RESEARCH ARTICLE



Three new species of Licania (Chrysobalanaceae) from Peru

Ghillean T. Prance¹

Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK

Corresponding author: Ghillean T. Prance (siriain01@yahoo.co.uk)

Academic editor: Geoffrey Levin | Received 17 May 2014 | Accepted 12 September 2014 | Published 16 September 2014

Citation: Prance GT (2014) Three new species of Licania (Chrysobalanaceae) from Peru. PhytoKeys 42: 1–10. doi: 10.3897/phytokeys.42.7924

Abstract

Recent collections received for identification contain three conspicuous new species for the mid altitude forests of Amazonian Peru. *Licania palcazuensis, L. apiknae* and *L. monteagudensis* are described as new and their relationship to other species is discussed. A key is provided for all the species of *Licania* subgenus *Licania* section *Licania* known to occur in Peru.

Keywords

Chrysobalanaceae, Licania, Amazonian Peru

Introduction

Since a world monograph of the Chrysobalanaceae (Prance and Sothers 2003a,b) new species are still being discovered (Prance 2013) and recently studied collections reveal three more in the genus *Licania*, all from Amazonian Peru, a region that is still yielding many novelties. The sterile inventory material that I have seen from this region indicates that there are many more yet to be described. The new species described here fall into two of the subgenera, subgenus *Licania* and subgenus *Moquilea*.

Species descriptions

Licania palcazuensis Prance, sp. nov.

urn:lsid:ipni.org:names:77142292-1 Figs 1, 2

Ab omnibus speciebus Licaniae inflorescentibus multi-ramificantibus, pseudopedicellis 1–3 floribus instructis, pilis bracteolium glandulosis differt.

Description. Tree to 25 m tall, young branches sparsely tomentellous, conspicuously lenticellate with age. Leaves with small triangular to linear stipules to 1.0 mm long, early caducous; petioles 4-7 mm long, terete, rugose, sparsely tomentellous; lamina oblong to oblong-lanceolate, subcoriaceous, $4-8.5 \times 1.5-3$ cm, cuneate at base, acuminate at apex, the acumen 4-8 mm long, glabrous above, densely rufous lanatetomentose beneath, with scattered palisade glands mainly near to midrib; midrib plane above, prominent beneath; veins 10-12 pairs, plane above, prominulous beneath. Inflorescence terminal and axillary much-branched panicles with many short branches bearing 1-3 flowers, the rachis and branches rufous-brown tomentose. Bracts and bracteoles membraneous, triangular-acute, c 1 mm long, borne at base and on pseudopedicels, the ciliate margins with glandular hairs; pedicels 0-5 mm long, flowers articulate just below receptacle base where upper bracteoles are borne 2-7 mm below articulations. Receptacle campanulate, rufous-tomentose on exterior. Flowers seen only in young fruiting condition; calyx lobes 5, markedly triangular, tomentose on exterior, interior glabrous towards base, tomentellous towards apex. Petals triangular, margins ciliate. Stamens 12-14, inserted around complete circle, slightly exceeding calyx lobes in length. Style basal; ovary of young developing fruit densely rufous-tomentose becoming less so with age, unilocular with 2 ovules. Mature fruit not seen.

Peru. Pasco: Oxapampa, Palcazu District, Parque Nacional Yanachaga-Chemillén, Cerro Panjil-Ozuz, Permanent plot tree 24, 10°10'S, 75°10'W, 850 m, 12 May 2005, *A Monteagudo, A Peña, R. Francis et al. 8250* (holotype, K; isotypes, AMAZ, HUT, MO, MOL, USM).

Additional material seen. Same locality, Tree 347, 10 June 2005, 15 May 2005, *A. Monteagudo, A Peña, R. Francis et al. 8585* (AMAZ, HUT, K, MO, MOL, USM), Tree 171, 15 May 2005, *A. Monteagudo, A Peña, R. Francis et al. 8418* (K, MO USM).

Differs from all other species of *Licania* in the inflorescence branching with pseudopedicels bearing one or several flowers that articulate from it, and the bracteoles have marginal hairs that terminate in tiny glands. This species belongs to subgenus *Moquilea* on account of the number of exserted stamens and the presence of petals, but the inflorescence distinguishes it from all the other species of the subgenus. The field notes mention that the flowers are white and that the fruit has yellow spots.



Figure 1. Photo of the holotype of *Licania palcazuensis* (Monteagudo et al. 8250).



Figure 2. Close up of distinctive inflorescence of *Licania palcazuensis*.

Licania apiknae Prance, sp. nov.

urn:lsid:ipni.org:names:77142293-1 Figs 3, 4

Ab *L. laxiflora* petiolis 10–13 mm longis (haud 4–8mm), apicibus foliorum acutis haud acuminatis, floribus parvioribus differt.

Description. Tree to 24 m tall, young branches glabrous, not lenticellate. Leaves with small lanceolate, caducous stipules to 2 mm long; petioles 10–13 mm long, sparsely puberulous or tomentellous when young, terete; lamina ovate-elliptic, coriaceous, $5-14 \times 3.5-9$ cm, rounded to subcuneate at base, acute to apiculate at apex, glabrous and shiny above; lower surface with deeply reticulate venation filled with a rufous pubescence; midrib impressed above, prominent beneath; veins 6–8 pairs, slightly impressed above, prominent beneath; secondary veins prominent and more or less parallel forming a reticulate pattern, tertiary venation flattened forming stomatal crypts. Inflorescence terminal and axillary towards apex of flowering branches, racemose once-branched panicles, the rachis and branches brown-tomentellous. Flowers ca 1.5–2 mm long, sessile on primary branches of inflorescence. Bracts and bracteoles minute, caducous. Receptacle cupuliform, sessile, short-tomentose on exterior, densely tomentose within; calyx lobes 5, acute, tomentose on both surfac-



Figure 3. Photo of the holotype of Licania apiknae (Diaz et al. 7016).

es. Petals absent. Stamens 5–6, inserted to one side of ring. Style basal, pubescent for 2/3 of length, included; ovary pilose-tomentose, inserted at base of receptacle. Fruit not seen.

Peru. Amazonas: Bagua Prov., Imaza Dist., Comunidad Aguaruna de Putuim, Monte Alto de Putuim, 5°00'54"S, 78°22'44"W, 500 m, 25 Aug 1994, *C.Diaz, S.J.Kayip, & P. Atamain 7016* (holotype K; isotype MO).

Additional material seen. Peru. Amazonas: Bagua Prov., Imaza Dist., Comunidad de Yamayakat, Quebrada Kus-Chapi, Río Marañon, 04°55'S, 78°19'W, 550 m, Feb 1995,



Figure 4. Close up of inflorescence of Licania apiknae.

R. Vásquez et al. 19477 (K, MO); Comunidad Aguaruna de Putuim, Monte Alto de Putuim, 22 Aug 1994, *C. Diaz et al. 7041* (K, MO).

Closest to *Licania laxiflora* Fritsch a species of the Guianas and Central Amazonia, but differs in the blunt leaf apex, the longer petioles (10–13 mm versus 4–8mm), the smaller flowers and bracteoles and the more compact inflorescence. This species has been confused with *Licania harlingii* Prance, but differs from that species in the longer petioles (5–6mm in *L. harlingii*), the blunter leaf apex, the deeply reticulate leaf venation beneath. It belongs to subgenus *Licania* section *Licania* on account of the included stamens and the absence of petals. The name for this species is derived from "Apikna", the Aguaruna name for it.

Licania monteagudensis Prance, sp. nov.

urn:lsid:ipni.org:names:77142294-1 Figs 5, 6

Ab *L. harlingii* foliis coriaceis, minoribus $3-7 \times 1.5-3.5$ (haud $7-12 \times 3-7$ cm), venis 6–7 (haud 8–11), petiolis 2–3 mm longis (haud 5–6 mm) differt.

Description. Tree to 25 m tall, the young branches sparsely puberulous, not conspicuously lenticellate. Leaves with lanceolate stipules to 2 mm long, caducous, adnate to



Figure 5. Photo of the type of *Licanis monteagudensis* (Monteagudo et al. 5164).



Figure 6. Close up of the inflorescence of Licania monteagudensis.

base of petiole; petioles 2–3 mm long, terete, tomentellous when young; lamina elliptic, coriaceous, $3-7 \times 1.5-3.5$ cm, cuneate at base, acuminate at apex, the acumen 3–6 mm long, glabrous above, densely brown-tomentellous beneath; midrib plane above, prominent beneath; veins 6–7 pairs, plane above, prominulous beneath. Inflorescence of terminal and subterminal panicles of racemes, the rachis and branches yellow-brown tomentose. Bracts and bracteoles lanceolate to triangular, 1–2 mm long, tomentose, caducous. Flowers almost sessile on primary inflorescence branches. Receptacle turbinate, tomentose on exterior, densely tomentose--pilose within, constricted at base to a minute pedicel 0.5 mm long; calyx lobes 5, acute, triangular, tomentose on exterior, sparsely tomentose within. Petals absent. Stamens 5–6, inserted opposite four calyx lobes. Style basal, pubescent for $\frac{34}{2}$ of length; ovary rufous tomentose. Fruit pyriform, 2–2.5 × 1 cm, exterior densely rufous-brown tomentose.

Peru. Pasco: Distr. Palcazu, Parque Nacional Yanachaga-Chemillén, Estación Biologica Paujil, 10°43'S, 74°54'W, 800 m, 12 May 2003, *A. Monteagudo, G. Ortiz & R. Francis 5164* (holotype, K; isotype, MO)

Additional material seen. Ecuador. Morona-Santiago: Limon Indanza, Cordillera del Condór, Comunidad Shuar Warints, 03°09'16"S, 78°14'50"W, 1020 m, 5 Oct 2002, *G. Toasa 8917* (AAU, K, MO, NY, QCNE, US). Peru. Pasco: Distr. Palcazu, Parque Nacional Yanachaga-Chemillén, Cerro Paujil-Ozuz, 10°10'S, 75°10"W. 850 m, 15 May, 2005, A. *Monteagudo et al. 8418* (K, MO, USM). Amazonas: Bagua Prov., Distr. Imaza, Comunidad Aguaruna Putuim, Anexo de Yamayakat, SW of Putuim, 700–750 m, 20 Jan 1996, *C. Díaz et al. 7723A* (K, MO); Cerros de Putuim,

5°03'20"S, 78°20'23"W, 350 m, 12 Jun 1996, *R. Vásquez et al. 21114* (K, MO);Tyu Mujaji, Comunidad Wawas, 5°15'56"S, 78°22'07"W, 600 m, 25 Oct 1997, *R. Vásquez et al. 24699* (K, MO); Quebrada El Amendro, 5°14'40"S, 78°21'24"W, 430 m, 9 Mar 1998 (K, MO).

This species falls into subgenus *Licania* section *Licania* and it is close to *Licania* harlingii Prance but differs in the smaller more coriaceous leaves $(3-7 \times 1.5-3.5 \text{ vs} 7-12 \times 3-7 \text{ cm})$, fewer veins (6-7 vs 8-11) and the shorter leaf acumen. The habitat is noted as primary forest. This is named for Abel Monteagudo, the collector of the types of two of the species described here.

Since two of these new species and the recently described *Licania condoriensis* Prance (2013) from the borders of Peru and Ecuador all belong to subgenus *Licania* section *Licania* I have provided a key based mainly on vegetative characters to all species of the section known to occur in Peru. All other species of *Licania* from Peru fall into other subgenera and sections of *Licania* of Prance and Sothers (2003a). They differ from *L. apiknae, L. condoriensis* and *L. monteagudensis* in one or more of the following characters:

Stamens 10-50, exserted (Subgenus Moquilea)

Petals present

Leaf undersurface with a furfuraceous pulverulent pubescence (Section *Pulverulenta*) Inflorescence a panicle of cymules (Section *Cymosa*)

Leaf undersurface glabrous or with a hirsute pubescence (Sections Hymenopus and Hirsuta)

1	Stipules adnate to base of petiole, usually persistent
2	Leaf base usually subcordate, midrib impressed above
3	Leaf undersurface with hair-filled stomatal crypts; stamens 5
	<i>L. bracteata</i> Prance
3'	Leaf undersurface deeply reticulate, but without stomatal crypts; stamens
	8–11 <i>L. mollis</i> Benth
2'	Leaf base rounded to cuneate, never subcordate; midrib plan or impressed
4	Leaf lower surface with stomatal crypts L. parviflora Benth
4'	Leaf lower surface deeply reticulate or plane under pubescence
5	Leaf apex round or mucronate; midrib deeply impressed; primary veins
	10-12 pairs L. paraensis Prance
5'	Leaf apex acute or acuminate, midrib plane or slightly impressed; primary
	veins 5–9 pairs
6	Leaf undersurface smooth under dense lanate-farinaceous pubescence
7	Flowers 1.5-2 mm, flowers and inflorescence with sparse grey-puberulous
	pubescence not completely covering surfaceL. kunthiana Hook. f.
7'	Flowers 2.5 mm, flowers and inflorescence with a dense tomentellous pubes-
	cence

Key to Peruvian species of Licania subgenus Licania section Licania

8	Leaves 4–15 × 2.5–8 cm; stamens 3 <i>L. micrantha</i> Miq
8'	Leaves 3–7 × 1.5–3.5 cm; stamens 5–6 <i>L. monteagudensis</i> Prance
6'	Leaf undersurface reticulate under pubescence which is hard to remove; flowers
	and inflorescence with densely tomentellous pubescence
9	Petioles glabrous; leaf undersurface only slightly reticulate L. cidii Prance
9'	Petioles tomentellous even when old; leaf undersurface deeply reticulate
	<i>L. blackii</i> Prance
1'	Stipules axillary and often caducous
10	Leaf base distinctly cordate, lamina triangular-ovate; midrib and petioles
	villous-pubescent
10'	Leaf base rounded to cuneate; lamina usually elliptic; midrib and petioles
	glabrous or short-puberulous
11	Leaf undersurface with stomatal crypts
12	Stamens 3; primary leaf veins 7–9 pairs L. triandra Mart. ex Hook. f.
12'	Stamens 5–8; primary leaf veins 13–15 L. condoriensis Prance
11'	Leaf undersurface without stomatal crypts (deeply reticulate in <i>L. apiknae</i>)
13	Petioles 10–13 mm long; leaf undersurface deeply reticulate; midrib impressed
	above
13'	Petioles 5–6 mm long; leaf undersurface more or less plane under pubescence;
	midrib plane or slightly impressed <i>L. harlingii</i> Prance

References

- Prance GT (2013) A new species of *Licania* (Chrysobalanaceae) from Cordillera del Cóndor, Ecuador. Phytokeys 26: 71–74. doi: 10.3897/phytokeys.26.4590
- Prance GT, Sothers CA (2003a) Chrysobalanaceae 1: *Chrysobalanus* to *Parinari*. Species Plantarum, Flora of the World 9: 1–201.
- Prance GT, Sothers CA (2003b) Chrysobalanaceae 2: *Acioa* to *Magnistipula*. Species Plantarum, Flora of the World 10: 1–268.

RESEARCH ARTICLE



Synopsis of Nekemias Raf., a segregate genus from Ampelopsis Michx. (Vitaceae) disjunct between eastern/ southeastern Asia and eastern North America, with ten new combinations

Jun Wen¹, John Boggan¹, Ze-Long Nie^{2,3}

I Department of Botany, MRC-166 Smithsonian Institution, P.O. Box 37012, Washington D.C. 20013-7012, USA 2 Key Laboratory for Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650201, Yunnan, China 3 Key Laboratory of Plant Resources Conservation and Utilization and College of Biology and Environmental Sciences, Jishou University, Jishou, 416000, Hunan, China

Corresponding author: Jun Wen (wenj@si.edu)

Academic editor: Hanno Schaefer | Received 11 April 2014 | Accepted 11 July 2014 | Published 16 September 2014

Citation: Wen J, Boggan J, Nie Z-L (2014) Synopsis of *Nekemias* Raf., a segregate genus from *Ampelopsis* Michx. (Vitaceae) disjunct between eastern/southeastern Asia and eastern North America, with ten new combinations. PhytoKeys 42: 11–19. doi: 10.3897/phytokeys.42.7704

Abstract

The genus *Nekemias* (Vitaceae) was first recognized by Rafinesque in 1838. It has been treated as a synonym of *Ampelopsis* Michx. Recent phylogenetic studies suggest that *Ampelopsis* as traditionally delimited is paraphyletic. To maintain the monophyly of each of the genera of Vitaceae, we herein segregate the *Ampelopsis* sect. *Leeaceifoliae* lineage from *Ampelopsis* and recognize these taxa in *Nekemias* Raf., which has a disjunct distribution in eastern to southeastern Asia and eastern North America. Nomenclatural changes are made for nine species and one variety: *Nekemias arborea* (L.) J. Wen & Boggan, *N. cantoniensis* (Hook. & Arn.) J. Wen & Z.L. Nie, *N. celebica* (Suess.) J. Wen & Boggan, *N. chaffanjonii* (H. Lév. & Van.) J. Wen & Z.L. Nie, *N. gongshanensis* (C.L. Li) J. Wen & Z.L. Nie, *N. grossedentata* (Hand.-Mazz.) J. Wen & Z.L. Nie, *N. hypoglauca* (Hance) J. Wen & Z.L. Nie, *N. megalophylla* (Diels & Gilg) J. Wen & Z.L. Nie, *N. megalophylla* var. *jiangxiensis* (W.T. Wang) J. Wen & Z.L. Nie, and *N. rubifolia* (Wall.) J. Wen & Z.L. Nie. A taxonomic key is provided for the genus to facilitate identification.

Keywords

Ampelopsis, Asia, eastern North America, Nekemias, Vitaceae

Introduction

Ampelopsis Michx. (Vitaceae) is one of the 15 recognized genera in Vitaceae with about 25 species (Suessenguth 1953; Chen et al. 2007; Wen 2007; Wen et al. 2013a). The genus was shown to be paraphyletic by recent phylogenetic analyses based on plastid (Soejima and Wen 2006; Ren et al. 2011; Nie et al. 2012) and nuclear *GAI1* (Wen et al. 2007) analyses. The plastid data (Soejima and Wen 2006; Ren et al. 2011; Nie et al. 2012) supported that the African *Rhoicissus* and the South American *Cissus striata* complex formed a clade with the simple or palmately leaved *Ampelopsis* (sect. *Ampelopsis*), while the nuclear data (Wen et al. 2007) suggested that they were more closely related to the pinnately leaved *Ampelopsis* (sect. *Leeaceifoliae*, as designated by Galet 1967 in the unpublished thesis). All analyses so far have supported the monophyly of each of the two sections based on leaf morphology (Galet 1967). Apart from the differences in leaf morphology, the two sections also differ in their axillary buds, with taxa in sect. *Ampelopsis* having serial accessory buds, and those in sect. *Leeaceifoliae* having complex axillary buds as in *Vitis vinifera* (Bernard 1972–1973; Gerrath and Posluszny 1989; Soejima and Wen 2006; Wen et al. 2007).

Within Vitaceae, five or six main clades are well supported based on analysis of molecular sequence data with the *Ampelopsis-Rhoicissus-Cissus striata* clade as one of these major clades of Vitaceae (Soejima and Wen 2006; Wen et al. 2007, 2013b; Ren et al. 2011; Liu et al. 2013). Ingrouille et al. (2002), however, resolved *Ampelopsis* as the basalmost branch of Vitaceae albeit with no support, and further argued that the presence of pinnate leaves, the thick corolla, and the floral and vegetative development in *Ampelopsis* were the least-derived characters within Vitaceae as compared with those in the outgroup taxa from Leeaceae. To maintain the monophyly of each of the genera of Vitaceae, we herein segregate the *Ampelopsis* sect. *Leeaceifoliae* lineage from *Ampelopsis*. Rafinesque (1838) established the genus *Nekemias* with *Ampelopsis bipinnata* Michx. [= *A. arborea* (L.) Koehne] possessing pinnately compound leaves as the type species. *Nekemias* has been rarely mentioned in subsequent taxonomic work on Vitaceae or treated as a synonym of *Ampelopsis* (Merrill 1949; Suessenguth 1953; Wen 2007), but it represents the earliest name at the generic rank for the pinnately-compound leaved *Ampelopsis* clade.

Taxonomic synopsis

Nekemias Raf., Sylva Tellur. 87. 1838.

Ampelopsis Michx., pro parte

Woody climbers. Branchlets with prominent lenticels. Pith white, continuous through nodes. Tendrils leaf-opposed, mostly bifurcate to sometimes trifurcate, and lacking adhesive discs. Leaves alternate, petiolate, stipulate, pinnately to ternately bipinnately or sometimes tripinnately compound. Inflorescences bifurcately compound cymes, long peduncled, leaf-opposite. Flowers pedicellate, mostly bisexual; calyx saucer-like; corolla of 5 thick petals; stamens 5, opposite to petals; disc adnate to the base of the

ovary; ovary 2-locular, style short, conical, stigma rounded. Fruit a berry, globose or subglobose, purple, blue or black, 1-4 seeded. Seeds obovoid.

Type species. *Nekemias bipinnata* (Michx.) Raf. [= *Nekemias arborea* (L.) J. Wen & Boggan].

Nine species with eight occurring in warm temperate to tropical areas of eastern and southeastern Asia (Suessenguth 1940; Galet 1967; Chen et al. 2007), and one species distributed in eastern North America extending to the Caribbean (Brizicky 1965). This intercontinental disjunct distribution between eastern Asia and eastern North America represent a classical biogeographic pattern of the Northern Hemisphere (Wen 1999; Wen et al. 2010).

Below we provide a taxonomic synopsis for the genus.

1. Nekemias arborea (L.) J. Wen & Boggan, comb. nov.

urn:lsid:ipni.org:names:77142315-1 Figure 1A–B

Basionym: Vitis arborea L., Sp. Pl. 1: 203. 1753.

Ampelopsis bipinnata Michx., Fl. Bor.-Amer. 1: 160. 1803, nom. illeg.

Cissus stans Pers., Syn. Pl. 1: 143. 1805, nom. illeg.

Cissus bipinnata (Michx.) Nutt., Gen. N. Amer. Pl. 1: 144. 1818, nom. illeg.

Nekemias bipinnata (Michx.) Raf., Sylva Tellur. 87. 1838, nom. illeg.

Vitis bipinnata (Michx.) Torrey & A. Gray, Fl. N. Amer. 1: 243. 1838, nom. illeg.

Cissus arborea (L.) Des Moulins in Durand, Actes Soc. Linn. Bordeaux 24: 156. 1862. *Ampelopsis arborea* (L.) Koehne, Deutsch. Dendrol. 400. 1893.

Ampelopsis arborea (L.) Rusby, Mem. Torrey Bot. Club 5: 221. 1894, comb. superfl.

Distribution. USA (Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Virginia and West Virginia) and the Caribbean.

