



Insights on underestimated Lentibulariaceae diversity in northeastern Brazil: new records and notes on distribution, diversity and endemism in the family

Felipe M. Guedes¹ · Gabriel S. Garcia² · Leonardo M. Versieux² · Lígia Q. Matias³ · Marccus Alves¹

Received: 8 May 2018 / Accepted: 13 August 2018
© Botanical Society of Sao Paulo 2018

Abstract

Here we present 36 new records of 22 species of Lentibulariaceae from northeastern Brazil, expanding their distribution range and providing taxonomic, habitat and phenological comments, in addition to distribution maps and photographs of living specimens. Rio Grande do Norte is the state with the highest number of new records (12), followed by Alagoas, with eight. This is the first insight on the actual richness of the family in the region, and some species show interesting disjunct distributions and habitat restrictions. Only one species treated here is endemic to northeastern Brazil, ten species seem to be restricted to lowland white-sand wetlands, and three are restricted to high altitudes in campos rupestres or in campos de altitude. The remaining ones have a wider distribution. Our data support previous hypotheses on plant dispersal and past connections between Brazilian vegetation formations, shedding light for future studies on the dispersal history and biogeography of Lentibulariaceae.

Keywords Carnivorous plants · Disjunct distribution · Extended distribution · *Genlisea* · Taxonomy · *Utricularia*

1 Introduction

Lentibulariaceae Rich. is the largest family of carnivorous plants, comprising c. 360 species and three genera: *Pinguicula* L., *Genlisea* A.St.-Hil. and *Utricularia* L., which are clearly distinguished from each other by their trapping systems (Fleischmann 2018; Fleischmann & Rocca 2018; Jobson et al. 2018). *Pinguicula* inhabits the subtropical and

temperate wet regions of the New World and Eurasia, comprising c. 100 species that present a basal rosette of fleshy leaves covered with sticky trichomes containing digestive enzymes (Heslop-Harrison 2004; Casper and Stimper 2009; Fleischmann & Rocca 2018).

Genlisea is less diverse, comprising 30 tropical and subtropical herbaceous species. Its traps (rhizophylls) consist of tubular, Y-shaped, modified leaves, with distal helically twisted arms; the inner surface is covered with inward-pointed trichomes that leads the prey to a proximal digestive chamber (Fleischmann 2012; Fleischmann et al. 2017; Fleischmann 2018).

Utricularia is the largest genus within the family and second largest among all carnivorous plants, comprising about 230 species (*Drosera* L. is larger with c. 250 spp.) (Fleischmann et al. 2018; Jobson et al. 2018). Its traps are the most complex foliar modifications among plants, consisting of tiny bladder-shaped structures that capture prey by fast suction under negative pressure compared to the surrounding water, forming a vacuum (Lloyd 1942; Vincent et al. 2011).

All *Utricularia* species are small- to medium-sized herbs with a plant body structure that deviate considerably from traditional models of morphological classification,

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s40415-018-0497-1>) contains supplementary material, which is available to authorized users.

✉ Felipe M. Guedes
felipehmartins09@gmail.com

¹ Laboratório de Morfo-Taxonomia Vegetal, Departamento de Botânica, Universidade Federal de Pernambuco, Recife, PE, Brazil

² Laboratório de Botânica Sistemática, Departamento de Botânica e Zoologia, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil

³ Laboratório de Morfologia e Taxonomia de Angiospermae, Departamento de Biologia, Universidade Federal do Ceará, Fortaleza, CE, Brazil

treated as morphological misfits (Rutishauser and Isler 2001). Lacking roots and not presenting a clear developmental distinction between leaves and stems, *Utricularia* species are certainly intriguing. A primordium can mature into a trap, a stem, a leaf or an inflorescence (Rutishauser and Isler 2001). The genus is distributed worldwide, and its species are capable of colonizing different wet environments, thus presenting different life and growth forms, such as terrestrial, aquatic, lithophytic, rheophytic and epiphytic (Taylor 1989).

Genlisea and *Utricularia* flowers are morphologically similar, consisting of a bilabiate, tubular corolla, usually with a prominent swelling at the base of the lower lip, and a spur at the base of the corolla tube, two stamens and one ovary of two fused carpels. Besides the trapping system, their calyces can easily distinguish them, since *Genlisea* has five sepals, while *Utricularia* has two or four. In *Genlisea*, bracts, scales and bracteoles are always basifixed and not very variable in shape and, thus, are not very informative taxonomically. In contrast, *Utricularia* has bracts and scales which can be basifixed or basisolute and vary a lot in shape, while bracteoles, when present, are basifixed (Taylor 1989; Fleischmann 2012).

In Brazil, Lentibulariaceae comprises 82 species, of which 27 are endemic, with the Northeast region home to about 60% of those species (Miranda et al. 2015). Therefore, the Brazilian Northeast can be considered an important diversity center of the family. Despite this finding, the diversity of the family in this region remains underestimated as works concerning the taxa are scarce and distribution data are incomplete or inaccurate. Local floras including new records are available only for the state of Sergipe (Carregosa and Monteiro 2013; Carregosa and Costa 2014). In addition, new species and records as well as taxonomic inventories have been published (Cheek and Taylor 1995; Fleischmann and Rivadavia 2009; Silva 2013; Silva and Cruz 2015).

2 Materials and methods

During visits to herbaria of northeastern Brazil (ALCB, CEPEC, EAC, HST, HUEFS, IPA, JPB, MAC, MUFAL, PEUFR, R, RB, UFP and UFRN) (acronyms according to Thiers 2018) and field work carried out between 2014 and 2017, 36 new records referring to 22 species of Lentibulariaceae from Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe states were confirmed. Abbreviations of Brazilian states are given in Table 1^(a). New records for states are based on the Lista de Espécies da Flora do Brasil (<http://floradobrasil.jbrj.gov.br>), now updated as Flora do Brasil 2020 (continuously updated). Here we present new data that extend the

distribution of these species, with some newly recorded populations revealing interesting disjunction patterns. All cited specimens have been examined personally by the first author. Maps (Electronic Supplementary Material Appendix 1: Figs. A1 and A2) were made using QGIS 2.18 based on geographic data from herbarium material, and the biogeographic regions and types of vegetation are according to IBGE (2012). Each species is briefly characterized, compared to the most similar congeners and discussed in terms of its overall geographic distribution and eventual disjunctions. A table (Table 1) summarizes all data of conservation status according to the IUCN (2017) and CNCFlora (2018) criteria, phytogeographic domains and phytophysiognomies according to IBGE (2012), distribution according to Taylor (1989) and Miranda et al. (2015) and regional conservation units where the treated species were collected.

3 Results

Genlisea filiformis — A.St.-Hil., Voy. Distr. Diam. 2: 430. 1833. Fig. 1(a, b)

This species is recognized by its yellow corolla with deeply trilobate lower lip, pale yellow to whitish spur, which is thick, saccate and with a rounded apex, glabrous or with few scattered glandular or eglandular trichomes. Its pedicels are covered exclusively with glandular trichomes, scape with few scattered glandular trichomes and capsule covered with short eglandular trichomes, and the dehiscence is circumscissile.

Its vegetative portions range from glabrous to covered with glandular or eglandular trichomes. It can also vary in stature (5–25 cm tall), but some dwarf individuals reach only up to 3 cm tall. These smaller individuals resemble *Genlisea pygmaea* A.St.-Hil, which is very diminutive, up to 8-cm tall, but differs by its conical spur with an acute apex, always covered with short glandular or eglandular trichomes, its pedicels covered with both glandular and eglandular trichomes and its scape densely covered with eglandular trichomes.

Among all Neotropical *Genlisea* species, *G. filiformis* is the most widespread, occurring from Central America to the North and South of the Amazon basin. In Brazil, it is cited to AM, RR, MT, MS, SP, GO, DF, MG, TO, BA, SE, PE, PB and CE (Fleischmann 2012; Miranda et al. 2015). Here we report new records to Rio Grande do Norte, where it occurs in seasonally flooded coastal plains, known as alluvial pioneer formations (Electronic Supplementary Material Appendix 1: Fig. A1a). This is a terrestrial species that also inhabits other wet phytophysiognomies such as park savannas, “campos rupestres”, “campos de altitude”, “campinaranas” and gallery forests (Fleischmann 2012). In the Northeast region, it

seems to tolerate a few months of dry season, still flowering and fruiting, before dying and leaving seed propagules during the highest water-stress period.

SPECIMENS EXAMINED. BRAZIL. Rio Grande do Norte Ceará Mirim, RN 064, estrada para Pureza, 18-VIII-2011 (fl. and fr.), JG Jardim et al. 6042 (UFRN); Espírito Santo, APA Piquirí-Una, 04-XII-2017 (fl. and fr.), FM Guedes et al. 66 (UFP); Nísia Floresta, dunas próximo ao vilarejo de Alcaçuz, 24-XII-2014 (fl. and fr.), GS Garcia 176 (UFRN), APA Bonfim-Guarairas, 25-XI-2015 (fl. and fr.), GS Garcia 33 (UFRN); Maxaranguape, depressão interdunar próximo à Maracajaú, 03-X-2017 (fl. and fr.), FM Guedes 57 (UFP); Rio do Fogo, dunas da praia de Zumbi, 11-X-2015 (fl.), GS Garcia et al. 59 (UFRN).

Genlisea lobata — Fromm, Bradea 5(14): 152. 1989. Fig. 1(c, d)

This species is readily distinguished from all other *Genlisea* species by its white corolla with divided lobe tips in both lips, pale lilac upper lip with dark purple stripes, white lower lip with a yellow blotch at its base and purple, cylindrical spur, parallel to the pedicel. Scape, bract, bracteoles, pedicels, spur, lower corolla surface and capsule are covered with glandular and eglandular trichomes. Capsule dehiscing longitudinally, bivalvate and pedicels are sharply reflexed in fruit.

This terrestrial species is very similar to *Genlisea violacea* A.St.-Hil.; however, the latter species has a purple or sometimes pale lilac corolla, but never with a bicolored pattern as found in *G. lobata*, also in both of its corolla lips, the lobe tips are entire. This species is assessed as “endangered” by CNCFlora (2018) and is threatened by fire and habitat degradation caused by human activities (Simonelli and Fraga 2007).

Previously known only from Minas Gerais and Espírito Santo (Fleischmann 2012; Miranda et al. 2015), here we report a new record to Bahia (Electronic Supplementary Material Appendix 1: Fig. A1a), in a seasonally wet area on the top of an inselberg at 813 m asl, with a predominance of an herbaceous subshrub vegetation in shallow soil, with bare rocks covered only by some lichens (Queiroz et al. 1996). This species is apparently restricted to submontane and montane vegetation (800–1800 m high) of “campos de altitude”, growing among *Sphagnum* sp. in peat-bog environments of granite outcrops (inselbergs) (Fleischmann 2012).

SPECIMENS EXAMINED. BRAZIL. Bahia Santa Terezinha, ápice da Serra, 09-X-2010 (fl. and fr.), E Melo et al. 8571 (HUEFS).

Utricularia amethystina — Salzm. ex A.St.-Hil. & Girard, Compt. Rend. Hebd. Séances Acad. Sci. 7: 870. 1838. Fig. 1(e–g)

This species is readily recognized by its violet corolla with a white and yellow blotch at the base of the lower lip, and white spur with a violet tip, or sometimes corolla entirely white with a yellow blotch at the base of the lower lip. Its lower corolla lip is trilobate with a conical spur, constricted below the middle and with an obtuse apex, twice as long as the lower lip. Its upper sepal has a hyaline margin, and its rosulate leaves are narrowly obovate to spatulate with anastomosing nerves. Bracts and bracteoles are basifixed and connate at their bases.

