 BL). The “African clade” also is not retrieved as monophyletic in the MP tree, but instead, its species are spread in the said basal polytomy.

The NDC is also not retrieved as monophyletic in the MP and ML analyses, as the *D. spatulata* accessions group together (100 BP, 100 BL) and are retrieved as sister to all species of the BTC, NDC and African clades with strong support (100 BP) in the MP analysis or in a polytomy with all these clades in the ML analysis. However, all the remaining accession group together with high support (97 BP, 100 BL). In the BI tree, the NDC is found as monophyletic, but only with weak support (57 PP).

Concatenated dataset tree

Both the BTC (<50 BP, 51 BL, 100 PP) and the NDC (<50 BP, 64 BL, 93 PP) are retrieved as monophyletic in all analytic approaches using the concatenated dataset, with the BTC as sister to the African clade and these two as sister to the NDC. The NDC is better resolved in the BI (Fig. 1) and ML (Fig. 2) trees, with similar topology, while in the MP tree only a few clades inside it are recognized, but they are mostly collapsed into polytomies. The BTC is also collapsed into a large polytomy in the MP tree, with only one clade recognized inside it (<50 BP) containing the two accessions of *D. latifolia* from the Sempre-Vivas National Park, the hybrid between *D. latifolia* and *D. tomentosa*, and *D. montana* from Serra do Ibitipoca. The clade *D. chimaera* to

D. villosa, found in the *rbcL* trees of the ML and BI analyses are also retrieved in the trees of the concatenated dataset of the same analytic approaches (<50 BL, 85 PP).

Morphological character states reconstruction

Circinate leaf vernation is a possible synapomorphy of the BTC, with a single reversal in *D. tentaculata*, which presents geniculate leaf vernation (Figure 3).

Styles in a number of three is a synapomorphy of *Drosera*, while the styles bifurcated at the base is a synapomorphy of *Drosera* sect. *Drosera* s.s. (Figure 4). Finally, the presence of stipules appears as a synapomorphy of the “core-*Drosera*” (Australian+Cosmopolitan clades), with many reversals within it (Figure 5).

Discussion

The topology of the trees here obtained corroborated that of the *rbcL* trees presented by Rivadavia et al. (2003, 2012), with two main clades splitting at the base of the *Drosera* phylogeny: the “Australian clade” and the “Cosmopolitan clade” form a monophyletic group. Within the later, Australian taxa (e.g. *D. adaelae*, *D. hamiltonii*) are found in clades connected to deeper nodes, while shallower nodes include taxa from the American and African continents (the NDC, BTC and African clades). Main disagreements occurred at the base of the concatenated ML tree regarding the position of *D. uniflora* and *D. burmannii*, but with low support. Also, *D. glanduligera* is not retrieved in the Australian clade in any of the analyses, but instead, it appears at the base of the Cosmopolitan clade with weak support. In the analyses of Rivadavia et al. (2003, 2012), the species appear at the base of the Australian clade, but also only weakly supported. Further studies using other genomic markers are necessary to better understand the placement this species in the *Drosera* phylogeny. In our analyses, *D. spatulata* emerged as sister to the rest of the NDC (in the ML and BI analyses) or within it (MP analysis), in disagreement with the results of Rivadavia et al. (2012), which show this taxon in a polytomy with the BTC and the African clade.

Although useful for the inference of the relationships at species level for the Australian clade (Fleischmann, unpublished data), the plastidial marker *rps16* intron could not be amplified for the Neotropical taxa of *Drosera* sect. *Drosera* s.s. Possible explanations could be the deletion of such site, or by a weaker affinity of the used primers due to substantial changes in the sequence of this region in these taxa, but such hypothesis should be further investigated.

The Neotropical diploid clade

In the NDC, *D. spatulata* and *D. rotundifolia* are consecutive sisters to the remaining of the species of the clade (Figure 1). This corroborates the hypothesis of an Australian origin of the group, migrating further north along SE and E Asia, from where it probably colonized North America (Rivadavia et al. 2003; Miranda et al. 2006). Our results further agree with the colonization of South America by a North American ancestor, as North American taxa diverged earlier in the history of the clade, being consecutive sisters to lineages from South America, where it presents its higher diversification.