2. *Nekemias cantoniensis* (Hook. & Arn.) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142316-1 Figure 1C–D

Basionym: *Cissus cantoniensis* Hook. & Arn., Bot. Beech. Voy.: 175. 1833. *Cissus diversifolia* Walp., Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 19 (Suppl. 1): 314. 1843, nom. illeg., non DC. 1824. *Ampelopsis cantoniensis* (Hook. & Arn.) K. Koch, Hort. Dendrol. 48: 11. 1853. *Vitis leeoides* Maxim., Mel. Biol. Acad. Sci. St. Petersb. 9: 148. 1873. *Vitis cantoniensis* (Hook. & Arn.) Seem., Bot. Voy. Herald: 370. 1875. *Ampelopsis cantoniensis* (Hook. & Arn.) Planch., Monogr. Phan. 5: 460. 1887, comb. superfl. *Ampelopsis cantoniensis* var. *harmandii* Planch., Monogr. Phan. 5: 460. 1887.



Figure I. Images of representative species of *Nekemias* Raf. **A–B** *Nekemias arborea* (L.) J. Wen & Boggan, voucher specimen: J. Wen 12005 (US), collected from Montgomery Co., Texas, USA **C–D** *N. cantoniensis* (Hook. & Arn.) J. Wen & Z.L. Nie, voucher specimen: J. Wen 10613 (US), collected from Xichou Xian, Yunnan province, China **E–F** *N. celebica* (Suess.) J. Wen & Boggan, voucher specimen: J. Wen 10242 (US), collected from SE Sulawesi, Indonesia.

Ampelopsis leeoides (Maxim.) Planch. [epithet published in error as "lecoides" by Planchon in 1887], Monogr. Phan. 5: 462. 1887.
Ampelopsis loureiroi Hort. Mazel. ex Planch., Monogr. Phan. 5: 461. 1887, nom. nud. pro syn. Vitis multijugata H. Lév. & Vaniot, Bull. Soc. Agric. Sci. Arts Sarthe 40: 41. 1905. Leea theifera H. Lév., Repert. Spec. Nov. Regni Veg. 8: 58. 1910.
Ampelopsis annamensis Gagnep., Bull. Soc. Bot. France 92: 166. 1946.
Ampelopsis cantoniensis var. leeoides (Maxim.) F.Y. Lu [published in error as "leecoides"; changed to "lecoides" in Index Kewensis], Fl. Taiwan 3: 667. 1977, nom. invalid.

Distribution. China (Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hong Kong, Hubei, Hunan, Taiwan, Xizang, Yunnan and Zhejiang), India, Japan (including the Ryukyu Islands), Vietnam, Laos, Malaysia (peninsular), and Indonesia (Java).

3. Nekemias celebica (Suess.) J. Wen & Boggan, comb. nov. urn:lsid:ipni.org:names:77142317-1 Figure 1E–F

Basionym: Ampelopsis celebica Suess., Repert. Spec. Nov. Regni Veg. 49: 14. 1940.

Distribution. Indonesia (Sulawesi).

4. Nekemias chaffanjonii (H. Lév. & Van.) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142323-1

Basionym: Vitis chaffanjonii H. Lév. & Van., Bull. Soc. Agric. Sci. Arts Sarthe 40: 37. 1905.
Leea dielsii H. Lév., Repert. Spec. Nov. Regni Veg. 8: 58. 1910.
Meliosma cavaleriei H. Lév., Repert. Spec. Nov. Regni Veg. 9: 457. 1911.
Ampelopsis watsoniana E.H. Wilson, J. Roy. Hort. Soc. 42: 37. 1916, nom. nud.
Vitis watsoniana (E.H. Wilson) Bean, Trees & Shrubs Brit. Isles 2: 673. 1921.
Ampelopsis chaffanjonii (H. Lév. & Van.) Rehder, J. Arnold Arbor. 15: 25. 1934.

Distribution. China (Anhui, Chongqing, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan and Yunnan).

5. Nekemias gongshanensis (C.L. Li) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142318-1

Basionym: Ampelopsis gongshanensis C.L. Li, Chinese J. Appl. Environ. Biol. 2(1): 48. 1996.

Distribution. China (Yunnan).

6. Nekemias grossedentata (Hand.-Mazz.) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142325-1

Basionym: Ampelopsis cantoniensis var. grossedentata Hand.-Mazz., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 59: 105. 1877.
Ampelopsis grossedentata (Hand.-Mazz.) W.T. Wang, Acta Phytotax. Sin. 17(3): 79. 1979.

Distribution. China (Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi and Yunnan).

7. Nekemias hypoglauca (Hance) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142319-1

Basionym: *Hedera hypoglauca* Hance, Ann. Bot. Syst. 2: 724. 1852. *Ampelopsis hypoglauca* (Hance) C.L. Li, Chinese J. Appl. Environ. Biol. 2(1): 48. 1996.

Distribution. China (Fujian, Guangdong, Hong Kong and Jiangxi).

8. Nekemias megalophylla (Diels & Gilg) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142320-1

Basionym: Ampelopsis megalophylla Diels & Gilg, Bot. Jahrb. Syst. 29: 466. 1900.

8a. Nekemias megalophylla (Diels & Gilg) J. Wen & Z.L. Nie var. megalophylla

Vitaeda megalophylla (Diels & Gilg) Börner, Abh. Nat. Ver. Bremen 21: 280. 1913.

Distribution. China (Chongqing, Gansu, Guizhou, Hubei, Shaanxi, Sichuan and Yunnan).

8b. Nekemias megalophylla var. jiangxiensis (W.T. Wang) J. Wen & Z.L. Nie, comb. nov.

urn:lsid:ipni.org:names:77142321-1

- Basionym: *Ampelopsis jiangxiensis* W.T. Wang, Bull. Bot. Res. North-East. Forest. Inst. 1(1–2): 170. 1981.
- Ampelopsis megalophylla var. jiangxiensis (W.T. Wang) C.L. Li, Chinese J. Appl. Environ. Biol. 2(1): 48. 1996.

Distribution. China (Jiangxi).

9. *Nekemias rubifolia* (Wall.) J. Wen & Z.L. Nie, comb. nov. urn:lsid:ipni.org:names:77142322-1

Basionym: *Vitis rubifolia* Wall., Fl. Ind., ed. Carey & Wall., 2: 480. 1824. *Ampelopsis rubifolia* (Wall.) Planch., Monogr. Phan. 5: 463. 1887. *Ampelopsis megalophylla* var. *puberula* W.T. Wang, Acta Phytotax. Sin. 17(3): 79, 90. 1979.

Distribution. China (Guangxi, Guizhou, Hunan, Jiangxi and Sichuan), and India.

Taxonomic key to species of Nekemias

1	Leaves abaxially strongly glaucous
1	Leaves green on both surfaces
2	Lower leaves pinnately compound, leaflet blades $7-15 \times 3-7$ cm
	N. chaffanjonii
2	Lower leaves bipinnately compound, leaflet blades $2.5-6 \times 1-3.5$ cm
	N. hypoglauca
3	Leaves pinnately compound
3	Leaves bipinnately, ternately bipinnately to tripinnately compound
4	Leaflets $3.5-14 \times 2-6.5$ cm, margin $5-15$ -toothed, abaxially densely ferruginous pilose; herries $8-15$ mm in diameter N rubifolia
4	Leaflets $3-6 \times 0.5-3$ cm, margin entire or with 1 to several inconspicuous teeth, midvein abaxially sparsely pilose; berries $5-7$ mm in diameter
	N. gongshanensis
5	Tendril trifurcate; leaflets $4-12 \times 2-6$ cm
5	Tendril bifurcate; leaflets $1-5 \times 0.5-2.5$ cm
6	Leaflet margin with 2–4 large coarse teeth; from North America or the Carib-
	bean
6	Leaflet margin serrate with 5–15 teeth on each side; from Asia7
7	Leaflet margin coarsely serrate, central leaflet ovate-elliptical
	N. grossedentata
7	Leaflet margin ± undulate, central leaflet obovate or ovate
8	Leaves and inflorescences pilose to glabrescent
8	Leaves and inflorescences pubescent to densely so N. celebica

Acknowledgments

This study was supported by NSF Award number DEB 0743474 to S.R. Manchester and J. Wen, the Smithsonian Endowment Grant Program, and the Small Grants Program of the National Museum of Natural History of the Smithsonian Institution. Laboratory work was done at and partially supported by the Laboratories of Analytical Biology

of the National Museum of Natural History, Smithsonian Institution. We thank Pedro Acevedo and Larry Dorr for advice on nomenclature, Larry Dorr and Marc Appelhans for translating references, Stefanie Ickert-Bond and an anonymous reviewer for their constructive suggestions, and Sue Lutz for assistance with preparing the figure.

References

- Bernard AC (1972–1973) A propos du complex axillaire chez certaines Vitacées. Naturalia Monspeliensia Série Botanique 23/24: 49–61.
- Brizicky GK (1965) The genera of Vitaceae in the southeastern United States. Journal of the Arnold Arboretum 46: 48–67.
- Chen ZD, Ren H, Wen J (2007) Vitaceae. In: Wu, CY, Hong, D-Y, Raven, PH (Eds) Flora of China, vol. 12. Science Press and Missouri Botanical Garden Press, Beijing and St. Louis, 173–222.
- Galet P (1967) Recherches sur les Methods d'identification et de Classification des Vitacées Temperées. II Thèse, présentée à la Faculté des Sciences de Montpellier. Université de Montpellier, Montpellier.
- Gerrath JM, Posluszny U (1989) Morphological and anatomical development in the Vitaceae.
 V. Vegetative and floral development in *Ampelopsis brevipedunculata*. Canadian Journal of Botany 67: 2371–2386. doi: 10.1139/b89-303
- Ingrouille MJ, Chase MW, Fay MF, Bowman D, Van der Bank M, Bruijin ADE (2002) Systematics of Vitaceae from the viewpoint of plastid *rbcL* sequence data. Botanical Journal of the Linnean Society 138: 421–432. doi: 10.1046/j.1095-8339.2002.00028.x
- Liu X-Q, Ickert-Bond SM, Chen L-Q, Wen J (2013) Molecular phylogeny of *Cissus* L. of Vitaceae (the grape family) and evolution of its pantropical intercontinental disjunctions. Molecular Phylogenetics and Evolution 66: 43–53. doi: 10.1016/j.ympev.2012.09.003
- Merrill ED (1949) Index Rafinesquianus. The Arnold Arboretum of Harvard University, Jamaica Plain, MA.
- Nie Z-L, Sun H, Manchester SR, Meng Y, Luke Q, Wen J (2012) Evolution of the intercontinental disjunctions in six continents in the *Ampelopsis* clade of the grape family (Vitaceae). BMC Evolutionary Biology 12: 17. doi: 10.1186/1471-2148-12-17
- Planchon JE (1887) Monographie des Ampélidées vrais. In: De Candolle AFPP, De Candolle C (Eds) Monographiae Phanaerogamarum, vol. 5(2). Sumptibus G Masson, Paris, 305–654.
- Rafinesque CS (1838) Sylva Telluriana. Mantis Synopt. New Genera and Species of Trees and Shrubs of North America, and Other Regions of the Earth, Omitted or Mistaken by the Botanical Authors and Compilers, or not Properly Classified, Now Reduced by their Natural Affinities to the Proper Natural Orders and Tribes. Printed for the author and publisher, Philadelphia.
- Ren H, Lu L-M, Soejima, Luke Q, Zhang D-X, Chen Z-D, Wen J (2011) Phylogenetic analysis of the grape family (Vitaceae) based on the noncoding plastid *trnC-petN*, *trnH-psbA*, and *trnL-F* sequences. Taxon 60: 629–637.
- Soejima A, Wen J (2006) Phylogenetic analysis of the grape family (Vitaceae) based on three chloroplast markers. American Journal of Botany 93: 278–287. doi: 10.3732/ajb.93.2.278

- Suessenguth K (1940) Einige neue und seltene Amarantaceen, Rhamnaceen und Vitaceen. Repertorium Specierum Novarum Regni Vegetabilis 49: 5–15. doi: 10.1002/ fedr.19400490104
- Suessenguth K (1953) Vitaceae. In: Engler A, Prantl K (Eds) Die natürlichen Pflanzenfamilien, vol. 20. Duncker and Humblot, Berlin, 174–333.
- Wen J (1999) Evolution of eastern Asian and eastern North American disjunct pattern in flowering plants. Annual Review of Ecology and Systematics 30: 421–455. doi: 10.1146/ annurev.ecolsys.30.1.421
- Wen J (2007) Vitaceae. In: Kubitzki K (Ed) The Families and Genera of Vascular Plants, vol. 9. Springer–Verlag, Berlin, 466–478. doi: 10.1139/B07-071
- Wen J, Nie Z-L, Soejima A, Meng Y (2007) Phylogeny of Vitaceae based on the nuclear GAI1 gene sequences. Canadian Journal of Botany 85: 731–745.
- Wen J, Ickert-Bond SM, Nie Z-L, Li R (2010) Timing and modes of evolution of eastern Asian -North American biogeographic disjunctions in seed plants. In: Long M, Gu H, Zhou Z (Eds) Darwin's Heritage Today: Proceedings of the Darwin 200 Beijing International Conference. Higher Education Press, Beijing, 252–269.
- Wen J, Lu L-M, Boggan JK (2013a) Diversity and evolution of Vitaceae in the Philippines. Philippine Journal of Science 142 (Special Issue): 223–244.
- Wen J, Xiong Z-Q, Nie Z-L, Mao L-K, Zhu Y-B, Kan X-Z, Ickert-Bond SM, Gerrath J, Zimmer EA, Fang X-D (2013b) Transcriptome sequences resolve deep relationships of the grape family. PLoS ONE 8(9): e74394. doi: 10.1371/journal.pone.0074394

CATALOGUE



Dr. Roberto Miguel Klein Herbarium (FURB), Blumenau, Southern Brazil

André Luís de Gasper^{1,2}, Alexander Christian Vibrans², Luís Adriano Funez², Morilo José Rigon-Jr², Felipe Bittencourt², Carina Vieira²

I Herbarium Curator **2** Universidade Regional de Blumenau (University of Blumenau). Antônio da Veiga, 140 - Victor Konder. CEP: 89012-900 - Blumenau – Santa Catarina- Brasil

Corresponding author: André Luís de Gasper (algasper@gmail.com)

Academic editor: L. Penev | Received 18 December 2013 | Accepted 17 September 2014 | Published 13 October 2014

Citation: Gasper AL, Vibrans AC, Funez LA, Rigon-Jr MJ, Bittencourt F, Vieira C (2014) Dr. Roberto Miguel Klein Herbarium (FURB), Blumenau, Southern Brazil. PhytoKeys 42: 21–37. doi: 10.3897/phytokeys.42.6865

Abstract

The premise of this study is to present the collection of the FURB herbarium, its collection area and type specimens, as well as its projects and contributions to the flora of the Subtropical Atlantic Forest. The FURB herbarium currently has nearly 41,000 records of vascular plants and has the largest collection of lycophytes and ferns in Southern Brazil, with more than 8,000 records. More than 4,500 scanned images of 4,436 species are available online, and it is expected that the whole collection will be scanned in less than one year. There are 198 families of angiosperms, 33 of ferns, three of lycophytes and six of gymnosperms. All collections of the Floristic and Forest Inventory of Santa Catarina project are recorded in FURB, which represents almost 35,000 herbarium specimens. The families with the largest number of species are: Cyperaceae (109 species), Rubiaceae (129), Solanaceae (131), Poaceae (155), Melastomataceae (157), Myrtaceae (257), Orchidaceae (288), Fabaceae (323), and Asteraceae (426), between angiosperms. Among the ferns and lycophytes are: Hymenophyllaceae (30), Thelypteridaceae (31), Aspleniaceae (32), Dryopteridaceae (43), Pteridaceae (54) and Polypodiaceae (60). There are five type specimens among them: one holotype, one isotype and three paratypes. To date, the FURB herbarium has donated 19,521 herbarium duplicates for identification or expansion of other herbaria.

Keywords

Catalogue, Scientific collection, Regional University of Blumenau, Ferns, Vascular plants, Spermatophyta, Pteridophyta, Compositae, Leguminosae, Southern Brazil, Rain Forest, Evergreen Rainforest, National Parks, Biodiversity

Copyright André Luís de Gasper et al. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

The Dr. Roberto Miguel Klein Herbarium (FURB) was founded in 1990 by Lucia Sevegnani, PhD. Roberto Miguel Klein (1923-1992) was an important botanist and ecologist. In 1949, together with Father Raulino Reitz, he founded the Sellowia Journal, which published contributions of researchers linked to Herbário Barbosa Rodrigues (HBR). In addition to HBR, the Sellowia papers are considered Klein's major works, among those that treated the relation between malaria outbreaks and the local flora (Klein 1967) and addressed the vegetation structure of Southern Brazil, published in a series of papers co-authored by Henrique Pimenta Veloso (Veloso and Klein 1957, 1959, 1961, 1963, 1968a, 1968b).

Klein and Reitz also created the Flora Ilustrada Catarinense (Reitz 1965; Citadini-Zanette 2013), published in 149 fascicles between 1965 and 1989. In addition to conducting a floristic assessment of Santa Catarina State, Klein studied autoecology and gathered information about tree communities, making himself one of the outstanding dendrologists of Southern Brazil (Amado 2013). His importance has been proven by tributes such as the genus *Kleinodendron* L.B.Sm. & Downs, besides 75 specific epithets, from 37 families (IPNI 2012). After his death, Klein's scientific contributions were not forgotten. The Flora Ilustrada Catarinense came to be published from 1996 on, with 17 volumes published to date (Bortoluzzi et al. 2011).

The FURB herbarium has been registered in Index Herbariorum since 2005, under the acronym FURB (http://sweetgum.nybg.org/ih/herbarium.php?irn=148203). The aim of the herbarium is to study the plant diversity of the local vegetation, especially that of the Serra do Itajaí National Park, Itajaí Valley, and Santa Catarina State. Initially the collection was established by professors for didactic purposes, but with the advent of new projects, such as the Floristic and Forest Inventory of Santa Catarina (IFFSC project - Vibrans et al. 2010), the collection has undergone a massive increase in the amount of material. At the beginning of the IFFSC project, the FURB herbarium had only approximately 5,000 herbarium specimens (now there are more than 41,000). At present, 86% of the FURB collection is georeferenced, with only a few early specimens not having coordinates.

The software that is used has been developed especially for the herbarium and the data has become available online, in INCT databases (http://inct.splink.org.br/), SpeciesLink (http://splink.cria.org.br/), and Reflora (http://reflora.jbrj.gov.br). The software (Herbaria 3.1), an Access-based software, has been developed by EPAGRI (http://www.epagri.sc.gov.br) in partnership with the herbarium staff (for more information see Miszinski et al. 2012).

The angiosperm collections are organized according to the APG system (Reveal and Chase 2011), the ferns according to Rothfels et al. (2012) and Smith et al. (2006), the lycophytes according to Øllgaard (2012), and the gymnosperms according to Christenhusz et al. (2011).

Data resources

The data underpinning the analyses reported in this paper are deposited in the GBIF, the Global Biodiversity Information Facility, http://ipt.pensoft.net/ipt/resource. do?r=furb_herbarium_database_11-09-2014

Available data

The herbarium has 41,325 specimens (Figure 1 and Figure 2), in addition to the largest collection of ferns and lycophytes (8,360 specimens) in Santa Catarina State. The full database is available via the INCT Virtual Herbarium (http://inct.splink.org.br/ FURB). There are 4,556 images of 4,436 species.

Recent projects

Flora Catarinense Revisited

This project aims to find the nomenclatural types collected in Santa Catarina in herbaria and publications; recollect specimens in the field in the type localities, mainly the older ones; scan nomenclatural types; perform collections; and get information about rare and endemic species that are only known by the type or by very few documented specimens in collections.

IFFSC - Floristic and Forest Inventory of Santa Catarina State

This project aims to develop the floristic inventory of forest formations in Santa Catarina and generate information to support the formulation of forest policy in the state, in particular the economic-ecological zoning for rural land use planning and environmental licensing, as well as the defining of priority areas for conservation, restoration of degraded ecosystems, and the updating of red lists. To complete these objectives, the remaining forests are periodically inventoried and their horizontal and vertical structures analyzed. The genetic diversity and structure of populations of 13 endangered species are assessed, as well as the social and economic importance of the state's native forest resources. Finally, a georeferenced information system has been designed and implemented and is to be updated in order to assist the preparation of the endangered species list. The project publications can be downloaded from the IFFSC website (http://www.iff.sc.gov.br/ – Vibrans et al. 2013a, 2013b, 2013c, 2012a, 2012b).



Figure 1. Number of specimens distributed among the division of vascular plants.

DNA bank

The establishment of a DNA database linked to the FURB herbarium aims to provide subsidies for studies in molecular biology including species of flora of Santa Catarina. In Brazil these initiatives have been shown to be necessary, since, despite the enormous biodiversity of the flora of the country, molecular studies are scarce (Santos et al. 2002). The bank starts in 2014 with the goal of maintaining samples of the main species of Santa Catarina's vascular plants and fungi. Field surveys will be performed and samples collected from young leaves will be stored in silica gel. This inexpensive and effective method, neither injurious to the DNA nor detrimental to the dehydration of leaves (Chase and Hills 1991), grants researchers the ability to preserve the DNA material for at least 10 years (Hodkinson et al. 2007), reducing the costs of research and allowing material to be donated and loaned. Gaudeul and Rouhan (2013) recommend a universalization of the method and this should be done in any field, since it is practical, avoids surveys in specific fields for this purpose, and increases the scientific value of the specimens and collection. In fact, other field surveys will be done, in addition to those related to the project, to ensure the existence of samples in DNA database. In the first year, the collections will prioritize the Itajaí Valley region of the state, which is home to 54 municipalities, and it estimated that at least 20% of the tree species will be collected and made available for study. The sample for the DNA bank will continue with the second cycle of IFFSC, whose collections will be performed throughout the state, and it is estimated that material will be collected for DNA extraction for about 75% of the tree species. The database of the species can be found at www.furb.br/herbarium.



Figure 2. Number of specimens of the main families of angiosperms (**a**), ferns and lycophytes (**b**) in FURB collection. Number of specimens of angiosperms (**c**), ferns and lycophytes (**d**).

Temporal coverage

The earliest specimen is dated March 1, 1937, a *Prosopis nigra* Hieron. (Fabaceae), but the first specimen for the FURB herbarium was collected on September 7, 1991, of a *Plinia rivularis* (Cambess.) Rotman. (Myrtaceae). The distribution of collected specimens by year can be seen in Figure 3. A great increase occurred between 2007 and 2012, during the first cycle of the IFFSC project. The second cycle of the project will start in 2014 and will surely result in an increase of the the number of specimens.

Plant sampling

Most of the plant samples are from Southern Brazil, Santa Catarina State (Figure 4) being the most widely represented area, and the aim is to cover the widest possible range of plant diversity of this territory. The majority of the samples comes from the IFFSC project and from the field work of undergraduate students. Other parts of the Brazilian South are represented mainly by exchanged samples.



Figure 3. Temporal coverage of Herbarium FURB.



Figure 4. Spatial coverage of FURB collection. Only the hundred best states collected.

Plant processing procedures

After being dried in ovens at 65 to 70 degrees Celsius, the specimens are incorporated into the database. All data such as scientific name, location, city, coordinates, altitude, and general descriptions of the plant are recorded. The registration number is generated automatically by the software. Afterwards, the plants are glued with hot glue onto A2 sheets, packed in plastic bags in order to avoid being contaminated by insects or fungi and to prevent loss of material during handling, and subsequently frozen for five days at -20 degrees Celsius. Next, the plants are stored in specific cans that are sealed and stored separately in groups: lycophytes and ferns, gymnosperms and angiosperms. Among the groups, the cans are alphabetized according to family and gender.

