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A synopsis of the *Bromeliaceae* of Panama, including new records for the country

Abstract

Cáceres González D. A., Schulte K., Schmidt M. & Zizka G.: A synopsis of the *Bromeliaceae* of Panama, including new records for the country. – Willdenowia 41: 357–369. December 2011. – Online ISSN 1868-6397; © 2011 BGBM Berlin-Dahlem.
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Based on extensive field and herbarium studies, twenty species of *Bromeliaceae* are newly reported for Panama: *Aechmea beeriana, A. penduliflora, A. pittieri, A. strobilacea, Bromelia hemispherica, Guzmania graminifolia, G. hollinensis, Pitcairnia halophila, P. wendlandii, Tillandsia dexteri, T. ionantha, T. longifolia, T. utriculata, Werauhia bracteosa, W. kathyae, W. macrantha, W. macrochlamys, W. notata*, *W. paniculata, W. viridis.* Former reports of six bromeliad species for Panama are revised as erroneous. The bromeliad flora of Panama now comprises 206 species. Endemism of the *Bromeliaceae* in Panama and Costa Rica is newly evaluated based on this revised inventory: 33 species are endemic to Panama, 32 to Costa Rica, 36 species to both countries. Only 3 of the 8 presently recognised subfamilies occur in Panama. The genus *Werauhia* has its centre of diversity in Panama (47 of 87 species) and Costa Rica. A distribution map is presented for the newly reported species.

Resumen

Basado en estudios extensivos de campo y de herbarios, veinte especies de Bromeliaceae son reportadas por primera vez para Panamá: *Aechmea beeriana, A. penduliflora, A. pittieri, A. strobilacea*, *Bromelia hemispherica, Guzmania graminifolia, G. hollinensis, Pitcairnia halophila, P. wendlandii, Tillandsia dexteri, T. ionantha, T. longifolia, T. utriculata, Werauhia bracteosa, W. kathyae, W. macrantha, W. macrochlamys, W. notata*, *W. paniculata, W. viridis*. Se informa la revisión de seis especies de bromelias de Panamá, erróneamente reportadas. La flora de bromelias de Panamá ahora comprende 206 especies. El alto endemismo de Bromeliaceae en Panamá y Costa Rica es revisado en este estudio: 33 especies son endémicas de Panamá, 32 de Costa Rica y 36 especies entre ambos países. Sólo 3 de las 8 subfamilias actualmente reconocidas, ocurren en Panamá. El género *Werauhia* tiene su centro de diversidad en Panamá (47 de 87 especies) y Costa Rica. Se presenta un mapa con la distribución de las nuevas especies reportadas.

Additional key words: bromeliads, endemism, life-form, taxonomy, systematic diversity, epiphytes

Introduction

Among the Central American countries, Panama (8560 species, Correa & al. 2004) and Costa Rica (8249 species, Hammel & al. 2004) are the countries with the highest diversity of flowering plants, which is well correlated with the overall biodiversity. The diversity of flowering plants scientifically documented for Panama has increased considerably in the last decades: from 5314 species in the "Flora of Panama" founded by Woodson and completed between 1943 and 1987 (D'Arcy 1987), to 7345 species in the checklist by D'Arcy (1987) and 8560 species in the most recent checklist by Correa & al. (2004). Keeping the

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comparatively small surface area of 75 845 km^2 (IGNTG 2007) in mind, Panama is obviously one of the hotspots of plant diversity in the Neotropics.

The *Bromeliaceae* (bromeliads) of Panama, though clearly outnumbered by the orchids, are one of the major groups of epiphytes and contribute considerably to overall forest diversity. Because of their ecological versatility they have attracted special attention from botanists, ecologists and physiologists (e.g. Smith & Downs 1974, 1977, 1979, Croat 1978, Laube & Zotz 2006 and Zotz & Schultz 2008).

Within a few decades, our knowledge of the Panamanian bromeliad flora has increased considerably. Smith (1944) reported 87 species, D'Arcy (1987) 136, Utley (1994) 148 and Correa & al. (2004) 178 species. Further additions were recently published by Morales (2009) *(Werauhia brunei, W. camptoclada)* and Wester & al. (2011) *(Aechmea mariae-reginae, Tillandsia pruinosa, Werauhia singuliflora)*.

Here we present updated and amended information on the diversity of *Bromeliaceae* in Panama, including patterns of endemism and systematic diversity. The results are based on detailed studies of the relevant herbarium collections and extensive fieldwork.

Material and methods

The herbarium collections of *Bromeliaceae* from 31 herbaria (B, BM, COL, CR, DS, DUKE, F, FR, GH, HEID, HUH, INB, K, LG, LI, MEXU, MICH, MO, NEU, NY, QCNE, PMA, SCZ, SEL, TEX, UC, UMO, US, USJ, W and WU; abbreviations following Thiers 2008+) were studied. Altogether 2968 herbarium specimens of *Bromeliaceae* from Panama and 4523 from Costa Rica were revised.

Field work in western Panama in 2004, 2008 and 2009 added 363 collections and 858 occurrence observations for *Bromeliaceae*. The specimens collected by *Cáceres & al.* are deposited in the herbaria of the Universidad de Panama, Panama City (PMA) and the Senckenberg Research Institute, Frankfurt/Main (Herbarium Senckenbergianum, FR).

These data provide the basis for a critical evaluation of the published records of *Bromeliaceae* in Panama and are also the basis of the quantitative, life form and endemism analysis of the *Bromeliaceae* presented.

Each entry in our list of bromeliad species of Panama is substantiated by the citation of representative specimens, which allow critical examination of the report.

Nomenclature and generic delimitation follow Luther (2008) and IPNI (2011).

Results

Bromeliaceae diversity in Panama

Twenty species are recorded here for Panama for the first time: *Aechmea beeriana, A. penduliflora, A. pittieri, A. strobilacea, Bromelia hemispherica, Guzmania graminifolia, G. hollinensis, Pitcairnia halophila, P. wendlandii, Tillandsia dexteri, T. ionantha, T. longifolia, T. utriculata, Werauhia bracteosa, W. kathyae, W. macrantha, W. macrochlamys, W. notata, W. paniculata* and *W. viridis*. Including these additions, the *Bromeliaceae* in Panama now comprise 206 species and account for 2.4 % of the total angiosperm flora of Panama. The whole family comprises 3172 species in 58 genera (Luther 2008), so 6.5 % of the species and 27.6 % of the generic diversity are represented in the country.