Drosera viridis appears as sister of *D. communis*, as expected from morphology (Rivadavia 2003; Gonella et al. in prep – Chapter 3). Although *D. viridis* is a taxon with weak morphological boundaries when compared to *D. communis* (Gonella et al. in prep. – Chapter 3), the results of our analyses corroborate the species status for this taxon. These two taxa are sister to *D. hirtella* (and *D. aff. hirtella*), with which *D. communis* is known to hybridize with (Gonella et al. in prep. – Chapter 3). All these taxa further share the presence of a curve at the base of the scape. The clade containing these species is sister to *D. cayennensis* and the probable new species *D. aff. cayennensis*. The latter taxon is found in Goiás state, in central Brazil, where *D. cayennensis* co-occurs with *D. hirtella* var. *lutescens*; so, further field and morphological studies are necessary to evaluate the species status for this taxon. The inclusion of *D. hirtella* var. *lutescens* in the sampling might bring some clarification to the relationship among the taxa within this clade.

The Brazilian tetraploid clade

Almost all putative BTC species (i.e. Neotropical taxa with circinate leaf veneration, Fig. 6; Gonella 2012, Gonella et al. 2016) were sampled in this work (exceptions being *D. condor* and *D. cendeensis*) and form a monophyletic group, with the circinate leaf veneration being a possible synapomorphy (Fig. 3). The group is centered in the Espinhaço Range and highlands of east Brazil, with a few taxa spreading towards the west of that country and neighbor countries (Gonella 2012; Gonella et al. 2012, 2014, 2015; Rivadavia et al. 2014).

Based on the circinate leaf veneration and triangular stipules, Gonella et al. (2016) postulated that *D. peruensis* and the morphologically similar *D. cendeensis* and *D. condor*, also from the Andes, could also belong to the BTC. Our results agree

with the inclusion of *D. peruensis* in the clade, as it appears in close relation to *D. grantsau* (Figure 1). Both species share the oblong leaves and the erect developed stem (forming a column of dead leaves in *D. peruensis*, while *D. grantsau* presents longer internodes and a slender stem), but scape and sepal indumentum is divergent in *D. peruensis*, when compared to all other members of the BTC (Gonella et al. 2016). Furthermore, the two species are well separated geographically: while *D. grantsau* is widespread in central and southwestern Brazil and in eastern Paraguay, *D. peruensis* is found in the sub-Andean cordilleras in Peru and Ecuador. Given the position of *D. peruensis* in a late diverging lineage within the BTC, either a colonization of the sub-Andean cordilleras from a widespread lower land ancestor or long distance dispersal are plausible scenarios.

The recently described *D. magnifica* was here first included in a phylogenetic study and, as already suggested by Gonella et al. (2015) based on general morphology (such as circinate-involute leaf vernation and triangular stipules), the inclusion of the species in the BTC is here corroborated. However, the close affinity of this species to *D. graminifolia* and *D. spiralis*, as postulated by Gonella et al. (2015), could not be supported by the data here available, as none of the analyses corroborated this hypothesis. The species falls within the basal polytomy of the BTC in most trees, with the exception of the ML trees for the ITS and concatenated matrices, that show *D. magnifica* sister to *D. quartzicola* or to the clade *D. latifolia* x *D. tomentosa* to *D. spirocalyx* (Fig. 2) respectively, but with low support.

Rivadavia (2009) postulated a closer affinity of *D. grantsau* to *D. tomentosa*, based on the occurrence of natural hybrids between both taxa and Gonella et al. (2014) and Rivadavia et al. (2014) suggested a closer relationship between some members of the *D. villosa* and *D. montana* complexes based on morphology and hybridization between them. This is partially corroborated here, as the accessions of *D. tomentosa*, *D. chimaera*, *D. latifolia*, *D. grantsau*, *D. villosa* and *D. montana* group together with strong support in the concatenated BI analysis (85 PP), but low support is found in the ML (<50 BL). *Drosera chimaera* was described as morphologically intermediate between *D. tomentosa* and *D. latifolia*, with most characteristics resembling the former (Gonella et al. 2014) – in our analyses, the species appear in close affinity with *D. tomentosa* (Figs. 1, 2), corroborating the hypothesis. The ML concatenated tree shows *D. latifolia* sister to the clade *D. tomentosa* var. *tomentosa* (Pico da Aliança) to *D. chimaera* (type location), and this clade as sister to *D. peruensis* to *D. villosa*, but all nodes with low support (<50 BL).