Utricularia amethystina belongs to a species complex that was recently taken under morphometric study to address taxonomic problems (Baleeiro et al. 2015) as well as nomenclatural reestablishments. It can be distinguished from allied taxa as follows: *Utricularia tricolor* A.St.-Hil. has much larger flowers 1–2.5 cm long (vs. *U. amethystina* flowers up to 0.7 cm long), entire to scarcely 3-crenate lower corolla lip, spur about as long as the lower lip and both sepals with hyaline margins. *Utricularia tridentata* Sylvén has larger flowers (0.6–1 cm long), shallowly trilobate lower corolla lip, spur slightly longer than the lower lip and bracts connate to the bracteoles above the middle.

This terrestrial species is distributed in tropical America and subtropical North America. In Brazil it is cited to AM, RR, PA, AP, MT, MS, TO, GO, DF, MG, SP, RJ, ES, BA, SE, MA, PE and PB (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas in seasonally flooded, coastal plain areas (Electronic Supplementary Material Appendix 1: Fig. A1b). According to Taylor (1989), it also inhabits peat-bog environments and seasonally flooded white-sand savannas.

SPECIMENS EXAMINED. BRAZIL. Alagoas Marechal Deodoro, próximo ao Brejo Água Santa e Cabreira, 30-VIII-2008 (fl. and fr.), RP Lyra-Lemos 11395 (MAC), Dunas do Cavalo Russo, 11-XI-2009 (fl. and fr.), ECO Chagas and MCS Mota 5370 (MAC).

Utricularia benjaminiana — Oliv., J. Linn. Soc. Bot. 4: 176. 1860. Fig. 1(h–j)

This species is readily recognized by its aquatic free-floating habit, large and thick botuliform spur, with rounded apex, longer than the lower lip, lilac or white corolla with a purple blotch at the base of the lower lip, deeply bilobate upper lip and reniform lower lip. Its whorl of fusiform floats at the base of the inflorescence sometimes holds 2–3 cleistogamous flowers. Its first two primary leaf segments form a distinct, long petiole. Its stolons, petioles and traps are densely covered with fine short trichomes (villous indumentum). This set of characters makes *Utricularia benjaminiana* not likely to be confused with any other aquatic species.

It is known from Africa, Madagascar, Central and northern South America, with Brazilian records confined to Roraima, in campinaranas (Taylor 1989; Miranda et al. 2015; Costa et al. 2016). Here we report new records to Rio Grande do Norte and Sergipe, in seasonal, interdune coastal lagoons and in temporary streams in a Cerrado enclave area (park savanna) (Oliveira et al. 2012), flowering from October to December (Electronic Supplementary Material Appendix 1: Fig. A1a).

This disjunct distribution is remarkable, although not surprising, since other species present a similar Neotropical-African distribution, such as *Utricularia foliosa* L., *U. juncea* Vahl, *U. livida* E.Mey. and *U. simulans* Pilg. (Dörrstock et al. 1996). Furthermore, considering the Brazilian areas of occurrence, some other species also show a similar distribution, such as *U. guyanensis* A.DC., *U. hispida* Lam., *U. hydrocarpa* Vahl, *U. nana* A.St.-Hil. & Girard, *U. resupinata* B.D.Greene ex Bigelow, *U. simulans* Pilg., *U. triloba* Benj. and *U. viscosa* Spruce ex Oliv. (Costa et al. 2016). Oliveira et al. (2012) emphasized the great biotic and abiotic similarities between the Amazonian campinaranas and the Cerrado enclaves in Rio Grande do Norte, both comprising areas of seasonally flooded, white-sand savannas, with acidic soils, and a vegetation conditioned by edaphic factors. This affinity is possibly related to the biogeography of the savannas (Cerrado), which may have served as connections and dispersal routes linking the Amazon and Atlantic Forests during the Quaternary (Bigarella et al. 1975; Costa 2003; Sobral-Souza et al. 2015).

SPECIMENS EXAMINED. BRAZIL. Rio Grande do Norte: Nísia Floresta, dunas de Búzios, 24-XII-2014 (fl. and fr.), GS Garcia 174 (UFRN); Rio do Fogo, Área Militar de Rio do Fogo, 11-X-2015 (fl.), GS Garcia et al. 47 (UFRN); **Sergipe:** Estância, Lagoa Azul, às margens da rodovia SE-100, 4-X-2013, WTZ Sousa s.n. (R 224186).

Utricularia blanchetii – A. DC., Prodr. 8: 13. 1844. Fig. 1(k, l)

This species is recognized by its purple or lilac corolla with a yellow blotch at the base of the lower lip, subreniform upper lip and transversally elliptical lower lip, subulate and slightly curved spur with acute or bifid apex and its sepals, bracts and bracteoles with denticulate margins. It is morphologically similar to *Utricularia purpureocaerulea* A.St.-Hil. & Girard, which differs by its sepals, bracts and bracteoles with entire margins, and its sepals with prominent nerves. *Utricularia parthenopipes* P.Taylor is also similar but has much smaller flowers, up to 6 mm long (vs. *U. blanchetii* 1.5–2 cm long), white corolla with obovate-cuneate upper lip with apex shallowly trilobate, which is white to pale lilac with dark purple streaks along its nerves and has a straight spur, constricted in the middle.

This particular terrestrial species was considered endemic to the northern areas of the Cadeia do Espinhaço in Bahia (Taylor 1989; Cheek and Taylor 1995; Miranda et al. 2015) until being recently found in Pernambuco, where it blooms after the rainy season, with specimens collected in flower from August to October (Electronic Supplementary Material Appendix 1: Fig. A1c). This species is apparently restricted to the “campos rupestres” phytophysiognomy, under Cerrado domain and enclaves. The Catimbau National Park is an area of sedimentary plateau with different types of phytophysiognomies including shrub “Caatinga” on the leeward slopes, “campos rupestres” on the highest elevations (900–1000 m), perennial forest vegetation on the foot of the plateau and semideciduous shrub vegetation on the windward slopes (Rodal et al. 1998; Andrade et al. 2004; Silveira et al. 2016). Floristic surveys have confirmed biotic similarities between the “campos rupestres” areas of the Catimbau National Park and the Chapada Diamantina (Stannard 1995; Conceição and Giulietti 2002; Zappi et al. 2003; Andrade et al. 2004).

SPECIMENS EXAMINED. BRAZIL. Pernambuco Buíque, Parque Nacional do Catimbau, Serra de Jerusalém, 19-VIII-1994 (fl.), MJN Rodal et al. 310 (PEUFR), 22-IX-1995 (fl.), L Figueiredo et al. 196 (PEUFR), 28-X-2017 (fl. and fr.), FM Guedes et al. 48 (UFP).

Utricularia breviscapa – CWright ex Griseb., Cat. Pl. Cub. 161. 1866. Fig. 1(o, p)

This species is readily recognized by its aquatic free-floating habit, yellow corolla with reddish marks at the base of the lower lip, ovate upper lip, with retuse apex, deeply trilobate lower lip and a narrowly conical spur, with bifid apex, as long as the lower lip. Its spongy inflorescence bearing a whorl of five cylindrical floats, connate at their bases, sometimes inflorescences holds cleistogamous flowers. Its primary and secondary leaf segments are arranged in threes. This set of characters makes *Utricularia breviscapa* not likely to be confused with any other aquatic species.

This aquatic species is Neotropical, and in Brazil, it is cited to AM, PA, BA, MG, GO, SP and MT (Miranda et al. 2015). Here we report a new record to Piauí, in a river source, near a waterfall, under “Cerrado” domain, collected in flower in June (Electronic Supplementary Material Appendix 1: Fig. A2a).

SPECIMENS EXAMINED. BRAZIL. Piauí Batalha, Cachoeira do Xixá, 9-VI-2011 (fl.), CP Bove et al. 2279 (R).

Utricularia cornuta – Michx., Fl. Bor. Am. 1: 12. 1803. Fig. 1(m, n)

This species is recognized by its yellow corolla, ca. 1.5–2-cm-long, galeate lower lip, curved spur, shorter than

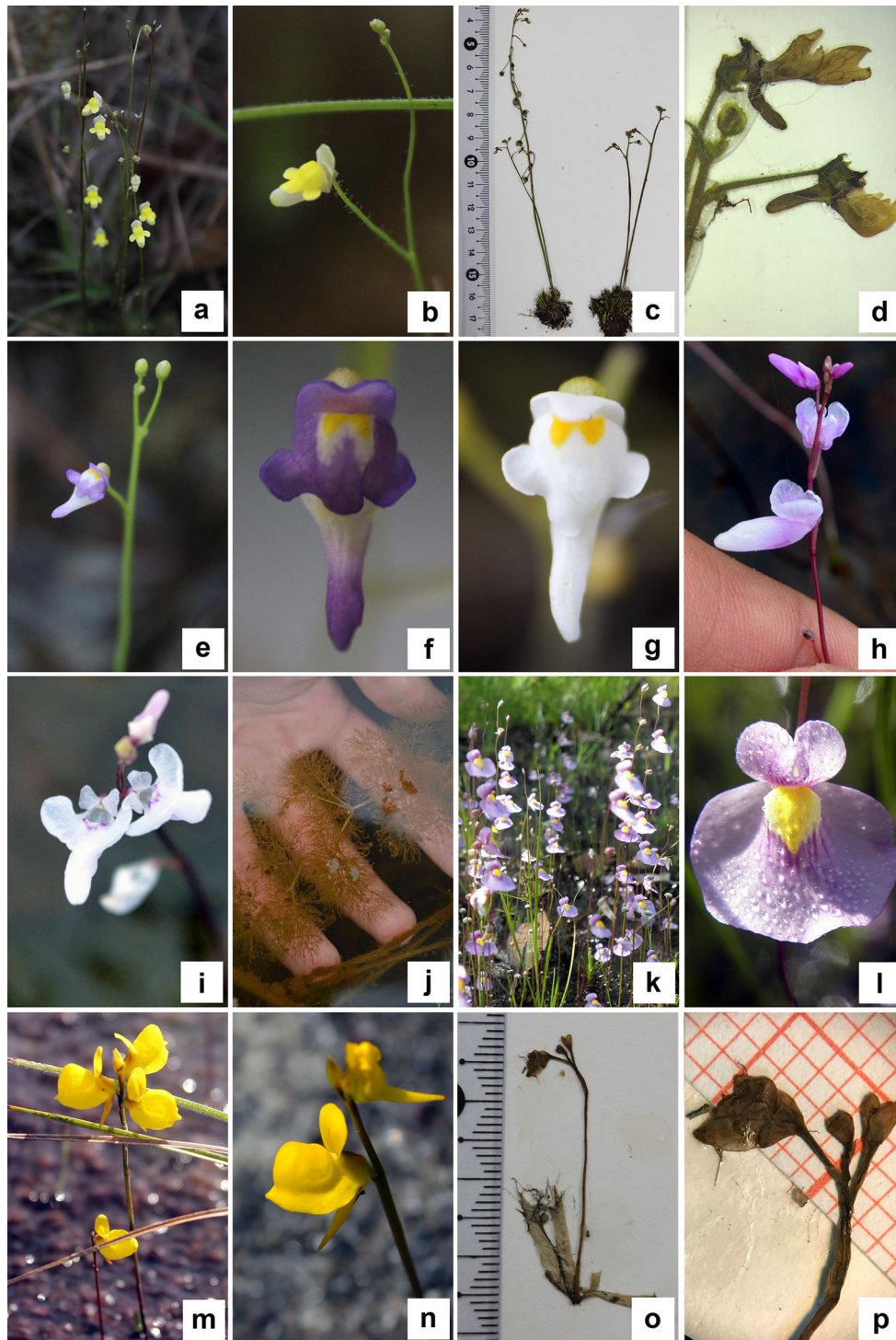


Fig. 1 a, b *Genlisea filiformis*; c, d *G. lobata*; e–g *Utricularia amethystina*; h–j *U. benjaminiana*; k, l *U. blanchetii*; m, n *U. cornuta*; o, p *U. breviscapa*

the lower lip, plicate calyx with ridged nerves and a short, congested inflorescence (up to 15 cm long) with stiff, green scape, ca. 0.5–1.5 mm diam.