Only three of eight subfamilies of the *Bromeliaceae* are represented in Panama, with a strong predominance of the *Tillandsioideae* (7 genera/147 species; 71.4 % of all Panamanian bromeliad species), followed by the *Bromelioideae* (7/34; 16.5 %) and the *Pitcairnioideae* s.str. (2/25; 12.1 %) (Table 1).

At the generic level, *Werauhia* is the most diverse taxon in Panama with 47 species (22.8 % of the bromeliad flora), followed by *Guzmania* (45 species, 21.8 %), *Tillandsia* (34 species, 16.5 %), *Pitcairnia* (28 species, 11.2 %) and *Aechmea* (22 species, 10.7 %) (Table 1).

All species are listed below with information on their life form (Lf: E = epiphytic, T = terrestrial, S = saxicolous) and endemism (En: PA = endemic to Panama, CR = Costa Rica, CO = Colombia). Three revised herbarium collections are listed for each species, except in cases where the number of available collections was less than three. Type specimens are indicated (holo = holotype, iso = isotype, lecto = lectotype). Three species still have to be described and are cited here as "sp.". The new species records for Panama are marked in bold and treated in more detail with information also on the distribution range of the species and with citation of all herbarium collections known from Panama. Six species recorded as erroneous for Panama are given in a separate list at the end.

Aechmea allenii L. B. Sm. – Lf: E, T; En: PA; *McPherson 8533* (MO), *Croat 37486* (MO), *Dressler 4603* (PMA).

Aechmea angustifolia Poepp. & Endl. – Lf: E; *Carrasquilla & Mendoza 1228* (PMA), *Allen 2378* (US, holo), *Cáceres & Pérez 3973* (FR, PMA).

Aechmea beeriana L. B. Sm. & M. A. Spencer – Lf: E. Distribution: Panama (Fig. 1), Peru, Guianas, Brazil. Panama: Darien, Chepigana, 7.8.1986, *McDonagh & al. 541* (MO).

Aechmea bracteata (Sw.) Griseb. – Lf: E; *von Wedel 2922* (MO), *de Nevers & al. 7686* (MO).

Aechmea dactylina Baker – Lf: E, T; *Fendler 450* (MO, holo). *Dwyer & Gentry 9508* (MO), *Cáceres & Fátima 4027* (FR, PMA).

Aechmea germinyana (Carrière) Baker – Lf: E; En: PA & CO; *Williams 960* (NY).

Aechmea haltonii H. Luther – Lf: E, S; En: PA; *Churchill & al. 5988* (MO), *Halton 85-1447* (SEL, holo), *Luther s.n.* (SEL).

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Aechmea jungurudoensis H. Luther & K. F. Norton – Lf: E; En: PA; *Kiehl s.n.* (SEL, holo).

Aechmea lingulata (L.) Baker – Lf: E; *Sytsma 1893* (MO), *Davidse & Hamilton 23698* (MO), *Cáceres & Fuentes 4023* (FR, PMA).

Aechmea magdalenae (André) André ex Baker – Lf: T; *Folsom 2552* (MO), *D'Arcy 9306* (MO), *Cáceres 4185* (FR, PMA).

Aechmea mariae-reginae H. Wend. – Lf: E, S; *Roubick & al. 1109* (PMA), *Cáceres & Pérez 3883* (FR, PMA), *Cáceres & Pérez 4129* (FR, PMA).

Aechmea mexicana Baker – Lf: E, T; *Churchill & Rauh 4999* (MO), *Antonio 3437* (MO), *Cáceres 4049* (FR, PMA).

Aechmea nudicaulis (L.) Griseb. – Lf: E; *Zizka Z50* (FR), *Correa & Dressler 1034* (PMA), *Cáceres & Pérez 3966* (FR, PMA).

Aechmea penduliflora André – Lf: E.
Distribution: Nicaragua, Costa Rica, Panama (Fig. 1), Colombia, Venezuela, Ecuador, Peru, Bolivia.
Panama: Bocas del Toro, Changuinola Distr., community of Junquito, 11.7.2008, *Cáceres & Pérez 3882* (FR, PMA), *3884* (FR, PMA); Chiriqui, Baru Distr., Puerto Armuelles (Chorogo), 22.6.2008, *Cáceres & al. 3839* (FR, PMA).

Aechmea pittieri Mez – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Renacimiento Distr., 7.6.2009, *Cáceres 4047* (FR, PMA).

Aechmea pubescens Baker – Lf: E, T; *Hammel 4260* (MO), *Hayes 538* (NY), *Cáceres & Pérez 4136* (FR, PMA).

Aechmea setigera Mart. ex Schult. f. – Lf: E; *Duke 10945* (MO), *Correa & al. 4682* (PMA), *Croat 8195* (SCZ).

Aechmea strobilacea L. B. Sm. – Lf: E.
Distribution: Panama (Fig. 1), Ecuador, Peru.
Panama: Panama Distr., east slope of Cerro Jefe, 15.2.1982, *Knapp 3563* (MO); Comarca Kuna Yala, Nargana, El Llano–Carti road, 16.1.1985, *de Nevers 4583* (MO); Darien, Comarca Embera–Wounaan 1, 25.8.1974, *Croat 27202* (MO).

Aechmea strobilina (Beurl.) L. B. Sm. & Read – Lf: E, T; En: PA; *Antonio 1185* (MO), *D'Arcy & Sytsma 14722* (MO), *de Nevers & al. 4740* (MO).

Aechmea tillandsioides (Mart. ex Schult. f.) Baker – Lf: E; *Hamilton & Davidse 2822* (PMA), *Luther 1128* (SEL), *Cáceres & Pérez 3861* (FR, PMA).

Aechmea tonduzii Mez & Pittier ex Mez – Lf: E, T; *Hamilton & D'Arcy 668* (MO), *Hammel & al. 16422* (MO), *McPherson 12656* (MO).

Aechmea veitchii Baker – Lf: E, T; *Monro & al. 5972* (PMA), *Ibáñez & al. AI5834* (SCZ), *Cáceres & Pérez 3930* (FR, PMA).

Ananas ananassoides (Baker) L. B. Sm. – Lf: T; *Cáceres 4187* (FR, PMA).

Ananas comosus (L.) Merr. – Lf: T; *Dwyer 1604* (MO), *Müller-Schwarze 145* (PMA), *Cáceres 4171* (FR, PMA).

Araeococcus pectinatus L. B. Sm. – Lf: E; *Whitefoord & Eddy 176* (MO), *Antonio & Hahn 4386* (PMA), *McPherson & al. 15396* (PMA).