All databases are reviewed by a DataClean tool, from CRIA (http://splink.cria. org.br/dc/index?criaLANG=pt&colecao=FURB), which checks the coordinates, toponymy, scientific names, and their authors. The "doubtful" records are reviewed by the curator. The names are checked using the List of Species of Brazilian Flora (2014), and the identifications are made by specialists visiting the herbarium or by comparison with photos or duplicates sent to other institutions.

The FURB herbarium uses a specific software, Herbaria 3.1 (Miszinski et al. 2012), that includes several control possibilities of the collection. These control possibilities include information about the synonymous names used, preventing the same species from being registered under several names. Thus, we use specific fields for family, genus, and specific epithet. When we enter a genus name, its family and division is automatically filled based on an ancillary table. A list of epithets linked to the genus is then released, allowing the choice of the same (new epithets can be linked at any time), which is chosen to fill the author's name and still shows the presence of varieties or subspecies.

Rare, endemic species and ecosystems sampled

FURB maintains 68% of all species listed by the List of Species of Brazilian Flora (2014) for Santa Catarina and 33.9% of all species in the Brazilian Atlantic Forest (Stehmann et al. 2009). The Atlantic Forest in Santa Catarina has three forest types: Evergreen Rainforest, Mixed Forest, and Seasonal Forest (for more information see Klein 1978 and Oliveira-Filho et al. 2013). 75% of FURB samples were collected in Evergreen Rainforest, 16% in Mixed Forest, and 5% in Seasonal Forest. The other formations (grasslands, mangroves, and coastal vegetation) constitutes 4% of the collections. Species of natural grasslands are represented still less, but will increase due to sample campaigns to be held within the IFFSC project during 2014 and 2015. Furthermore, 27 species of the Brazilian Official List of Endangered Species (Brazil 2008) are represented in the collection, available for conservation and other studies, 19 of these being native of Santa Catarina. Of the 235 endemic species of Santa Catarina (Brazilian List of Species of Flora 2014), 52 are found in the herbarium.

Protected area	Species
Morro do Baú Municipal Park	101
Canela Preta Biological Reserve	123
Prima Luna Private Reserve of Natural Patrimony	159
Lagoinha do Leste Municipal Park	165
Caraguatá Private Reserve of Natural Patrimony	194
São Joaquim National Park	211
Bugerkopf Private Reserve of Natural Patrimony	248
Acaraí State Park	260
Lagoa do Peri Municipal Park	283
Dona Francisca Environmental Protection Area	292
Serra do Tabuleiro State Park	340
Rio Vermelho Humboldt Environmental Protection Area	522
São Francisco de Assis Municipal Park	592
Serra do Itajaí National Park	2428

Table 1. Number of specimens from main Conservation Units represented in the herbarium.

The database SpeciesLink (http://splink.cria.org.br/) shows that the FURB herbarium possesses 0.0725 records per sq km of the Southern region. Although seemingly small, it is a high number compared to other featured herbaria in Santa Catarina; FLOR, JOI and CRI have 0.0677, 0.0150, and 0.0119 records per sq km, respectively. Among these herbaria, FURB also has the largest number of herbarium specimens with photographs available online (4,354 in total), and the goal is to start photographing all specimens before the end of 2014. It also deserves to be mentioned that the collection has 1,417 unique names not found in other herbaria. This is quite a high number despite the fact that, due to the impracticability of this analysis, possible synonyms were not excluded.

Although the flora of Santa Catarina is well documented in the FURB herbarium, recent studies are still reporting new records for the state (Gasper and Sevegnani 2010, Gasper et al. 2012b, Funez and Gasper, unpublished data), suggesting that there are even more species to find.

The Conservation Units are represented at FURB by 2,428 specimens collected in Serra do Itajaí National Park, the largest remaining area of Evergreen Rainforest (Atlantic Rain Forest), 4,771 specimens being collected in other Conservation Units (Table 1).

Taxonomic coverage

The main herbarium collection is composed of vascular plants (Figure 1), representing 4,267 species. Among the vascular plants is the collection of ferns (368 species and 7,904 specimens) and lycophytes (33 species with 456 specimens), which corresponds to 20% of the total specimens and 9,4% of the species. Bryophytes *lato sensu* corre-

spond to 0,2% of the collection. There are 198 families of angiosperms (Figure 2), 33 of ferns, 3 of lycophytes and 6 of gymnosperms. There are 203 plants without identification. The main collections are from Santa Catarina State (Figure 4).

With the implementation of an exchange program and the aim of supporting other collections, the FURB herbarium has donated 19,521 herbarium specimens. The families with more than 500 duplicates donated are: Solanaceae (532 donations), Bromeliaceae (542), Aspleniaceae (612), Piperaceae (769), Orchidaceae (848), Myrtaceae (854), Melastomataceae (1,026), Rubiaceae (1,054), Polypodiaceae (1,156), Fabaceae (1,257), Asteraceae (1,478), and Lauraceae (1,621). Likewise, 3,794 herbarium specimens have already been loaned to perform theses, dissertations, and other taxonomic studies.

It is worth mentioning that there are five types in the collection: Holotypus of *Vriesea rubens* J.G.Silva & A.F.Costa (Bromeliaceae), isotypus of *Croton pygmaeus* L.R.Lima (Euphorbiaceae), paratypus of *Calystegia brummittii* P.P.A.Ferreira & Sim.-Bianch (Convolvulaceae), paratypus of *Pleurostachys arcuate* W.W. Thomas, M. Alves & R. Trevis (Cyperaceae), and paratypus of *Sarcoglottis catharinensis* Mancinelli & E.C.Smidt (Orchidaceae).

Taxonomic ranks

Kingdom: Chlorobionta

Subclass: Lycopodiidae (lycophytes), Equisetidae, Marattiidae, Ophioglossidae, Polypodiidae, Psilotidae (ferns), Ginkgoidae, Cycadidae, Pinidae, Gnetidae (gymnosperms), and Magnoliidae (angiosperms)

Lycophyte families: Isoetaceae (1 specimen/1 species); Lycopodiaceae (326/21) and Selaginellaceae (129/11).

Fern families: Anemiaceae (261 specimens/6 families); Aspleniaceae (833/32); Athyriaceae (234/13); Blechnaceae (542/18); Culcitaceae (1/1); Cyatheaceae (425/10); Cystopteridaceae (2/1); Davalliaceae (2/1); Dennstaedtiaceae (70/9); Dicksoniaceae (69/2); Dryopteridaceae (954/43); Equisetaceae (13/3); Gleicheniaceae (99/9); Hemidictyaceae (1/1); Hymenophyllaceae (578/30); Lindsaeaceae (185/8); Lomariopsidaceae (40/6); Lygodiaceae (32/1); Marattiaceae (104/5); Marsileaceae (3/3); Ophioglossaceae (25/4); Osmundaceae (12/2); Parkeriaceae (3/1); Plagiogyriaceae (2/1); Polypodiaceae (2163/60); Psilotaceae (5/1); Pteridaceae (760/54); Saccolomataceae (44/2); Salviniaceae (16/6); Schizaeaceae (25/2); Tectariaceae (68/4); and Thelypteridaceae (330/31).

Gymnosperm families: Araucariaceae (17 specimens/3 species); Cupressaceae (59/10); Cycadaceae (6/3); Ginkgoaceae (2/1); Pinaceae (26/8); and Podocarpaceae (40/4).

Magnoliidae families: Acanthaceae (384 specimens/35 species); Achatocarpaceae (2/2); Actinidiaceae (1/1); Adoxaceae (15/3); Aizoaceae (3/2); Alismataceae (14/4); Alstroemeriaceae (23/4); Amaranthaceae (185), 23); Amaryllidaceae (51/13); Anacardiaceae (135/13); Annonaceae (271/23); Apiaceae (84/22); Apocynaceae (339/70); Aquifoliaceae (196/8); Araceae (547/35); Araliaceae (123/21); Arecaceae (154/14);

Aristolochiaceae (13/6); Asparagaceae (15/6); Asteraceae (2839/426); Balanophoraceae (10/2); Balsaminaceae (7/1); Basellaceae (10/1); Begoniaceae (325/24); Berberidaceae (16/3); Bignoniaceae (271/53); Bixaceae (8/2); Boraginaceae (172/23); Brassicaceae (23/8); Bromeliaceae (1676/85); Burmanniaceae (11/1); Burseraceae (12/1); Cabombaceae (1/1); Cactaceae (356/28); Calceolariaceae (4/3); Calyceraceae (12/2); Campanulaceae (81/19); Canellaceae (17/2); Cannabaceae (65/4); Cannaceae (25/2); Capparaceae (18/3); Caprifoliaceae (32/7); Cardiopteridaceae (13/3); Caricaceae (11/3); Caryocaraceae (4/1); Caryophyllaceae (31/12); Casuarinaceae (8/1); Celastraceae (116/18); Ceratophyllaceae (1/1); Chloranthaceae (37/1); Chrysobalanaceae (44/13); Cleomaceae (5/2); Clethraceae (65/2); Clusiaceae (140/9); Combretaceae (46/14); Commelinaceae (176/19); Connaraceae (11/3); Convolvulaceae (133/33); Costaceae (15/4); Crassulaceae (3/1); Cucurbitaceae (124/26); Cunoniaceae (52/5); Cyclanthaceae (26/1); Cyperaceae (656/109); Dilleniaceae (60/7); Dioscoreaceae (36/10); Droseraceae (2/1); Ebenaceae (11/4); Elaeagnaceae (1/1); Elaeocarpaceae (43/5); Ericaceae (69/11); Eriocaulaceae (48/15); Erythroxylaceae (74/14); Escalloniaceae (27/5); Euphorbiaceae (594/83); Fabaceae (1611/323); Fagaceae (8/6); Gentianaceae (29/7); Geraniaceae (3/2); Gesneriaceae (364/25); Goodeniaceae (4/1); Griseliniaceae (18/1); Gunneraceae (8/1); Heliconiaceae (64/3); Hernandiaceae (1/1); Humiriaceae (8/2); Hydrangeaceae (1/1); Hydrocharitaceae (3/1); Hydroleaceae (5/1); Hypericaceae (35/5); Hypoxidaceae (7/1); Icacinaceae (3/1); Iridaceae (97/17); Juglandaceae (2/1); Juncaceae (59/9); Juncaginaceae (1/1); Krameriaceae (3/1); Lacistemataceae (5/3); Lamiaceae (448/70); Lauraceae (921/66); Lecythidaceae (4/2); Lentibulariaceae (15/5); Liliaceae (13/2); Linaceae (1/1); Linderniaceae (3/3); Loasaceae (4/2); Loganiaceae (69/8); Loranthaceae (56/5); Lythraceae (120/21); Magnoliaceae (26/3); Malpighiaceae (255/43); Malvaceae (388/66); Marantaceae (97/10); Marcgraviaceae (33/3); Melastomataceae (1811/157); Meliaceae (368/18); Menispermaceae (41/6); Menyanthaceae (5/1); Molluginaceae (3/1); Monimiaceae (297/12); Moraceae (259/24); Musaceae (5/3); Myristicaceae (16/4); Myrtaceae (1899/257); Nyctaginaceae (132/11); Nymphaeaceae (3/1); Ochnaceae (152/8); Olacaceae (25/2); Oleaceae (15/4); Onagraceae (166/18); Opiliaceae (2/1); Orchidaceae (2611/288); Orobanchaceae (22/6); Oxalidaceae (53/10); Papaveraceae (3/2); Passifloraceae (116/23); Paulowniaceae (7/1); Pentaphylacaceae (9/2); Peraceae (54/2); Phrymaceae (2/1); Phyllanthaceae (72/11); Phytolaccaceae (92/12); Picramniaceae (21/4); Piperaceae (1528/89); Pittosporaceae (1/1); Plantaginaceae (90/18); Platanaceae (2/1); Plumbaginaceae (3/2); Poaceae (641/155); Podostemaceae (3/1); Polygalaceae (93/11); Polygonaceae (110/21); Pontederiaceae (24/9); Portulacaceae (7/6); Primulaceae (427/21); Proteaceae (36/7); Quillajaceae (9/1); Ranunculaceae (25/6); Rapateaceae (3/2); Rhamnaceae (58/11); Rhizophoraceae (7/1); Rosaceae (178/17); Rubiaceae (1779/129); Rutaceae (256/23); Sabiaceae (32/1); Salicaceae (195/21); Santalaceae (59/10); Sapindaceae (435/40); Sapotaceae (100/15); Saxifragaceae (1/1); Schlegeliaceae (7/1); Schoepfiaceae (4/2); Scrophulariaceae (32/3); Simaroubaceae (14/4); Siparunaceae (5/1); Smilacaceae (68/4); Solanaceae (1218/131); Styracaceae (53/4); Symplocaceae (84/15); Talinaceae (15/1); Tamaricaceae (1/1); Theaceae (18/2); Thymelaeaceae (37/3); Trigoniaceae

(19/1); Tropaeolaceae (2/1); Typhaceae (8/2); Urticaceae (208/25); Velloziaceae (6/5); Verbenaceae (286/38); Violaceae (47/8); Viscaceae (3/0); Vitaceae (53/8); Vivianiaceae (12/1); Vochysiaceae (28/15); Winteraceae (103/2); Xanthorrhoeaceae (2/1); Xyridaceae (27/11); and Zingiberaceae (27/8).

Research activities

Herbarium collections have a fundamental importance in biodiversity conservation, exhibiting aspects such as reducing the distribution of a particular species or accumulating information in regard to rare or endangered species (e.g. Schatz 2012; Iganci and Morim 2012), and they often serve as a starting point for conservation (Bridson and Forman et al. 1992; for more information see Pyke and Ehrlich 2010). Currently, many species are described using the herbarium specimens, and this fact according to Bebber et al. (2010), is one of the great frontiersof new species.

To date, the collection has enabled comprehensive floristic studies of the three forest types of Santa Catarina (Gasper et al. 2012a, 2013a, 2013b; Sevegnani et al. 2013a). Phytosociological analyses were conducted by Schorn et al. (2012), Lingner et al. (2013a), and Meyer et al. (2013a). Understory species and regeneration strata were researched by Meyer et al. (2012, 2013b, 2013c). Spatial distribution of vascular plant and fern diversity were analyzed by Gasper and Sevegnani (2010), Gasper et al. (2012b), and Uhlmann et al. (2012). The influence of environmental (geoclimatic) variables on species richness, composition, and distribution in forest remnants was investigated within Evergreen Rainforest by Lingner et al. (2013b), fern species being considered by Gasper et al. (2013c). Spatial patterns of *Dicksonia sellowiana* Hook. (Dicksoniaceae), a threatened species, have been described by Gasper et al. (2011) in a study that was also based on the FURB collection. Finally, the collection has enabled studies on secondary succession and the assessment of the conservation status of the sampled forests (Vibrans et al. 2012c; Sevegnani et al. 2013b, 2013c).

In the future, the phylogenetic information will be provided by the DNA stored in the bank and will be extremely important for taxonomic studies. For this reason it is crucial that incentives for research and the maintenance of herbarium activities continue.

Current situation and future perspectives

Of the 170 active herbaria listed in the Catalogue of the Brazilian Herbaria (http:// www.botanica.org.br/rede_herbarios.php), most have fewer than 50,000 records (80% according to Peixoto et al. 2006). It is estimated that the FURB herbarium will reach this value in two years, and in the meantime must have its registration approved as "Fiel Depositário" (Azevedo 2005; CGEN 2014).

In addition to the novelties promoted by the e-taxonomy, the availability of data online, including the recently added images, allows for the rapid updating of herbariums (Smith and Figueiredo 2009;. Smith et al. 2011), as well as the discovery of gaps in collections (Canhos et al. 2013).

Finally, one of the novelties of the FURB herbarium is the expansion of its fungi collection. This may result from the second cycle IFFSC, with the collection of macrofungi, which requires special care (Wu et al. 2004). The collection of macrofungi in the Herbarium FURB is small at presentand has only 159 specimens, stemmed mainly from sporadic collections of a small number of students.

Acknowledgements

The authors offers thanks to Joelma Miszinski (EPAGRI/CIRAM) for developing the Herbaria 3.1 software, the students that contributed to the increase of the herbarium, and the University of Blumenau for all of its support, and Kyle York for English review. Two reviewers provided comments and suggestions to the paper.

References

- Amado T (2013) Histórico sobre a primeira edição de O Reino Vegetal de Rio do Sul. Sellowia
 Anais Botânicos do Herbário Barbosa Rodrigues, 5–20.
- Azevedo CMA (2005) Regulation to access to genetic resources and associated traditional knowledge in Brazil. Biota Neotropica 5(1): 19–27. doi: 10.1590/S1676-06032005000100002
- Bebber DP, Carine MA, Wood JRI, Wortley AH, Harris DJ, Prance GT, Davidse G, Paige J, Pennington TD, Robson NKB, Scotland RW (2010) Herbaria are a major frontier for species discovery. Proceedings of the National Academy of Sciences 107.51: 22169–22171. doi: 10.1073/pnas.1011841108
- Bortoluzzi RL da C, Reis A; Mantovani A, Bernardes ZHD (2011) Herbários Catarinenses. Ciência & Ambiente 42: 171–181.
- Brasil (2008) Ministério do Meio Ambiente (MMA). Instrução Normativa nº 6, de 23 de setembro de 2008. Lista oficial das espécies da flora brasileira ameaçadas de extinção. Diário Oficial [da República Federativa do Brasil], Brasília, DF, v. 145, n. 185, 24 set. 2008. Seção 1, 75–83.
- Bridson DM, Forman L (1992) The Herbarium Handbook. Royal Botanic Gardens, Kew.
- Canhos DAL, Sousa-Baena MS, Souza S, Garcia LC, De Giovanni R, Maia LC, Bonacelli MBM (2013) Lacunas: a web interface to identify plant knowledge gaps to support informed decision-making. Biodiversity and Conservation 23: 109–131. doi: 10.1007/ s10531-013-0587-0
- CGEN (2014) Conselho de Gestão do Patrimônio Genético Ministério do Meio Ambiente. Published on the Internet. http://www.mma.gov.br/patrimonio-genetico/conselho-degestao-do-patrimonio-genetico [accessed 03.05.2014]
- Chase MW, Hills HH (1991) Silica gel: an ideal material for field preservation of leaf samples for DNA studies. Taxon 40(2): 215–220. doi: 10.2307/1222975

- Christenhusz MJM, Reveal JL, Farjon A, Gardner MF, Mill RR, Chase MW (2011) A new classification and linear sequence of extant gymnosperms. Phytotaxa 19: 55–70.
- Citadini-Zanette V (2013) Tributo ao Pe. Raulino Reitz e Roberto Miguel Klein. In: Sevegnani L, Schroeder E (Eds) Biodiversidade Catarinense: características, potencialidades, ameaças. Edifurb, Blumenau, 86–87.
- Gasper AL de, Eisenlohr PV, Salino A (2013c) Climate-related variables and geographic distance affect fern species composition across a vegetation gradient in a shrinking hotspot. Plant Ecology & Diversity. doi: 10.1080/17550874.2013.843604
- Gasper AL de, Meyer L, Sevegnani L, Sobral M, Bonnet A (2012a) Flora vascular de Santa Catarina uma síntese do Inventário Florístico Florestal de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume I - Inventário Florístico Florestal de Santa Catarina. Diversidade e Conservação dos Remanescentes Florestais. Edifurb, Blumenau, 110–125
- Gasper AL de, Salino A, Vibrans AC, Sevegnani L, Verdi M, Korte K, Stival-Santos A, Dreveck S, Cadorin TJ, Schmitt JL, Caglioni E (2012b) Pteridófitas de Santa Catarina, um olhar sobre os dados do Inventário Florístico Florestal de Santa Catarina, Brasil. Acta Botanica Brasilica 26: 421–434.
- Gasper AL de, Sevegnani L (2010) Lycophyta e samambaias do Parque Nacional da Serra do Itajaí, Vale do Itajaí, Santa Catarina, Brasil. Hoehnea 37(4): 755–767. doi: 10.1590/ S2236-89062010000400006
- Gasper AL de, Sevegnani L, Vibrans AC, Sobral M, Uhlmann A, Lingner DV, Rigon-Júnior MJ, Verdi M, Stival-Santos A, Dreveck S, Korte A (2013a) Inventário florístico florestal de Santa Catarina: espécies da Floresta Ombrófila Mista. Rodriguésia 64: 201–210. doi: 10.1590/S2175-78602013000200001
- Gasper AL de, Uhlmann A, Sevegnani L, Lingner DV, Rigon-Júnior MJ, Verdi M, Stival-Santos A, Dreveck S, Sobral M, Vibrans AC (2013b) Inventário Florístico Florestal de Santa Catarina: espécies da Floresta Estacional Decidual. Rodriguésia 64: 427–443. doi: 10.1590/S2175-78602013000300001
- Gaudeul M, Rouhan G (2013) A plea for modern botanical collections to include DNA-friendly material. Trends in Plant Science 18(4): 184–185. doi: 10.1016/j.tplants.2012.12.006
- Hodkinson TR, Waldren S, Parnell JAN, Kelleher CT, Salamin K, Salamin N (2007) DNA banking for plant breeding, biotechnology and biodiversity evaluation. Journal of Plant Research 120(1): 17–29. doi: 10.1007/s10265-006-0059-7
- Iganci JRV, Morim, MP (2012) Coleções botânicas para conservação: um estudo de caso em Abarema Pittier (Leguminosae, Mimosoideae). Revista Brasileira de Biociências 10(2): 164–170.
- IPNI (International Plant Names Index) (2012) Published on the Internet. http://www.ipni.org [accessed 02.05.2014]
- Klein RM (1967) Aspectos do problema "Bromélia-Malária" no sul do Brasil. Sellowia 19: 125–135.
- Klein RM (1978) Mapa fitogeográfico do estado de Santa Catarina. In: Reitz R (Ed.) Flora Ilustrada Catarinense. Herbário Barbosa Rodrigues, Itajaí, 1–24.
- Lingner DV, Schorn LA, Vibrans AC, Meyer L, Sevegnani L, Gasper AL de, Sobral M, Klemz G, Schmitt R, Anastacio-Jr C, Kruger A (2013a) Fitossociologia do componente arbóreo/

arbustivo da Floresta Ombrófila Densa no Estado de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume IV - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau, 157–198.