Rivadavia & Gonella (2011), Gonella (2012), Gonella *et al.* (2012, 2015) all suggested a closer affinity between the species of the BTC presenting glandular indumentum on leaves and also large, triangular stipules. This closer affinity was not retrieved in the majority of our analyses, as the species presenting such feature do not group together, but mostly collapse in a polytomy (Fig. 3) – ergo, not discarding the hypothesis. Such taxa only form a clade in the ML ITS tree, however with low support (<50 BL). In this tree, *D. schwackei* is sister to the remaining species, and it also shows a closer relationship of *D. camporupensis* with *D. chrysolepis*, and *D. graminifolia* with *D. spiralis*, as proposed by Rivadavia (2003) and Gonella *et al.* (2012), respectively. This topology suggests that the glandular indumentum of leaves appeared first in the history of the group, as this feature is present in *D. schwackei*, and the large triangular stipules only appearing later (*D. schwackei* has smaller, rectangular stipules; Gonella 2012).

Drosera montana has long been treated in a broader sense, including *D. hirtella*, *D. tomentosa*, *D. tentaculata*, *D. schwackei*, among others. Rivadavia *et al.* (2003) showed that these taxa do not form a monophyletic group and Rivadavia *et al.* (2014) further described the morphological diversity of the complex and recognized four species in the affinity, while *D. hirtella* and *D. schwackei* were excluded from it. The four species (*D. montana*, *D. spirocalyx*, *D. tentaculata* and *D. tomentosa*), however, do not form a monophyletic group in our trees. Furthermore, the *D. montana* accessions used in the current study do not group together but are instead spread within the BTC. Rivadavia *et al.* (2014) argued that the species, even in its stricter sense adopted in their work, is still highly variable, and recognized three regional morphotypes. Further studies, comparing these morphotypes using morphometric approaches and other genomic markers could bring more clarity to the understanding of this taxon.

Concluding Remarks

The analyses performed with our dataset were not conclusive for the inference of the relationships among the taxa belonging to *Drosera* sect. *Drosera* s.s., as they did not retrieve strong support or resolution within the clades. This could be explained by the recent diversification of these lineages, especially the BTC, estimated to have started diversifying around 8–7.5 Mya (Yesson & Culham 2006). The use of other genomic markers or approaches that do not depend on the success of a few markers (e.g. Next Generation Sequencing – NGS) could improve our knowledge on the

topology inside such clades.

Nevertheless, our results corroborated the topology found in previous phylogenetic works (Rivadavia et al. 2003, 2012) and further refined the resolution within the BTC and the NDC. We also corroborated the species circumscriptions adopted in previous taxonomic works (Rivadavia 2003, 2008, Rivadavia & Gonella 2011, Gonella et al. 2012, 2014, 2015, 2016, Rivadavia et al. 2014), showed that leaf veneration is an important trait for the taxonomy of Neotropical *Drosera*, and that particular characteristics (e.g. leaf shape, indumentum, seed shape, among others) should be taken into account for the identification and classification of these taxa over an overall similarity – hence, a more “splitter” taxonomic approach seems better backed by the phylogeny than a “lumper” approach.

Our data, in a broader context, combined with accessions of the other clades not treated here, will be of crucial importance for a new infrageneric classification of the genus, possibly raising each of the three clades of *Drosera* sect. *Drosera* s.s to section level, supported by morphology, geographical distribution, and phylogeny.

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Figure 2. Tree obtained from the Maximum Likelihood analysis of the combined datasets (*rbcL*+ITS). Numbers above branches indicate bootstrap support. Only values ≥ 50 are shown.

Figure 3. Selected morphological characters optimized in the BI tree obtained for the concatenated datasets. A, Leaf vernation; B, Glandular indumentum on leaves.

Figure 4. Selected morphological characters optimized in the BI tree obtained for the concatenated datasets. A, Style number; B, Style division.

Figure 5. Morphological character “Stipules” optimized in the BI tree obtained for the concatenated datasets.

Figure 6. Examples of leaf vernation in *Drosera*. A, geniculate leaf vernation in *D. madagascariensis*. B, circinate leaf vernation in *D. villosa*. C, entire leaf vernation in *D. sessilifolia*.

Table 1. Taxa sampled for the current study, location data, voucher, herbarium, labels used in the tree figures and sequences obtained for *rbcl* and/or ITS.