Billbergia macrolepis L. B. Sm. – Lf: E; *Shattuck 373* (MO), *Croat 11247* (MO), *Cáceres & Pérez 3879* (FR, PMA).

Bromelia hemispherica Lam. – Lf: T.
Distribution: Mexico, Nicaragua, Costa Rica, Panama (Fig. 1).
Panama: Cocle, Penonome Distr., 27 km north of Penonome on road to Coclesito, 20.2.1978, *Hammel 1640* (MO).

Bromelia karatas L. – Lf: T; *Saunders 525* (MO), *Nee 7455* (MO, PMA), *Cáceres & al. 4088* (FR, PMA).

Bromelia pinguin L. – Lf: T; *Tyson 2737* (MO, SCZ), *Croat 9746* (NY), *Aizprúa & Alvarez B4357* (PMA).

Catopsis berteroniana (Schult. & Schult. f.) Mez – Lf: E; *Seibert 646* (MO), *Allen 738* (MO), *Gentry & al. 3415* (MO).

Catopsis juncifolia Mez & Wercklé – Lf: E; *Miller 1754-A* (US, n.v.).

Catopsis micrantha L. B. Sm. – Lf: E; *Tyson & al. 4423* (MO, PMA), *Pierce 00-27* (SCZ), *Cáceres 4101* (FR, PMA).

Catopsis nitida (Hook.) Griseb. – Lf: E, T, S; *Davidson 863* (MO), *Folsom & al. 5470* (PMA), *Cáceres & Pérez 3853* (FR, PMA).

Catopsis nutans (Sw.) Griseb. – Lf: E; *Dodge 16585* (MO), *Croat 12310* (PMA), *Cáceres & al. 4058* (FR, PMA).

Catopsis pisiformis Rauh – Lf: E; En: PA; *Rauh 58635* (HEID, holo).

Catopsis sessiliflora (Ruiz & Pav.) Mez – Lf: E; *Correa & Dressler 423* (PMA), *Ibáñez & al. AI5717* (SCZ), *Cáceres 4166* (FR, PMA).

Catopsis wangerinii Mez & Wercklé – Lf: E; *Stern & al. 1117* (MO), *Croat 26280* (MO), *Cáceres & Pérez 3921* (FR, PMA).

Greigia columbiana L. B. Sm. – Lf: T; *Davidse & al. 25247* (MO), *Cáceres 4141* (FR, PMA).

Greigia sylvicola Standl. – Lf: T; En: CR, PA; *Gómez & al. 22416* (MO, SEL), *Aranda & al. 1481* (PMA), *Cáceres & Pérez 3957* (FR, PMA).

Guzmania angustifolia (Baker) Wittm. – Lf: E; *Croat 37106* (MO), *Terry & Terry 1579* (MO), *Cáceres 4116* (FR, PMA).

Guzmania armeniaca H. Luther – Lf: E; En: PA; *Luther s.n.* (SEL, holo).

Guzmania attenuata L. B. Sm. & Read – Lf: E; *Gentry & al. 16866* (MO, holo).

Guzmania berteroniana (Schult. & Schult. f.) Mez – Lf: E; *Allen 3957* (MO, n.v.).

Guzmania butcheri Rauh – Lf: E; En: CO, PA; *Antonio 3747* (MO), *Herrera 850* (MO).

Guzmania calamifolia André ex Mez – Lf: E, T; *Antonio*

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1124 (MO, NY), *Nee 11221* (MO), *Luther & al. 1116* (PMA).

Guzmania cerrohoyaensis H. Luther – Lf: T; En: PA; *Skotak s.n.* (SEL, holo).

Guzmania cinnabarina H. Luther & K. F. Norton – Lf: E; En: PA; *Luther s.n.* (SEL, iso).

Guzmania circinnata Rauh – Lf: E, T; En: CR, PA; *Grant 97-2665* (MO, SEL), *Carrasquilla 3061* (PMA), *Cáceres 3998* (FR, PMA).

Guzmania coriostachya (Griseb.) Mez – Lf: E; *Bristan 491* (MO), *Pierce 00-26* (PMA), *Luther s.n.* (SEL).

Guzmania darienensis H. Luther – Lf: E; En: PA; *Herrera & al. 1006* (MO, holo), *Skotak s.n.* (SEL), *Anon. s.n.* (SEL).

Guzmania desautelsii Read & L. B. Sm. – Lf: E, S; *Sytsma & Stevens 2213* (MO), *de Nevers 4529* (PMA), *Cáceres & Pérez 3900* (FR, PMA).

Guzmania dissitiflora (André) L. B. Sm. – Lf: E; *Sytsma 2972* (MO), *McPherson 20766* (MO), *Carrasquilla 3060* (PMA).

Guzmania donnellsmithii Mez ex Donn. Sm. – Lf: E, T; *Sytsma & Antonio 2984* (MO), *D'Arcy 10342* (MO), *Cáceres & Pérez 3813* (FR, PMA).

Guzmania elvallensis H. Luther – Lf: E; En: PA; *Knapp 5320* (MO, holo), *Read 84* (SEL), *Berg P40* (SEL).

Guzmania filiorum L. B. Sm. – Lf: E; En: PA; *Antonio & al. 3405* (MO), *Mori & al. 3743* (MO), *Pierce 00-37* (PMA).

Guzmania flagellata S. Pierce & J. R. Grant – Lf: E, T; En: PA; *Duke 8022* (MO), *Tyson 3532* (SCZ), *Berg s.n.* (SEL).

Guzmania glomerata Mez & Wercklé – Lf: E, T; *Dwyer & Lallathin 8694* (NY), *Luther 1095* (SEL), *Cáceres & Pérez 3894* (FR, PMA).

Guzmania graminifolia (André ex Baker) L. B. Sm. – Lf: E.

Distribution: Panama (Fig. 1), Colombia, Ecuador, Peru.

Panama: Darien, Chepigana, Darien National Park, Cerro Pirre, 7.2.1991, *Herrera & al. 880* (MO, PMA).

Guzmania hollinensis H. Luther – Lf: T.

Distribution: Panama (Fig. 1), Colombia, Ecuador, Peru.

Panama: Chiriqui, Gualaca Distr., Fortuna Forest Reserve (Bijao, Chiriqui river-top), 20.6.2009, *Cáceres 4062* (FR, PMA).

Guzmania kennedyae L. B. Sm. & Read – Lf: E; En: CO, PA; *Churchill & al. 4931* (MO), *Croat 22674* (MO), *Hammel 2326* (MO).