- Lingner DV, Sevegnani L, Gasper AL de, Uhlmann A, Vibrans AC (2013b) Grupos florísticos estruturais da Floresta Ombrófila Densa em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume IV - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau, 141–155.
- List of Species of Brazilian Flora (2014) Published on the Internet. http://floradobrasil.jbrj.gov. br/ [accessed 02.05.2014]
- Meyer L, Gasper AL de, Sevegnani L, Lingner DV, Vibrans AC, Verdi M, Stival-Santos A, Dreveck S, Korte A (2012) Regeneração natural da Floresta Estacional Decidual em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume II -Inventário Florístico Florestal de Santa Catarina. Floresta Estacional Decidual. Edifurb, Blumenau, 163–183.
- Meyer L, Gasper AL de, Sevegnani L, Schorn LA, Vibrans AC, Lingner DV, Verdi M, Stival-Santos A, Dreveck S, Korte A (2013b) Regeneração natural da Floresta Ombrófila Densa no estado de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume IV - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau, 201–245.
- Meyer L, Gasper AL de, Sevegnani L, Schorn LA, Vibrans AC, Lingner DV, Verdi M, Stival-Santos A, Dreveck S, Korte A (2013c) Regeneração natural da Floresta Ombrófila Mista no Estado de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume III - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Mista. Edifurb, Blumenau, 191–222.
- Meyer L, Sevegnani L, Gasper AL de, Schorn LA, Vibrans AC, Lingner DV, Sobral M, Klemz G, Schmitt R, Anastacio-Jr C, Brogni E (2013a) Fitossociologia do componente arbóreo/ arbustivo da Floresta Ombrófila Mista no Estado de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume III - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Mista. Edifurb, Blumenau, 157–189.
- Miszinski J, Souza JM de, Carrião SL, Antunes EN, Maraschin F, Pinto ESP, Orsi V (2012) Sistemas de Informações Florístico-Florestais de Santa Catarina – SIFFSC. In: Vibrans AC, Sevegnani L, Gasper AL de, Lingner DV (Eds). Volume I - Inventário Florístico Florestal de Santa Catarina. Diversidade e Conservação dos Remanescentes Florestais. Edifurb, Blumenau, 263–277.
- Oliveira-Filho AT, Budke JC, Jarenkow JA, Eisenlohr PV, Neves DRM (2013) Delving into the variations in tree species composition and richness across South American subtropical Atlantic and Pampean forests. Journal of Plant Ecology. doi: 10.1093/jpe/rtt058
- Øllgaard B (2012) Nomenclatural changes in Brazilian Lycopodiaceae. Rodriguésia 63: 479–482. doi: 10.1590/S2175-78602012000200020
- Peixoto AL, Barbosa MRV, Menezes M, Maia LC (2006) Diretrizes e estratégicas para a modernização das coleções botânicas brasileiras com base na formação de taxonomistas e na consolidação de sistemas integrados de informação sobre biodiversidade. In: Egler I, Santos MM, Canhos VP (Eds). Diretrizes e estratégicas para a modernização de coleções biológi-

cas brasileiras e a consolidação de sistemas integrados de informação sobre biodiversidade. Ministério da Ciência e Tecnologia, Brasília, 145-182.

- Pyke GH, Ehrlich PR (2010) Biological collections and ecological/environmental research: a review, some observations and a look to the future. Biological Reviews of the Cambridge Philosophical Society 85(2): 247–266. doi: 10.1111/j.1469-185X.2009.00098.x
- Reitz R (1965) Plano de coleção. In: Reitz R (Ed) Flora Ilustrada Catarinense. Herbário Barbosa Rodrigues, Itajaí, 70p.
- Reveal JL, Chase MW (2011) APG III: Bibliographical Information and Synonymy of Magnoliidae. Phytotaxa 19: 71–134.
- Rothfels CJ, Sundue MA, Kuo LY, Larsson A, Kato M, Schuettpelz E, Pryer KM (2012) A revised family-level classification for eupolypod II ferns (Polypodiidae: Polypodiales). Taxon 61: 515–533.
- Santos FR, Guimarães PEM, Redondo RAF (2002) Bancos de DNA: coleções estratégicas para estudos da biodiversidade. Lundiana 3(1): 93–98.
- Schatz GE (2002) Taxonomy and Herbaria in Service of Plant Conservation: Lessons from Madagascar's Endemic Families. Annals of the Missouri Botanical Garden 89: 145–152. doi: 10.2307/3298559
- Schorn LA, Lingner DV, Vibrans AC, Gasper AL de, Sevegnani L, Sobral M, Meyer L, Klemz G, Schmitt R, Anastacio-Jr C, Kruger A (2012) Estrutura do componente arbóreo/arbustivo da Floresta Estacional Decidual em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume II - Floresta Estacional Decidual. Edifurb, Blumenau, 139–159.
- Sevegnani L, Gasper AL de, Bonnet A, Sobral M, Vibrans AC, Verdi M, Stival-Santos A, Dreveck S, Korte A, Schmitt JL, Cadorin TJ, Oliveira CPL, Caglioni E, Torres JF, Meyer L (2013a) Flora vascular da Floresta Ombrófila Densa em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume IV - Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau, 127–139.
- Sevegnani L, Vibrans AC, Gasper AL de (2013b) Considerações finais sobre a Floresta Ombrófila Densa e Restinga. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume IV Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau, 325–327.
- Sevegnani L, Vibrans AC, Gasper AL de (2013c) Considerações finais sobre a Floresta Ombrófila Mista em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume III Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Mista. Edifurb, Blumenau, 275–278.
- Smith AR, Pryer KM, Schuettpelz E, Korall P, Schneider H, Wolf PG (2006) A classification for extant ferns. Taxon 55: 705–731. doi: 10.2307/25065646
- Smith GF, Figueiredo E (2009) E-taxonomy: an affordable tool to fill the biodiversity knowledge gap. Biodiversity and Conservation 19: 829–836. doi: 10.1007/s10531-009-9738-8
- Smith GF, Roux JPK, Raven P, Figueiredo E (2011) African Herbaria Support Transformation on the Continent. Annals of the Missouri Botanical Garden 98: 272–276. doi: 10.3417/2010050
- Smith LB, Downs RJ (1964) Kleinodendron, novo gênero de Euforbiáceas. Sellowia 16: 175-178.

- Stehmann JR, Forzza RC, Salino A, Sobral M, Costa DP, Kamino LHY (2009) Plantas da Floresta Atlântica. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro.
- Uhlmann A, Gasper AL de, Sevegnani L, Vibrans AC, Meyer L, Lingner DV (2012) Fitogeografia de Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume I - Inventário Florístico Florestal de Santa Catarina. Diversidade e Conservação dos Remanescentes Florestais. Edifurb, Blumenau, 113–126.
- Veloso HP, Klein RM (1957) As comunidades e Associações vegetais da mata pluvial do sul do Brasil - I. As comunidades do município de Brusque, Estado de Santa Catarina. Sellowia 8: 81–236.
- Veloso HP, Klein RM (1959) As comunidades e associações vegetais da Mata Pluvial do Sul do Brasil - II. Dinamismo e fidelidade das espécies em associações do Município de Brusque, Estado de Santa Catarina. Sellowia 10: 9–124.
- Veloso HP, Klein RM (1961) As comunidades e associações vegetais da mata pluvial do sul do Brasil - III. As associações das planícies costeiras do quaternário, situadas entre o Rio Itapocu (Estado de Santa Catarina) e a Baia de Paranaguá (Estado do Paraná). Sellowia 13: 205–261.
- Veloso HP, Klein RM (1963) As comunidades e associações vegetais da mata pluvial do sul do Brasil - IV. As associações situadas entre o rio Tubarão e a Lagoa dos Barros. Sellowia 15: 57–114.
- Veloso HP, Klein RM (1968a) As comunidades e associações vegetais da mata pluvial do Sul do Brasil - V. Agrupamento arbóreos dos contra-fortes da Serra Geral situados ao sul da costa Catarinense e ao norte da costa sul-riograndense. Sellowia 20: 127–180.
- Veloso HP, Klein RM (1968b) As comunidades e associações vegetais da mata pluvial do Sul do Brasil - V. Agrupamentos arbóreos da encosta catarinense, situados em sua parte Norte. Sellowia 20: 53–126.
- Vibrans AC, Bonnet A, Caglioni E, Gasper AL de, Lingner DV (2013a) Volume V Inventário Florístico Florestal de Santa Catarina. Epífitos Vasculares da Floresta Ombrófila Densa. Edifurb, Blumenau.
- Vibrans AC, Sevegnani L, Gasper AL de (2012c) Considerações finais sobre a Floresta Estacional Decidual em Santa Catarina. In: Vibrans AC, Sevegani L, Gasper AL de, Lingner DV (Eds) Volume II - Inventário Florístico Florestal de Santa Catarina. Floresta Estacional Decidual. Edifurb, Blumenau, 225–228
- Vibrans AC, Sevegnani L, Gasper AL de, Lingner DV (2012a) Volume I Inventário Florístico Florestal de Santa Catarina. Diversidade e Conservação dos Remanescentes Florestais. Edifurb, Blumenau.
- Vibrans AC, Sevegnani L, Gasper AL de, Lingner DV (2012b) Volume II Inventário Florístico Florestal de Santa Catarina. Floresta Estacional Decidual. Edifurb, Blumenau.
- Vibrans AC, Sevegnani L, Gasper AL de, Lingner DV (2013b) Volume III Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Mista. Edifurb, Blumenau.
- Vibrans AC, Sevegnani L, Gasper AL de, Lingner DV (2013c) Volume IV Inventário Florístico Florestal de Santa Catarina. Floresta Ombrófila Densa. Edifurb, Blumenau.
- Vibrans AC, Sevegnani L, Lingner DV, Gasper AL de, Sabbagh S (2010) Inventário florístico florestal de Santa Catarina (IFFSC): aspectos metodológicos e operacionais. Pesquisa Florestal Brasileira 30: 291–302. doi: 10.4336/2010.pfb.30.64.291
Wu Q, Thiers BM, Pfister DH (2004) Preparation, Preservation, and Use of Fungal Specimens in Herbaria. In: Mueller GM, Bills GF, Foster MS (Eds) Biodiversity of fungi - inventory and monitoring methods. Academic Press, London: 23–36. doi: 10.1016/B978-012509551-8/50005-2

RESEARCH ARTICLE



Bidens meyeri (Asteraceae, Coreopsideae): a new critically endangered species from Rapa, Austral Islands

Vicki A. Funk¹, Kenneth R. Wood²

US National Herbarium, Department of Botany, Smithsonian Institution, PO Box 37012, Washington, DC 20013-7012, USA 2 National Tropical Botanical Garden, 3530 Papalina Road, Kalaheo, HI 96741, USA

Corresponding author: Vicki A. Funk (funkv@si.edu)

Academic editor: Alexander Sennikov | Received 8 August 2014 | Accepted 16 September 2014 | Published 13 October 2014

Citation: Funk VA, Wood KR (2014) *Bidens meyeri* (Asteraceae, Coreopsideae): a new critically endangered species from Rapa, Austral Islands. PhytoKeys 42: 39–47. doi: 10.3897/phytokeys.42.8408

Abstract

Bidens meyeri (Asteraceae/Compositae) is described and illustrated from Rapa, Austral Islands, (French Polynesia). This new species is presumed to be most closely related to *Bidens saint-johniana* from nearby Marotiri Island. *Bidens meyeri* may be distinguished from *B. saint-johniana* based on the length of the peduncle (3 cm versus 10 cm), apex of the inner involucral bracts (glabrous vs. puberulent), smaller leaves (2.0–2.3 cm vs. 5–6 cm), and the general smaller size of the new species. Known from less than 50 individuals and restricted to one remote location, *Bidens meyeri* falls into the IUCN Critically Endangered (CR) category. The new species is named in honor of Dr. Jean-Yves Meyer, Délégation à la Recherche, Polynésie Française,

Keywords

Asteraceae, Austral Islands, *Bidens*, Coreopsideae, Compositae, conservation, endemic, French Polynesia, IUCN Red List Category, Oceania, Rapa Iti.

Introduction

The Austral Islands are situated in the Southern Pacific and are part of French Polynesia. The Archipelago lies south of the Society Islands and consists of seven main islands of volcanic origin, and one atoll (Maria). The high islands include Rurutu, Tubuai, Rimatara, and Ra'ivavae as well as Rapa (27°36'00"S; 144°17'00"W), the second largest island (i.e., 40 km²). Rapa is about 5 million years old and it is very rugged, characterized by steep central ridges, mist shrouded spires, and towering black basalt seacliffs (Clarke 1971, Clouard and Bonneville 2005, Appelhans et al. 2014). The highest peak, Mont Perau (ca. 650 m), is covered by a small area of cloud forest (Meyer 2010).

Rapa is a high volcanic island and its climate is considered to be wet subtropical / subtemperate with a mean annual temperature of 20.6°C, a minimum at 8.5°C, and mean annual rainfall of 2500 mm at sea level (Barsczus 1980; Meyer 2011). Levels of endemism have been reported as very high among certain organisms, such as weevils (Paulay 1985). Area, altitude, and nearest land mass all have an effect on the evolution of the biota in these islands with Rapa being the second largest, highest, and most distant of all of the Austral islands. It is nearly 1200 km southeast of Tahiti, 3700 km northeast of the north island of New Zealand, and 8500 km southwest of the Baja Peninsula in Mexico. Threats to the biodiversity are primarily a result of burning, grazing (in particular goats and cattle), and invasive alien plant species.

Rapa has 238 native taxa of flowering plants and ferns including infraspecific categories, 85 of these are endemic to the Austral islands (35%), 73 of these are single island endemic taxa (30%) including this new species of *Bidens*. Considering only flowering plants, Rapa has 152 native flowering plant taxa, of these 65 (43%) are endemic to the Austral islands and 53 (35%) are endemic to Rapa (Meyer 2002, Wood 2002, Wood pers. com.). Two island endemic genera in the Compositae have been reported: *Apostates* N.S. Lander in the Madieae tribe, part of the Heliantheae Alliance, and *Pacifigeron* G.L. Nesom in the Astereae. Also, there are endemic Compositae species on Rapa that belong to two 'endemic to Polynesia' genera, namely *Fitchia* Hook. f. and *Oparanthus* Sherff both in the Coreopsideae tribe which is also part of the Heliantheae Alliance (Florence 1997, Shannon and Wagner 1997, Wagner and Lorence 2014).

In March – April 2002, during an expedition supported by the National Geographic Society, a group of scientists from the New York Botanical Garden (NYBG); the Délégation à la Recherche, Polynésie Française; and the National Tropical Botanical Garden (NTBG), Kaua`i, Hawai`i, conducted a botanical survey of the island of Rapa. They expected to stay there for a month. In fact, because of a logistic problem that delayed the supply ship (their means of transportation), several of them stayed for two months. During this Rapa expedition a number of very interesting taxa were discovered, one of which was a *Bidens* that could not be placed into any existing species (Fig. 1; Meyer 2002, Wood 2010).

Describing this taxon was unusually difficult because of the scant material (Fig. 2 a, b). Other samples were collected during the expedition but are inaccessible. The collector of the holotype specimen gathered several isotypes that would have been sufficient, however, all except the small one he retained (the type) have evidently been misplaced and with the untimely death of the expeditions team leader, Dr. Timothy Motley (NY followed by ODU), the specimens have not been available for study. On a subsequent expedition in December of 2002, an additional collection was made by Jean-Yves Meyer close to the original location (*Meyer 2315*; Fig. 1). Meyer's collection was sent to the Paris herbarium (P) but cannot now be located (Meyer, pers. com.). After waiting for over ten years we have decided to go forward with the description of this new taxon as it is being included in a forthcoming molecular analysis and needs to



Figure 1. Photos of *Bidens meyeri:* **A** Close up of a flowering plant, note the gloved finger holding the plant **B** J-Y Meyer climbing with *Bidens* in his teeth, note yellow flowering plant on the cliff face just above his left hand. [Photo credits: **A** by J-Y Meyer; **B** by R Englund; both taken 16 Dec 2002].

be recognized for future conservation efforts. The leaf sample for the molecular analysis was taken from the holotype, prior to its designation as a holotype, with permission from the National Tropical Botanical Garden.

Taxonomic treatment

Bidens meyeri V.A. Funk & K.R. Wood, sp. nov. urn:lsid:ipni.org:names:77142603-1 Fig. 2A–C

Type. Austral Islands. Rapa, cliffs above Maitua, rappel below Maungaoa, 3 Apr 2002, *K.R. Wood & Heimoana Faraire 9515* (holotype: PTBG-067702!); 27°37'30"S; 144°20'20"W.

Description. Sub-shrub with 3-4 branches growing on cliff faces, ca. 25 cm tall, small side branches ca. 8 cm tall; stems brown, glabrous, lower portion smooth, upper portion striated, ca. 1 mm wide (when dry), glabrous, older nodes with the remains of leaf bases. Leaves opposite, simple, somewhat fleshy, glabrous, without true petioles but looking petiolate because of narrowed blade bases, 2.1-2.3 cm long; broad part of *leaf* ovate, glossy green above, dull green below, 1.1-1.5 cm long × 1.0-1.2 cm wide; margins of broad part of leaf dentate with teeth curved toward apex and with mucronate tips, 6-9 teeth per side; apex mucronate or apiculate; venation pinnate usually with one lateral vein for each tooth; narrow portion of leaf ca. 1 cm long decurrent with leaf bases wrapping around stem and nearly touching one another. *Heads* solitary, ~ 1 cm in diameter (excluding rays), peduncle 3 cm long, glabrous with prominent ribs (when dried); involucral bracts in 2-3 rows, outer two rows bright green, purple tipped in some, slightly fleshy, glabrous with 3 prominent veins (when dried), arched outward, ca. 5 mm × 1.3 mm (at the broadest point near the apex), apex rounded with a small acute tip; innermost row (may also be outer row of receptacular bracts) lanceolate, brownish with lighter hyaline margins, glabrous, 5.5 mm × 1.1 mm (at widest point near the base). Ray flowers yellow with many veins, 8-9 per head, sterile, ca. 9 mm long (including 2 mm tube) × 1.5–2.0 mm wide; disk flowers ca. 30–40, perfect; corollas yellow, glabrous; anther thecae dark, pollen yellow; style branches yellow. Pappus of 2 very short irregular awns with scattered hairs but without barbs. Achenes immature but apparently dark colored and glabrous, at least near the apex.

Additional collection. Austral Islands: Rapa, Tevaitau on cliff, only two plants seen, 272 m, on bare rock, 16 Dec 2002, *J.-Y. Meyer 2315* (Specimen hopefully at P). Fig. 1.

Distribution and ecology. The type of *Bidens meyeri* was discovered during a rappel utilizing ropes and climbing-saddle around the windswept mesic cliffs above Maitua, Rapa, French Polynesia. The holotype location is the only population of any size; the second collecting site had only two individuals. The type locality can be described as a windswept mesic cliff habitat with small ledges and pockets of granular



Figure 2. Photos of *Bidens* type specimens: **A–C** *Bidens meyeri* holotype (PTBG): **A–B** Specimen before mounting **A** Side with the involucral bracts and (mostly) upper surface of the leaves showing **B** Side with the flowers and (mostly) the undersurface of leaves showing **C** Holotype of *Bidens meyeri*, housed at PTBG **D** Holotype of *Bidens saint-johniana*, housed at BISH. [Photo credits: A–C by Jesse Adams, PTBG; D sent by BISH].

soil, bordered by steep slopes interspersed with herbs and low-statured native forest and shrubland. The aspect is northeast with a 70% open canopy for exposure to sun. Associated tree species include Oparanthus coriaceus (F. Br.) Sherff, O. rapensis (F. Br.) Sherff, Corokia collenettei Riley, Fitchia rapense F. Br., Metrosideros collina (J.R. Forst. & G. Forst.) A. Gray var. villosa (L.) A. Gray, Apetahia margaretae (F. Br.) Wimmer, and Sophora rapaensis H. St. John. Shrubs, vines, and herbs include Plantago rupicola Pilg., Dianella intermedia Endl. var. punctata F. Br., Veronica rapensis F. Br., Kadua rapensis F. Br., Alyxia stellata (J.R. Forst. & G. Forst.) Roem. & Schult., Dichelachne crinita (L. f.) Hook. f., and some Freycinetia arborea Gaudich. Associated ferns include Blechnum attenuatum (Sw.) Mett., Blechnum vulcanicum (Blume) Kuhn var. rapense E.D. Br., Sphaeropteris medullaris (G. Forst.) Bernh., Alsophila stokesii (E.D. Br.) R.M. Tryon, Polystichum rapense E.D. Br., Belvisia dura (Copel.) Copel., Thelypteris margaretae (E.D. Br.) Ching, Davallia solida (G. Forst.) Sw., Selaginella arbuscula (Kaulf.) Spring, Nephrolepis exaltata (L.) Schott, and Pteris comans G. Forst (Wood 2002, pers. com.). Meyer 2315 was collected at a site with Pyrrosia serpens (G. Forst.) Ching, Peperomia sp., Verbena litoralis Kunth, Commelina diffusa Burm. f, Davallia solida (G. Forst.) Sw. and Psilotum nudum (L.) P. Beauv (pers. com.).

Etymology. The new species is named in honor of Dr. Jean-Yves Meyer, friend and conservation biologist at the Délégation à la Recherche, Polynésie Française, in recognition of his research of this species and his efforts in exploring and conserving the unique biota of Rapa (e.g., Meyer 2011).

Discussion

The only other native species of *Bidens* from the Austral Islands is *B. saint-johniana* Sherff (1937) found on Marotiri, a group of small rocky islets located ca. 80 km southeast of Rapa. Marotiri has been surveyed only twice by botanists: St. John and Forges. *Bidens saint-johniana* was first collected at the Southeast Islet, 22 July 1934, by Harold St. John (Fosberg 1972; St. John 1982) and his assistant at the time, Ray Fosberg (*St. John 15683*; holotype: BISH; isotype F, http://plants.jstor.org/specimen/f0075334f?history=true; images of both were examined; Fig. 2D), and again in 1979 by B. Richer de Forges (*Nicolas Hallé 6860*, P; Hallé 1980). *Bidens saint-johniana* is a much more robust plant than *B. meyeri*, its leaves are larger (total length 5–6 cm, width at the widest part 3.5–4.0 cm) and peduncle longer (10 cm vs. 3 cm), and the apex of the inner involucral bracts is puberulent (vs. glabrous). Based on the images of the holotype (BISH; Fig. 2D) and isotype (F) the leaves are not thickened and the teeth are larger and not as curved and do not have a mucronate tip. Finally the length of the side branches was 14–15 cm as opposed to those of *B. meyeri* which are less than 8 cm.

When the new species was run through the key in the *Bidens* treatment written by Welsh (1998) covering the Society Islands, it did not key out to anything remotely similar and it did not fit any of the descriptions. It does, however, have some superficial resemblance to *B. molokaiensis* Sherff and *B. mauiensis* Sherff from Hawaii, as Sherff (1937) observed.

Rapa's flora is usually mentioned as being closely allied to that of New Zealand and Australia. However, after evaluating the results of numerous exceptions, some botanists (e.g., van Balgooy 1971) consider Rapa to be an 'anomalous district' in the SE Polynesian Province, and the high levels of endemic biological diversity in both the flora and fauna still puzzle many scientists because of the island's relatively small size. There are 53 flowering plant species (35%) that are single island endemics to Rapa, including three endemic plant genera, namely *Apostates* (Asteraceae: Bahieae), *Pacifigeron* (Asteraceae: Astereae) and *Metatrophis* F. Br. (Urticaceae). The new species is clearly related to the Pacific *Bidens* radiation (Hawaii & French Polynesia) rather than taxa found on Rapa's neighbors to the South.