Utricularia cornuta is morphologically very similar to *Utricularia juncea* Vahl, and both belong to *Utricularia*

sect. *Stomoisia*. However, the latter species has a much longer and lax inflorescence (up to 45 cm long), flexuous scape, ca. 0.4–0.8 mm diam., and smaller flowers (ca. 0.2–1 cm long) with straight or slightly curved spur, about as long as the lower lip.

This terrestrial or semiaquatic species occurs in North and Central America and, in Brazil, is only cited to Maranhão (Taylor 1989; Miranda et al. 2015). However, three specimens were wrongly cited to Mato Grosso (FC Hoehne 2276, 3304 and 3501 - RB); in fact, they are *U. erectiflora* A.St.-Hil. & Girard, which is relatively similar to *U. cornuta* in terms of the corolla shape, congested inflorescence and scape consistency, but readily distinguished by its calyx with inconspicuous nerves, involute margins, flowers less than 1.2 cm long and winged pedicels. Here we report new records to Ceará, in seasonally flooded coastal plains and coastal lagoons between dunes (Electronic Supplementary Material Appendix 1: Fig. A1b). In Ceará, it is known only from one specimen, but in Rio Grande do Norte it seems to be abundant and widespread along the east coast, where its occurrence is documented in a recent, unpublished thesis and numerous specimens (Versieux, pers. comm.), flowering throughout almost the entire year.

SPECIMENS EXAMINED. BRAZIL. Ceará: Jijoca de Jericoacoara, Lagoa de Jijoca, 20-VIII-2000 (fl.), LQ Matias 311 (EAC); **Rio Grande do Norte:** Ceará-Mirim, área do empreendimento Dunas de Muriú, 04-II-2016 (fl. and fr.), EO Moura et al. 490 (UFRN); Nísia Floresta, Lagoa do Cágado, 04-XII-2014 (fl. and fr.), JAS Leroy 58 (UFRN), Lagoa Amarela, 07-XII-2014 (fl. and fr.), JAS Leroy 67 (UFRN), Lagoa do Carcará, 14-VII-2016 (fl.), GS Garcia 277 (UFRN), Lagoa do Alcaçuz, 04-X-2017 (fl. and fr.), FM Guedes et al. 63 (UFP); Extremoz, APA de Jenipabu, 30-I-2012 (fl.), EO Moura 60 (UFRN); Maxaranguape, depressão interdunar próximo à Maracajaú, 11-X-2015 (fl.), GS Garcia et al. 64 (UFRN); Rio do Fogo, Área Militar de Rio do Fogo, 03-X-2017, (fl.), FM Guedes et al. 53 (UFRN); Touros, 27-II-2016 (fl.), AM Marinho 213 (UFRN).

Utricularia costata – P. Taylor, Kew Bull. 41(1): 7. 1986. Fig. 2(a, b)

This species is easily recognized by its very small stature (up to 4 cm tall), lilac corolla with a white blotch at the base of the lower lip and white spur with a lilac tip, scarcely trilobate lower lip and thickly conical, straight spur with obtuse apex, twice as long as the lower lip. Its pale green calyx has prominent nerves, and when in fruit the lower sepal takes an enlarged navicular form.

Utricularia costata is morphologically similar to *U. rostrata* A.Fleischm. & Rivadavia, but differs by its upper sepal with obtuse, denticulate apex (vs. acute and rostrate apex) and its straight spur with obtuse apex, twice as long as the lower corolla lip (vs. curved upward spur with bifid apex, slightly shorter than the lower corolla lip).

This terrestrial South American species was previously restricted to Venezuela and, in Brazil, is cited to Roraima,

Pará, Mato Grosso and Goiás (Taylor 1989; Miranda et al. 2015). Recently, its distribution was extended to the state of Sergipe (Carregosa and Costa 2014), and here, we report new records to Bahia and Alagoas, both in wet soil areas of submontane and montane, perennial seasonal forest (260–800 m asl), collected in flower in July and August (Electronic Supplementary Material Appendix 1: Fig. A1a).

SPECIMENS EXAMINED. BRAZIL. Alagoas: Chã Preta, Serra Lisa, 28-VII-2009 (fl. and fr.), ECO Chagas and MCS Mota 4469 (MAC); **Bahia:** Serrinha, próximo à Torre da Embratel, povoado Barra do Vento, 18-VIII-2006 (fl. and fr.), LP de Queiroz et al. 12292 (HUEFS).

Utricularia erectiflora – A.St.-Hil. & Girard, Compt. Rend. Hebd. Séances Acad. Sci. 7: 870. 1838. Fig. 2(c, d)

This is a very distinctive species due to its coriaceous sepals with inconspicuous nerves, involute margins and rounded decurrent bases and also its winged pedicels and a rather congested inflorescence with a straight and stiff scape, up to 1 mm diam. Its yellow corolla is usually not much larger than the calyx, with a galeate lower lip, and a curved subulate spur, with acute apex, about twice as long as the lower sepal. Its traps are also very distinctive from the other members of *Utricularia* sect. *Oligocista*. They are sessile, mouth basal, with two dorsal subulate appendages, reflexed, and with a ventral chin-like swelling.

Utricularia erectiflora is frequently misidentified as *U. adpressa* Salzm. ex A.St.-Hil. & Girard, *U. cornuta* and *U. juncea* because of its similar galeate lower corolla lip and curved spur. However, the calyces and traps of these species are nothing alike. It could be confused with *Utricularia meyeri* Pilg., which differs by its sepals with sagittate base, corolla much larger than the calyx and a spur 3–4 times longer than the lower sepal.

This terrestrial or semiaquatic species is Neotropical; in Brazil, it is cited to RR, CE, RN, SE, BA, GO, MT, ES, RJ, SP and SC (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas, Maranhão and Piauí in seasonally flooded coastal plains (Electronic Supplementary Material Appendix 1: Fig. A1c), but according to Taylor (1989) it can also inhabit flooded, white-sand savannas and marshy environments.

SPECIMENS EXAMINED. BRAZIL. Alagoas: Piaçabuçu, próximo à Mata das Varas, 19-XI-1982 (fl. and fr.), R Rocha et al. 390 (MAC); Vargem Grande, 22-IX-1987 (fl. and fr.), MNR Staviski et al. 1013 (MAC), 18-X-1988 (fl. and fr.), RP Lyra-Lemos et al. 1566 (MAC); **Maranhão:** Morros, Rodovia MA-402 margem direita (Barreirinhas-São Luís), 25-IX-2014 (fl. and fr.), NFO Mota 2799 (RB); **Piauí:** Parnaíba, Ilha de Santa Isabel, 4-X-1973, D Araújo et al. 458 (RB); 4-X-1973 (fl. and fr.), D Sucre 10283 (RB).

Utricularia flaccida – ADC., Prodr. 8: 17. 1844. Fig. 2(e, f)

This species is distinctive and easily recognized by its lithophytic habit, yellow corolla, upper lip with retuse apex, trilobate lower lip, spur shorter than the lower lip, with truncate apex, basisolute bracts and scales and the absence of bracteoles. *Utricularia flaccida* belongs to *Utricularia* sect. *Setiscapella*, which consists of nine species with corollas very similar in general shape and color, except for *Utricularia physoceras* P. Taylor, which is pink; however, the truncate spur is unique to *U. flaccida*.

This lithophytic species is endemic to Brazil, with populations previously restricted to wet habitats of mountain chains in Bahia (Taylor 1989), until its distribution was extended to Roraima, Minas Gerais, Mato Grosso and Sergipe, always in high altitudes (above 600 m asl) (Miranda and Absy 2000; Ritter et al. 2010; Borges et al. 2011; Carregosa and Monteiro 2013; Miranda et al. 2015). Here we report new records to Ceará, in the Ibiapaba plateau, where it occurs associated with creeping *Sphagnum* clumps on rocks, at wet cliffs, under montane perennial seasonal forest (Electronic Supplementary Material Appendix 1: Fig. A1d), collected in flower between May (at the end of the rainy season) and October (dry season).

SPECIMENS EXAMINED. BRAZIL. Ceará Ubajara, Sítio São Luís, 03-X-2003 (fl. and fr.), EB Souza *s.n.* (EAC 54561), Cachoeira do Frade, 21-VII-2008 (fl.), LQ Matias 553 (EAC), Estrada entre Ibiapina e Mucambo, 23-VI-2012 (fl.), LQ Matias et al. 695 (EAC), Parque Nacional de Ubajara, paredão úmido acima do Mijo da Velha, 07-VI-2014 (fl.), FM Guedes 02 (EAC), 27-V-2016 (fl.), FM Guedes 05 (EAC).

Utricularia guyanensis – A. DC., Prodr. 8: 11. 1844. Fig. 2(g, h)

This species is readily recognized by its diminutive or obsolete spur, concealed by the lower corolla lip, reddish scape and golden yellow corolla with entire lower lip. Its filiform, upward-bent filaments and style are unique. This species is not likely to be confused with any other given these morphological traits, even though the shape of its traps resembles those found in *U. cornuta*, *U. juncea* and *U. nana*.

This terrestrial species is Neotropical; in Brazil, it is cited to Roraima and Bahia (Taylor 1989; Miranda et al. 2015). It was wrongly cited to Paraíba (Silva 2013), but the specimens are actually *Genlisea* sp. (JPB 18.042). Here we report new records to Maranhão and Rio Grande do Norte, in seasonally flooded coastal plains and in some river sources at the southernmost part of Rio Grande do Norte (Garcia, pers. comm.) (Electronic Supplementary Material

Appendix 1: Fig. A1c). It was collected in flower in May and from October to January.

SPECIMENS EXAMINED. BRAZIL. Maranhão: Morros, Rodovia MA-402 margem direita (Barreirinhas-São Luís), 25-IX-2014 (fl. and fr.), NFO Mota 2794 (RB); **Rio Grande do Norte:** Maxaranguape, depressão interdunar próximo à Maracajaú, 11-X-2015 (fl. and fr.), GS Garcia et al. 68 (UFRN); Rio do Fogo, Área Militar de Rio do Fogo, 07-XII-2014 (fl. and fr.), GS Garcia 172 (UFRN), 08-I-2015 (fl. and fr.), GS Garcia 180 (UFRN), 02-V-2015 (fl. and fr.), GS Garcia 186 (UFRN).

Utricularia hispida – Lam., Tabl. Encycl. 1: 50. 1791. Fig. 2(i, j)

This is an extremely variable species concerning its corolla color, usually violet or lilac with a yellow blotch at the base of the lower lip, but also reported as white or pale yellow. Its outer corolla surface is densely covered with shortly stipitate glands; it has a scarcely trilobate lower lip and a curved subulate spur, constricted at the middle, with acute apex, slightly longer than the lower lip. It is also recognized by its densely glandular calyx with rather inconspicuous nerves and erose margins, basifixed glandular bracts and bracteoles with lacinate margins and scape hispid below. This species is most similar to *Utricularia praelonga* A.St.-Hil. & Girard, which has an invariably larger, yellow corolla (ca. 1.5–2 cm long), while *U. hispida* has smaller ones (ca. 0.6–1 cm long).

This terrestrial or subaquatic species is Neotropical; in Brazil, it is cited to MT, MS, GO, DF, SP, MG, TO and MA (Taylor 1989; Miranda et al. 2015). Here we report a new record to Rio Grande do Norte, where it was collected in a pond of a gallery forest, under lowland, perennial seasonal forest phytophysiognomy (Electronic Supplementary Material Appendix 1: Fig. A1b). According to Taylor (1989), its habitat also includes seasonally flooded white-sand savannas. The population is small and restricted, bearing flowers with a pale yellow corolla, collected in flower in December.

SPECIMENS EXAMINED. BRAZIL. Rio Grande do Norte Espírito Santo, APA Piquiri-Una, 26-XII-2015 (fl.), GS Garcia et al. 95 (UFRN).