Taxon	Location	Voucher	Herb.	Label	rbcl	ITS
<i>Drosera</i> aff. <i>cayennensis</i> Sagot ex Diels	Chapada dos Veadeiros, GO	Gonella 666	SPF	<i>Drosera_affcayennensis_666</i>	y	y
<i>Drosera</i> aff. <i>cayennensis</i> Sagot ex Diels	Chapada dos Veadeiros, GO	Gonella 663	SPF	<i>Drosera_affcayennensis_663</i>	y	y
<i>Drosera</i> aff. <i>hirtella</i> A.St.-Hil.	Chapada dos Veadeiros, GO	Gonella 650	SPF	<i>Drosera_affhirtella_1</i>	y	y
<i>Drosera</i> aff. <i>hirtella</i> A.St.-Hil.	Chapada dos Veadeiros, GO	Gonella 658	SPF	<i>Drosera_affhirtella_2</i>	y	y
<i>Drosera ascendens</i> A.St.-Hil.	Parque Nacional das Sempre Vivas, MG	Gonella 734	SPF	<i>Drosera_ascendens_1</i>	y	y
<i>Drosera brevifolia</i> Pursh	Campo Largo, PR	Alves 38	SPF	<i>Drosera_brevifolia_CL</i>	y	
<i>Drosera camporupetris</i> Rivadavia	Parque Nacional das Sempre Vivas, MG	Gonella 726	SPF	<i>Drosera_camporupetris_PNSV</i>	y	y
<i>Drosera camporupetris</i> Rivadavia	Serra do Cipó, MG	Gonella 257	SPF	<i>Drosera_camporupetris_SC</i>	y	
<i>Drosera cayennensis</i> Sagot ex Diels	Chapada dos Veadeiros, GO	Gonella 661	SPF	<i>Drosera_cayennensis_CV2</i>	y	y
<i>Drosera chimaera</i> Gonella & Rivadavia	Grão Mogol, MG	Gonella 489	SPF	<i>Drosera_chimaera_2</i>	y	y
<i>Drosera chimaera</i> Gonella & Rivadavia	Cristália, MG	Gonella 500	SPF	<i>Drosera_chimaera_TYPE</i>	y	
<i>Drosera chrysolepis</i> Taub.	Congonhas do Norte, MG	Gonella 629	SPF	<i>Drosera_chrysolepis_CN</i>	y	y
<i>Drosera chrysolepis</i> Taub.	Serra do Cipó, MG	Gonella 269	SPF	<i>Drosera_chrysolepis_SC</i>	y	y
<i>Drosera chrysolepis</i> Taub.	Chapada Diamantina, BA	Gonella 532	SPF	<i>Drosera_chrysolepis_CD</i>	y	
<i>Drosera chrysolepis</i> Taub.	Serra do Cipó, MG	Gonella 634	SPF	<i>Drosera_chrysolepis_SC2</i>	y	y
<i>Drosera communis</i> A.St.-Hil.	Balsa Nova	Alves 22	SPF	<i>Drosera_communis_BN</i>		y
<i>Drosera communis</i> A.St.-Hil.	Serra do Cipó, MG	Gonella 126	SPF	<i>Drosera_communis_SC</i>		y
<i>Drosera communis</i> A.St.-Hil.	Parque Nacional das Sempre Vivas, MG	Gonella 733	SPF	<i>Drosera_communis_PNSV</i>	y	y
<i>Drosera communis</i> A.St.-Hil.	Jalapão, TO	Gonella 557	SPF	<i>Drosera_communis_Jal</i>	y	y
<i>Drosera graminifolia</i> A.St.-Hil.	Serra do Caraça, MG	Gonella 412	SPF	<i>Drosera_graminifolia</i>	y	y
<i>Drosera grantsau</i> Rivadavia	Parque Nacional das Sempre Vivas, MG	Gonella 736	SPF	<i>Drosera_grantsaui_PNSV2</i>	y	y
<i>Drosera grantsau</i> Rivadavia	Grão Mogol, MG	Gonella 482	SPF	<i>Drosera_grantsaui_GM</i>	y	
<i>Drosera grantsau</i> Rivadavia	Jalapão, TO	Gonella 556	SPF	<i>Drosera_grantsaui_Jal</i>		y
<i>Drosera grantsau</i> Rivadavia	Posse, GO	Gonella 513	SPF	<i>Drosera_grantsaui_Poss</i>		y

Table 1. cont.