Conservation status

Utilizing the World Conservation Union (IUCN) criteria for endangerment (IUCN 2001), we find that *Bidens meyeri* easily falls into the Critically Endangered (CR) category, and faces a very high risk of extinction in the wild. The IUCN alphanumeric summary of our evaluation of criteria and subcriteria is: B1ab(v); B2a, B2b(i–iii); D. These criteria are defined as: B1, extent of occurrence less than 100 km²; B1a, known to exist at only a single location; B1b(v) continuing decline inferred in number of mature individuals; B2, total area of occupancy less than 10 km²; B2a, one population known; B2b(i–iii), habitat continuing decline inferred; D, population estimated to number fewer than 50 individuals. Threats to *B. meyeri* include possible fires, habitat degradation and destruction by feral goats (*Capra hircus* L.), along with competition with nonnative plant taxa especially *Psidium cattleianum* Sabine and, of course, climate change.

Acknowledgements

We would like to thank Jean-Yves Meyer and Priscille Frogier of the Délégation à la Recherche de la Polynésie Française, for their support of research in French Polynesia; Staff at the National Tropical Botanical Garden for continued support and assistance at the PTBG herbarium, especially Tim Flynn, Dave Lorence, and Jesse Adams; Timo-thy J. Motley† (NYBG at the time of the expedition), organizer of the 2002 Rapa Expedition, and the National Geographic Society for partial funding; Steve Perlman (NTBG), Jean-Francois Butaud (Service du Développement Rural, Tahiti), Cerdan and Heimoana Faraire (Rapa) for field assistance. We also thank Jean-Yves Meyer, Ron Englund, and Jessie Adams for the photographs, Alice Tangerini (US) for helping assemble Fig. 2, Shelly James (BISH) who kindly made available a high-resolution image of the holotype of *B. saint-johniana*, and the herbarium of the Field Museum (F), and *JSTOR Global Plants Initiative* for putting the image of the isotype online.

References

- Appelhans MS, Wagner WL, Wood KR (2014) *Melicope balgooyi* Appelhans, W.L.Wagner & K.R. Wood, a new species and new record in *Melicope* section *Melicope* (Rutaceae) for the Austral Islands. Phytokeys 39: 77–86. doi: 10.3897/phytokeys.39.7691
- Barsczus HG (1980). Les îles Australes (Polynésie francaise) et la théorie des points chauds. Notes et Documents de Géophysique. ORSTOM, Papeete, Tahiti, 27 pp.
- Clarke JFG (1971) The Lepidoptera of Rapa Island. Smithsonian Contributions to Zoology 56: 1–282. http://www.sil.si.edu/smithsoniancontributions/zoology/pdf_hi/sctz-0056.pdf
- Clouard V, Bonneville A (2005) Ages of seamounts, islands and plateaus on the Pacific Plate. In: Foulger GR, Natland JH, Presnall DC, Anderson DL (Eds) Plates, plumes, and paradigms. Geological Society of America, Special Paper 388, 71–90. doi: 10.1130/0-8137-2388-4.71
- Florence J (1997) Flore de la Polynésie francaise. Volume 1. Collection Faune et Flore Tropicales. Editions de l'ORSTOM, Paris, 34 pp.
- Fosberg R (1972) Morotiri (Bass Rocks) Austral Islands. Atoll Research Bulletin 162: 9–10. http://www.sil.si.edu/digitalcollections/atollresearchbulletin/issues/00258.pdf
- Hallé N (1980) Les Orchidées de Tubuaï (archipel des Australes, Sud Polynésie): Suivies d'un catalogue des Plantes à fleurs et Fougères des îles Australes. Cahiers de l'Indo-Pacifique. 2(3): 69–130. [catalogue 85–130]
- IUCN (2001) IUCN Red List Categories and Criteria Version 3.1. Prepared by the IUCN Criteria Review Working Group. IUCN, Cambridge. http://www.iucnredlist.org/technicaldocuments/categories-and-criteria/2001-categories-criteria
- Meyer J-Y (2002) Rapport de mission d'exploration botanique à Tubuai et Rapa (Australes) du 13 mars au 5 avril 2002. Délégation à la Recherche de la Polynésie française, Papeete, 26 pp. http://www.li-an.fr/jyves/Meyer_2002_Rapport_mission_Tubuai_&_Rapa.pdf
- Meyer J-Y (2010) Montane cloud forests in remote islands of Oceania: the example of French Polynesia (South Pacific Ocean). In: Bruijnzeel LA, Scatena FN, Hamilton LS (Eds) Tropical Montane Cloud Forests: Science for Conservation and Management. Cambridge University Press, Cambridge, 121–129.
- Meyer J-Y (2011) Rapa, îles Australes: guide de la flore indigène et endémique. Direction de l'Environnement, Délégation à la Recherche: STPmultipress, Papeete.
- St. John H (1982) Marotiri rock pinnacles in the South Pacific. Occasional Papers of the Bernice P. Bishop Museum 25(4): 1–4. http://hbs.bishopmuseum.org/pubs-online/pdf/op25-4.pdf
- Shannon RK, Wagner WL (1997) Oparanthus (Asteraceae, subtribe Coreopsidinae) revisited. Allertonia 7: 273–295. https://repository.si.edu/bitstream/handle/10088/20991/bot_ Shannon_and_Wagner_1997_Oparanthus.pdf?sequence=1
- Sherff EE (1937) Some Compositae of southeastern Polynesia (Bidens, Coreopsis, Cosmos, and Oparanthus). Occasional Papers of the Bernice P. Bishop Museum 12(19): 1–19. http://hbs.bishopmuseum.org/pubs-online/pdf/op12-19.pdf
- van Balgooy MMJ (1971) Plant-geographical analysis of the pacific. Blumea Supplement 6: 1–122.

- Wagner WL, Lorence DH (2011) Two new Marquesan species of the southeastern Polynesian genus *Oparanthus* (Asteraceae, Coreopsidinae). PhytoKeys 4: 139–148. doi: 10.3897/phytokeys.4.1603
- Welsh SL (1998) Flora Societensis: a summary revision of the flowering plants of the Society Islands. Mehetia, Tahiti, Moorea, Tetiaroa (iles du vent); Huahine, Raiatea, Tahaa, Bora Bora, Tupai, Maupiti, and Mopelia (iles sous le vent). Orem, Utah: E.P.S. Inc., 420 pp.
- Wood KR (2002) Further Notes on Rapa, Austral Islands, French Polynesia. Garden Chronicles, National Tropical Botanical Garden, Kalaheo, Hawai'i, 3(2): 13–15.
- Wood KR (2010) Tales from the Field: Following an inner voice in search of Rapa's rare *Apostates*. The Bulletin, National Tropical Botanical Garden, Kalaheo, Hawai'i, 27(2): 11–17. http://ntbg.org/sharing/magazine.php#804

RESEARCH ARTICLE



Dorstenia luamensis (Moraceae), a new species from eastern Democratic Republic of Congo

Miguel E. Leal¹

I Wildlife Conservation Society, Kiwafu Road 802, Kansanga, Kampala, Uganda

Corresponding author: Miguel E. Leal (mleal@wcs.org)

Academic editor: Hugo De Boer | Received 28 March 2014 | Accepted 7 October 2014 | Published 24 October 2014

Citation: Leal ME (2014) *Dorstenia luamensis* (Moraceae), a new species from eastern Democratic Republic of Congo. PhytoKeys 42: 49–55. doi: 10.3897/phytokeys.42.7604

Abstract

A new species of *Dorstenia* L. (*Moraceae*), *D. luamensis* M.E.Leal, is described from the Luama Wildlife Reserve, west of Lake Tanganyika and north of the town of Kalemie in the eastern part of the Democratic Republic of Congo (DRC). This species is endemic to the region and differs from any of the other species by its fernlike lithophytic habit and lack of latex. A description and illustration of this species is presented here. *Dorstenia luamensis* M.E.Leal inhabits moist and shady vertical rock faces close to small waterfalls in the forest; the species is distributed in small populations within the type locality, and merits the conservation status of endangered (EN).

Keywords

Dorstenia, Albertine Rift, endemic, lithophytic

Introduction

In 2012, a specimen of *Dorstenia* L. was collected from the Luama Wildlife Reserve in eastern DRC (M.E. Leal 2551) hanging from vertical cliffs and rock faces close to a waterfall on the shear zone of two plateaus. These plants have a typical *Dorstenia* L. inflorescence but their hanging habit and lack of latex is unusual. The only other hanging *Dorstenia* species (hemi-epiphyte) is *D. astyanactis* Aké Assi first described from Ivory Coast (Ake Assi 1967) and later also collected in Cameroon (Pollard et al. 2003). Its inflorescence only has one appendix whereas the specimens from Luama have between 8 to12 appendices. The only other species in Africa mentioned in the revision of Berg and Hijmans (1999) growing on rocks is *D. zanzibarica* Oliver, but this species has dentate leaves and its receptacle is triangular to subquadrangular.

The specimens collected in the Luama Wildlife Reserve keyed out to the section of *Kosaria* using Berg and Hijman (1999) key to the sections of *Dorstenia* based on the two rows of appendages, short ones in the inner and longer ones in the outer row. Ignoring its hanging herbaceous habit, the specimens keyed out closest to *D. benguellensis* Welw. in the key to "Succulent and semi-succulent species of the Old World" (Bergman and Hijman 1999). They also mention in the species description that *D. benguellensis* Welw. grows "often among rocks" close to water courses and that its morphology is highly variable.

Therefore in this study, I compared the specimens collected from the Luama Wildlife Reserve with *D. benguellensis* Welw. to determine: 1) whether differences are insignificant and the existing description of *D. benguellensis* Welw. should be broadened to incorporate these specimens, or 2) whether differences are significant and these specimens should be described as a separate species. I argue that differences beyond habit are significant and that they merit their own status as a new species from the Luama Wildlife Reserve, *D. luamensis* M.E.Leal.

Methods

The collected specimens from the Luama Wildlife Reserve were compared to *D. benguellensis* Welw. following terminology and description format of Berg and Hijman (1999). Similarly, characteristics used in the Berg and Hijman (1999) key were applied to validate whether these specimens from the Luama Wildlife Reserve were significantly different from similar species within section *Kosaria*. The website Global Plants (www.plants.jstor. org) was also consulted to identify and measure specimens of *Dorstenia* collected and entered into the database after the publication of Berg and Hijman (1999).

Results

Table 1 shows the description of *D. benguellensis* Welw. and the specimens collected in the Luama Wildlife Reserve. Besides the hanging habit and lack of latex, the specimens collected differ most distinctively from *D. benguellensis* Welw. on leaf arrangement, spiral versus horizontal; leaf shape subfalcate with an asymmetric base versus oblong, sub(ob)ovate, linear, elliptic, ovate and a symmetrical base; and peduncle length 0.1 cm versus (0.3)0.5–2.5(7) cm. The only specimen of *D. benguellensis* Welw. entered in the Global Plants database website collected close to a waterfall was M.G. Bingham 13204, but it did not resemble the specimens collected at the waterfall in the Luama Wildlife Reserve as its habit was erect and its leaves ovate.

	D. benguellensis	D. luamensis	
Plant	Succulent herb	Herbaceous Herb	
length	Up to 50(-60) cm	10–17 cm	
Root system	Tuber	Tuber	
posture	Erect	Hanging	
Leaves arrangement	Spiral	horizontal	
lamina	Oblong, sub(ob)ovate, linear, elliptic, ovate	Subfalcate	
dimensions	1–15×0.2–4.5 cm	5–7×1.1.4 cm	
apex	acute to subacuminate or obtuse	Acute and micrunate	
base	cuneate, sometimes obtuse to rounded	asymetrical cunate and rounded	
margin	finely to rather coarsely dendate (to subcrenate) or sometimes serrulate	Entire to coarsely dendate	
surfaces	puberulous to hirstellous or to hispidulous	Glabrous, subspiculate, bicolorous	
lateral veins	4–12, up to 25 pairs, often (fainly) loop connected, reticulum rather narrow	5–7	
petiole	(0-)0.1–0.2(-0.5) cm long	1–2 mm long	
stipules	persistent, triangular to oblong, up to 5mm long, sometimes foliaceous, puberulous	Not observed	
Inflorescences	solitary or sometimes in pairs	solitary	
Deducede	(0.3-)0.5–2.5(-7) cm long, ca. 1–1.5 mm thick	0.1cm long	
reduncie	minutely puberulous to hirstellous or to hispulous	glabrous	
rocontado	discoid to broadly turbinate, sometimes, shallowly cup- shaped, suborbicular 0.5–2(2.5) cm in diameter	elliptic to round, 3–4 mm in diameter, patelliform	
receptacie	outside sparsely, to densely minutely puberulous to hirtellous to hispidulous	glabrous	
flowering face (sub)orbicular, sometimes to subangular or almost fringe up to 1 mm broad or absent		elliptic to round	
	inner (=marginal) row numerous, triangular to subulate or filiform, up to 1–5(-7) mm long, forming a (sub)crenate rim, or indistinct and the rim entire to faintly repand,	triangular lobes, 1 mm	
appendages	outer (=submarginal) row, usually ca. 5–12 mm, less commonly more than 12, up to 23, or less than 5, down to 2, or even 0, (broadly) ligulate to filiform or sometimes subspatulate or oblong, (0.1)0.2–3.5(-8) cm long, up to 2.5 mm broad	subspathulate, 2–3 mm long, 0.5 mm broad	
staminate flowers ±crowed, tepals 2, puberulous with white, red-brown or almost black hairs, stamen 2, filaments ca. 0.3–0.5 mm long, slender		few, glabrous, stamen 2, filaments ca.0.1 mm	
pistillate flowers	several to many, free part of the perianth shortly tubular, puberulous with white, red-brown or almost black hairs, stigmas 2, filiform, ca. 0.2–0.3 mm long, equal or unequal in length, sometimes one of the stigmas strongly reduced or a single stigma	few, glabrous, stigmas 2, filiform, ca. 0.1 mm long,	
Endocarp body tetrahedral to subglobose, ca. 2 mm long, tuberculate, pale brown		Not observed	

Table 1. Comparison D. benguellensis and D. luamensis.

Discussion

D. benguellensis Welw. and the specimens collected from the Luama Wildlife Reserve are most conspicuously different in vegetative morphology, both in size and shapes. Key differences mentioned in the key to "succulent and semi-succulent species of the Old world" (Berg and Hijman 1999) distinguishes sister species mainly based on vegetative morphology, e.g. absent, short or long internodes; habit hanging, erect or ascending; root tuberous or rhizome at the base and or at internods; petiole short or long; number of lateral veins; length of the plant; and some ambiguous characteristics for some species such as absence or presence of stipules.

D. benguellensis has been characterized as highly variable, which might raise the question whether the specimens from the Luama Wildlife Reserve are an adaptation to growing on vertical rock faces. Are there two types of *D. benguellensis* Welw.? The most common one is erect and grows in between rocks and the hanging one is rare and only grows on vertical rock faces. If this were the case, than I would have expected to find the erect type at the same location of the hanging type. This was however, not the case.

Conclusion

Based on the differences in vegetative morphology, the specimens from the Luama Wildlife Reserve can easily be keyed out from the sister species in the same section of *Kosaria* (see the key provided under "distinct from other species". These plants from the Luama Wildlife Reserve resemble ferns hanging from rocks. This has not been observed elsewhere for the genus. Therefore, I conclude that the specimens from the Luama Wildlife Reserve merit their own separate status as new species, *Dorstenia luamensis* M.E.Leal, sp. nov.

Taxonomic treatment

Dorstenia luamensis M. E. Leal, sp. nov.

urn:lsid:ipni.org:names:77142870-1 Figs 1A, B, 2

Diagnosis. Haec species notabilis ab omnibus *Dorstenia* speciebus differt ob filicinu lithophitu habitu novu familae

Type. THE DEMOCRATIC REPUBLIC OF CONGO, Katanga Province, Tumbwe Sector, Luama Wildlife Reserve, M.E. Leal 2551 (holo LWI, iso BR), S5°14,526', E 28°52,215', 1176m, 31 October 2012.

Description. Lithophytes 10–17 cm long with a tuber 0.5 cm; stems aerial, hanging, glabrous; internodes 2.5–3 cm long; no white latex or translucent exu-



Figure I. Dorstenia luamensis M.E. Leal A habit B receptacle.



Figure 2. A population of *Dorstenia luamensis* M.E.Leal on a vertical rock face (photo: M.E. Leal 2012).

date. Stipules absent or deciduous without scars. Leaves distichous; blade narrowly subfalcate $5-7 \times 1-1.4$ cm, membranaceous, apex micrunate, base cunate, adaxial side glabrous and subspiculate, abaxial side white and glabrous; margins entire;

petiole 1–2 mm long; venation brochidodromous; 5–7 pairs of secondary veins; tertiary veins scalariform. Receptacle elliptic to round, 3–4 mm in diameter, patelliform; margin greenish with triangular lobes (1 mm) and subspathulate appendages, 2–3 mm long; peduncle 1 mm long, glabrous. Staminate and pistilate flowers (7 to 8) tightly packed in receptacle: perianth short lobed, whit apex minutely 2–3 lobed, glabrous; stigma 0.1 mm long. Drupes and seeds are unknown.

Distinction from other species. This new species can be distinguished from any other *Dorstenia* species by its fernlike habit, hanging from vertical rock faces and the absence of latex.

The new species is added to the existing key of Berg and Hijman (1999) the "key to succulent and semi-succulent species of the Old World"

1	Stems succulent and thick, internodes short; leaves subrosulate		
	section Acauloma		
1'	Stems (semi-)succulent, or herbaceous, internodes long; leaves spaced, some-		
	times crowded at stem apicessection Kosaria, 2		
2	Plants stem hanging		
3	Plant lithophyte, multiple appendagesD. luamensis		
3'	Plant epiphyte, one appendage <i>D. astyanactis</i>		
2'	Plants stem erect to ascending		
4	Plants annual, without a rhizome or a tuber		
4'	Plants perennial, with rhizome or a tuber		
5	Petiole relatively short, (0-)0.1-0.2(-0.5) cm longD. benguellensis		
5'	Petiole relatively long (0.2-)0.5–2.5(-3) cm long		
	other species of section Kosaria		

Phenology. The specimens were collected in late October.

Ecology. *D. luamensis* M.E.Leal inhabits moist and shady vertical rock faces close to small waterfalls in forest within a riverine forest-open woodland-savanna mosaic.

Distribution and conservation status. The species is distributed in small populations within the type locality, and according to these demographic characteristics it merits the conservation status of endangered (EN).

Etymology. The epithet *luamensis* refers the Luama Wildlife Reserve which is drained by the Luama River.

Acknowledgements

This study was financially supported by the Mac Arthur Foundation. The author is grateful to the Centre de Recherche en Sciences Naturelles (CRSN/Lwiro) for administrative support and to Phytokeys secretary for providing the essential references and the reviewers for their valuable comments.

References

Ake Assi L (1967) Un nouveau *Dorstenia* (Moracees) de Cote D'Ivoire. Adansonia 7(3): 387–390. Berg CC, Hijman MEE (1999) The genus *Dorstenia* (Moraceae) *Ilicifolia* 2: 1–211.

IUCN Standards and Petitions Subcommittee (2011) Guidelines for using the IUCN Red List Categories and Criteria. Version 9.0. Prepared by the Standards and Petitions Subcommittee. Linnaeus C (1753) Species plantarum. Impensis Laurentii Salvii, Holmiae.

Pollard BJ, Cheek M, Bygrave P (2003) New *Dorstenia* (Moraceae) Discoveries in Western Cameroon. Kew Bulletin 58(1): 185–193.

RESEARCH ARTICLE



Four new species of Andean *Pilea* (Urticaceae), with additional notes on the genus in Venezuela

Laurence J. Dorr¹, Basil Stergios²

l Department of Botany, MRC-166, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012, USA **2** Universidad Nacional Experimental de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ), Mesa de Cavacas, Guanare, Estado Portuguesa 3323, Venezuela

Corresponding author: Laurence J. Dorr (dorrl@si.edu)

Academic editor: Cl. Morden | Received 20 August 2014 | Accepted 16 October 2014 | Published 24 October 2014

Citation: Dorr LJ, Stergios B (2014) Four new species of Andean *Pilea* (Urticaceae), with additional notes on the genus in Venezuela. PhytoKeys 42: 57–76. doi: 10.3897/phytokeys.42.8455

Abstract

Four new species of *Pilea* (Urticaceae) from the Andes of Venezuela are described and illustrated: *Pilea matthewii* **sp. nov.**, *P. miguelii* **sp. nov.**, *P. nicholasii* **sp. nov.**, and *P. nidiae* **sp. nov.** The affinities of these species and their positions within the informal classifications of *Pilea* proposed by Weddell and Killip are discussed. Notes on other species of *Pilea* found in Venezuela also are presented.

Keywords

Urticaceae, Pilea, Venezuela, Andes

Introduction

Pilea Lindl. (Urticaceae), a large genus of 700 or more species, is found worldwide in tropical, subtropical, and temperate areas although it is absent from Australia, New Zealand, and Europe (Monro et al. 2012). Southeast Asia is believed to be the center of morphological and phylogenetic diversity for the genus, while the center of species diversity is in the Caribbean and Andes (Monro 2006). Field and herbarium work focused on producing a flora of Guaramacal National Park (Portuguesa and Trujillo states), which protects part of the Venezuelan Andes, convinced us that the following four species of *Pilea* from the Andes of Venezuela should be described as new.

Copyright Laurence J. Dorr, Basil Stergios. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

There has been no critical examination of the genus *Pilea* in the northern Andes (including the Coastal Cordillera of Venezuela) since Killip (1936, 1939) published his regional revision and it is not surprising that undescribed species are found. The most recent enumeration of the genus for Venezuela (Romaniuc Neto 2008) recognized 28 species of which 12 are reported from Andean states. In addition to the four species described here, we believe Romaniuc Neto (2008) overlooked two species reported from Venezuela, recognized another two species that do not occur in the country, and listed two species that might not occur in Venezuela. Thus, by our count there are at least 32 species of *Pilea* in Venezuela, the majority occurring in the Andes and the Coastal Cordillera. Our modifications to the enumeration of the species of *Pilea* known from Venezuela (Romaniuc Neto 2008) are summarized in the final section of this paper.

We are aware that the classification of *Pilea* proposed by Weddell (1869) and modified by Killip (1936, 1939) is artificial, but Killip's informal classification especially is the only current practical way to group Andean species. A world-wide monograph of the genus is unlikely to be prepared anytime soon although Monro (2006) has proposed a phylogenetic framework for revising the genus based on *cp*DNA, *nr*DNA, and morphology. He did not find support for Weddell's (1869) classification but did find a strong geographical signal in his molecular phylogeny. This led Monro (2006) to conclude that a combination of morphologically and geographically circumscribed groups may provide a pragmatic way to identify monophyletic units for an eventual global revision of *Pilea*.

Methods

The new species are based principally on our collections and those of our collaborators, which were made as part of the Flora of Guaramacal project (PORT-US). We also examined collections from throughout Venezuela and adjacent Colombia that are deposited in MO, NY, PORT, US, and VEN (herbarium abbreviations follow Index Herbariorum, http://sweetgum.nybg.org/ih). The US collections were particularly useful because Killip was based at the U.S. National Herbarium (US) when he published his revisions of the Andean species of the genus (Killip 1936, 1939).

Sheet numbers are cited for the holotypes deposited in PORT. Barcodes are cited for isotypes deposited in US. Identification numbers (sheet numbers and/or barcodes) are not available for the remaining type material collected by us and our collaborators, which will only be distributed upon publication of this paper.