Utricularia hydrocarpa – Vahl., Enum. 1: 200. 1804. Fig. 2(k, l)

This species is recognized by its aquatic free-floating habit, rose pink corolla with a yellow blotch at the base of the bilobate lower lip and conical spur with acute apex, shorter than the lower lip. Its pedicels and sepals are reflexed while in fruit, and a cleistogamous flower is always present at the base of the inflorescence. In sterile herbaria specimens, it can be identified by its growth

form, which consists of a single short and pauci-branched stolon, bearing short capillary dichotomous leaves. Its traps are dimorphic, the smaller ones, in primary leaf segments, have a basal mouth without appendages, and the larger ones, with lateral mouth and two branched, dorsal appendages.

It is very similar to *U. poconensis* Fromm, but the latter species lacks the basal cleistogamous flower, usually has peduncle scales, the sepals in fruit are flat and accrescent, and seeds have winged peripheral projections.

This aquatic species is Neotropical and widely distributed in Brazil with records to AM, PA, AP, MT, MS, GO, MG, SC, SP, RJ, BA, MA, CE, SE, PB and PE (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas, Piauí and Rio Grande do Norte, therefore, extending its distribution throughout the Northeast region (Electronic Supplementary Material Appendix 1: Fig. A1d). Some herbarium specimens were misidentified as *U. poconensis* (UFRN 19.504) and *U. hispida* (MAC 25.606). It inhabits lakes and ponds under different phytophysiognomies at low altitudes and possibly flowering throughout the year.

SPECIMENS EXAMINED. BRAZIL. Alagoas: Penedo, Povoado de Capela, várzea do Rio Murituba, 31-X-2005 (fl. and fr.), E Melo et al. 4183 (HUEFS); Piaçabuçu, Ponta da Terra, 13-VII-1987 (fl. and fr.), GL Esteves et al. 1860 (MAC), Rio Marituba, 28-VII-1988 (fl. and fr.), GL Esteves and AIL Pinheiro 2139 (MAC); **Piauí:** Piripiri, Parque Nacional de Sete Cidades, 27-V-1997 (fl.), LP Félix et al. 7814 (HST); **Rio Grande do Norte:** Ceará Mirim, acesso pela RN 064, esquerda na RN 309, 11-VII-2011 (fl. and fr.), AA Roque et al. 1170 (UFRN); Maxaranguape, próximo à Maracajaú, 24-IV-2016 (fl. and fr.), GS Garcia et al. 151 (UFRN); Rio do Fogo, Barra do Rio Punaú, 07-XII-2014 (fl. and fr.), GS Garcia 164 (UFRN); Tibau do Sul, Rio Catú, 27-II-2015 (fl. and fr.), JAS Leroy 213 (UFRN).

Utricularia juncea – Vahl, Enum. 1: 202. 1804. Fig. 2(m, n)

This species is recognized by its yellow corolla (ca. 0.2–1.2 cm long) with galeate lower lip, straight or slightly curved spur, about as long as the lower lip, plicate calyx with ridged nerves and long lax inflorescence (up to 45 cm long) with often vinaceous and flexuous scape (ca. 0.4–0.8 mm diam.). As aforementioned, *U. juncea* is very similar to *U. cornuta* (see comments under *U. cornuta*).

This terrestrial or subaquatic species is distributed from North to South America; in Brazil, it is cited to RR, AP, PI, CE, PB, PE, AL and BA (Taylor 1989; Miranda et al. 2015). Here we report new records to Rio Grande do Norte in seasonally flooded coastal plains, park savanna

(Cerrado enclave) and in a pond of a gallery forest (Electronic Supplementary Material Appendix 1: Fig. A1d). It blooms throughout almost the entire year, but most abundantly at the end of the rainy season (from October to December). *Utricularia juncea* inhabits perennial and seasonal wetlands, mainly alluvial pioneer formations, park savannas, marshes and swamps, by ponds and streams of shallow water.

SPECIMENS EXAMINED. BRAZIL. Rio Grande do Norte Espírito Santo, APA Piquiri-Una, 26-XII-2015 (fl. and fr.), GS Garcia et al. 93 (UFRN), 04-X-2017 (fl. and fr.), FM Guedes et al. 69 (UFP); Macaíba, Escola Agrícola de Jundiá, Mata do Bebo, 10-II-2012 (fl.), JL Costa-Lima et al. 640 (UFRN); Nísia Floresta, Floresta Nacional de Nísia Floresta, 17-X-2015 (fl.), GS Garcia et al. 74 (UFRN), Sete Lagoas, 28-V-2016 (fl. and fr.), VF Sousa and LM Versieux 336 (UFRN); Rio do Fogo, Área Militar de Rio do Fogo, Lagoa da Cotia, 11-X-2015 (fl. and fr.), GS Garcia et al. 56 (UFRN); Tibau do Sul, Rio Catú, 27-II-2015 (fl. and fr.), JAS Leroy 212 (UFRN).

Utricularia nana – ASt.-Hil. & Girard, Compt. Rend. Hebd. Séances Acad. Sci. 7: 869. 1838. Fig. 2(o, p)

This species is readily recognized by its diminutive stature, yellow corolla with reduced upper lip, entire to slightly 4-crenate lower lip, slightly swollen at the base, subulate straight spur, held at an angle of 90° to the lower lip. Its upper sepal has ridged nerves, and the lower one is broader with auriculate base and inconspicuously nerved. When in fruit, the pedicels and calyx take different forms, the pedicels become reflexed and the lower sepal becomes broader and navicular, enclosing the fruit. *Utricularia nana* is usually misidentified as *U. adpressa*, due to their slightly similar corolla shape in herbarium specimens, but the calyx is distinct.

This terrestrial species is South American; in Brazil, it is cited to PA TO, MT, MS, MG, GO, DF, SP, PR, BA, MA, PB and SE (Taylor 1989; Carregosa and Monteiro 2013; Silva 2013; Miranda et al. 2015). Here we report a new record to Rio Grande do Norte, in areas of seasonally flooded white-sand savannas (Electronic Supplementary Material Appendix 1: Fig. A2a), in a Cerrado enclave (park savanna) surrounded by restinga and Caatinga vegetation, both areas with vegetation conditioned by edaphic factors (IBAMA 2003; Oliveira et al. 2012), collected in flower between May and October.

SPECIMENS EXAMINED. BRAZIL. Paraíba: Mamanguape, Reserva Biológica Guaribas, Sema I - Capim Azul, 13-VI-1991 (fl. and fr.), LP Félix et al. 3968 (JPB), 24-V-1994 (fl.), SM Rodrigues et al. 109 (HST), 07-X-2017 (fl. and

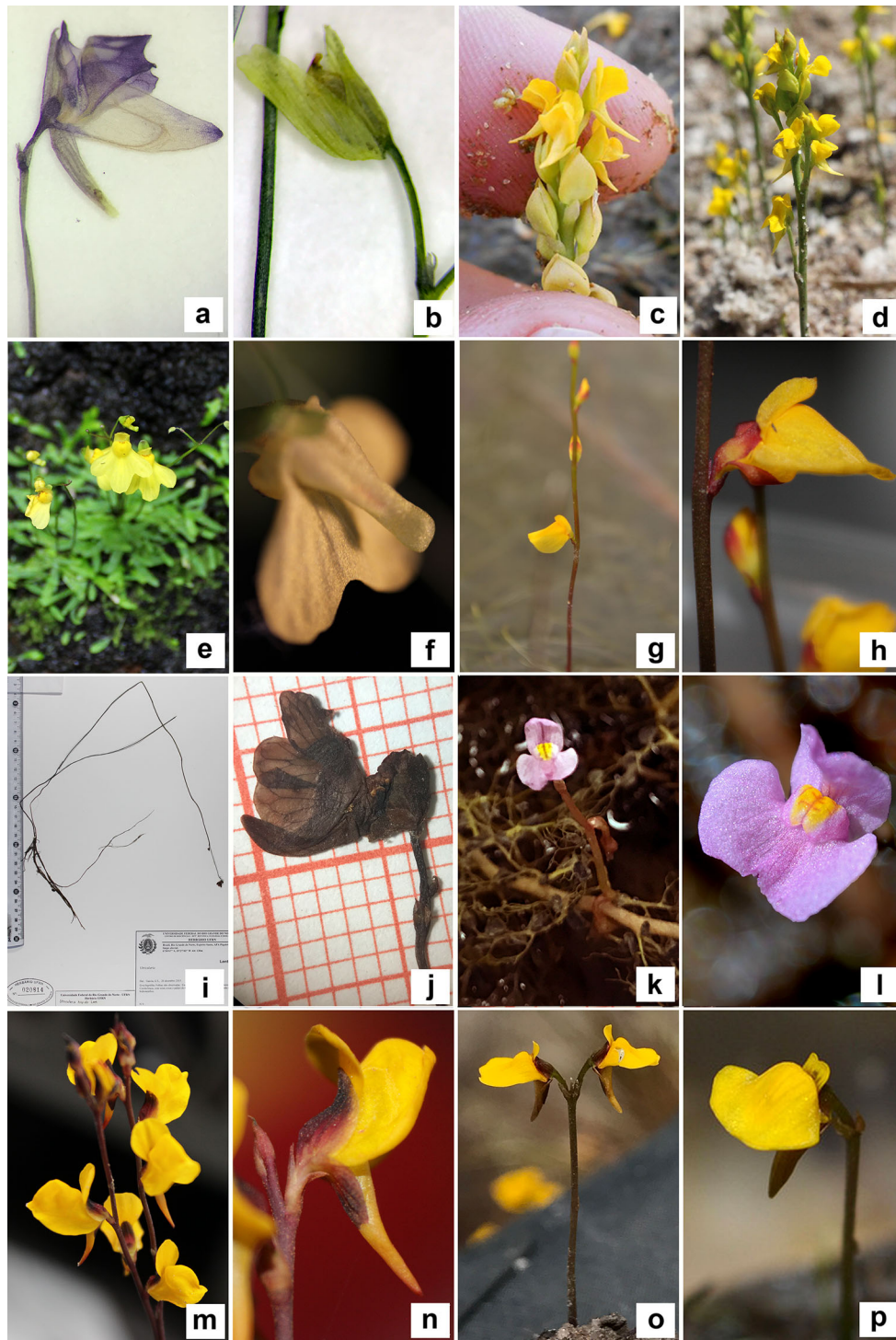


Fig. 2 a, b *Utricularia costata*; c, d *U. erectiflora*; e, f *U. flaccida*; g, h *U. guyanensis*; i, j *U. hispida*; k, l *U. hydrocarpa*; m, n *U. juncea*; o, p *U. nana*

fr.), FM Guedes et al. 77 (UFP); **Rio Grande do Norte:** Rio do Fogo, Área Militar de Rio do Fogo, Lagoa da Cotia, 11-X-2015 (fl.), GS Garcia et al. 57 (UFRN), 03-X-2017 (fl.), FM Guedes et al. 55 (UFP).

Utricularia pusilla – Vahl, Enum. 1: 202. 1804. Fig. 3(a, b)

This species is recognized by its green to vinaceous scape with sterile bracts on the raceme axis, its small, yellow corolla (5–8 mm long) with deeply trilobate lower

lip, and acute spur, longer than the lower lip and sometimes slightly curved downward. Its calyx has conspicuous nerves, not reaching the margins and apex, lower sepal with emarginate apex and greatly elongated in fruit and by its narrowly obovate to spatulate leaves. Bracts and scales are basisolute, and bracteoles are absent. It is very common to find *U. pusilla* and *U. subulata* L. misidentified in herbaria. They are similar, but *U. subulata* lacks sterile bracts on raceme axis, has larger flowers (up to 1 cm long) with spur not much longer than the lower lip, and its lower sepal does not elongate in fruit.