<i>Drosera graomogolensis</i> T.Silva	Grão Mogol, MG	Gonella 486	SPF	<i>Drosera_graomogolensis_GM</i>	y
<i>Drosera hirtella</i> A.St.-Hil.	Serra do Cipó, MG	Gonella 668	SPF	<i>Drosera_hirtella_SC</i>	y
<i>Drosera hirtella</i> A.St.-Hil.	Chapada dos Veadeiros, GO	Gonella 655	SPF	<i>Drosera_hirtella_CV</i>	y
<i>Drosera hirtella</i> x <i>D. communis</i>	Chapada dos Veadeiros, GO	Gonella 657	SPF	<i>Drosera_hirtellaxcommunis</i>	y
<i>Drosera latifolia</i> (Eichler) Gonella & Rivadavia	São Bernardo do Campo, SP	Gonella 31	SPF	<i>Drosera_latifolia_SB</i>	y
<i>Drosera latifolia</i> (Eichler) Gonella & Rivadavia	Parque Nacional das Sempre Vivas, MG	Gonella 452	SPF	<i>Drosera_latifolia_PNSV</i>	y
<i>Drosera latifolia</i> (Eichler) Gonella & Rivadavia	Aiuruoca, MG	Rohrbacher 221	SPF	<i>Drosera_latifolia_Aiur</i>	y
<i>Drosera latifolia</i> (Eichler) Gonella & Rivadavia	Parque Nacional das Sempre Vivas, MG	Gonella 735	SPF	<i>Drosera_latifolia_PNSV2</i>	y
<i>Drosera latifolia</i> (Eichler) Gonella & Rivadavia	Serra do Quiriri, SC	Rivadavia 2439	SPF	<i>Drosera_latifolia_Quir</i>	y
<i>Drosera latifolia</i> x <i>D. tomentosa</i>	Diamantina, MG	Gonella 272	SPF	<i>Drosera_latifoliaxtomentosa</i>	y
<i>Drosera magnifica</i> Rivadavia & Gonella	Pico do Pe. Ângelo, MG	Gonella 645	SPF	<i>Drosera_magnifica</i>	y
<i>Drosera montana</i> A.St.-Hil.	Chapada dos Veadeiros, GO	Gonella 665	SPF	<i>Drosera_montana_CV</i>	y
<i>Drosera montana</i> A.St.-Hil.	Serra de Ibitipoca, MG	Gonella 361	SPF	<i>Drosera_montana_Ibit</i>	y
<i>Drosera montana</i> A.St.-Hil.	Serra do Cipó, MG	Gonella 166	SPF	<i>Drosera_montana_SC</i>	y
<i>Drosera montana</i> A.St.-Hil.	Campo Largo, PR	Alves 17	SPF	<i>Drosera_montana_CL</i>	y
<i>Drosera peruensis</i> T.Silva & M.D.Correa	Sira Mountains, Peru	Graham 6038	SPF	<i>Drosera_peruensis</i>	y
<i>Drosera quartzicola</i> Rivadavia & Gonella	Serra do Cipó, MG	Gonella 264	SPF	<i>Drosera_quartzicola_1</i>	y
<i>Drosera quartzicola</i> Rivadavia & Gonella	Serra do Cipó, MG	Gonella 633	SPF	<i>Drosera_quartzicola_2</i>	y
<i>Drosera quartzicola</i> x <i>D. chrysolepis</i>	Serra do Cipó, MG	Gonella 265	SPF	<i>Drosera_quartzicolaxchrysolepis</i>	y
<i>Drosera riparia</i> Rivadavia & Gonella	Chapada Diamantina, BA	Gonella 543	SPF	<i>Drosera_riparia_Type</i>	y
<i>Drosera riparia</i> Rivadavia & Gonella	Chapada Diamantina, BA	Santos 1	ALCB	<i>Drosera_riparia_CD</i>	y
<i>Drosera schwackei</i> (Diels) Rivadavia	Diamantina, MG	Gonella 617	SPF	<i>Drosera_schwackei_Diam</i>	y
<i>Drosera schwackei</i> (Diels) Rivadavia	Congonhas do Norte, MG	Gonella 630	SPF	<i>Drosera_schwackei_CN</i>	y
<i>Drosera sessilifolia</i> A.St.-Hil.	Barra do Bugres, MT	Borges 818	SPF	<i>Drosera_sessilifolia_BB</i>	y
<i>Drosera spiralis</i> A.St.-Hil.	Parque Nacional das Sempre Vivas, MG	Gonella 737	SPF	<i>Drosera_spiralis_PNSV</i>	y
<i>Drosera spiralis</i> A.St.-Hil.	Itacambira, MG	Gonella 720	SPF	<i>Drosera_spiralis_ITA</i>	y
<i>Drosera spirocalyx</i> Rivadavia & Gonella	Serra do Cipó, MG	Gonella 266	SPF	<i>Drosera_spirocalix</i>	y

Table 1. cont.