A morphological species concept was adopted and descriptions were modeled on those of Monro (2001, 2006) and Monro et al. (2012) in order to facilitate comparisons. Material was examined and measured using an Olympus SZH binocular microscope.

Conservation assessments were undertaken using IUCN (2001) criteria. However, the only available data for our new species concern the geographic range of these species: IUCN criteria B1 (extent of occurrence) or B2 (area of occupancy). We have no data with respect to population size or dynamics (viz., whether or not populations are declining or expanding).

Taxonomic treatment

Pilea matthewii Dorr & Stergios, sp. nov.

urn:lsid:ipni.org:names:77142871-1 Figure 1

Pilea sp. A; Dorr et al., Contr. U.S. Natl. Herb. 40: 146. 2000 [2001].

Diagnosis. *Pilea matthewii* resembles *P. crugeriana* Wedd. from which it differs by having simple (versus 3-rayed) foliar cystoliths and shortly pedicellate (versus sessile) staminate flowers.

Type. VENEZUELA. Trujillo: Mpio. Boconó: Páramo de Guaramacal, SE of television towers, ca 09°14'N, 070°11'W, 2000 m, 28 Apr 1988, *L.J. Dorr et al.* 4994 (holotype (\mathcal{Q}): PORT [39536]; isotypes (\mathcal{Q}): NY, US (excluding \mathcal{J} branchlet) [00534984], VEN).

Description. Herb, 30-80 cm tall; terrestrial; dioecious. Stems erect, succulent, branched, drying dark grayish-brown or almost black, glabrous, cystoliths fusiform to elliptic or absent, internodes $7-50 \times 1-3$ mm (shorter and narrower distally), terete, somewhat angular in cross-section when dry. Stipules ca 0.5-1 mm long, broadly deltate, drying dark brown with lighter brown margins, persistent. Leaves petiolate, distichous; petioles at each node unequal by a ratio of 1:3-24; major petioles 3-15 (-20) mm long, canaliculate above, glabrous; minor petioles 0.5-1 mm long or subsessile, canaliculate above, glabrous; laminae at each node unequal by a ratio of 1:3.1–11.1; major laminae in a pair $2.2-11.5 \times (0.8-)$ 1.2-2.7 cm, lanceolate or elliptic, slightly falcate, sub-chartaceous to chartaceous, 3-nerved from the base, midrib and lateral nerves prominent below, lateral nerves visible almost the entire lamina length but disappearing just below the apex, secondary nerves 8-16 pair, borne 70-80 (-90)° to the midrib and then strongly curved distally, upper surface drying dark grayish-brown or almost black, glabrous except for scattered, minute, orange-brown peltate scales, cystoliths fusiform or absent, lower surface drying dark greenish- or reddish-brown, glabrous, base slightly asymmetrical, cuneate, margin regularly toothed, apex acuminate; minor laminae in a pair $0.7-2 \times 0.4-1.5$ mm, ovate to broadly-ovate, base slightly asymmetrical, auriculate, apex abruptly acuminate, otherwise as major laminae. Inflorescences 8-10 per stem, unisexual; bracts ca 0.75-1 mm long; bracteoles ca 0.75 mm long. Staminate inflorescences (1) 2 per axil, 6-12 mm long, bearing 12-25 flowers in a lax cyme; peduncles 1.5–7 mm long, usually shorter than major petioles, occasionally with cystoliths and/or minute, peltate scales present, otherwise glabrous; pedicels ca 0.5 mm long, glabrous. Staminate flowers ca 1.5 × 1 mm immediately prior to anthesis, whitish-green; tepals 4, ca 1.5 mm long, occasionally cystoliths present and often minute, peltate scales present at base, otherwise glabrous, the subapical appendages unequal, ca 0.25 mm long, corniculate, glabrous; stamens 4. Pistillate inflorescences (1) 2 per axil, ca 3 mm long, bearing 10–26 flowers in a congested cyme; peduncles ca 1–15 mm long, glabrous; pedicels 0.25-1 mm long, glabrous. Pistillate flowers ca 1-1.25 mm long; cucullate



Figure I. *Pilea matthewii.* **A** Habit of pistillate plant; note the sessile unequal leaf laminae at each node **B** Branchlet of staminate plant; note the unequal leaf laminae at each node **C** Leaf detail (upper surface of minor lamina) showing cystoliths **D** Staminate inflorescence **E** Staminate flower **F** Staminate flower showing anthers **G** Pistillate inflorescence **H** Pistillate flower. (**A–C, G, H** from *L.J. Dorr et al. 4994* (US); **D–F** from *B. Stergios et al. 20080* (US)).

tepal ca 1–1.25 mm long, ± lanceolate, appendage ca 0.25 mm long; lateral tepals ca 1–1.25 mm long, narrowly ovate. Infructescences 8–17 (–29) mm long; peduncles 5–13 (–23) mm long; achenes ca 1–1.5 × 0.5–1 mm, compressed, asymmetrically ellipsoid or lachrymiform, vertucose, margin narrowly thickened.

Distribution and ecology. Known only from the Andes of Venezuela (Portuguesa and Trujillo states) where it is found in the understory of cloud forest; 1000–2600 m.

Etymology. The epithet recognizes Matthew Dorr who participated in a number of expeditions to Guaramacal in search of specimens for the Flora of Guaramacal project (PORT-US).

Specimens examined. VENEZUELA. Portuguesa: Mpio. Sucre: Parque Nacional Guaramacal, Sector El Paramito, Camino Real Paramito – Batatal, 09°19,03'N, 070°04,25'W to 09°20,35'N, 070°04,08'W, 1550-1950 m, 17 Mar 1999, N. Cuello et al. 1470 (PORT, US); Los Paramitos, a 20 km por aire al SO de Biscucuy, a orillas de la quebrada El Alto tambien conocida como La Lora, 09°20'N, 069°05'W, 1000-1500 m, 17 Sep 1983, B. Stergios et al. 6340 (PORT); La Divisoria de la Concepción, 09°18'N, 070°06'W, 1700 m, 23 Oct 1985, H. van der Werff et al. 7560 (PORT). Trujillo: Mpio. Boconó: linderos del Parque Nacional Guaramacal, Laguna de Agua Negra, 09°18'N, 070°10'W, 1840 m, 27 Oct 2001, J. Angulo & J. Infante 17 (PORT); 2 km al N-O del Caserío Cerros de Guaramacal, 42 km al S-E de Boconó, ca 09°11'N, 070°10'W, 1500 m, 25 Jul 1984, G. Aymard & F. Ortega 2903 (PORT); Limites del Páramo de Guaramacal y el bosque nublado, 25 km al S-E de Boconó, ca 09°13'N, 070°10'W, 2200-2600 m, 26 Jul 1984, G. Aymard et al. 2954 (NY, PORT); Parque Nacional Guaramacal, Sector Las Cruces, Camino Real La Aguadita - Batatal, 09°20,11'N, 070°05,57'W, 1900–1950 m, 17 Mar 1999, N. Cuello et al. 1486 (PORT, US), Ibid., N. Cuello et al. 1498 (NY, PORT, US); P.N. Guaramacal, "El Campamento" below Cerro El Diablo, ca 10 km S of Boconó on road from Fundación La Salle to El Santuario, 09°09'N, 070°17'W, 1910 m, 21 Jul 1995, L.J. Dorr et al. 8192 (G, K, NY, PORT, US, VEN); Parque Nacional Guaramacal, trail from la Laguna de las Aguas Negras to la Qda. Salvaje, N slope of mountain, 09°19'N, 070°11'W, 27 Oct 1998, L.J. Dorr et al. 8292 (K, PORT, US); Parque Nacional Guaramacal, road from Boconó to Guaramacal, SE of Boconó, ca 15 km from the post of the park guards, 09°13'N, 070°12'W, 2 Nov 1998, L.J. Dorr et al. 8404 (PORT-unicate), Ibid., L.J. Dorr et al. 8407 (K, MO, PORT, US); Parque Nacional Guaramacal, trail from El Cafenol (E of Mosquey) to Fila Los Recostaderos, 1790-2200 m, 12 Jun 2001, L.J. Dorr et al. 8924 (K, PORT, US); 12 km ESE of Boconó, 1 km N to 4 km NE of Guaramacal, 09°12' to 09°13'N, 070°09'W, 1600-1900 m, 15 Mar 1982, R. Liesner et al. 12947 (PORT, VEN), Ibid., R. Liesner et al. 12998 (PORT, VEN), Ibid., R. Liesner et al. 13019 (PORT, VEN); Parque Nacional Guaramacal, sector El Santuario, "La Punta," 1860 m, 9–16 Jul 1998, B. Stergios 17348 (PORT, US), Ibid., B. Stergios 17401 (K, NY, PORT, US); Parque Nacional Guaramacal, sector El Santuario, vertiente y cresta-divisoria entre qbda. Honda y qbda. Kubiscú, 2000–2300 m, Jan 2001, B. Stergios & R. Caracas 19064 (K, PORT, US); Parque Nacional Guaramacal, sector vertiente sur, Aug 2001, B. Stergios & R. Caracas 19301 (PORT, US); Cerro Guaramacal, Boconó, bajando hacia el caserío

Characters	Pilea matthewii	Pilea crugeriana
Foliar cystoliths	simple	3-rayed, rarely simple
Leaf margins	teeth sharp, apices often hyaline	teeth blunt, rarely sharp, apices never hyaline
Stipules	persistent	caducous
Staminate flower pedicels	ca 0.5 mm	sessile
Staminate tepals	appendages ca 0.25 mm	unappendaged

Table 1. Diagnostic characters that distinguish *Pilea matthewii* and *P. crugeriana*.

de Guaramacal, 25–26 Nov 1982, *B. Stergios et al. 4700* (PORT, US); Parque Nacional Guaramacal, trail from Casa Vicuyal toward Páramo de Vicuyal, 2200–2600 m, 10 Apr 2003, *B. Stergios et al. 20080* (K, MO, NY, PORT, US); Parque Nacional Guaramacal, Casa Vicuyal, 2100 m, 12 Apr 2003, *B. Stergios et al. 20182* (K, MO, NY, PORT, US); Parque Nacional Guaramacal, SE slopes of Cerro Guaramacal on road from Boconó to Guaramacal, Qda. Pollo, 09°13'N, 070°10'W, 2200 m, 22 Sep 2003, *B. Stergios et al. 20668* (K, MO, NY, PORT, US). Parque Nacional Guaramacal, "El Campamento," below Cerro El Diablo and vicinity, 1800–2000 m, 16–18 Aug 2005, *B. Stergios et al. 20859* (K, PORT, US).

Discussion. *Pilea matthewii* belongs in the Heterophyllae species group of Weddell (1869) and the Centradenioideae species group of Killip (1936). The new species most closely resembles *P. crugeriana* of the Coastal Cordillera of Venezuela, but it is readily distinguished by its simple (versus 3-rayed) cystoliths and shortly pedicellate (versus sessile) staminate flowers. Other characters that separate these two species are given in Table 1.

Conservation status. Using IUCN criteria (IUCN 2001) we could not identify a threat to *Pilea matthewii*. We are aware of 15–20 distinct populations in Guaramacal National Park, which protects an area of 225 km². Although this area is relatively small, the species is frequently encountered and the number of known populations exceeds the number of locations deemed critical under IUCN criterion B2(a) for either Endangered (E) or Vulnerable (VU). In addition, the east-facing slopes of the Sierra Nevada de Mérida, which have similar habitat, are very poorly collected (Dorr et al. 2005) and might harbor additional populations of this species.

Pilea miguelii Dorr & Stergios, sp. nov.

urn:lsid:ipni.org:names:77142872-1 Figure 2

Pilea sp. B, Dorr et al., Contr. U.S. Natl. Herb. 40: 146. 2000 [2001]. *Pilea* sp. B, vel aff., Dorr et al., Contr. U.S. Natl. Herb. 40: 146. 2000 [2001].

Diagnosis. Similar to *Pilea haenkei* Killip in the extreme difference in size of leaf laminae at each node, but differing in lamina shape (narrowly ovate to ovate or obovate versus ovate-lanceolate) and base (asymmetrically cuneate versus cordate).

Type. VENEZUELA. Trujillo: Mpio. Boconó: "Laguna Negra," carretera entre Batatal y Mosquey, 1700 m, 3 Apr 1994, *B. Stergios & M. Niño 16028* (holotype: PORT [58122]; isotypes: NY, US [00727846]).

Description. Herb or shrublet, to 1.5 m tall; terrestrial; monoecious. Stems erect, branched, ± suffruticose, drying dull green or dark blackish-brown, glabrous, cystoliths fusiform, sometimes very dense, internodes $2.3-11 \text{ cm} \times 2-3 \text{ mm}$ (shorter distally), terete and becoming ± angulate in cross-section when dry. Stipules ca 2 mm long, deltoid, drying light-brown, caducous. Leaves petiolate, distichous; petioles at the same node unequal by a ratio of 1:(5-) 10-20, major petioles 0.5-4 cm long, minor petioles ca 1 mm long or subsessile, glabrous; laminae of leaves at each node unequal by a ratio of 1:5–11.5; major laminae in a pair 5–11.5 \times 2–5.5 (–7) cm, narrowly ovate to ovate or obovate, slightly asymmetric, membranous, 3-nerved from the base or lateral nerves diverging from the midrib 1–2 mm above the base, secondary nerves 12–14 pair, borne 80-90° to the midrib; upper surface dull or dark green, glabrous, cystoliths fusiform, unequal in size, often dense, lower surface pale or dull green, glabrous, midrib and secondary nerves prominently raised, base asymmetrically cuneate, margin coarsely crenate to serrate its entire length, apex long acuminate; minor laminae in a pair $0.9-2 \times$ 0.5–1 cm, otherwise as major laminae. Inflorescences > 20 per stem, unisexual, white, whitish-green or green; bracts broadly deltate, ca 1 mm long; bracteoles broadly deltate, ca 1 mm long. Staminate inflorescences 4 per axil, 10–15 × 17–20 mm, bearing > 50 flowers in a loose, spreading cyme; peduncles 2-5 mm long, glabrous; pedicels ca 0.5-1 mm long, glabrous. Staminate flowers ca 1 mm long, greenish-white; tepals 4, ca 0.75 mm long, ± verrucose; stamens 4. Pistillate inflorescences 4 per axil, ca 10 × 18 mm, bearing > 50 flowers in a loose, spreading cyme; peduncles 2-5 mm long, glabrous; pedicels 0.5-0.75 mm long, glabrous. Pistillate flowers ca 0. 5 mm long. Infructescences not seen.

Distribution and ecology. Known only from the Andes of Venezuela (Lara, Mérida, and Trujillo states) where it forms colonies in the understory of cloud forest; 1490–2600 (-3210) m.

Etymology. This species is named for S. Miguel Niño, professor at UNELLEZ, Guanare, and valued collaborator in our investigations of the Andean flora.

Specimens examined. VENEZUELA. Lara: Mpio. Morán: Quebrada Los Cedros (09°31'N, 070°01'W), 15 km al S de Humocaro Alto, hacia Guaitó, 1500 m, 8 Jul 1974, *J.A. Steyermark & V. Carreño Espinoza 110270* (VEN). **Mérida:** Mpio. Arzobispo Chacón: NW- and W-facing slopes of Quebrada de Montaña, in La Montaña de Los Torritos, tributary to Río Canaguá, above Finca La Montaña, 8 km SW of Canaguá, 1925–2075 m, 8 May 1944, *J.A. Steyermark 56365* (US). Mpio. Rangel: Quebrada entre Aracay y La Cuchilla, 08°56'N, 070°36'W, 2250 m, 28 Dec 1985, *A. Fernandez 1582* (PORT). Mpio. Libertador: between Los Corales and Las Cuadras, 1490–3210 m, 25 Mar 1944, *J.A. Steyermark 55767* (US). **Trujillo:** Mpio. Boconó: Límites del Páramo de Guaramacal y el bosque nublado, 25 km SE de Boconó, ca 09°13'N, 070°10'W, 2200–2600 m, 23 Jan 1986, *G. Aymard et al. 5000* (PORT); Parque Nacional Guaramacal, en los alrededores del acueducto de Boconó, detras de la



Figure 2. *Pilea miguelii*. A Habit; note the unequal leaf laminae at each node B Leaf detail (major lamina upper surface) showing cystoliths C Staminate inflorescence D Detail of staminate inflorescence.
E Staminate flower showing tepals covering anthers F Pistillate inflorescence G Pistillate flower H Pistillate flower with tepals teased apart to show mature ovary. (A from *B. Stergios & M. Niño 16028* (PORT);
B–E from *B. Stergios & M. Niño 16028* (US); F–H from *J.A. Steyermark 55767* (US)).

Laguna de Los Cedros, 09°14'38"N, 070°13'12"W, 1850 m, 12 Mar 1998, *N. Cuello et al. 1399* (PORT, US); Parque Nacional Guaramacal, vertiente occidental, Sector El Santuario, alrededores de La Cueva, ca 09°10'N, 070°18'W, 1800 m, 1 May 1998, *N. Cuello et al. 1432* (NY, PORT, US); 13 km ESE of Boconó, 1 km W of Guaramacal, 09°11'N, 070°09'W, 1600 m, 16 Mar 1982, *R. Liesner et al. 12896* (MO, PORT, VEN). Entre Boconó y El Batatal, 1800 m, 5 Sep 1966, *J.A. Steyermark & M. Rabe 97410* (NY, US, VEN).

Discussion. *Pilea miguelii* belongs in the Heterophyllae species group of Weddell (1869) and the Centradenioideae species group of Killip (1936). The new species is easily recognized by the combination of the extreme difference in leaf laminae size at each node and the branching inflorescences.

One of the specimens (*Steyermark* 56365, US) that fits our concept of *Pilea miguelii* was identified by Killip (in sched.) as *P. losensis* Killip, but the similarity is superficial. Killip (1936) included *P. losensis* in his Multiflorae species group and unlike our new species the leaf laminae at each node are \pm equal in size (versus distinctly unequal), the laminae are narrowly elliptic to oblong-elliptic (versus narrowly ovate to ovate or obovate), and the apices are acuminate (versus long acuminate). In addition, the type of *P. losensis*, at least, is sparingly branched while most collections of *P. miguelii* are profusely branched.

Another specimen (*Steyermark 55767*, US) that fits our concept of *Pilea miguelii* was identified by Killip (in sched.) as *P. carnosula* Wedd., also in his Multiflorae species group (Killip 1936). This "new record" for Venezuela was reported by Steyermark (1957 as "*carnulosa*") and subsequently repeated by Romaniuc Neto (2008 as "*carnulosa*"). The two species are only superficially similar. The leaf laminae at each node are ± similar in size in *P. carnosula* and the major laminae of *P. carnosula* are smaller than those of *P. miguelii* (0.8–4 versus 5–11.5 cm long).

The very dense, whitish covering of cystoliths on the leaves and stems of one collection (*Steyermark & Rabe 97410*) from Trujillo makes the material look different than the type of *Pilea miguelii*, but a careful examination of other morphological characters (leaf size, shape, venation, etc.) convinces us that this sterile collection belongs with *P. miguelii* as does another sterile collection (*A. Fernandez 1582*) from Mérida that also has a dense covering of cystoliths.

Table 2 summarizes the differences between *Pilea miguelii* and other species to which it is compared (see diagnosis) or with which it has been confused.

Characters	Pilea miguelii	Pilea carnosula	Pilea haenkei	Pilea losensis
Leaf laminae at a node	unequal	± equal	unequal	± equal
Leaf shape	narrowly ovate to ovate or obovate	narrowly lanceolate	ovate-lanceolate	narrowly elliptic to oblong-elliptic
Major lamina size	5–11.5 × 2–5.5 (–7) cm	0.8–4 × 0.5–1.5 cm	9–13 × 3.5–4.5 cm	6–12 × 2–2.5 cm
Leaf base	asymmetrically cuneate	indistinctly cordate	indistinctly cordate	indistinctly cordate
Leaf apex	long acuminate	long acuminate	acuminate	acuminate

Table 2. Diagnostic characters that distinguish Pilea miguelii and several similar species.

Conservation status. We cannot discern a threat to *Pilea miguelii* using IUCN criteria (IUCN 2001). We are aware of 15–20 distinct populations, all but one of which is in either Guaramacal National Park or the Sierra Nevada National Park. The extent of occurrence (EOO) is less than 5000 km² and the area of occupancy (AOO) is less than 500 km², which might suggest that the species is Endangered (E) under criteria B1 or B2, but there are > 5 populations and no evidence of their decline.

Pilea nicholasii Dorr & Stergios, sp. nov.

urn:lsid:ipni.org:names:77142873-1 Figure 3

Pilea sp. C, Dorr et al., Contr. U.S. Natl. Herb. 40: 147. 2000 [2001].

Diagnosis. Most similar to *Pilea hydrocotyliflora* Killip from which it can be distinguished by the distinctly asymmetrical laminae that are pruinose (i.e., with a waxy, powdery, whitish bloom) below.

Type. VENEZUELA. Trujillo: Mpio. Boconó: Parque Nacional Guaramacal, Laguna de Agua Negra – parte alto [sic] de la Qda. Salvaje, 2000–2100 m, 14 Apr 2003, *B. Stergios & L.J. Dorr 20208* (holotype: PORT [86924]; isotypes: BM, G, K, MO, NY, P, US [00728426]).

Description. Herb, to 50 cm tall; terrestrial or hemiepiphytic; monoecious. Stems erect, ascending or spreading, rarely trailing, branched or not, succulent, drying brown or dark reddish-brown, glabrous, younger stems often with minute peltate glands, cystoliths fusiform or absent, internodes $6-50 \times ca \ 1-3 \text{ mm}$ (shorter distally), terete, ± flattened when dry, fragrant when crushed (fide Licata & Culleo 233). Stipules ca 1–1.25 mm long, broadly deltate, drying dark brown, persistent. Leaves petiolate, distichous; petioles at each node unequal by a ratio of 1:4.3-17 (-33); major petioles 12–33 mm long, canaliculate above, glabrous; minor petioles 1–4 mm long or subsessile, canaliculate above, glabrous; laminae of leaves at each node unequal by a ratio of 1:1.2-3.2; major laminae in a pair $3.7-9 \times 1.4-3.2$ cm (laminae usually larger distally), ovate or obovate, asymmetrical, subcoriaceous, 3-nerved from the base or lateral nerves diverging from midrib 1-2 mm above the base, sometimes forming flap-like domatia where the 3 nerves join, midrib and lateral nerves prominent or not, lateral nerves visible almost the entire length but disappearing just below the apex, secondary nerves 6-9 (-20) pair, often becoming obscure or fading distally, borne 60-80 (-90)° to the midrib, often strongly curved distally, upper surface dark green, drying dark brown or reddish-brown, glabrous or with minute, peltate scales, cystoliths fusiform, varying in length, lower surface pruinose, pale green, drying whitish with scattered dark spots and minute, peltate scales, cystoliths sometimes present, base cuneate or less commonly truncate, asymmetrical, margin regularly toothed, sometimes teeth overlapping the lamina, apex acute to shortly acuminate, sometimes asymmetrical; minor laminae in a pair $1.4-3.5 \times 0.8-1.6$ mm, otherwise as major laminae. Inflorescences 1–5 per stem,

unisexual; bracts ca 1 mm long; bracteoles ca 1 mm long. Staminate inflorescences 1 per axil, 33–50 mm long, bearing (18–) 40–60 flowers in a \pm compact to loose cyme; peduncles 25–45 mm long, equal to or exceeding major petioles in length, glabrous except for minute, peltate scales, occasionally cystoliths present; pedicels 0.5–1.25 mm long, glabrous. Staminate flowers ca 1 × 1.5 mm immediately prior to anthesis, white, creamy-white, greenish-white or greenish-red; tepals 4, ca 1 mm long, glabrous, occasionally cystoliths present and also often minute, peltate scales, apices ca 0.25 mm long, glabrous; stamens 4. Pistillate inflorescences 1 per axil, 1–12 mm long, bearing 15–30 flowers in a \pm compact head-like cyme; peduncles 0.5–8 mm long, glabrous; pedicels ca 0.25–1 mm long, glabrous. Pistillate flowers ca 1.25 mm long, cucullate tepal ca 1 mm long, elliptic or ovate, lateral tepals minute. Infructescences 23–28 mm long; peduncles 19–25 mm long; achenes 1–1.5 × ca 1 mm, slightly compressed, \pm ellipsoid, verrucose, margin narrowly thickened.