Guzmania lingulata (L.) Mez – Lf: E, T; *Gentry 8776* (MO), *Hamilton & Davidse 2605* (PMA), *Cáceres & Fuentes 4012* (FR, PMA).

Guzmania loraxiana J. R. Grant – Lf: E; En: PA; *Grant & Rundell 97-2660* (US, holo, n.v.). *Cáceres & Pérez 3964* (FR, PMA).

Guzmania macropoda L. B. Sm. – Lf: E, T; En: PA; *Tyson & al. 4446* (MO, iso), *McPherson 12114* (MO), *Pierce 00-25* (PMA).

Guzmania membranacea L. B. Sm. & Steyerm. – Lf: T; *McPherson 10625* (MO), *Skotak s.n.* (SEL).

Guzmania mitis L. B. Sm. – Lf: E; *Sytsma & al. 2734* (MO).

Guzmania monostachia (L.) Rusby ex Mez – Lf: E; *Croat 22011* (MO), *Liesner 1089* (PMA), *Cáceres & Pérez 4134* (FR, PMA).

Guzmania multiflora (André) André ex Mez – Lf: E; *Churchill & Rauh 4997* (MO, n.v.).

Guzmania musaica (Linden & André) Mez – Lf: E, T; *Sytsma & D'Arcy 3573* (MO), *Folsom 3618* (PMA), *Cáceres & Pérez 3893* (FR, PMA).

Guzmania nicaraguensis Mez & C. F. Baker ex Mez – Lf: E, T; *Kirkbride & Duke 1290* (MO, NY), *Mori & Kallunki 5842* (PMA), *Cáceres & Pérez 3913* (FR, PMA).

Guzmania obtusiloba L. B. Sm. – Lf: E; *Knapp 5063* (MO), *Croat 69032* (MO), *Cáceres 4066* (FR, PMA).

Guzmania patula Mez & Wercklé – Lf: E; *Mori & Kallunki 2725* (MO), *Gentry 2133* (MO, SCZ), *Dressler 4121* (PMA).

Guzmania plicatifolia L. B. Sm. – Lf: E, T; En: CR, PA; *Knapp 1152* (MO, NY), *Foster 1902* (PMA), *Cáceres & Pérez 3906* (FR, PMA).

Guzmania polycephala Mez & Wercklé ex Mez – Lf: E, T; *Croat 15691* (MO), *Hammel 4731* (MO), *Luther s.n.* (SEL).

Guzmania sanguinea (André) André ex Mez – Lf: E; *Antonio 5126* (MO), *Cáceres 4100* (FR, PMA).

Guzmania scandens H. Luther & W. J. Kress – Lf: E, T; En: CR, PA; *Gentry & Clewell 7006* (MO), *Croat 68929* (MO), *Cáceres 4152* (FR, PMA).

Guzmania scherzeriana Mez – Lf: E; *De Nevers & al. 5264* (MO), *Hamilton & Davidse 2838* (PMA), *Cáceres & Pérez 3801* (FR, PMA).

Guzmania sp. – Lf: E; En: PA; *Luther 1093* (SEL).

Guzmania speciosa H. Luther – Lf: E; En: PA; *Luther s.n.* (SEL), *Skotak s.n.* (SEL).

Guzmania sphaeroidea (André) André ex Mez – Lf: E; *Stevens 18434* (MO), *de Nevers & al. 5574* (MO), *Carrasquilla 2099* (MO, PMA).

Guzmania sprucei (André) L. B. Sm. – Lf: E, T; *Liesner 698* (MO), *Peña & al. 441* (PMA), *Cáceres & Pérez 3815* (FR, PMA).

Guzmania stenostachya L. B. Sm. – Lf: E, T; En: CR, PA; *Kirkbride Jr. & Duke 929* (MO, NY), *Van der Werff & Van Hardeveld 6738* (PMA), *Cáceres & Pérez 3789* (FR, PMA).

Guzmania subcorymbosa L. B. Sm. – Lf: E; *Duke 14205* (MO), *Herrera & al. 1491* (MO), *Hamilton & D'Arcy 1394* (MO).

Guzmania teucamae H. Luther & K. F. Norton – Lf: E; En: PA; *Skotak s.n.* (SEL, iso).

Guzmania zahnii (Hooker f.) Mez – Lf: E; *Croat 37894* (MO), *D'Arcy & McPherson 16200* (MO), *Cáceres 4114* (FR, PMA).

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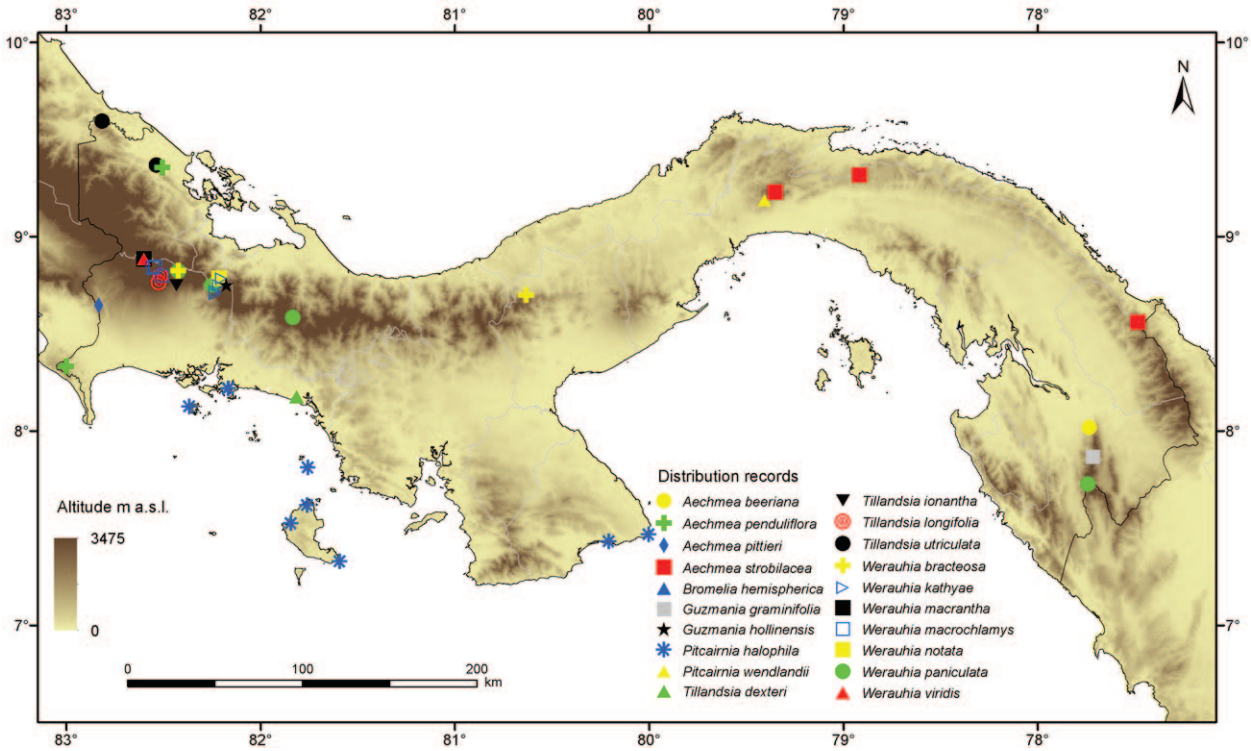