<i>Drosera tentaculata</i> Rivadavia	Serra do Cipó, MG	Gonella 421	SPF	<i>Drosera_tentaculata_SC</i>	y
<i>Drosera tentaculata</i> Rivadavia	Itacambira, MG	Gonella 721	SPF	<i>Drosera_tentaculata_ITA</i>	y
<i>Drosera tomentosa</i> var. <i>glabrata</i> A.St.-Hil.	Serra do Cipó, MG	Gonella 270	SPF	<i>Drosera_tomentosa_g_SC</i>	y
<i>Drosera tomentosa</i> A.St.-Hil. var. <i>tomentosa</i>	Serranópolis de Minas, MG	Gonella 492	SPF	<i>Drosera_tomentosa_t_SM_2</i>	y
<i>Drosera tomentosa</i> A.St.-Hil. var. <i>tomentosa</i>	Itacambira, MG	Gonella 722	SPF	<i>Drosera_tomentosa_t_ITA</i>	y
<i>Drosera tomentosa</i> A.St.-Hil. var. <i>tomentosa</i>	Serranópolis de Minas, MG	Gonella 498	SPF	<i>Drosera_tomentosa_t_SM</i>	y
<i>Drosera tomentosa</i> A.St.-Hil. var. <i>tomentosa</i>	Serra do Cipó, MG	Gonella 258	SPF	<i>Drosera_tomentosa_t_SC</i>	y
<i>Drosera tomentosa</i> A.St.-Hil. var. <i>tomentosa</i>	Pico da Aliança, MG	Gonella 678	SPF	<i>Drosera_tomentosa_t_PA</i>	y
<i>Drosera villosa</i> A.St.-Hil.	Serra Negra, Mantiqueira, MG	Gonella 252	SPF	<i>Drosera_villosa_SN</i>	y
<i>Drosera viridis</i> Rivadavia	Balsa Nova, PR	Alves 23	SPF	<i>Drosera_viridis_BN</i>	y
<i>Drosera viridis</i> Rivadavia	Embu Guaçu, SP	Rivadavia 2143	SPF	<i>Drosera_viridis</i>	y

Table 2. Sequences from GenBank for the *rbcl*. Taxa, accession number, labels used in the tree figures and continental distribution.

Taxon	GenBank Accession #	Label	Distribution
<i>Drosera adelsae</i>	AB072514.1	<i>Drosera_adelsae</i>	Australia
<i>Drosera aliciae</i>	AB072516.1	<i>Drosera_aliciae</i>	Africa
<i>Drosera anglica</i> Huds.	AB355692.1	<i>Drosera_anglica_a</i>	Circumboreal
<i>Drosera barbigera</i>	JQ712489.1	<i>Drosera_barbigera</i>	Australia
<i>Drosera binata</i> Labill.	L01906.2	<i>Drosera_binata</i>	Australia
<i>Drosera brevifolia</i> Pursh	AB072519.1	<i>Drosera_brevifolia</i>	Americas
<i>Drosera capensis</i> L.	AB917049.1	<i>Drosera_capensis</i>	Africa
<i>Drosera capillaris</i> Poir.	AB355693.1	<i>Drosera_capillaris</i>	Americas
<i>Drosera chrysosolepis</i> Taub.	AB072522.1	<i>Drosera_chrysosolepis</i>	South America
<i>Drosera cistiflora</i> L.	AB072523.1	<i>Drosera_cistiflora</i>	Africa
<i>Drosera collinsiae</i>	AB072524.1	<i>Drosera_collinsiae</i>	Africa

Table 2. cont.