Distribution and ecology. Known only from the Andes of Venezuela (Lara, Portuguesa, and Trujillo states) where it is found in the understory of montane and cloud forest; 1900–2800 m.

Etymology. This species is named for Nicholas Dorr who assisted with field work in the Venezuelan Andes, but clearly prefers the rigors of Chichiriviche to those of the mountains.

Specimens examined. VENEZUELA. Lara: Mpio. Morán: SW-facing slopes at Los Aposentos, above Las Sabanetas, above Humocaro Bajo, 2500-2530 m, 3 Feb 1944, J.A. Steyermark 55213 (NY, US, VEN); Pica que va desde Buenos Aires a Páramo Las Rosas, 09°34'N, 070°06'W, 2300–2600 m, 15 Nov 1984, H. van der Werff & R. Rivero 7963 (PORT). Portuguesa: Mpio. Sucre: Fila del Helechal, en el límite con el Edo. Lara, 80 km al NO de Guanare, al N de Chabasquén, ca 2000 m, 09°32'N, 069°58'30"W, 9 Feb 1984, B. Stergios et al. 6722 (PORT, US). Trujillo: Mpio. Boconó: Guaramacal, 20 km al E de Boconó, ca 09°14'N, 070°11'W, 1900-2300 m, 7 Feb 1987, G. Aymard et al. 5226 (PORT); Parque Nacional Guaramacal, vertiente sur, ca 09°12'45'N, 070°09'51"W, 2350 m, 21 Apr 1998, N. Cuello et al. 1416 (NY, PORT, US); Parque Nacional Guaramacal, trail from la Laguna de las Aguas Negras to la Qda. Salvaje, N slope of mountain, 09°19'N, 070°11'W, 27 Oct 1998, L.J. Dorr et al. 8279 (PORT, US); Parque Nacional Guaramacal, road from Boconó to Guaramacal, SE of Boconó, ca 15 km from the post of the park guards, S slope of mountain, 09°13'N, 070°12'W, 3 Nov 1998, L.J. Dorr et al. 8455 (K, MO, PORT, US), Ibid., L.J. Dorr et al. 8471 (G, K, MO, P, PORT, US); Parque Nacional Guaramacal, trail from El Cafenol (E of Mosquey) to Fila Los Recostaderos, 1790-2200 m, 12 Jun 2001, L.J. Dorr et al. 8872 (G, K, MO, P, PORT, US); Parque Nacional Guaramacal, en la vertiente norte, 2300 m, 27 May 1995, A. Licata & N. Cuello 158 (PORT, US), Ibid., 09°14'59.78"N, 070°12'43.36"W, 2100 m, 19 Jun 1995, A. Licata & N. Cuello 233 (PORT, US); Camino al Cerro Guaramacal via la laguna de "Los Cedros," 21 Mar 1981, B. Stergios 2544 (PORT); P.N. Guaramacal, vertiente norte, 2100 m, Mar 2003, B. Stergios 19986 (PORT, US); Parque Nacional Guaramacal, sector trocha Laguna Negra – quebrada del Salvaje, 1850–2100 m, 15 Jun 2002, B. Stergios &



Figure 3. *Pilea nicholasii.* **A** Habit; note the unequal leaf laminae at each node **B** Leaf detail (major lamina upper surface) showing cystoliths **C** Stipules, stem, and petiole bases with cystoliths **D** Staminate inflorescence **E** Staminate flower ± in bud **F** Staminate flower showing stamens **G** Infructescence **H**, **I** Pistillate flowers with developing achenes. (**A**, **D**–**F** from *B. Stergios et al. 20074* (US); **B**, **C** from *B. Stergios & R. Caracas 19671* (US); **G–I** from *B. Stergios 19986* (US)).

R. Caracas 19671 (MO, PORT, US); Fila de Agua Fria, 09°16.70'N, 070°8.65'W, 2700–2800 m, Jan–Feb 1996, *B. Stergios & L. Zambrano 17701* (PORT, US); Cerro Guaramacal, Boconó, 09°15'N, 070°13'W, ca 2000 m, 29 Nov 1983, *B. Stergios et al. 6561* (NY, PORT); Parque Nacional Guaramacal, trail from Casa Vicuyal toward Páramo de Vicuyal, 2200–2600 m, 10 Apr 2003, *B. Stergios et al. 20074* (G, K, MO, NY, PORT, US); Parque Nacional Guaramacal, NE slopes of Cerro Guaramacal between Laguna de Los Cedros and the summit of the road to Guaramacal, 09°15'N, 070°125'W, 21 Sep 2003, *B. Stergios et al. 20639* (PORT, US). Mpio. Carache: Entre La Peña y Agua de Obispo, 22–28 km de Carache, 2400–2500 m, 1 Mar 1971, *J.A. Steyermark 104972* (US-2 sheets).

Discussion. The majority of collections of *Pilea nicholasii* have either staminate or pistillate inflorescences on a stem. Several collections, including the type (*Stergios & Dorr 20208*), however, have both staminate and pistillate inflorescences on the same stem, and at least one collection (*Cuello et al. 1416*) has both staminate and pistillate inflorescences arising from the same leaf axil. This suggests to us that the species is monoecious rather than dioecious.

Sometimes the pedicels on staminate inflorescences are sterile. The cause of this is not clear: it may be that some male flowers are caducous or, as suggested by one of the reviewers of this manuscript, the consequence of fungal infection. A number of the pistillate inflorescences, especially on specimens with conspicuous staminate inflorescences, are very cryptic with very short peduncles. Other pistillate inflorescences have pronounced peduncles. In any case, there appears to be a bias toward collecting specimens with either staminate inflorescences or infructescences probably because these plants are more visible and manifestly fertile.

Pilea nicholasii belongs in the Heterophyllae species group of Weddell (1869). Its placement in one of the species groups proposed by Killip (1936) is somewhat problematic as depending upon which pair of leaves at a single node are measured *P. nicholasii* falls into either Killip's Centradenioideae species group with major leaf laminae more than twice as long as minor leaf laminae or his Capitellatae species group with the major leaf laminae less than twice as long as the minor ones. Among species placed in the former group, *P. nicholasii* is similar to *P. hydrocotyliflora* Killip, which was described from Colombia (Norte de Santander). However, the undersurface of the laminae is pruinose in the former and glabrous in the latter species. This makes the leaves of *P. nicholasii* look lighter below than above while those of *P. hydrocotyliflora* are uniformly green. In addition, the major laminae of the former are markedly asymmetrical whereas in the latter they appear to be ± symmetrical.

Pilea nicholasii also bears a superficial resemblance to *Pilea pichisana* Killip, another species in the Centradenioideae group that is known only from Peru (Junín). The major leaf laminae of *P. pichisana*, however, are smaller than those of *P. nicholasii* $(2-2.8 \times 1-1.3 \text{ versus } 7-9 \times 1.4-3.2 \text{ cm})$ and the cystoliths are different (punctiform versus fusiform).

Pilea nicholasii does not appear to have any close allies in the Capitellatae species group of Killip (1936). It keys to a group of three species that are monoecious, but

Characters	Pilea nicholasii	Pilea hydrocotyliflora	Pilea pichisana
Leaf symmetry	asymmetrical	± symmetrical	symmetrical to asymmetrical
Major lamina size	7–9 × 1.4–3.2 cm	4–8 × 1.5–2.5 cm	2–2.8 × 1–1.3 cm
Leaf base	cuneate or less commonly truncate	subrounded	rounded or subacute
Leaf apex	acute to shortly acuminate	long acuminate	acute or acuminate
Foliar indument	pruinose	glabrous	glabrous
Foliar cystoliths	fusiform	fusiform	punctiform

Table 3. Diagnostic characters that distinguish Pilea nicholasii and two similar species.

none of these three species has the pruinose undersurface of the leaf laminae found in our new species.

Characters for distinguishing *Pilea nicholasii* from *P. hydrocotyliflora* and *P. pichisana* are given in Table 3.

Conservation status. Using IUCN criteria (IUCN 2001) we could not identify a threat to *Pilea nicholasii*. We are aware of 15–20 distinct populations, the majority of which are in Guaramacal National Park. The extent of occurrence (EOO) is less than 5000 km² and the area of occupancy (AOO) is less than 5000 km², which might suggest that the species is Endangered (E) under IUCN criteria B1 or B2, but there are > 5 populations and as with *P. matthewii* we would expect the species to be found in similar habitat along the east-facing slopes of the Sierra Nevada de Mérida.

Pilea nidiae Dorr & Stergios, sp. nov.

urn:lsid:ipni.org:names:77142874-1 Figure 4

Pilea sp. D, Dorr et al., Contr. U.S. Natl. Herb. 40: 147. 2000 [2001].

Diagnosis. Similar to *Pilea flexuosa* Wedd. from which it differs by its asymmetrically elliptic to narrowly-elliptic or obovate (versus broadly ovate) laminae that are asymmetrically cuneate (versus rounded or cordate) at the base.

Type. VENEZUELA. Trujillo: Mpio. Boconó: Parque Nacional Guaramacal, sector vertiente sur, 2800–2900 m, 25–30 Jul 2002, *B. Stergios & R. Caracas 19810* (holotype: PORT [85861]: isotypes: K, MO, US [00772535]).

Description. Herb, to 1.25 m tall; terrestrial; dioecious. Stems erect or prostrate (fide *Stergios & Caracas 19810*), succulent, branched, drying reddish-brown, dull purple (fide *Steyermark 55533*) or almost black, glabrous, cystoliths punctiform or short fusiform, often clustered at nodes, internodes $0.8-3.5 \times 1-4$ mm (shorter distally), terete in cross-section, angulate when dry, nodes constricted (at least when dry). Stipules 6–11 mm long, narrowly triangular, drying pale brown or tan, persistent. Leaves petiolate, distichous; petioles at the same node unequal by a ratio of 1:11.5–13.5 (–23), canaliculate above, glabrous; major petioles 2.3–2.7 cm long; minor petioles ca

1-2 mm long; laminae of leaves at each node unequal by a ratio of 1:1.7-2.2, major laminae in a pair $6.5-9.5 \times 1.5-3.2$ cm, asymmetrically elliptic to narrowly-elliptic or obovate, membranous, 3-nerved with lateral nerves diverging from midrib 1-6 mm above the base, forming pocket domatia where the 3 nerves join, midrib and lateral nerves prominent below, slightly impressed (or not) above, lateral nerves visible almost the entire lamina length but disappearing below the apex, secondary nerves 8–14 pair, borne 70–90° to the midrib and then curved distally, upper surface dark green, drying dark brown, glabrous except for scattered, minute peltate scales, cystoliths fusiform or absent, lower surface pale green drying dark brown, glabrous except for scattered, minute peltate scales, base cuneate, asymmetrical, margin coarsely toothed entire length, apex long acuminate; minor laminae in a pair $3-5 \times 0.8-1.5$ cm, otherwise as major laminae. Inflorescences 1-10 per stem, unisexual, green suffused with maroon; bracts ca 2 mm long; bracteoles ca 1 mm long. Staminate inflorescences 1 per axil, 2.8-3.5 cm long, bearing ca 50 flowers in a compact head-like cyme; peduncles 2-3 cm long, glabrous with minute, scattered peltate scales, occasionally cystoliths present; pedicels ca 0.25 mm long. Staminate flowers ca $1.5 \times 1-1.25$ mm (mature flowers not seen); tepals 4, ca 2 mm long, notched inside; stamens 4. Pistillate inflorescences 1 or 2 per axil, ca 5 mm long, bearing ca 50 flowers in a ± loose cyme; peduncles ca 2 mm long, glabrous; pedicels minute. Pistillate flowers ca 0.5-0.75 mm long, cucullate tepal ca 0.5 mm long, ± lanceolate; lateral tepals minute. Infructescences 1-2.5 cm long, frequently including receptive pistillate flowers; peduncles 0.7-1.8 cm long; achenes ca 1.25 × 1 mm, compressed, asymmetrically ellipsoid or lachrymiform, verrucose, margin narrowly thickened with a very narrow hyaline wing.

Distribution and ecology. Known only from the Andes of Venezuela (Lara and Trujillo states) where it is found in the moist, shaded understory of montane forest; 2285–2900 m.

Etymology. This species is named in honor of Nidia Cuello, Director of Herbario PORT, UNELLEZ, Guanare, and expert on the vegetative ecology of Guaramacal National Park.

Specimens examined. VENEZUELA. Lara: Mpio. Morán: Trail from Humocaro to Buenos Aires (caserío) below Páramo Los Rosas (ca 09°40'N, 070°05'W), 2750 m, 25 Jul 1979, *R. Liesner et al.* 8158 (MO, VEN); Between Buenos Aires to Canyon of El Callado, above Humocaro Alto, 2285–2740 m, 12 Feb 1944, *J.A. Steyermark* 55533 (NY, US). **Trujillo:** Mpio. Boconó: Páramo Guaramacal, 20–21 km beyond jct. with hwy. NE of Boconó, ca 09°13'N, 070°13'W, 2640–2700 m, 14 Mar 1984, *J.L Luteyn & E. Cotton 9705* (MO, NY, PORT, VEN).

Discussion. *Pilea nidiae* belongs in the Heterophyllae group of Weddell (1869). Its 3-nerved, toothed leaves that are unequal in size at each node and conspicuous, persistent stipules place it in the Flexuosae group of Killip (1936, 1939). We have not encountered any other Andean species from Venezuela with stipules that are as large as those of *P. nidiae*.

The leaf laminae of one of the paratype collections (*Steyermark 55533*) are narrower than in the type of *Pilea nidiae* and densely covered in cystoliths above and below



Figure 4. *Pilea nidiae*. A Habit; note the unequal leaf laminae at each node B Leaf detail (major lamina upper surface) showing cystoliths C Stipules and stem covered with cystoliths D Staminate inflorescence E Infructescence F, G Pistillate flowers with developing achenes. (A, D from *J.L. Luteyn & E. Cotton 9705* (NY); B, C from *J.A. Steyermark 55533* (US); E–G from *B. Stergios & R. Caracas 19810* (US)).
Characters	Pilea nidiae	Pilea flexuosa
Stipule shape (length)	narrowly triangular (6–11 mm)	ovate orbicular (4–6 mm)
Major leaf lamina size	6.5–9.5 × 1.5–3.2 cm	2–6 ×1.5–4 cm
Leaf shape	elliptic to narrowly elliptic or obovate	broadly ovate
Leaf base	cuneate	rounded or cordate
Leaf apex	long acuminate	abruptly acute to acuminate

Table 4. Diagnostic characters that distinguish Pilea nidiae and P. flexuosa.

(the type mostly lacks cystoliths). All other characters (leaf shape, venation, toothing, etc.) agree with our concept of this new species.

Conservation status. Using IUCN criteria (IUCN 2001) we tentatively consider *Pilea nidiae* to be Endangered (E). The known range of the species is less than 5000 km² (IUCN criterion B1) and there are only four known populations and of these only two are in a protected area (IUCN criterion B1(a)). We know nothing, however, about the dynamics of these populations and whether or not they are declining.

Additional Notes on Pilea in Venezuela

The following list includes corrections, additions, and deletions to the checklist of *Pilea* published in the catalog of the vascular flora of Venezuela (Romaniuc Neto 2008).

- Pilea acuminata Liebm. This species should be added to the flora of Venezuela. Our voucher is: Trujillo: Mpio. Boconó: 13 km ESE of Boconó, 1 km W of Guarama-cal, 09°11'N, 070°09'2, 1600 m, 16 Mar 1982, *R. Liesner et al. 12884* (PORT). Earlier Dorr et al. (2000) reported this collection as *Pilea pubescens* Liebm., with which it is allied, but from which it can be separated by the coarse serrations on the leaf margin. Also, according to Killip (1939) *P. pubescens* is a species found at low elevations in South America.
- *Pilea arguta* (Kunth) Wedd. The authorship as given by Romaniuc Neto (2008) is corrected. Also, Killip (1939) expressed doubt as to whether or not this species occurs in Venezuela. The type locality is "prope Nova Valencia Caracasarum," but the species is otherwise known only from high elevations in Colombia and Ecuador and it has not been recollected near Valencia, Carabobo nor anywhere else along the Coastal Cordillera of Venezuela.
- *Pilea carnosula* Wedd. This species should be deleted from the flora of Venezuela because the published record (Steyermark 1957; Romaniuc Neto 2008) of its occurrence is based on a misidentification of a specimen (*Steyermark 55767*, US) here considered to be *Pilea miguelii* (see above).
- *Pilea centradenioides* Seem. Although Romaniuc Neto (2008) stated that this species occurred in the Distrito Federal, it was not reported from Venezuela by Killip (1936, 1939). The Coastal Cordillera record conflicts with what otherwise appears to be a range corresponding to the Chocó in Central and South America. Consequently, we

suspect the Venezuelan record is based on misidentification of material that might represent *P. crugeriana*.

- Pilea dauciodora Pav. ex Wedd. Dorr et al. (2000) reported this species from Trujillo, a state record overlooked by Romaniuc Neto (2008). Lara also should be added to the distribution given by Romaniuc Neto (2008). The following collections serve as vouchers: Lara: Mpio. Morán: Parque Nacional Dinira, Páramo de Jabón, 09°34'N, 070°06'W, 2900 m, 29 Dec 1999, *R. Riina et al. 911* (US); S- and SW-facing slopes at Palojosco above Los Aposentos, above Humocaro Bajo, 2530–2375 m, 4 Feb 1944, *J.A. Steyermark 55233* (US).
- *Pilea fallax* Wedd. Dorr et al. (2000) reported this species from Trujillo, a state record overlooked by Romaniuc Neto (2008). In addition, the authorship cited by Romaniuc Neto (2008) is here corrected.
- Pilea hyalina Fenzl Killip (1939) reported this species from Aragua, a state record overlooked by Romaniuc Neto (2008). Miranda and Zulia also should be added to its Venezuelan distribution. Our vouchers are: Miranda: Mpio. Sucre: Parque Nacional El Avila ruta entre Puesto de Guarda Parques Sabas Nieves y Quebra-da Chacaíto, 10°32'N, 066°51'W, 1000–1500 m, Oct 1992, A. Fernández 8321 (US). Zulia: Machiques de Perijá: Sierra de Perijá, faldas inferiores, a lo largo del Río Yasa, vecinidad de «Guasáma,» arriba de «Kasmera» (Estación Biológica de la Universidad del Zulia), al Suroeste de Machiques, 500–600 m, 26–27 Aug 1967, J.A. Steyermark & J.E. Fernández 99757 (US).
- *Pilea latifolia* Wedd. This species was reported from Venezuela by Killip (1939), who cited a collection (*Cruger s.n.*, K) that lacks detailed locality data but which presumably was made in the Coastal Cordillera.
- *Pilea lindeniana* Wedd. Killip (1939) reported this species from Mérida, a state record overlooked by Romaniuc Neto (2008).
- Pilea losensis Killip Killip (1936) described this species from a single collection from Colombia (Norte de Santander) and later (Killip, 1939) extended its range to include Venezuela (Aragua). The Venezuelan voucher (*H. Pittier 13984*, US), however, is imperfect and we are uncertain as to its identity. Romaniuc Neto (2008) reported this species from Mérida but we do not know the source of his report. Killip (in sched.) did determine a collection from Mérida (*Steyermark 56365*, US) as *Pilea losensis* but that collection does not agree with the type of *P. losensis* and we believe it represents *P. miguelii* (see above).
- *Pilea microphylla* (L.) Liebm. Dorr et al. (2000) reported this species from Trujillo, a state record overlooked by Romaniuc Neto (2008). Romaniuc Neto (2008) considered *Pilea serpyllacea* (Kunth) Liebm. to be a synonym of *P. microphylla* but the cyme and leaf shape characters cited by Killip (1936) distinguish the two species. We have not seen material of *P. serpyllacea* from Venezuela and the voucher (*Gehriger 258*, US) cited by Killip (1939) has subsessile (versus pedunculate) cymes and appears to be one of the large-leaved forms of *P. microphylla* s.l.
- *Pilea parietaria* (L.) Blume This appears to be the correct name for the Andean species that Killip (1939) recognized as *Pilea rhombea* (L.f.) Liebm. Monro (2001)

placed *P. rhombea*, described from Mexico, in synonymy under *P. parietaria*, described from the West Indies. Monro (2001), however, did not mention a South American element. Killip (1939) thought that *P. rhombea* and *P. alsinifolia* Wedd. were both confused with the West Indian *P. parietaria*. He did acknowledge, however, that all three species were part of the same complex.

Pilea rhombea (L.f.) Liebm. – This species should be deleted from the flora of Venezuela because it is a synonym of *Pilea parietaria* (see above).

Acknowledgments

Field work was supported by funds from the Biological Survey and Inventories Program of the National Museum of Natural History, Smithsonian Institution. We are indebted to the staff of Guaramacal National Park for generous assistance in the field; the Ministerio del Poder Popular para el Ambiente and INPARQUES for collecting permits; and the curators of the herbaria cited in the text for allowing us to study their collections. The illustrations were prepared by Alice Tangerini (US). Two anonymous reviewers made suggestions for improving the original manuscript.