Fig. 1. Distribution of bromeliad species newly recorded for the flora of Panama. – Details see text.

Table 1. *Bromeliaceae* of Panama: species richness and endemism.

Subfamily & genera	Number of species	% of bromeliad flora	Number of endemic species	% of endemic species
Tillandsioideae				
Catopsis	8	3.9	1	3
Guzmania	45	21.8	12	36.4
Mezobromelia	1	0.5	0	0
Racinaea	5	2.4	0	0
Tillandsia	34	16.5	0	0
Vriesea	7	3.4	3	9.1
Werauhia	47	22.8	6	18.2
Subtotal = 7	**147**	**71.4**	**22**	**66.7**
Bromelioideae				
Aechmea	21	10.2	4	12.1
Ananas	2	1	0	0
Araeococcus	1	0.5	0	0
Billbergia	1	0.5	0	0
Bromelia	3	1.5	0	0
Greigia	2	1	0	0
Ronnbergia	3	1.5	0	0
Subtotal = 7	**34**	**16.5**	**4**	**12.1**
Pitcairnioideae				
Pepinia	2	1	1	3
Pitcairnia	23	11.2	6	18.2
Subtotal = 2	**25**	**12.2**	**7**	**21.2**
Total = 16	**206**	**100**	**33**	**100**

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Fig. 2. A: *Pitcairnia halophila,* Gulf of Chiriqui Marine National Park, Paridas Islands; B: *Tillandsia dexteri,* Remedios Distr.; C: *T. utriculata,* Changuinola Distr., after the community of El Silencio; D: *Werauhia paniculata,* Boquete Distr., El Pianista Trail to Culebra. – Photographs A, B, D by D. Cáceres; photograph C by L. Pérez.

Mezobromelia pleiosticha (Griseb.) Utley & H. Luther – Lf: E; *Dwyer & Lallathin 8748* (MO, NY), *Cáceres & Pérez 3850* (FR, PMA).

Pepinia aphelandriflora André – Lf: T, S; *Aizprúa & Alvarez B4181* (F n.v., MO, PMA, SCZ), *von Wedel 2282* (MO), *McPherson 10706* (MO, PMA).

Pepinia hammelii (H. Luther) H. Luther – Lf: T, S; En: PA; *Hammel 3182* (MO), *Hammel & de Nevers 13599* (MO, iso; SEL, holo).

Pitcairnia arcuata (André) André – Lf: E, T; *Folsom & Page 5945* (MO, NY), *Churchill 3950* (SCZ), *Cáceres & Pérez 3795* (FR, PMA).

Pitcairnia atrorubens (Beer) Baker – Lf: E, T, S; *Gentry & al. 3483* (MO, NY), *Kennedy 1533* (SCZ), *Cáceres & Pérez 3793* (FR, PMA).

Pitcairnia brittoniana Mez – Lf: E; *Gentry & Mori 14017* (MO), *Cáceres & Pérez 3951* (FR, PMA).

Pitcairnia carnea Beer – Lf: T; En: PA; *Manzanares 7433* (MO, QCNE), *Warscziewicz s.n.* (MO photo; NY photo).

Pitcairnia chiriquensis L. B. Sm. – Lf: T, S; En: PA; *Allen 5016* (MO, iso), *Grant & Rundell 97-2826* (MO, NY, SEL), *Cáceres & Pérez 3829* (FR, PMA).

Pitcairnia croatii H. Luther – Lf: T; En: PA; *Croat 66448* (MO, holo).

Pitcairnia diffusa L. B. Sm. – Lf: E, T; *Hammel 2405* (MO), *Bruce & Hamilton 1106* (MO), *de Nevers & al. 6734* (MO).

Pitcairnia geotropa J. R. Grant – Lf: T; En: PA; *Grant & Rundell 97-2645* (SEL, iso), *Grant 97-2816* (SEL).

Pitcairnia halophila L. B. Sm. – Lf: S, T.
Distribution: Costa Rica, Panama (Fig. 1, 2A).

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Panama: Chiriqui, San Lorenzo Distr., Horconcitos (Hermosa Beach), 8.8.2008, *Cáceres & al. 3939* (FR, PMA); ibid., 16.5.2009, *Cáceres & al. 3994* (FR, PMA); David Distr., Pedregal, Golfo de Chiriqui Marine National Park, Paridas Islands, 25.6.2009, *Cáceres & al. 4093* (FR, PMA); Veraguas, Montijo Distr., Coiba Island, 27.8.1970, *Foster 1639* (MO, PMA); Montijo Distr., Coiba Island, 1.12.1996, *Galdames & al. 3566* (MO, NY, SCZ); Montijo Distr., Coiba National Park, 3.12.1996, *Galdames & al. 3616* (SCZ); Las Palmas Distr., Coiba National Park (Uva Island), 3.6.2004, *Ibáñez s.n.* (SEL). Los Santos, Pedasi, Punta Mala, 14.4.1970, *Croat 4216* (MO); Pedasi, Venado Beach, 30.10.1978, *Hammel 5474* (MO, SCZ).

Pitcairnia heterophylla (Lindl.) Beer – Lf: E, T, S; *Dodge & Allen 17467* (MO), *Croat 13587* (SCZ), *Cáceres & Pérez 3916* (FR, PMA).

Pitcairnia imbricata (Brongn.) Regel – Lf: T, S; *Schmalzel & al. X38* (MO), *Hamilton & Krager 3792* (MO), *Cáceres 4048* (FR, PMA).