This terrestrial species is Neotropical; in Brazil, it is cited to AM, RR, PA, MT, GO, MG, SP, RJ, BA, MA, SE, CE, PB and PE (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas and Rio Grande do Norte (Electronic Supplementary Material Appendix 1: Fig. A2a). This species is able to colonize different types of wet habitats such as areas of seasonally flooded, white-sand savannas (“campinaranas”, “campos rupestres”, “campos de altitude” and park savannas), alluvial pioneer formations (coastal plains), gallery forests and perennial seasonal forests, flowering throughout almost the entire year.

SPECIMENS EXAMINED. BRAZIL. **Alagoas:** Chã Preta, Serra Lisa, 28-VII-2009 (fl. and fr.), ECO Chagas and MCS Mota 4467 (MAC); Feliz Deserto, Várzea da Marituba, 15-IX-1999 (fl. and fr.), R Rocha et al. 2640 (MUFAL); Maceió, Serra da Saudinha, 18-IX-2009 (fl. and fr.), ECO Chagas and MCS Mota 5551 (MAC); Matriz do Camaragibe, Serra da Curitiba, 30-VIII-2003 (fl. and fr.), RP Lyra-Lemos et al. 7909 (MAC); Quebrangulo, Reserva Biológica da Pedra Talhada, 24-X-2014 (fl. and fr.), L Nusbaumer et al. 4233 (MAC); São Luís do Quitunde, RPPN Mata Garabu, 22-VIII-2004 (fl. and fr.), RP Lyra-Lemos et al. 8527 (MAC); Tanque d’Arca, Morro do Cruzeiro, 15-VIII-2009 (fl. and fr.), ECO Chagas and MCS Mota 4987 (MAC); Viçosa, Serra Dois Irmãos, 02-VIII-2008 (fl. and fr.), ECO Chagas and MCS Mota 964 (MAC); **Rio Grande do Norte:** Ceará Mirim, RN 064 estrada para Pureza, 18-VIII-2011 (fl. and fr.), JG Jardim et al. 6027 (UFRN); Espírito Santo, APA Piquiri-Uma, próximo à barragem Piquiri, 04-X-2017 (fl. and fr.), FM Guedes et al. 67 (UFP); Macaíba, Escola Agrícola de Jundiá, Mata do Bebo, 10-II-2012 (fl. and fr.), JL Costa-Lima et al. 622 (UFRN); Parnamirim, Riacho Águas Vermelhas, Hidrominas Santa Maria, 06-IX-2004 (fl. and fr.), A Ribeiro 71 (UFRN).

Utricularia resupinata – BD.Greene ex Bigelow, Fl. Boston 3: 10. 1840. Fig. 3(c–e)

This species is readily recognized by its single terminal flower, with lilac or white corolla with a yellow blotch at the base of the lower lip, which is broadly 3-crenate with strongly inflexed lateral margins and also by its ascending

spur with emarginate apex, tubular bracts, the absence of bracteoles and its cylindrical articulated leaves. *Utricularia resupinata* is not likely to be confused with any other species except *U. spruceana* Benth. ex Oliv., which differs by its laminar, dichotomously forked leaves.

This terrestrial or subaquatic species occurs in North and Central America, extending to Brazil where it is cited to Amazonas, Rio Grande do Norte and Sergipe (Taylor 1989; Carregosa and Costa 2014; Miranda et al. 2015). Here we report a new record to Ceará, where a population occurs in an interdune coastal lagoon, sympatrically with *U. subulata* and *U. erectiflora*. The species distribution along Rio Grande do Norte is also extended; we registered three new populations along the northern coast (Electronic Supplementary Material Appendix 1: Fig. A2a). This species inhabits shallow water environments of seasonal white-sand wetlands at low altitude, such as the “campinaranas” in Amazonas state and the coastal plains in the Northeast region, flowering from September to December, during the dry season, when the water level recedes.

SPECIMENS EXAMINED. BRAZIL. **Ceará:** Aquiraz, Lagoa do Tapuio, 17-IX-2016 (fl.), FM Guedes 10 (EAC). **Rio Grande do Norte:** Maxaranguape, depressão interdunar próximo à Maracajaú, 11-X-2015 (fl. and fr.), GS Garcia et al. 65 (UFRN); Rio do Fogo, Área Militar de Rio do Fogo, 07-XII-2014 (fl. and fr.), GS Garcia 166 (UFRN).

Utricularia simulans – Pilg., Not. Bot. Gart. Berl. 6: 194. 1914. Fig. 3(f–h)

This species is recognized by its basifixed scales, bracts, bracteoles and deeply fimbriate calyx, while only its scales and bracts are auriculate, its straight raceme axis, gold to pale yellow corolla with entire lower lip, thickly conical and dorsiventrally compressed spur, with obtuse apex, about as long as the lower lip. *Utricularia simulans* is very variable with regard to general stature as well as number, size, disposition and color of flowers. It is very similar to *U. fimbriata* Kunth, *U. longeciliata* A.DC. and *U. sandwithii* P.Taylor, differing as follows: *U. fimbriata* has geniculate raceme axis and auriculate bracteoles, *U. longeciliata* has only the lowermost scales auriculate, the uppermost scales and bracts are not auriculate, while *U. sandwithii* has basisolute bracts and bracteoles, and an acute spur.

This terrestrial species is widely distributed in tropical Africa and America; in Brazil, it is cited to AM, RR, PA, MT, GO, SP, MG, BA, MA, PI, CE and PB (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas, Pernambuco and Rio Grande do Norte (Electronic Supplementary Material Appendix 1: Fig. A1b). It inhabits seasonally flooded, white-sand savannas (“Cerrado” enclaves and “campinaranas”), coastal plains and lowland, semideciduous seasonal forests (“tabuleiros”) (Taylor

1989; Oliveira et al. 2012), flowering from June (rainy season) to October (dry season).

SPECIMENS EXAMINED. BRAZIL. Alagoas: Marechal Deodoro, próximo ao Brejo Água Santa e Cabreira, 30-VIII-2008 (fl. and fr.), RP Lyra-Lemos et al. 11422 (MAC); **Pernambuco:** Goiana, 1985 (fl.), R Pereira *s.n.* (IPA 49.833), 12-VIII-2007 (fl.), JR Maciel 511 (UFP); Igarassu, Campinas dos Marcos, 26-VI-1955 (fl.), A Lima 55-2086 (PEUFR); **Rio Grande do Norte:** Ceará Mirim, acesso pela RN 064 esquerda na RN 309, 11-VIII-2011 (fl. and fr.), AA Roque et al. 1171 (HUEFS, UFRN); Rio do Fogo, Pititinga, 18-VIII-2012 (fl.), EO Moura et al. 88 (UFRN), dunas da praia de Zumbi, 11-X-2015 (fl. and fr.), GS Garcia et al. 62 (UFRN), Área Militar de Rio do Fogo, 03-X-2015 (fl. and fr.), FM Guedes et al. 51 (UFP); Nísia Floresta, APA Bonfim-Guaráfras, próximo à Lagoa de Alcaçuz, 25-IX-2015, (fl. and fr.), GS Garcia et al. 32 (UFRN).

Utricularia subulata – L, Sp. Pl. 1: 18. 1753. Fig. 3(i, j)

This species is recognized by its yellow cross-shaped corolla, up to 1 cm long, with deeply trilobate lower lip, subulate spur with acute or shortly 2–4 denticulate apex, slightly shorter than to slightly longer than the lower lip. Basisolute bracts and scales and frequently the lowermost scale have ciliate margins, the absence of bracteoles and usually geniculate (less frequently straight) inflorescence. The nerves of its sepals are not prominent and do not reach the margins and apex.

This terrestrial species is very similar to the other members of *Utricularia* sect. *Setiscapella*, differing as follows: *U. pusilla* has sterile bracts on the raceme axis and quite different sepals (see comments in *U. pusilla* above). *U. triloba* has sepals with very prominently folded nerves that reach its margins and apex, and the lower corolla lip is scarcely trilobate. *Utricularia nigrescens* Sylvén has larger flowers (up to 1.7 cm long) with a downward-curving spur, twice as long as the lower lip. *Utricularia trichophylla* Spruce ex Oliv. has sepals with rather inconspicuous nerves, straight inflorescence axis and branched leaves. *Utricularia nervosa* G.Weber ex Benj. has much larger flowers (1.3–2 cm long), acute spur, longer than the lower lip, and the base of the scape is sparsely pubescent. *Utricularia flaccida* has a lithophytic habit and corolla with a truncate spur, shorter than the lower lip.

Utricularia subulata is almost pantropical, having the widest distribution range in the genus. In Brazil, it is cited to all states except Acre and Alagoas (Taylor 1989; Miranda et al. 2015). Here we report new records to Alagoas, occurring in submontane perennial seasonal forests and seasonally flooded coastal plains (Electronic Supplementary Material Appendix 1: Fig. A2b). Our field observations

confirm that it is often the first species spotted in a soil moisture gradient of pioneer formations, such as coastal lagoons, showing remarkable drought tolerance, and flowering throughout almost the entire year.

SPECIMENS EXAMINED. BRAZIL. Alagoas Barra de São Miguel, ao lado direito da AL-101 Sul, 01-VIII-1985 (fl. and fr.), RP Lyra-Lemos and AIL Pinheiro 950 (MAC); Chã Preta, Serra Lisa, 28-VII-2009 (fl. and fr.), ECO Chagas and MCS Mota et al. 4468 (MAC); Marechal Deodoro, Povoado das Cabreiras, 11-VIII-2005 (fl. and fr.), NM Rodrigues 1778 (MAC), Dunas do Cavalo Russo, 25-IX-2008 (fl. and fr.), ECO Chagas and MCS Mota 1434 (MAC); Piaçabuçu, cordões litorâneos, 31-X-1985 (fl. and fr.), RP Lyra-Lemos and AIL Pinheiro 1075 (MAC), Vargem Grande, 22-IX-1987 (fl. and fr.), MNR Staviski et al. 1007 (MAC); Quebrangulo, Reserva Biológica de Pedra Talhada, Três Lagoas, 01-VIII-2014 (fl.), JS Correia et al. 179 (MAC).

Utricularia trichophylla – Spruce ex Oliv., J. Linn. Soc. Bot. 4: 173. 1860. Fig. 3(k, l)

This species is recognized by its yellow corolla with trilobate lower lip, conical spur with acute to 2–4-denticulate apex, about as long as the lower lip. It has an inconspicuously nerved calyx, pinnately branched and narrowly linear to lanceolate leaves, straight inflorescence axis, usually with cleistogamous inflorescences on stolon nodes or leaf axils. With regard to reproductive characters, this species is quite similar to *U. subulata*, but the aforementioned set of vegetative traits readily distinguishes it from the latter species and from any other placed in *Utricularia* sect. *Setiscapella* (see comments in *U. subulata* above).

This terrestrial or subaquatic species is Neotropical; in Brazil, it is cited to RR, AM, AC, AP, PA, MT, GO, DF, MG, SP, BA and PI (Taylor 1989; Miranda et al. 2015). Here we report new records to Ceará and Rio Grande do Norte, collected in flowing streams in perennial, seasonal forest areas (Electronic Supplementary Material Appendix 1: Fig. A1c). However, according to Taylor (1989) it can also inhabit ponds, marshes and wet, sandy environments from low to high altitude, collected with chasmogamous flowers in June and December.

SPECIMENS EXAMINED. BRAZIL. Ceará: Ubajara, Sítio Feiras, Lajedo abaixo do bunitizal, 07-VI-2012 (fl.), LQ Matias et al. 682 (EAC); **Rio Grande do Norte:** Espírito Santo, APA Piquiri-Una, 10-X-2015, GS Garcia et al. 41 (UFRN), 26-XII-2015 (fl.), GS Garcia et al. 96 (UFRN).