References

- Dorr LJ, Stergios B, Niño SM (2005) The Ramal de Guaramacal in the Venezuelan Andes. In: Krupnick GA, Kress WJ (Eds) Plant conservation: A natural history approach. The University of Chicago Press, Chicago and London, 72–76.
- Dorr LJ, Stergios B, Smith AR, Cuello A NL (2000) [2001] Catalogue of the vascular plants of Guaramacal National Park, Portuguesa and Trujillo states, Venezuela. Contributions from the United States National Herbarium 40: 1–155.
- International Union for Conservation of Nature and Natural Resources Species Survival Commission (2001) IUCN Red List Categories: Version 3.1 (second edition). International Union for Conservation of Nature and Natural Resources, Gland and Cambridge, 70 pp.
- Killip EP (1936) New species of *Pilea* from the Andes. Contributions from the United States National Herbarium 26(8): 367–394.
- Killip EP (1939) The Andean species of *Pilea*. Contributions from the United States National Herbarium 26(10): 475–530, tt. 30–40.
- Monro AK (2001) Synopsis of Mesoamerican *Pilea* (Urticaceae), including eighteen typifications and a key to the species. Bulletin of the Natural History Museum London, Botany 31: 9–25.
- Monro AK (2006) The revision of species-rich genera: A phylogenetic framework for the strategic revision of *Pilea* (Urticaceae) based on cpDNA, nrDNA, and morphology. American Journal of Botany 93: 426–441. doi: 10.3732/ajb.93.3.426
- Monro AK, Wei YG, Chen CJ (2012) Three new species of *Pilea* (Urticaceae) from limestone karst in China. PhytoKeys 19: 51–66. doi: 10.3897/phytokeys.19.3968

- Romaniuc Neto S (2008) Urticaceae. In: Hokche O, Berry PE, Huber O (Eds) Nuevo catálogo de la flora vascular de Venezuela. Fundación Instituto Botánico de Venezuela Dr. Tobías Lasser, Caracas, 649–652.
- Steyermark JA (1957) Botanical exploration in Venezuela IV. Fieldiana, Botany 28(4): 679–1190.
- Weddell HA (1869) *Pilea*. In: deCandolle ALLP (Ed) Prodromus 16(1). Treuttel and Wurtz, Paris, 104–163.

RESEARCH ARTICLE



Two new species of *Tynanthus* Miers (Bignonieae, Bignoniaceae) from Brazil

Maria Cláudia M. P. de Medeiros¹, Lúcia G. Lohmann¹

I Universidade de São Paulo, Instituto de Biociências, Departamento de Botânica, Rua do Matão, 277, 05508-090, São Paulo, SP, Brazil

Corresponding authors: *Maria Cláudia M. P. de Medeiros* (mariaclaudiamedeiros@hotmail.com); *Lúcia G. Lohmann* (llohmann@usp.br)

Academic editor: Alan Paton | Received 7 July 2014 | Accepted 7 October 2014 | Published 24 October 2014

Citation: Medeiros MCMP, Lohmann LG (2014) Two new species of *Tynanthus* Miers (Bignonieae, Bignoniaceae) from Brazil. PhytoKeys 42: 77–85. doi: 10.3897/phytokeys.42.8210

Abstract

Tynanthus is a genus of lianas that is broadly distributed through the Neotropics. Two new species of *Tynanthus* from Brazil are here described and illustrated: *T. densiflorus*, from Amazonas, and *T. espiritosantensis*, from Espírito Santo. *T. densiflorus* is recognized by the conspicuous interpetiolar glandular fields, a feature rarely found in *Tynanthus*, and the dense thyrses. *Tynanthus espiritosantensis*, on the other hand, is recognized by the bromeliad-like prophylls of the axillary buds and the lax thyrses. Information on the distribution, conservation status and morphologically similar species are provided.

Keywords

Amazonia, Atlantic forest, "cipó-cravo", lianas, neotropical flora

Introduction

Tynanthus Miers (Bignonieae, Bignoniaceae) is a monophyletic genus of lianas that is easily recognized by small bilabiate flowers, fruits with raised margins and by the smell of cloves in vegetative organs (Lohmann 2006). These features, along with flowers arranged in thyrses, corolla externally densely pubescent, thecae curved forward, ovary densely pubescent and poorly developed nectar disk characterize the genus (Medeiros and Lohmann submitted). Species of *Tynanthus* are distributed throughout the Neotropics, occurring predominantly in wet forests (Lohmann and Taylor 2014). The

highest diversity of *Tynanthus* is found in Brazil, with most species occurring in Amazonia and the Atlantic Forest.

During the preparation of a taxonomic revision of *Tynanthus* (Medeiros and Lohmann submitted), multiple collections with morphological features that did not match any of the described species were found. Additional fieldwork and molecular phylogenetic studies provided further support for the recognition of two new species in the genus, one from the Amazon region and another from the Atlantic Forest of Brazil.

Material and methods

Morphological analyses and compilation of phenology and distribution data were based on specimens deposited at CVRD, G, INPA, K, MBM, MG, MO, NY, RB, SP, SPF and US (Thiers, continuously updated). Descriptions were elaborated following terminology presented in Radford (1986), Weberling (1989), the Leaf Architecture Working Group (1999), Gomes-Silva (2009), Nogueira et al. (2013) and Lohmann and Taylor (2014).

Key to the species of Tynanthus with known occurrences in Brazil

1	Interpetiolar glands present
1'	Interpetiolar glands absent
2	Leaflets with caudate-mucronate apices; flowers arranged in dense thyrses
	T. densiflorus
2'	Leaflets with acuminate or obtuse-mucronate apices; flowers arranged in lax
	thyrses
3	Prophylls of the axillary buds foliaceous
3'	Prophylls of the axillary buds minute and triangular, or bromeliad-like5
4	Young branchlets puberulent to glabrescent; tendrils trifid; corolla 1.2-1.7
	cm
4'	Young branchlets villous to pubescent; tendrils simple; corolla 0.4–0.8 cm
5	Prophylls of the axillary buds minute and triangular
5'	Prophylls of the axillary buds bromeliad-like7
6	Flowers arranged in dense thyrses; calyx laciniate
6'	Flowers arranged in lax thyrses; calyx minutely denticulate or truncate8
7	Leaflet domatia with trichomes; petioles, petiolules and inflorescence axis
	without patelliform trichomes
7'	Leaflet domatia without trichomes; petioles, petiolules and inflorescence axis
	with patelliform trichomes
8	Branchlets tomentose to pubescent throughout; fruits unwinged, with mar-
	gins slightly raised <i>T. cognatus</i>

79

8'	Branchlets glabrescent (sometimes pubescent only at the nodes); fruits
	winged, with margins prominently raised9
9	Leaflets with acuminate-mucronate apices; corolla 1-1.4 cm T. labiatus
9'	Leaflets with caudate-mucronate apices; corolla 0.5-0.9 cm T. micranthus

Taxonomy

1. *Tynanthus densiflorus* M.C. Medeiros & L.G. Lohmann, sp. nov. urn:lsid:ipni.org:names:77142875-1

Type. Brazil. Amazonas: Manaus-Itacoatiara, km 26, Reserva Florestal Adolpho Ducke, 16 Aug 1996, L.C. Procópio et al. 14 (holotype: INPA-189631!; isotypes: G!, K!, MG, MO!, NY!, RB!, SP!, U) Fig. 1A–I.

Diagnosis. Tynanthus densiflorus differs from Tynanthus panurensis (Bureau) Sandwith by the interpetiolar gland fields (lacking in *T. panurensis*), minute triangular prophylls of the axillary buds (versus foliaceous in *T. panurensis*) and dense thyrses (versus lax in *T. panurensis*). It further differs from *Tynanthus pubescens* A.H. Gentry in the leaflets with a caudate-mucronate apex (versus acuminate or obtuse-mucronate apices in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*).

Description. Liana. Branchlets subtetragonal to terete, finely striate, with lenticels, pubescent to puberulent, with simple and peltate trichomes; interpetiolar ridge absent or present; interpetiolar glands present; prophylls of the axillary buds 0.5–0.8 mm long, 1–2.5 mm wide, minute, shallowly triangular, puberulent throughout, with simple and peltate trichomes. Leaves 2-3 foliolate; terminal leaflets modified into a trifid tendril: petioles and petiolules with a more or less conspicuous canalicule on the upper side, puberulent to glabrescent throughout, with simple and peltate trichomes; petioles 1.8–5.6 cm long; petiolules (0.6–)1.4–3.8 cm long, lateral ones with equal lengths and the terminal one longer, when present; leaflets (3.2-)5-16.1 cm long, (1.3-)2-9.5 cm wide, membranous to chartaceous (sometimes subcoriaceous), discolor or concolor, ovate, apex caudate, mucronate, base cuneate to truncate or subcordate, symmetrical or asymmetrical, margin entire; the abaxial surface pubescent to puberulent throughout (sometimes only on and near the veins), with simple, peltate and patelliform trichomes; the adaxial surface pubescent to glabrescent throughout (sometimes only on and near the veins), with simple, peltate and patelliform trichomes; glandular trichomes evenly distributed throughout both surfaces; first venation pinnate, second venation weak brochidodromous, third venation alternate percurrent (sometimes random reticulate); pocket domatia with (sometimes without) trichomes. Inflorescence 3-9.5 cm long, a thyrse, axillary, dense, corymbose to conical in aspect; axis densely pubescent to puberulent, with simple and peltate trichomes; inflorescence bracts 0.5-2.5 mm long, predominantly caducous, triangular to linear triangular, densely pubescent to pubescent throughout; floral bracts 0.4-0.6 mm long, triangular; floral pedicels 1-7 mm long. Calyx green to gravish, 1.5-2.2 mm long, 1.4-1.9 mm wide, membranous



Figure I. *Tynanthus densiflorus* sp. nov.: **A** Flowering branch **B** Detail of lenticels in the oldest portion of branchelet **C** Detail of pubescent indumentum in the youngest portion of branchelet **D–E** Interpetiolar glands **F** Detail of inflorescence axis with bracts **G** Open corolla showing the androecium **H** Open calyx showing the gynoecium **I** Ovary cross section showing ovules [L.C. Procópio 14 (NY)].

to chartaceous, with a transversal aperture, truncate or minutely 5-denticulate, densely pubescent to pubescent outside, with simple and peltate trichomes, glabrous inside; lobes 0.1–0.2 mm long. *Corolla* cream or pale yellow, 0.8–1.5 cm long, 0.3–0.5 cm

wide at the tube opening, bilabiate, with two (almost totally fused) upper lobes and three lower lobes, densely pubescent throughout outside, with simple and peltate trichomes; tube 3–5 mm long, internally glabrous at the top, tomentose at the base, with simple, long and short stipitate trichomes; nectar guides present, yellow; lobes entire, densely pubescent to pubescent throughout lower ones and at margins of or throughout upper ones; upper ones 0.4-1.4(-2.9) mm long, 0.7-1.5(-2.4) mm wide, acute to obtuse; lower ones 2.1-4 mm long, 2-3.6 mm wide, obtuse to rounded. Androecium with four fertile stamens inserted at 1.5-2.5 mm from the base of the corolla; shorter ones 3.5–5.5 mm long; longer ones 4.5–7 mm long; filaments with long and short stipitate trichomes at the base; anther thecae cream, 1.1-1.4 mm long, obovate to elliptic, divergent and reflexed forward, glabrous, subexserted; connective extending 0.2-0.3 mm beyond anther attachment; staminode covered with long and short stipitate trichomes, 1.5–2.7 mm long. *Gynoecium* ca. 7–9 mm long; ovary 1.3–1.5 mm long, 0.7–0.8 mm wide, conical, velutinous, with simple trichomes, with a ring of longer trichomes at the base, with two or four series of ovules per locule; nectar disc reduced, not evident; style 5-7 mm long, tomentose at the base, with simple trichomes; stigma with lamellae lanceolate, glabrous. Fruit not seen. Seeds not seen.

Distribution and habitat. Known from wet forests in Manaus and proximity (Amazonas, Brazil).

Etymology. The species epithet refers to the thyrses with flowers densely arranged. **Phenology.** Flowers in August. Fruiting period is unknown.

Conservation status. According to IUCN (2001) criteria, this species is considered Vulnerable (VU B2ab(iii)). The type collection is from a protected area (Reserva Florestal Adolpho Ducke), where a reasonable number of individuals are found (pers. obs.). Nevertheless, the proximity of Manaus can be considered a region characterized by continuous urbanization. Additional studies on distribution and abundance of *T. densiflorus* are still necessary in order to confirm its conservation status.

Discussion. *Tynanthus densiflorus* is characterized by dense thyrses, with a corymbose to conical aspect, as well as the presence of interpetiolar glands. The type collection of *T. densiflorus* was treated as *T. panurensis* (Bureau) Sandwith for the Guide of the Ducke Reserve (Lohmann and Hopkins 1999). Indeed, the two species are similar in the occurrence of ovate leaflets and corolla tube that is internally tomentose at base. However, the presence of interpetiolar glands in *T. densiflorus* (versus absent in *T. panurensis*), the minute prophylls (versus foliaceous in *T. panurensis*) and dense inflorescences (versus lax in *T. panurensis*) allow the distinction of these taxa. *Tynanthus pubescens* A.H. Gentry is another species that is morphologically similar to *T. densiflorus*. Both taxa have similar corolla lengths (around 1–1.6 cm in *T. pubescens*) and show interpetiolar gland fields; however, the caudate-mucronate leaflet apex (versus acuminate or obtuse-mucronate in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*) and the dense inflorescences (versus lax in *T. pubescens*) differentiate both taxa.

Additional specimens examined. BRAZIL. Amazonas: 2-5 km N of Manaus-Itacoatiara Road at km 79 near Rio Preto da Eva, 100–200 m, 24 November 1974, *A. Gentry 12849* (INPA, MG, MO). Rio Camanau, 28 June 1987, *P. Grenand et al. 2787* (INPA). Manaus, Campus of INPA, Estrada do Aleixo, 22 November 1974, *A. Gentry 12792* (INPA); 30 November 1974, *A. Gentry 13018* (INPA, MO); *Ibid.*, Transect vouchers, Line 1, 11 December 1974, *A. Gentry 13181* (INPA, MO); Estrada do Aleixo near Manaus, km 6–7 past INPA, 2 December 1974, *A. Gentry 13040* (INPA, MO); Reserva Florestal Adolpho Ducke, Parcela PPBio (L03 1000 m), 100 m, 02°56'03"S, 59°57'32"W, 14 December 2010, *M.C. Medeiros et al. 21* (SPF); *Ibid.*, próximo à estação meteorológica, 120 m, 02°55'37"S, 59°58'33"W, 15 December 2010, *M.C. Medeiros et al. 22* (SPF); *Ibid.*, proximidades do refeitório da base da reserva, na beira da estrada, 110 m, 02°55'59"S, 59°57'56"W, 16 December 2010, *M.C. Medeiros et al. 25* (SPF).

2. *Tynanthus espiritosantensis* M.C. Medeiros & L.G. Lohmann, sp. nov. urn:lsid:ipni.org:names:77142876-1

Type. Brazil. Espírito Santo: Linhares, Reserva Natural da CVRD, Estrada Oiticica, km 2.3, 6 Feb 2008, D.A. Folli 5931 (holotype: CVRD-11073!; isotype: SPF!) Fig. 2A–I.

Diagnosis. Tynanthus espiritosantensis differs from Tynanthus schumannianus (Kuntze) A.H. Gentry by the presence of trichomes in the leaflet domatia (versus absence in *T. schumannianus*), lack of patelliform trichomes on petioles, petiolules and inflorescence axis (versus presence in *T. schumannianus*) and larger calyx, 2.3–2.7 mm long, 1.8–2.5 mm wide (versus 1–2 mm long, 1.1–1.9 mm wide in *T. schumannianus*).

Description. Liana. Branchlets tetragonal to terete, finely striate, with lenticels, glabrescent (sometimes pubescent at the nodes), with peltate and patelliform trichomes (sometimes simple trichomes also present); interpetiolar ridge absent; interpetiolar glands absent; prophylls of the axillary buds 1.2-2.5 mm long, 0.7-1.1 mm wide, bromeliad-like, glabrescent (rarely puberulent), with peltate trichomes (rarely with simple trichomes as well). Leaves (2-)3 foliolate; terminal leaflets modified into a trifid tendril; petioles and petiolules with a more or less conspicuous canalicule on the upper side, puberulent throughout, with simple and peltate trichomes; petioles 1-6 cm long; petiolules 0.5-3.5 cm long, lateral ones with equal lengths and the terminal one longer, when present; leaflets (4-)5-11.9 cm long, (1.5-)1.9-5.4 cm wide, membranous to chartaceous, discolor, elliptic, apex acuminate or caudate, mucronate, base cuneate, symmetrical, margin entire; the abaxial surface glabrescent (sometimes pubescent) on and near the veins, with peltate and patelliform trichomes (sometimes also simple); the adaxial surface glabrescent on and near the veins, with peltate and patelliform trichomes; glandular trichomes distributed especially on the abaxial surface; first venation pinnate, second venation weak brochidodromous, third venation alternate percurrent (sometimes random reticulate); pocket domatia with trichomes. Inflorescence 3.6-7 cm long, a thyrse, axillary, lax, conical in aspect; axis pubescent, with simple and peltate trichomes; inflorescence bracts 0.7-3.9(-9) mm long, predominantly caducous, triangular to linear triangular, pubescent throughout or only at margins; floral bracts 0.5-0.7 mm long, triangular; floral pedicels 3.5-9 mm long. Calyx green, 2.3-2.7 mm



Figure 2. *Tynanthus espiritosantensis* sp. nov.: **A** Flowering branch **B–D** Leaflet with pubescent domatia in the abaxial surface **E** Interpetiolar region with bromeliad-like prophylls of the axillary buds **F** Detail the of inflorescence axis, showing bracts, simple and peltate trichomes **G** Open corolla, showing the androecium **H** Anther **I** Open calyx showing the gynoecium [D.A. Folli 5931 (SPF)].

long, 1.8–2.5 mm wide, membranous to chartaceous, with a transversal (sometimes oblique) aperture, minutely 5-denticulate, glabrescent (sometimes pubescent at teeth) outside, with simple, peltate and patelliform trichomes, glabrous inside;

lobes 0.1–0.4 mm long. Corolla white, 0.7–0.8 cm long, 0.25–0.34 cm wide at the tube opening, bilabiate, with two (almost totally fused) upper lobes and three lower lobes, densely pubescent throughout outside, with simple and peltate trichomes; tube 2.5-4 mm long, internally glabrous at the top, tomentose to pubescent at the base or glabrescent, with simple, long and short stipitate trichomes; nectar guides absent, but with a path of long and short stipitate trichomes; lobes entire, densely pubescent to pubescent throughout lower ones and at the margin of upper ones; upper ones 0.4-1.1 mm long, 1-1.5 mm wide, acute to obtuse; lower ones 1.8-3.2 mm long, 2.1-2.5 mm wide, obtuse to rounded (sometimes acute). Androecium with four fertile stamens, inserted at 1-1.5 mm from the base of the corolla; shorter ones 2.5-3.5 mm long; longer ones 4.5-5 mm long; filaments with long and short stipitate trichomes at the base; anthers thecae cream, 0.8-1.1 mm long, obovate to elliptic, divergent and reflexed forward, glabrous, subexserted; conective extending 0.2–0.3 mm beyond anther attachment; staminode glabrescent, with long and short stipitate trichomes, 2.4 mm long. Gynoecium ca. 4.5-6 mm long; ovary 0.8-1 mm long, 0.7–0.9 mm wide, conical, velutinous, with simple trichomes, with a ring of longer trichomes at the base, with two or four series of ovules per locule; nectar disc reduced, not evident; style 3.3-5 mm long, tomentose at the base, with simple trichomes; stigma with lamellae lanceolate, glabrous. Fruits not seen. Seeds not seen.

Distribution and habitat. Known exclusively from wet forests in Linhares and proximity (Espírito Santo, Brazil).

Etymology. The species epithet refers to the type locality.

Phenology. Flowers from December to February. Fruiting period is unknown.

Conservation status. According to the IUCN (2001) criteria, this species is considered Data Deficient (DD), given the small number of known collections. Further detailed investigation on the distribution of *T. espiritosantensis* is necessary in order to properly assess its conservation status. The two localities in which this species has been collected fall within a single municipality (Linhares), suggesting that this might represent another narrowly distributed species of *Tynanthus*. Fortunately, the type collection was obtained inside a protected area (Reserva Natural da CVRD).

Discussion. *Tynanthus espiritosantensis* is characterized by the bromeliad-like prophylls of the axillary buds and lax thyrses. This species is morphologically similar to the Amazonian *T. schumannianus* (Kuntze) A.H. Gentry. However, these taxa can be easily separated by the pubescent leaflet domatia (versus glabrous in *T. schumannianus*), absence of patelliform glands on petioles, petiolules and inflorescence axis (versus presence in *T. schumannianus*) and the larger calyx, 2.3–2.7 mm long, 1.8–2.5 mm wide (versus 1–2 mm long, 1.1–1.9 mm wide in *T. schumannianus*).

Additional specimens examined. BRAZIL. Espírito Santo: Linhares, Rancho Alto, 7 December 1984, *G. Hatschbach & J.M. Silva 48693* (MBM, MO, US); Reserva Natural da CVRD, Estrada Oiticica, próximo à porteira, antes do cruzamento com a estrada municipal, 53 m, 19°07'59"S, 40°00'07"W, 27 January 2014, *M.C. Medeiros & R.B. Louzada 41* (CVRD, SPF).

Acknowledgements

This study is part of the Ph.D. thesis of M.C.M.P.M. conducted at the Universidade de São Paulo. The authors thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a fellowship to M.C.M.P.M. (142379/2010-7) and a Pq-1C grant to L.G.L. (307781/2013-5); the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for a fellowship to M.C.M.P.M. (2010/51579-0), a regular research grant to L.G.L. (2011/50859-2); two collaborative Dimensions of Biodiversity-BIOTA grants supported by FAPESP, NSF, and NASA (2012/50260-6 and 2013/50297-0); and, the International Association for Plant Taxonomy for a Research Grant to M.C.M.P.M. We also thank the curators of the herbaria cited in the text for sending specimens on loan and for permission to visit and study their specimens; Instituto Nacional de Pesquisas da Amazônia (INPA) and the Reserva Natural da CVRD for authorizing us to conduct fieldwork inside the Reserves; Rafael Louzada for assistance during fieldwork; and Klei Sousa for the preparation of the botanical illustrations.

References

- Gomes-Silva F (2009) Evolução de acarodomácias em Bignoniacea (Bignoniaceae). MSc. Dissertation, Universidade de São Paulo, São Paulo, 114 pp.
- IUCN (2001) IUCN Red List Categories and Criteria, Version 3.1. http://www.iucn.org/
- Leaf Architecture Working Group (1999) Manual of leaf architecture morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms. Smithsonian Institution, Washington, 65 pp.
- Lohmann LG (2006) Untangling the phylogeny of Neotropical lianas (Bignoniaeae, Bignoniaeae). American Journal of Botany 93: 304–318. doi: 10.3732/ajb.93.2.304
- Lohmann LG, Hopkins MJG (1999) Bignoniaceae. In: Ribeiro JELS, Hopkins MJG, Vicentini A, Sothers CA, Costa MAS, Brito JM, Souza MAD, Martins LHP, Lohmann LG, Assunção PACL, Pereira EC, Silva CF, Mesquita MR, Procópio LC (Eds) Flora da Reserva Ducke: Guia de Identificação das plantas vasculares de uma floresta de terra-firme na Amazônia Central. INPA/DIFD, Manaus, 608–623.
- Lohmann LG, Taylor CM (2014) A new generic classification of Tribe Bignonieae (Bignoniaceae). Annals of the Missouri Botanical Garden 99: 348–489. doi: 10.3417/2003187
- Nogueira A, El-Ottra JHL, Guimarães E, Machado SR, Lohmann LG (2013) Trichome structure and evolution in Neotropical lianas. Annals of Botany 112: 1331–1350. doi: 10.1093/aob/mct201
- Radford AE (1986) Fundamentals of plant systematics. Harper & Row, New York, 512 pp.
- 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/ih/ [accessed: April 2014]
- Weberling F (1989) Morphology of flowers and inflorescences. Cambridge University Press, Cambridge, 348 pp.