Pitcairnia kalbreyeri Baker – Lf: T; *Knapp & al. 4232* (MO), *Davidson 300* (MO), *Cáceres 4081* (FR, PMA).

Pitcairnia kressii H. Luther – Lf: E, T; En: PA; *Croat 66836* (MO), *Luther & al. 1131* (SEL, holo), *Cáceres 4000* (FR, PMA).

Pitcairnia lymansmithiana H. Luther – Lf: E, T; En: CR, PA; *McPherson 12577* (MO), *Luther 1099* (SEL, holo), *Cáceres & Pérez 3891* (FR, PMA).

Pitcairnia maidifolia (C. Morren) Decne. – Lf: E, T, S; *D'Arcy 9552* (MO), *Lewis & al. 3156* (MO), *Croat 12380* (MO).

Pitcairnia megasepala Baker – Lf: E, T; *Sytsma & D'Arcy 3456* (MO), *Hernández & al. FH1295* (SCZ), *Cáceres & Pérez 3851* (FR, PMA).

Pitcairnia multiflora L. B. Sm. – Lf: E, T; En: PA & CO; *Hamilton & Davidse 2681* (MO), *Ibáñez & al. AI5841* (SCZ), *Cáceres 4064* (FR, PMA).

Pitcairnia nigra (Carrière) André – Lf: E, T; *Zizka Z40* (FR), *Luther 1041* (SEL), *Cáceres & Pérez 3947* (FR, PMA).

Pitcairnia rundelliana J. R. Grant – Lf: T; En: PA; *D'Arcy 16279* (MO, PMA), *Grant 97-2882* (SEL, iso), *Cáceres & Pérez* 3787 (FR, PMA).

Pitcairnia saxicola L. B. Sm. – Lf: S; *Warszewicz s.n.* (MO photo).

Pitcairnia schultzei Harms – Lf: T, S; *Luteyn & Foster 1384* (MO), *Croat 37040* (MO).

Pitcairnia valerioi Standl. – Lf: E, T; En: CR, PA; *Hamilton & Davidse 2629* (MO), *Luther 1078* (SEL), *Cáceres 4155* (FR, PMA).

Pitcairnia wendlandii Baker – Lf: T.
Distribution: Mexico, Belize, Guatemala, Costa Rica, Panama (Fig. 1).
Panama: Panama Distr., Cerro Azul, 8.1985, *Halton s.n.* (SEL).

Racinaea adpressa (André) J. R. Grant – Lf: E; *Zizka Z35* (FR), *Gentry & al. 28697* (MO), *Croat 48626* (MO).

Racinaea contorta (Mez) M. A. Spencer & L. B. Sm. – Lf: E; *Antonio 2820* (MO), *Dwyer & Gentry 9386* (MO, NY, PMA), *Cáceres & Pérez 3816* (FR, PMA).

Racinaea crispa (Baker) M. A. Spencer & L. B. Sm. – Lf: E; *Folsom 4306* (MO), *Foster 14131* (PMA), *Gentry & Mori 13670* (SCZ).

Racinaea schumanniana (Wittm.) J. R. Grant – Lf: E; *Blum & Dwyer 2662* (MO, SCZ), *Luther 1090* (SEL), *Cáceres & al. 3984* (FR, PMA).

Racinaea spiculosa (Griseb.) M. A. Spencer & L. B. Sm. – Lf: E; *McPherson 10586* (MO), *Antonio 5141* (MO, NY), *Cáceres & Pérez 3892* (FR, PMA).

Ronnbergia explodens L. B. Sm. – Lf: E, T; *De Nevers & al. 5380* (MO, PMA), *Correa & Dressler 42* (PMA), *Ibáñez & al. AI6108* (SCZ).

Ronnbergia hathewayi L. B. Sm. – Lf: E, T; *Zizka Z48* (FR), *McPherson 7340* (MO), *Cáceres 4068* (FR, PMA).

Ronnbergia maidifolia Mez – Lf: T; En: PA & CO; *Allen 4493* (MO, n.v.).

Tillandsia anceps Lodd. – Lf: E; *Davidse & Hamilton 23618* (MO, PMA), *Liesner 1097* (PMA), *Cáceres & Pérez 3825* (FR, PMA).

Tillandsia balbisiana Schult. f. – Lf: E; *Croat 12309* (MO, NY), *Nee 10103* (MO, PMA), *Cáceres & Pérez 4135* (FR, PMA).

Tillandsia biflora Ruiz & Pav. – Lf: E; *Stevens 18164* (MO), *Gentry 5981* (MO, PMA), *Cáceres 4145* (FR, PMA).

Tillandsia brachycaulos Schltdl. – Lf: E; *Allen 3478* (MO), *Cáceres & Pérez 3836* (FR, PMA), *Cáceres & Pérez 3944* (FR, PMA).

Tillandsia bulbosa Hook. – Lf: E; *Peterson & Annable 6740* (MO, SEL), *Croat 7048* (SCZ), *Cáceres & Pérez 3826* (FR, PMA).

Tillandsia butzii Mez – Lf: E; *Allen 1592* (MO), *Pittier 3011* (NY), *Cáceres 3997* (FR, PMA).

Tillandsia caput-medusae E. Morren – Lf: E; *Zizka Z9* (FR), *Folsom 3998* (MO), *Cáceres & al. 4095* (FR, PMA).

Tillandsia complanata Benth. – Lf: E; *Woodson Jr. & Schery 602* (MO), *Jerry 1369 (SCZ)*, *Cáceres 4142* (FR, PMA).

Tillandsia compressa Bert. ex Schult. f. – Lf: E; *Woodson Jr. & Schery 823* (MO).

Tillandsia dexteri H. Luther – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1, 2B).
Panama: Chiriqui, Remedios Distr., 12.7.2008, *Cáceres & Pérez 3888* (FR, PMA); ibid., 21.4.2009, *Cáceres 3971* (FR, PMA).

Tillandsia elongata Kunth – Lf: E; *Croat & Porter 15449* (MO), *Allen 4152* (SCZ), *Cáceres 4005* (FR, PMA).

Tillandsia excelsa Griseb. – Lf: E; *Liesner 936* (MO,

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PMA), *Grant 00-3714* (SEL), *Cáceres & Pérez 3945* (FR, PMA).

Tillandsia fasciculata Sw. – Lf: E; *Carrasquilla 2137* (MO, PMA), *Peterson & Annable 7082* (MO, SEL), *Cáceres & al. 4086* (FR, PMA).