Utricularia triloba – Benj. in Mart., Fl. Bras. 10: 248. 1847. Fig. 3(m, n)

This species is morphologically very similar to *U. subulata*, but it is characterized by its sepals with five very prominent ridged nerves reaching the margins and apex, yellow corolla with a scarcely trilobate lower lip, subulate spur with acute apex, slightly longer than the lower lip. Its scape is capillary (ca. 0.1–0.2 mm diam.), with numerous narrowly rhombic scales, the lowermost ones sometimes bearing ciliate margins. This set of features can tell *U. triloba* apart from *U. subulata* and any other species of *Utricularia* sect. *Setiscapella*.

This terrestrial species is Neotropical; in Brazil, it is cited to RR, AM, PA, AP, MT, MS, TO, GO, DF, MG, SP, RJ, PR, SC, PB and BA (Taylor 1989; Silva 2013; Miranda et al. 2015). Here we report new records to Rio Grande do Norte and Alagoas (Electronic Supplementary Material Appendix 1: Fig. A1d). It probably also occurs in Pernambuco; however, the specimens were not found in herbarium (B Pickel *s.n.* - IPA 21.817). It inhabits seasonally flooded white-sand savannas (“campinaranas” and “Cerrado” enclaves), lowland, semideciduous seasonal forest (“tabuleiros”), riparian and gallery forests, collected in flower between July and October.

SPECIMENS EXAMINED. BRAZIL. Alagoas: Marechal Deodoro, 27-VIII-1981 (fl. and fr.), GL Esteves et al. 900 (MAC); **Paraíba:** Mataraca, Millenium Inorganic Chemicals Mineração LTDA, 15-IX-2011, (fl. and fr.), PC Gadelha-Neto et al. 3059 (JPB); Mamanguape, Reserva Biológica Guaribas, Sema I – Capim Azul, 10-VIII-2012 (fl.), CV Silva 10 (JPB); 07-X-2017 (fl. and fr.), FM Guedes et al. 73 (UFP); Sema II, 24-IX-2010 (fl.), A Melo et al. 478 (JPB); 27-VII-2017 (fl.), FM Guedes 21 (UFP); **Rio Grande do Norte:** Espírito Santo, APA Piquirí-Uma, próximo à barragem Piquirí, 10-X-2015 (fl. and fr.), GS Garcia et al. 42 (UFRN); 04-X-2017 (fl. and fr.), FM Guedes et al. 64 (UFP).

Utricularia viscosa – Spruce ex Oliv., J. Linn. Soc. Bot. 4: 172. 1860. Fig. 3(o, p)

This species is readily recognized by its sticky scape, viscid glandular above, and hispid below, stolons and traps are densely covered with short hair-like trichomes. It has a lilac corolla with a white and yellow blotch at the base of the lower lip, which is quadrate, with a 3-crenate apex, and a narrowly cylindrical spur with obtuse apex, twice as long as the lower lip, basisolute bracts and scales, with entire margins, and the absence of bracteoles.

This set of morphological features distinguishes *U. viscosa* from all other congeners, even though the basisolute bracts and the form of the inflorescence resemble members of *Utricularia* sect. *Setiscapella*. The sticky scape is also observable in herbaria specimens, which often present sand grains attached to the scapes.

This terrestrial species is Neotropical; in Brazil, it is cited to RR, AM, PA, RO, PI, CE and MT (Taylor 1989; Miranda et al. 2015). Here we report new records to Rio Grande do Norte, with populations found in areas of seasonally flooded, white-sand savannas (“Cerrado” enclave) and coastal plains (Electronic Supplementary Material Appendix 1: Fig. A2b), collected in flower from October to January.

SPECIMENS EXAMINED. BRAZIL. Rio Grande do Norte Rio do Fogo, Área Militar de Rio do Fogo, 07-XII-2014 (fl. and fr.), GS Garcia 167 (UFRN), 08-I-2015 (fl. and fr.), GS Garcia 181 (UFRN), 11-X-2015 (fl. and fr.), GS Garcia et al. 49 (UFRN).

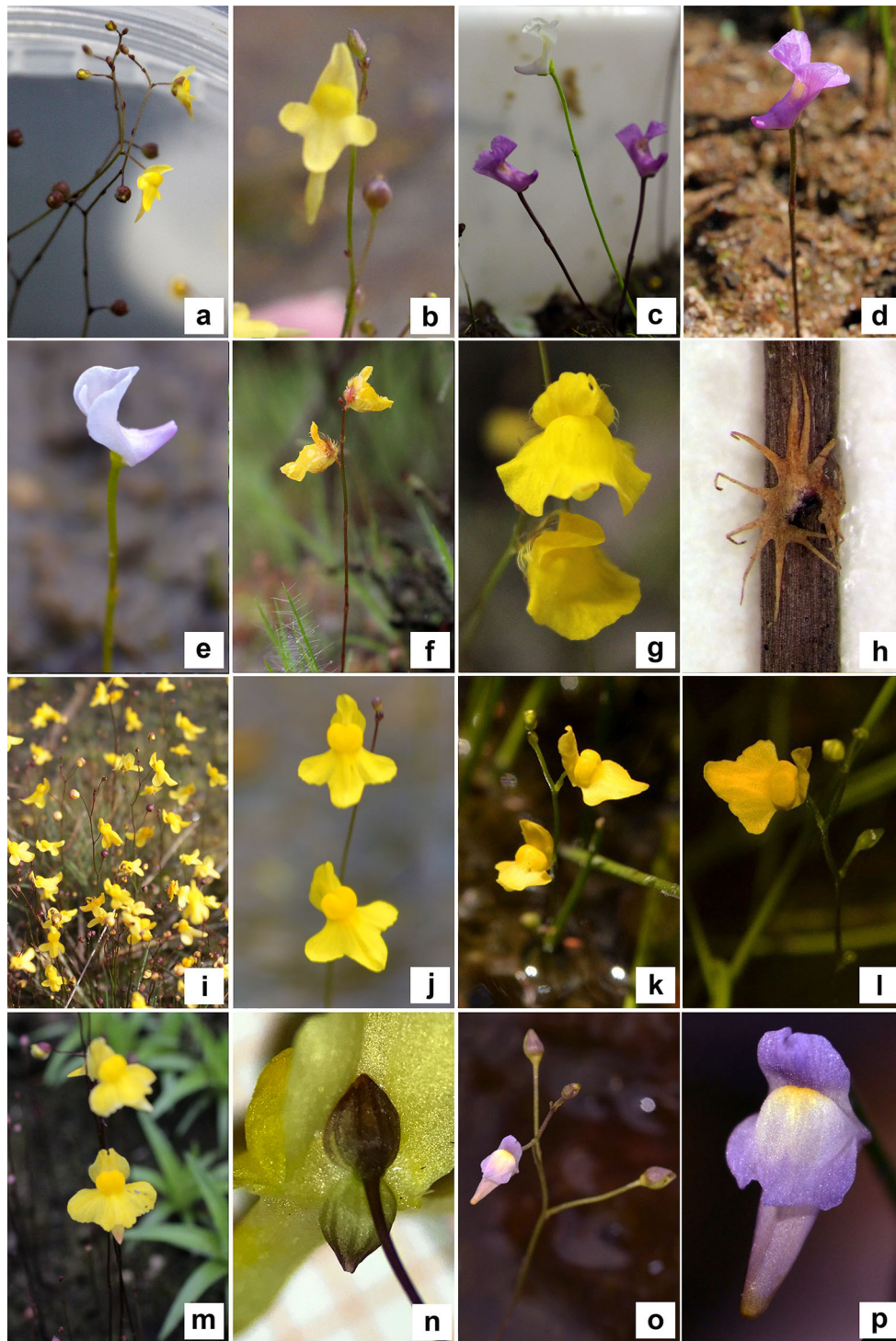


Fig. 3 a, b *Utricularia pusilla*; c–e *U. resupinata*; f–h *U. simulans*; i, j *U. subulata*; k, l *U. trichophylla*; m, n *U. triloba*; o, p *U. viscosa*

4 Discussion

Recent phylogenetic studies inferred the possible last common ancestor of the *Genlisea-Utricularia* clade to be South American, arising around 39 million years ago (mya), counting with transoceanic dispersal routes for *Genlisea* and *Utricularia* lineages and northward dispersal routes for Neotropical *Utricularia* (Fleischmann 2012; Silva et al. 2018). This lineage diversified very recently, so its distribution seems most explanatory by long-distance dispersal than by vicariance (Fleischmann 2012; Christenhusz and Chase 2013; Silva et al. 2018). Such ability to disperse, possibly due to its minute and numerous seeds, would support the many new disjunctions documented here. In fact, Lentibulariaceae seeds are minute and with ornamented testa cells, which accumulate air bubbles and favor the buoyancy to long-distance dispersal (Menezes et al. 2014; Silva et al. 2018).

The majority of Brazilian *Genlisea* species are restricted to “campos rupestres” (Fleischmann 2012) as are a few *Utricularia*, such as *U. blanchetii*, *U. parthenopipes*, *U. purpureocaerulea* and *U. rostrata* (Taylor 1989; Fleischmann and Rivadavia 2009). According to our data (Table 1), some species seem to be from lowland, seasonally flooded sandy areas, such as *U. adpressa*, *U. amethystina*, *U. benjaminiana*, *U. cornuta*, *U. erectiflora*, *U. guyanensis*, *U. hydrocarpa*, *U. juncea*, *U. resupinata* and *U. viscosa*.

Alves et al. (2007) claim that “restinga” species colonized these areas after originating from savannic ancestors typical from “campos rupestres”, which is a pattern observed in other species of plant communities adapted to these disjunct scattered habitats, such as Xyridaceae and Eriocaulaceae (typically found among species of Lentibulariaceae in wet habitats). These species have an

outstanding capacity to disperse compared to other groups of the vegetation around (Fleischmann 2012).

Most of the new records of Lentibulariaceae species present disjunct distributions. The “Cerrado” environments, notably “campos rupestres” and “veredas” systems, share several species of the family with the eastern coastal plains of northeastern Brazil, consistent with hypothesis of other vegetation invasions of the Atlantic Forest domain in the past, during moister climatic conditions (Sobral-Souza et al. 2015). The present distribution of *G. filiformis*, *U. amethystina*, *U. flaccida*, *U. hispida*, *U. nana* and *U. trichophylla* could be explained by the past connection between these two phytogeographic domains.

A few other species exhibit a more disjunct pattern, occurring over North America, the Caribbean, Guyana Shield and, as reported in this paper, in the Brazilian Northeast Coast. *U. benjaminiana*, *U. cornuta*, *U. guyanensis*, *U. juncea*, *U. resupinata* and *U. viscosa* share this pattern of distribution, which suggest a connection between the upper Amazon environments and the formations of the study area. The new records of *U. cornuta* and *U. resupinata* to Ceará especially point to this connection, which possibly happened across the seasonally flooded coastal plains between Maranhão and Rio Grande do Norte, a connection hypothesis proposed by Sobral-Souza et al. (2015) for forest species migration. Many examples of disjunctions between the Amazon forest and the Brazilian Atlantic Coast were documented by Mori et al. (1981). We believe that as the northern portion of the Northeast region (i.e., MA, PI, CE, RN states) has its flora better studied, more interesting cases of disjunctions involving humid habitats between such areas will appear. Wang et al. (2004) suggest that the moister climate in the past affected the present rainforest distribution pattern by increasing the number of suitable habitats for moist-dependent species (i.e., flooded formations along the Brazilian coast).

Our results are particularly important if we consider that coastal lagoons and humid habitats within seasonally flooded coastal plains are being quickly transformed through land use or city expansions, leading to great habitat loss for many taxa (Scarano 2009; Santos-Filho et al. 2013). Of the 41 Lentibulariaceae species assessed in the Red List, only three treated in this paper (*U. cornuta*, *U. resupinata* and *U. subulata*) are listed as of least concern (IUCN 2017). According to the CNCFlora (2018), only 16 Lentibulariaceae species (of 83 from Brazil) were assessed and two of them are listed as threatened: *G. lobata* (EN) and *U. tridentata* (VU). The low number shows a clear need for more research on threats to carnivorous plants, especially Lentibulariaceae, since these plants are very sensitive to pollution and changes in environmental conditions, playing a potential role as bioindicators for ecosystem health (Ellison and Gotelli 2001, 2002; Jennings and Rohr 2011). Many carnivorous plants are fairly threatened solely for being highly endemic, confined to small, moist areas within the surrounding phytophysiology, and for having lower reproductive effort and dispersal capacity (Jennings and Rohr 2011; Jobson et al. 2018).