<i>Drosera cuneifolia</i>	AB072525.1	<i>Drosera_cuneifolia</i>	Africa
<i>Drosera ericksoniae</i>	AB072507.1	<i>Drosera_ericksoniae</i>	Australia
<i>Drosera esmeraldae</i>	AB072526.1	<i>Drosera_esmeraldae</i>	South America
<i>Drosera felix</i>	AB072527.1	<i>Drosera_felix</i>	South America
<i>Drosera filiformis</i>	AB355694.1	<i>Drosera_filiformis</i>	North America
<i>Drosera glanduligera</i>	AB072511.1	<i>Drosera_glanduligera</i>	Australia
<i>Drosera graomogolensis</i> T.Silva	AB072529.1	<i>Drosera_graomogolensis</i>	South America
<i>Drosera hamiltonii</i>	AB072921.1	<i>Drosera_hamiltonii</i>	Australia
<i>Drosera hilaris</i>	AB072530.1	<i>Drosera_hilaris</i>	Africa
<i>Drosera hirtella</i> A.St.-Hil.	AB072531.1	<i>Drosera_hirtella</i>	South America
<i>Drosera intermedia</i> Hayne	JN891175.1	<i>Drosera_intermedia</i>	Americas and Europe
<i>Drosera kaeteurensis</i>	AB072533.1	<i>Drosera_kaeteurensis</i>	South America
<i>Drosera latifolia</i> (as <i>villosa</i> var. <i>ascendens</i>)	AB072542.1	<i>Drosera_latifolia</i>	South America
<i>Drosera madagascariensis</i>	AB072533.1	<i>Drosera_madagascariensis</i>	Africa
<i>Drosera meristocaulis</i>	JN388035.1	<i>Drosera_meristocaulis</i>	South America
<i>Drosera microscapa</i> (as <i>D. occidentalis</i> var. <i>microscapa</i>)	AB072506.1	<i>Drosera_microscapa</i>	Australia
<i>Drosera montana</i> A.St.-Hil.	AB072534.1	<i>Drosera_montana</i>	South America
<i>Dionaea muscipula</i> Ellis	L01904.2	<i>Drosera_muscipula</i>	North America
<i>Drosera natalensis</i>	AB072537.1	<i>Drosera_natalensis</i>	Africa
<i>Drosera neocaledonica</i>	AB072544.1	<i>Drosera_neocaledonica</i>	New Caledonia
<i>Drosera nitidula</i>	JN388036.1	<i>Drosera_nitidula</i>	Australia
<i>Drosera ordensis</i>	JN388037.1	<i>Drosera_ordensis</i>	Australia
<i>Drosera pauciflora</i>	AB072552.1	<i>Drosera_pauciflora</i>	Africa
<i>Drosera planchonii</i> (as <i>D. macrantha</i> subsp. <i>planchonii</i>)	AB072549.1	<i>Drosera_planchonii</i>	Australia
<i>Drosera platypoda</i>	AB072547.1	<i>Drosera_platypoda</i>	Australia
<i>Drosera prostratoscaposa</i>	AB072554.1	<i>Drosera_prostratoscaposa</i>	Australia

Table 2. cont.

<i>Drosera pygmaea</i>	AB072505.1	Drosera_pygmaea	Australia
<i>Drosera rosulata</i>	AB072555.1	Drosera_rosulata	Australia
<i>Drosera rotundifolia</i> L.	AB355691.1	Drosera_rotundifolia	Circumboreal
<i>Drosera rotundifolia</i> L.	JN893776.1	Drosera_rotundifolia_2	Circumboreal
<i>Drosera schwackei</i> (as <i>D. montana</i> var. <i>schwackei</i>)	AB072535.1	Drosera_schwackei	South America
<i>Drosera scorpoides</i>	AB072509.1	Drosera_scorpoides	Australia
<i>Drosera sessilifolia</i> A.St.-Hil.	AB072551.1	Drosera_sessilifolia	South America
<i>Drosera spatulata</i> Labill.	AB298090.1	Drosera_spatulata_1	Asia and Oceania
<i>Drosera spatulata</i> Labill.	AB355696.1	Drosera_spatulata_2	Asia and Oceania
<i>Drosera spiralis</i> A.St.-Hil. (as <i>D. graminifolia</i>)	AB072528.1	Drosera_spiralis	South America
<i>Drosera tomentosa</i> A.St.-Hil. (as <i>D. montana</i> var. <i>tomentosa</i>)	AB072536.1	Drosera_tomentosa	South America
<i>Drosera trinervia</i>	AB072553.1	Drosera_trinervia	Africa
<i>Drosera uniflora</i>	AB072540.1	Drosera_uniflora	South America
<i>Drosera villosa</i> A.St.-Hil.	AB072541.1	Drosera_villosa	South America

Table 3. Sequences from GenBank for the ITS. Taxa, accession number, labels used in the tree figures and continental distribution.

Taxon	GenBank		Distribution
	Accession #	Label	
<i>Drosera anglica</i> Huds.	AB355665.1	Drosera_anglica_a	Circumboreal
<i>Drosera anglica</i> Huds.	AB355666.1	Drosera_anglica_b	Circumboreal
<i>Drosera barbigera</i>	JQ712490.1	Drosera_barbigera	Australia
<i>Drosera brevifolia</i> Pursh	JN388055.1	Drosera_brevifolia	Americas
<i>Drosera burmannii</i>	KT794004.1	Drosera_burmannii	Asia and Oceania
<i>Drosera capensis</i> L.	JN388058.1	Drosera_capensis	Africa
<i>Drosera capillaris</i> Poir.	AB355667.1	Drosera_capillaris	Americas

Table 3. cont.