Tillandsia festucoides Brongn. ex Mez – Lf: E; *Kirkbride & Bristan 1532* (MO, NY), *Whitefoord & Eddy 493* (PMA), *Cáceres & Pérez 4133* (FR, PMA).

Tillandsia flexuosa Sw. – Lf: E; *Woodson Jr. & al. 1488* (MO, NY), *Knapp 1926* (MO, PMA), *Cáceres & Pérez 3831* (FR, PMA).

Tillandsia guatemalensis L. B. Sm. – Lf: E; *Allen 4361* (MO, n.v.).

Tillandsia ionantha Planch. – Lf: E.
Distribution: Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama (Fig. 1), Peru.
Panama: Chiriqui, Boquete Distr., Alto Boquete, 24. 1.1969, *Partch 69-107* (MO).

Tillandsia juncea Poir. – Lf: E; *Sytsma & D'Arcy 3455* (MO, NY), *Liesner 120* (MO, PMA), *Cáceres 4084* (FR, PMA).

Tillandsia kegeliana Mez – Lf: E; *Tyson & Smith 4158* (MO), *Hammel 7325* (MO), *Duke 14314* (MO, NY).

Tillandsia leiboldiana Schltdl. – Lf: E; *Stevens 18438* (MO), *Laube & al. SL133* (PMA, SCZ), *Cáceres 3993* (FR, PMA).

Tillandsia longifolia Baker – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1), Peru, Venezuela, Bolivia.
Panama: Chiriqui, Dolega Distr., El Burro, Potrerillos, 18.6.2009, *Cáceres & al. 4060* (FR, PMA); Boquete Distr., 16.7.2009, *Cáceres 4146* (FR, PMA).

Tillandsia monadelpha (E. Morren) Baker – Lf: E; *Gentry & al. 3453* (MO, NY, PMA), *Hamilton & Davidse 2657* (MO, PMA), *Cáceres & Pérez 3805* (FR, PMA).

Tillandsia multicaulis Steud. – Lf: E; *Croat 26966* (MO), *Dressler & Williams 4007* (PMA), *Cáceres & Pérez 3922* (FR, PMA).

Tillandsia oerstediana L. B. Sm. – Lf: E; En: CR, PA; *Carrasquilla 3054* (MO), *Cáceres 4004* (FR, PMA), *Cáceres 4149* (FR, PMA).

Tillandsia pinnata Mez & Sodiro – Lf: E; *Croat 60500* (MO), *Dressler 4592* (PMA), *Skotak s.n.* (SEL).

Tillandsia pruinosa Sw. – Lf: E; *Laube & al. SL460* (SCZ), *Luer 10597* (SEL).

Tillandsia punctulata Schltdl. & Cham. – Lf: E; *Hamilton & al. 1225* (MO), *Woodson Jr. & al. 991* (MO, NY), *Cáceres & Pérez 3846* (FR, PMA).

Tillandsia singularis Mez & Wercklé – Lf: E, T; *Croat 25888* (MO, PMA), *Blance 3001* (SEL), *Cáceres 4074* (FR, PMA).

Tillandsia subulifera Mez – Lf: E; *Cáceres & Pérez 3935* (FR, PMA).

Tillandsia tricolor Schltdl. & Cham. – Lf: E; *Antonio 5142* (MO), *Liesner 259* (MO, PMA), *Cáceres 3996* (FR, PMA).

Tillandsia usneoides (L.) L. – Lf: E; *Allen 3667* (MO, NY), *Dressler 4296* (MO, PMA), *Cáceres & Pérez 3887* (FR, PMA).

Tillandsia utriculata L. – Lf: E.
Distribution: Mexico, Belize, Guatemala, Costa Rica, Honduras, Nicaragua, Panama (Fig. 1, 2C), Dominican Republic, Haiti, Jamaica, Puerto Rico, United States (Florida) and Virgin Islands, Trinidad and Tobago.
Panama: Bocas del Toro, Changuinola Distr., after the community of El Silencio, 2.8.2008, *Cáceres & Pérez 3933* (FR, PMA); Changuinola Distr., Las Tablas, near the river and community of Sibube, 14.7.2009, *Cáceres & Pérez 4128* (FR, PMA).

Tillandsia variabilis Schltdl. – Lf: E; *von Wedel 1395* (MO), *Dodge & Steyermark 17033* (MO), *Cáceres & al. 3976* (FR, PMA).

Tillandsia venusta Mez & Wercklé – Lf: E; *Mori & al. 4205* (MO, PMA), *Laube & al. SL274* (SCZ), *Luther s.n.* (SEL).

Vriesea alta E. Morren *ex* Baker – Lf: E; En: PA; *Morren s.n.* (K, n.v.).

Vriesea chontalensis (Baker) L. B. Sm. – Lf: E; *Croat 23073* (MO), *Liesner 260* (MO, PMA), *Cáceres 3988* (FR, PMA).

Vriesea heliconioides Lindl. – Lf: E; *Tyson & Dwyer 4470* (SCZ), *de Nevers 5960* (MO, PMA), *Cáceres & Pérez 3843* (FR, PMA).

Vriesea incurva (Griseb.) Read – Lf: E; *Folsom & Collins 1831* (MO), *Hammel & al. 6908* (MO), *Cáceres 4105* (FR, PMA).

Vriesea monstrum (Mez) L. B. Sm. – Lf: E, T; *Croat 27083* (MO, PMA), *Pierce 01-42* (SCZ), *Cáceres & Pérez 3817* (FR, PMA).

Vriesea sp. – Lf: E; En: PA; *Hammel & al. 16454* (MO), *Kirkbride & Duke 1376 (*MO, NY, SEL), *Skotak s.n.* (SEL).

Vriesea sp. – Lf: E; En: PA; *Sytsma 3808* (MO), *McPherson 10742* (MO).

Werauhia acuminata (Mez & Wercklé) J. R. Grant – Lf: E, T; En: CR, PA; *Mori & Kallunki 3451* (MO), *Luther 1088* (SEL), *Cáceres 4080* (FR, PMA).

Werauhia attenuata (L. B. Sm. & Pittendr.) J. R. Grant – Lf: E; En: CR, PA; *Mori & Kallunki 4854* (MO), *Nee 9732* (MO), *Croat 67013* (MO).

Werauhia bicolor (L. B. Sm.) J. R. Grant – Lf: E; En: CR, PA; *Luther 1043* (SEL), *Luther 1091* (SEL), *Cáceres 4083* (FR, PMA).