Of the 22 species treated in this paper, only four do not occur in protected areas in northeastern Brazil (Table 1), the remaining 18 are under some level of protection and, however, this does not mean they are free from threats, as occasional fires might occur in a few areas and anthropic impacts affect habitat integrity (IBAMA 2003; ICMBio

2016). These plants provide important ecosystem services on which other specialist species depend on. Therefore, assuring their conservation will help sustain these services and prevent secondary extinctions (Jennings and Rohr 2011).

The substantial number of new records presented here also highlights that northeastern Brazil is still not well botanically sampled, especially concerning the herbaceous stratum, and that Lentibulariaceae are frequently neglected in floristic surveys (Rocha et al. 2004; Oliveira et al. 2012; Versieux et al. 2017). Most of the records were from Rio Grande do Norte (12/36), where the family was intensively sampled, followed by Alagoas (8/36). The remaining states still lack collection efforts in wetland areas, especially in Piauí, Maranhão and Ceará (the least well-sampled states in the study area). The majority of these new records derived from misidentified herbaria material or that lacking identification, while only 12 records resulted from recent sampling effort by the authors. This finding reinforces the need to improve curation, stimulate visits by taxonomic specialists and keep forming and training local botanists.

This paper provides the first insights into the actual richness and species distribution of Lentibulariaceae in northeastern Brazil, which is much higher than previously reported for each state (i.e., before our work RN, CE and AL had seven, 14 and four spp., respectively; now with 19, 18 and eleven spp.) and leading to an even more complex biogeographic history that still needs further investigation.

Table 1 New records of Lentibulariaceae species from Northeastern Brazil including threat category according to IUCN (2017) or CNCFIora (2018), phylogeographic domain and phytophysiology where they can be found (IBGE 2012), distribution (Taylor 1989; Miranda et al. 2015) and regional conservation units where they are inserted. Legend: APA (Environmental Protection Area), REBIO (Biological Reserve), PARNA (National Park), FLONA (National Forest), TI (Indian Territory), PE (State Park), RPPN (Private Reserve of Natural Heritage)

Species	Threat category	Brazilian phylogeographic domain (IBGE 2012)	Type of vegetation (phytophysiology) (IBGE 2012)	Distribution (Taylor 1989; Miranda et al. 2015) ^a	Northeast Brazil conservation units
<i>Genlisea filiformis</i>	LC (CNCFIora)	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campos rupestres” “Campos de altitude” “Campinaranas” Park savannas Gallery forests Seasonally flooded white-sand savannas	Neotropical Brazil: AM, RR, MT, MS, SP, GO, DF, MG, TO, BA, SE, PE, PB, CE and RN	APA Piquiri-Una (RN) APA Bonfim-Guarairas (RN) REBIO Guaribas (PB) PARNA da Serra de Itabatana (SE)
<i>G. lobata</i>	EN (CNCFIora)	“Mata Atlântica”	Seasonally flooded white-sand savannas	Brazil: ES, MG and BA	
<i>Utricularia anethysina</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campos rupestres” “Campos de altitude” “Campinaranas” Park savannas	Tropical America and Subtropical North America Brazil: AM, RR, PA, AP, MT, MS, TO, GO, DF, MG, SP, RJ, ES, BA, SE, MA, PE, PB and AL	REBIO Guaribas (PB) PARNA da Serra de Itabatana (SE)
<i>U. benjaminiana</i>	Not evaluated	“Mata Atlântica” “Floresta Amazônica”	Seasonally flooded white-sand savannas “Campinaranas” Park savannas	Africa, Madagascar, Central and northern South America Brazil: RR, RN and SE	APA Bonfim-Guarairas (RN)
<i>U. blanchetii</i>	Not evaluated	“Cerrado” “Caatinga”	Seasonally flooded white-sand savannas “Campos rupestres”	Brazil: BA and PE	PARNA do Catimbau (PE) PARNA da Chapada Diamantina (BA)
<i>U. breviscapa</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Pantanal”	Gallery forests Alluvial pioneer formations Coastal plains	Neotropical Brazil: AM, PA, BA, MG, GO, SP, MT and PI	
<i>U. cornuta</i>	LC (IUCN)	“Mata Atlântica” “Cerrado”	Alluvial pioneer formations Coastal plains	North and Central America Brazil: MA, CE and RN	APA de Jijoca de Jericoacoara (CE) APA Jenipabu (RN) APA Bonfim-Guarairas (RN)

Table 1 (continued)

Species	Threat category	Brazilian phytogeographic domain (IBGE 2012)	Type of vegetation (phytogeography) (IBGE 2012)	Distribution (Taylor 1989; Miranda et al. 2015) ^a	Northeast Brazil conservation units
<i>U. costata</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas” Park savannas Submontane and montane perennial seasonal forests	South America Brazil: RR, PA, MT, GO, AL, SE and BA	PARNA da Serra de Itabatana (SE)
<i>U. erectiflora</i>	LC (CNCFlora)	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas Park savannas High altitude perennial seasonal forests	Neotropical Brazil: RR, CE, RN, SE, BA, GO, MT, ES, RJ, SP, SC, AL, MA and PI	TI Lagoa Encantada (CE) APA do Lagamar do Cauipe (CE) APA Jenipabu (RN) APA de Piaçabuçu (AL) PARNA de Ubajara (CE) PARNA da Serra de Itabatana (SE)
<i>U. flaccida</i>	NT (CNCFlora)	“Mata Atlântica” “Cerrado” “Floresta Amazônica”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas	Neotropical Brazil: RR, BA, SE, MT, MG and CE	
<i>U. guyanensis</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas”	Neotropical Brazil: RR, BA, RN and SE	
<i>U. hispida</i>	Not evaluated	“Mata Atlântica” “Cerrado”	Seasonally flooded white-sand savannas Park savannas Gallery forests	Neotropical Brazil: MT, MS, GO, DF, SP, MG, TO, MA and RN	APA Piquiri-Una (RN)
<i>U. hydrocarpa</i>	LC (CNCFlora)	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas Park savannas Lowland semideciduous seasonal forests Perennial seasonal forests	Neotropical Brazil: AM, PA, AP, MT, MS, GO, MG, SC, SP, RJ, BA, MA, CE, SE, PB, PE, AL, PI and RN	PE Dois Irmãos (PE) APA de Piaçabuçu (AL)

Table 1 (continued)

Species	Threat category	Brazilian phytogeographic domain (IBGE 2012)	Type of vegetation (phytogeography) (IBGE 2012)	Distribution (Taylor 1989; Miranda et al. 2015) ^a	Northeast Brazil conservation units
<i>U. juncea</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas” Park savannas Lowland semideciduous seasonal forests	North to South America Brazil: RR, AP, PI, CE, PB, PE, AL, BA and RN	FLONA de Nísia Floresta (RN) APA Piquiri-Una (RN) APA Bonfim-Guararás (RN) REBIO Guaribas (PB)
<i>U. nana</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica”	Seasonally flooded white-sand savannas “Campinaranas” Park savannas Lowland semideciduous seasonal forests	South America Brazil: PA TO, MT, MS, MG, GO, DF, SP, PR, BA, MA, SE, PB and RN	REBIO Guaribas (PB)
<i>U. pusilla</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campos rupestres” “Campos de altitude” “Campinaranas” Park savannas Lowland semideciduous seasonal forests	Neotropical Brazil: AM, RR, PA, MT, GO, MG, SP, RJ, BA, MA, SE, CE, PB, PE, AL and RN	APA da Chapada do Araripe (CE) APA Piquiri-Una (RN) REBIO Guaribas (PB) RPPN Frei Caneca (PE) REBIO de Pedra Talhada (AL) RPPN Garabu (AL) PARNA da Serra de Itabaiana (SE)
<i>U. resupinata</i>	LC (IUCN)	“Mata Atlântica” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas”	North and Central America Brazil: AM, RN, SE and CE	TI Lagoa Encantada (CE) APA Jenipabu (RN) APA do Litoral Sul (SE)
<i>U. simulans</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas” Park savannas	Tropical Africa and America Brazil: AM, RR, PA, MT, GO, SP, MG, BA, MA, PI, CE, PB, PE, RN and AL	APA Bonfim-Guararás (RN) REBIO Guaribas (PB)

Table 1 (continued)

Species	Threat category	Brazilian phytogeographic domain (IBGE 2012)	Type of vegetation (phytogeography) (IBGE 2012)	Distribution (Taylor 1989; Miranda et al. 2015) ^a	Northeast Brazil conservation units
<i>U. subulata</i>	LC (IUCN)	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campos rupestres” “Campos de altitude” “Campinaranas” Park savannas Perennial seasonal forests	Pantropical Brazil: all except AC	TI Lagoa Encantada (CE) APA Bonfim-Guararás (RN) APA Jenipabu (RN) APA Piquiri-Una (RN) REBIO Guaribas (PB) APA de Piaçabuçu (AL) REBIO de Pedra Talhada (AL) PARNA da Serra de Itabatana (SE) APA Piquiri-Una (RN)
<i>U. trichophylla</i>	LC (CNCFlora)	“Mata Atlântica” “Cerrado” “Floresta Amazônica”	Gallery forests Perennial seasonal forests	Neotropical Brazil: RR, AM, AC, AP, PA, MT, GO, DF, MG, SP, BA, PI, CE and RN	APA Piquiri-Una (RN)
<i>U. triloba</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica” “Caatinga”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campos de altitude” “Campinaranas” Park savannas Perennial seasonal forests	Neotropical Brazil: RR, AM, PA, AP, MT, MS, TO, GO, DF, MG, SP, RJ, PR, SC, BA, RN, PB and AL	APA Piquiri-Una (RN) REBIO Guaribas (PB)
<i>U. viscosa</i>	Not evaluated	“Mata Atlântica” “Cerrado” “Floresta Amazônica”	Alluvial pioneer formations Coastal plains Seasonally flooded white-sand savannas “Campinaranas” Park savannas	Neotropical Brazil: RR, AM, PA, RO, PI, MT, CE and RN	

^a Abbreviations of Brazilian states: (AC) Acre, (AL) Alagoas, (AM) Amazonas, (AP) Amapá, (BA) Bahia, (CE) Ceará, (DF) Distrito Federal, (ES) Espírito Santo, (GO) Goiás, (MA) Maranhão, (MG) Minas Gerais, (MS) Mato Grosso do Sul, (MT) Mato Grosso, (PA) Pará, (PB) Paraíba, (PE) Pernambuco, (PI) Piauí, (PR) Paraná, (RJ) Rio de Janeiro, (RN) Rio Grande do Norte, (RO) Rondônia, (RR) Roraima, (RS) Rio Grande do Sul, (SC) Santa Catarina, (SE) Sergipe, (SP) São Paulo and (TO) Tocantins

Acknowledgements We thank the curators of ALCB, CEPEC, EAC, HST, HUEFS, IPA, JPB, MAC, MUFAL, PEUFR, R, RB, UFP and UFRN herbaria. We are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the concession of a masters' scholarship to the first author and to Post-Graduation Program in Plant Biology, Biosciences Centre/Federal University of Pernambuco (CB/UFPE), for granting logistic and laboratory support. The second author had a Capes fellowship (#88887.124186/2014-00).