<i>Drosera chrysolepis</i> Taub.	JN388060.1	<i>Drosera chrysolepis</i>	South America
<i>Drosera communis</i> A.St.-Hil.	JN388070.1	<i>Drosera communis</i>	South America
<i>Drosera filiformis</i>	AB355688.1	<i>Drosera filiformis</i>	North America
<i>Drosera glanduligera</i>	JN388039.1	<i>Drosera glanduligera</i>	Australia
<i>Drosera graminifolia</i> A.St.-Hil.	JN388064.1	<i>Drosera graminifolia_2</i>	South America
<i>Drosera graomogolensis</i> T.Silva	JN388065.1	<i>Drosera graomogolensis</i>	South America
<i>Drosera intermedia</i> Hayne	AB355690.1	<i>Drosera intermedia_2</i>	Americas and Europe
<i>Drosera intermedia</i> Hayne	JN388069.1	<i>Drosera intermedia</i>	Americas and Europe
<i>Drosera madagascariensis</i>	JN388071.1	<i>Drosera madagascariensis</i>	Africa
<i>Drosera meristocaulis</i>	JN388038.1	<i>Drosera meristocaulis</i>	South America
<i>Drosera montana</i> A.St.-Hil.	JN388072.1	<i>Drosera montana</i>	South America
<i>Dionaea muscipula</i> Ellis	AB675913.1	<i>Drosera muscipula</i>	North America
<i>Drosera natalensis</i>	JN388073.1	<i>Drosera natalensis</i>	Africa
<i>Drosera nitidula</i>	JN388040.1	<i>Drosera nitidula</i>	Australia
<i>Drosera occidentalis</i>	JN388042.1	<i>Drosera occidentalis</i>	Australia
<i>Drosera ordensis</i>	JN388075.1	<i>Drosera ordensis</i>	Australia
<i>Drosera paradoxa</i>	JN388043.1	<i>Drosera paradoxa</i>	Australia
<i>Drosera peltata</i>	KT794005.1	<i>Drosera peltata</i>	Australia
<i>Drosera regia</i> Stephens	JN388077.1	<i>Drosera regia</i>	Africa
<i>Drosera rotundifolia</i> L.	AB355664.1	<i>Drosera rotundifolia</i>	Circumboreal
<i>Drosera scorpioides</i>	JN388041.1	<i>Drosera scorpioides</i>	Australia
<i>Drosera spatulata</i> Labill.	AB355670.1	<i>Drosera spatulata_1</i>	Asia and Oceania
<i>Drosera spatulata</i> Labill.	AB355671.1	<i>Drosera spatulata_2</i>	Asia and Oceania
<i>Drosera tomentosa</i> A.St.-Hil.	JN388053.1	<i>Drosera tomentosa</i>	South America
<i>Drosera villosa</i> A.St.-Hil.	JN388054.1	<i>Drosera villosa</i>	South America

General Conclusions

Drosera diversity in the Neotropics has long been underestimated by taxonomists, possibly due to a combination of poorly preserved herbarium specimens, reduced size of the plants and its morphological traits, an overall similarity that may arise from the recent diversification of such plants, and the difficult access and location of natural populations of some of the species for field studies. Consequently, phylogenetics rises as an important source of information for the classification of such species, as it can be used for the corroboration of hypotheses concerning species delimitation.

Even though the results of the phylogenetic analyses here presented (Chapter 4) were not conclusive to establish well-supported relationship hypotheses within the two Neotropical lineages of *D.* sect. *Drosera* s.s., they shed some light on the importance of some morphological traits for the classification and placement of said species in those lineages. Furthermore, those results back up a more “splitter” approach, dividing complex and morphologically diverse taxa into well-delimited species, that have been adopted in recent taxonomic works, such as Gonella et al. (2012, 2014, 2015), Rivadavia & Gonella (2011), Rivadavia et al. (2014).

Thirty-two species are here recognized for the Brazilian flora (Chapter 3), and forty-two for South America, more than doubling the number of accepted taxa in relation to the Flora Neotropica treatment (Correa & Silva 2005). A comprehensive taxonomic treatment dealing with the Brazilian *Drosera* is presented, meeting the goals of the Brazilian Flora 2020 project. The description of new species, either rather overlooked and inconspicuous, such as *Drosera condor* (Gonella et al. 2016 – Chapter 2), or completely and obviously new, such as *D. magnifica* (Gonella et al. 2015 – Chapter 1), reinforces the importance of the taxonomist’s work in the XXI Century, especially in a megadiverse country such as Brazil.

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