References

- Alves RJV, Cardin L, Kropf MS (2007) Angiosperm disjunction “Campos rupestres-restingas”: a re-evaluation. *Acta Bot Bras* 21:675–685
- Andrade KVSA, Rodal MJN, Lucena MFA, Gomes APS (2004) Composição florística de um trecho do Parque Nacional do Catimbau, Buíque, Pernambuco – Brasil. *Hoehnea* 31:337–348
- Baleeiro PC, Jobson RW, Sano PT (2015) Morphometric approach to address taxonomic problems: the case of *Utricularia* sect. *Foliosa* (Lentibulariaceae). *J Syst Evol* 54:175–186
- Bigarella JJ, Andrade-Lima D, Riehs PJ (1975) Considerações a respeito das mudanças paleoambientais na distribuição de algumas espécies vegetais e animais no Brasil. *An Acad Bras Ciênc* 47:411–464
- Borges RAX, Carneiro MAA, Viana PL (2011) Altitudinal distribution and species richness of herbaceous plants in campos rupestres of the Southern Espinhaço Range, Minas Gerais, Brazil. *Rodriguésia* 62:139–152
- Carregosa T, Costa SM (2014) Ampliação da distribuição geográfica de três espécies de *Utricularia* (Lentibulariaceae) para o bioma Mata Atlântica. *Rodriguésia* 65:563–565
- Carregosa T, Monteiro SHN (2013) Lentibulariaceae. In: Prata APN (ed) *Flora de Sergipe*. Aracaju: Gráfica e Editora Triunfo, vol 1, pp 306–321
- Casper SJ, Stimpert R (2009) Chromosome numbers in *Pinguicula* (Lentibulariaceae): survey, atlas, and taxonomic conclusions. *Plant Syst Evol* 277:21–60
- Cheek M, Taylor P (1995) Lentibulariaceae. In: Stannard B (ed) *Flora of the Pico das Almas, Chapada Diamantina, Bahia, Brazil*. RBG, Kew, pp 395–406
- Christenhusz MJM, Chase MW (2013) Biogeographical patterns of plants in the Neotropics—dispersal rather than plate tectonics is most explanatory. *Bot J Linn Soc* 171:277–286
- CNCFlora (Centro Nacional de Conservação da Flora) (2018) *Genlisea lobata* in Lista Vermelha da flora brasileira versão 2012.2. <http://cncflora.jbrj.gov.br/portal/pt-br/profile/Genlisea%20lobata>. Accessed 26 Feb 2018
- Conceição AA, Giulietti AM (2002) Composição florística e aspectos estruturais de campo rupestre em dois platôs do Morro do Pai Inácio, Chapada Diamantina, Bahia, Brasil. *Hoehnea* 29:37–48
- Costa LP (2003) The historical bridge between the Amazon and the Atlantic Forest of Brazil: a study of molecular phylogeography with small mammals. *J Biogeogr* 30:71–86
- Costa SM, Bittrich V, Amaral MCE (2016) Lentibulariaceae from the Viruá National Park in the northern Amazon, Roraima, Brazil. *Phytotaxa* 258:1–25
- Dörrstock S, Seine R, Porembski S, Barthlott W (1996) First record of the American *Utricularia juncea* (Lentibulariaceae) from Africa. *Kew Bull* 51:579–583
- Ellison AM, Gotelli NJ (2001) Evolutionary ecology of carnivorous plants. *Trends Ecol Evol* 16:623–629
- Ellison AM, Gotelli NJ (2002) A fine-scale indicator of nitrogen saturation in northern ecosystems. *Proc Natl Acad Sci* 99:4409–4412
- Fleischmann A (2012) Monograph of the genus *Genlisea*. Redfern Natural History Productions Ltd., Poole
- Fleischmann A (2018) Systematics and evolution of Lentibulariaceae: II. *Genlisea*. In: Ellison AM, Adamec L (eds) *Carnivorous plants: physiology, ecology and evolution*. Oxford University Press, Oxford, pp 81–88
- Fleischmann A, Rivadavia F (2009) *Utricularia rostrata* (Lentibulariaceae), a new species from the Chapada Diamantina, Brazil. *Kew Bull* 64:155–159
- Fleischmann A, Rocchia A (2018) Systematics and evolution of Lentibulariaceae: I. *Pinguicula*. In: Ellison AM, Adamec L (eds) *Carnivorous plants: physiology, ecology and evolution*. Oxford University Press, Oxford, pp 70–80
- Fleischmann A, Costa SM, Bittrich V, Amaral MCE, Hopkins M (2017) A new species of corkscrew plant (*Genlisea*, Lentibulariaceae) from the Amazon lowlands of Brazil, including a key to all species occurring north of the Amazon River. *Phytotaxa* 319:289–297
- Fleischmann A, Cross AT, Gibson R, Gonella P, Dixon KW (2018) Systematics and evolution of Droseraceae. In: Ellison AM, Adamec L (eds) *Carnivorous plants: physiology, ecology and evolution*. Oxford University Press, Oxford, pp 45–57
- Heslop-Harrison Y (2004) *Pinguicula* L. *J Ecol* 92:1071–1118
- IBAMA (Instituto Brasileiro do Meio Ambiente) (2003) Plano de manejo da Reserva Biológica Guaribas. MMA/IBAMA, Brasília
- IBGE (Instituto Brasileiro de Geografia e Estatística) (2012) Manual técnico da vegetação brasileira, 2ed. Rio de Janeiro
- ICMBio (Instituto Chico Mendes de Conservação da Biodiversidade) (2016) Plano de Manejo do Parque Nacional da Serra de Itabaiana. MMA/ICMBio, Brasília
- IUCN (2017) The IUCN Red List of Threatened Species Version 2017.3. <http://www.iucnredlist.org>. Accessed 26 Feb 2018
- Jennings DE, Rohr JR (2011) A review of the conservation threats to carnivorous plants. *Biol Conservation* 144:1356–1363
- Jobson RW, Baleeiro PC, Guisande C (2018) Systematics and evolution of Lentibulariaceae: III. *Utricularia*. In: Ellison AM, Adamec L (eds) *Carnivorous plants: physiology, ecology and evolution*. Oxford University Press, Oxford, pp 89–104
- Lloyd FE (1942) The carnivorous plants. In: *Chronica Notanica* co. Waltham, Massachusetts
- Menezes CG, Gasparino EC, Baleeiro PC, Miranda VFO (2014) Seed morphology of bladderworts: a survey on *Utricularia* sect. *Foliosa* and sect. *Psyllosperma* (Lentibulariaceae) with taxonomic implications. *Phytotaxa* 167:173–182
- Miranda IS, Absy ML (2000) Fisionomia das Savanas de Roraima, Brasil. *Acta Amaz* 30:423–440
- Miranda VFO, Menezes CG, Silva SR, Díaz YCA, Rivadavia F (2015) Lentibulariaceae. In: Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB146>. Accessed 01 Aug 2018
- Mori SA, Boom BM, Prance GT (1981) Distribution patterns and conservation of eastern Brazilian coastal forest tree species. *Brittonia* 33:233–245
- Oliveira ACPD, Penha ADS, Souza RFD, Loiola MIB (2012) Composição florística de uma comunidade savânica no Rio Grande do Norte, Nordeste do Brasil. *Acta Bot Bras* 26:559–569
- Queiroz LP, Sena TSN, Costa MJSL (1996) Flora vascular da Serra da Jibóia, Santa Terezinha – Bahia: I. O campo rupestre. *Sititibus* 15:27–40
- Ritter LMO, Ribeiro MC, Moro RS (2010) Composição florística e fitofisionomia de remanescentes disjuntos de Cerrado nos Campos Gerais, PR, Brasil – limite austral do bioma. *Biota Neotrop* 10:379–414

- Rocha PLB, Queiroz LP, Pirani JR (2004) Plant species and habitat structure in a sand dune field in the Brazilian Caatinga: a homogeneous habitat harbouring an endemic biota. *Rev Bras Bot* 27:739–755
- Rodal MJN, Andrade KVA, Sales MF, Gomes APS (1998) Fitosociologia do componente lenhoso de um refúgio vegetacional no município de Buíque, Pernambuco. *Rev Bras Biol* 58:517–526
- Rutishauser R, Isler B (2001) Developmental genetics and morphological evolution of flowering plants, especially bladderworts (*Utricularia*): fuzzy Arberian morphology complements Classical Morphology. *Ann Bot* 88:1173–1202
- Santos-Filho FS, Almeida-Júnior EB, Zickel CS (2013) A flora das restingas de Parnaíba e Luiz Correia — litoral do Piauí, Brasil. In: Santos-Filho FS, Soares AFCL, Almeida-Júnior EB (eds) Biodiversidade do Piauí: pesquisas and perspectivas, vol 2. Curitiba, CRV, pp 37–60
- Scarano FR (2009) Plant communities at the periphery of the Atlantic rain forest: rare-species bias and its risks for conservation. *Biol Conserv* 142:1201–1208
- Silva CV (2013) Preliminary studies reveal richness of carnivorous plants in an underexplored area of Northeastern Brazil. *Carniv Pl Newslett* 42:130–136
- Silva CV, Cruz DD (2015) First records of *Utricularia tenuissima* Tutin and *U. nigrescens* Sylvén (Lentibulariaceae) in northeastern Brazil. *Rev Bras Bioci* 13:10–14
- Silva SR, Gibson R, Adamec L, Domínguez Y, Miranda VFO (2018) Molecular phylogeny of bladderworts: a wide approach of *Utricularia* (Lentibulariaceae) species relationships based on six plastidial and nuclear DNA sequences. *Mol Phylogenet Evol* 118:244–264
- Silveira FA, Negreiros D, Barbosa NP, Buisson E, Carmo FF, Carstensen DW, Conceição AA, Cornelissen TG, Echternacht L, Fernandes GW, Garcia QS, Guerra TJ, Jacobi CM, Lemos-Filho JP, Stradic SL, Morellato LP, Neves FS, Oliveira RS, Schaefer CE, Viana PL, Lambers H (2016) Ecology and evolution of plant diversity in the endangered campo rupestre: a neglected conservation priority. *Plant Soil* 403:129–152
- Simonelli M, Fraga CN (2007) Espécies da Flora Ameaçadas de Extinção no Estado do Espírito Santo. IPEMA, Vitória, ES
- Sobral-Souza T, Lima-Ribeiro MS, Solferini VN (2015) Biogeography of Neotropical Rainforests: past connections between Amazon and Atlantic Forest detected by ecological niche modelling. *Evol Ecol* 29:643–655
- Stannard BL (1995) Flora of the Pico das Almas - Chapada Diamantina, Bahia, Brazil. Royal Botanic Gardens, Kew
- Taylor P (1989) The genus *Utricularia*—a taxonomic monograph. Kew Bulletin Additional Series. Royal Botanical Gardens, Kew, London
- Thiers B [continuously updated] Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/science/ih/>. Accessed 30 Apr 2018
- Versieux LM, Dávilla N, Delgado GC, Sousa VF, Moura EO, Filgueiras T, Alves MV, Carvalho E, Piotto D, Forzza RC, Calvente A, Jardim JG (2017) Integrative research identifies 71 new plant species records in the state of Rio Grande do Norte (Brazil) and enhances a small herbarium collection during a funding shortage. *PhytoKeys* 86:43–774
- Vincent O, Weibkopf C, Poppinga S, Masselter T, Speck T, Joyeux M, Quilliet C, Marmottant P (2011) Ultra-fast underwater suction traps. *Proc R Soc B* 287:2909–2914
- Wang X, Auler AS, Edwards RL, Cheng H, Cristalli PS, Smart PL, Richards DA, Shen CC (2004) Wet periods in Northeastern Brazil over the past 210 kyr linked to distant climate anomalies. *Nature* 432:740–743
- Zappi DC, Lucas E, Stannard B, Lughadha EN, Pirani JR, Queiroz LP, Atkins S, Hind DJN, Giuliatti AM, Harley RM (2003) Lista das plantas vasculares de Catolés, Chapada Diamantina, Bahia, Brasil. *Bol Bot Univ São Paulo* 21:345–398