Werauhia bracteosa (Mez & Wercklé) J. R. Grant – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Boquete Distr., Los Naranjos, El Pianista Trail to Culebra, 15.8.2008, *Cáceres & Pérez 3946* (FR, PMA); Cocle, Ola Distr., Nature Reserve El Cope (General de División Omar Torrijos Herrera National Park), 3.3.2004, *Zizka Z55* (FR).

Werauhia brunei (Mez & Wercklé) J. R. Grant – Lf:

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E; En: CR, PA; *Stevens 18426* (MO), *Croat 15787* (MO), *Croat 48630* (MO).

Werauhia burgeri (L. B. Sm.) J. R. Grant – Lf: E; En: CR, PA; *Hamilton & Stockwell 3531* (MO), *Cáceres & Pérez 3792* (FR, PMA), *Cáceres 4112* (FR, PMA).

Werauhia camptoclada (Mez & Wercklé) J. F. Morales – Lf: E; En: CR, PA; *Zizka Z29* (FR), *Schmalzel 1928* (MO).

Werauhia capitata (Mez & Wercklé) J. R. Grant – Lf: E; En: CR, PA; *Mori & Kallunki 3619* (MO), *Pierce 10* (PMA), *Pierce 2* (SEL).

Werauhia comata (Mez & Wercklé) J. R. Grant – Lf: E, T, S; En: CR, PA; *Liesner 924* (MO), *Foster 2072* (PMA), *Luther 1057* (SEL).

Werauhia dressleri (Rauh) J. R. Grant – Lf: T; En: PA; *Dressler s.n.* (HEID).

Werauhia gladioliflora (H. Wendl.) J. R. Grant – Lf: E, T; *Croat 22202* (MO), *Knapp & Chazdon 1406* (MO), *Cáceres 4051* (FR, PMA).

Werauhia graminifolia (Mez & Wercklé) J. R. Grant – Lf: E; *Hammel 2602* (MO), *Correa & al. 2324* (PMA), *Cáceres 4150* (FR, PMA).

Werauhia greenbergii (Utley) J. R. Grant – Lf: E, T, S; *Grant & Rundell 97-2814* (MO, SEL), *Luther 1120* (SEL), *Cáceres 4053* (FR, PMA).

Werauhia hygrometrica (André) J. R. Grant – Lf: E, T, S; *Liesner 888* (MO), *Grant 96-2411* (SEL), *Cáceres 4164* (FR, PMA).

Werauhia insignis (Mez) W. Till, Barfuss & M. R. Samuel – Lf: E, T, S; En: CR, PA; *Knapp & al. 2157* (MO, PMA), *Luther 1051* (SEL), *Cáceres & Pérez 3908* (FR, PMA).

Werauhia jenii S. Pierce – Lf: E; En: PA; *Pierce 15* (SEL, holo).

Werauhia kathyae (Utley) J. R. Grant – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Gualaca Distr., between Quebrada Higueron and Gutiérrez, Chiriquicito-Caldera Trail, 18.4. 1968, *Kirkbride & Duke 767* (MO, NY); Fortuna Dam area, Quebrada Bonito to N of reservoir, 30.7.1984, *Churchill 5760* (MO); Hornito, trail to Hornito River, Fortuna Forest Reserve, 16.7.2008, *Cáceres & Pérez 3897* (FR, PMA); Fortuna Forest Reserve, Quebrada Alemán, 7.7.2009, *Cáceres 4098* (FR, PMA).

Werauhia kupperiana (Suess.) J. R. Grant – Lf: E, T; *Churchill & al. 4171* (MO), *Luther 1134* (SEL), *Cáceres & Fuentes 4036* (FR, PMA).

Werauhia latissima (Mez & Wercklé) J. R. Grant – Lf: E, T; En: CR, PA; *Croat 14785* (MO), *Luther s.n.* (SEL), *Cáceres 4115* (FR, PMA).

Werauhia laxa (Mez & Wercklé) J. R. Grant – Lf: E, T, S; En: CR, PA; *McPherson 7830* (MO), *Luther 1118* (SEL), *Cáceres 4117* (FR, PMA).

Werauhia leucophylla (L. B. Sm.) J. R. Grant – Lf: E, T; En: CR, PA; *Dwyer & Hayden 7756* (MO), *Grant 00-3717* (SEL).

Werauhia lutheri S. Pierce & J. E. Aranda – Lf: E; En: PA; *Pierce 13* (SEL, holo), *Cáceres 4099* (FR, PMA), *Cáceres 4163* (FR, PMA).

Werauhia macrantha (Mez & Wercklé) J. R. Grant – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Las Nubes near Cerro Punta, 7.8.1974, *Croat 26445* (MO), *26446* (MO).

Werauhia macrochlamys (Mez & Wercklé) J. F. Morales – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Boquete Distr., ridgetop above Alto Boquete, 9.4.1979, *D'Arcy & al. 13126* (MO); Bugaba Distr., slopes of Las Cumbres near Cerro Punta, 20.2.1971, *Croat 13773* (MO); Bugaba Distr., 2.2 km SW of Cerro Punta, 7.8.1974, *Croat 26310* (MO).

Werauhia marnier-lapostollei (L. B. Sm.) J. R. Grant – Lf: E; En: CR, PA; *Croat 22204* (MO).

Werauhia millennia J. R. Grant – Lf: E, T; En: PA; *Hammel 2362* (MO), *Tyson & al. 4390* (SCZ), *Grant & Rundell 97-2697* (SEL, iso).

Werauhia nephrolepis (L. B. Sm. & Pittendr.) J. R. Grant – Lf: E, T; *D'Arcy & al. 12945* (MO), *Gentry 6007* (MO, SCZ), *Cáceres & Pérez 3928* (FR, PMA).

Werauhia notata (L. B. Sm. & Pittendr.) J. R. Grant – Lf: E, T.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Bocas del Toro, Bosque Protector Palo Seco, Fortuna Forest Reserve (Cordillera Central), 16.7. 2008, *Cáceres & Pérez 3902* (FR, PMA).

Werauhia ororiensis (Mez) J. R. Grant – Lf: E, T; *Antonio 1587* (MO), *Hammel & al. 7140* (MO), *Cáceres 4139* (FR, PMA).

Werauhia panamaensis (E. Gross & Rauh) J. R. Grant – Lf: E, T; En: PA; *Pierce 99-10* (PMA), *Cáceres 4065 & 4160* (FR, PMA).

Werauhia paniculata (Mez & Wercklé) J. R. Grant – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1, 2D).
Panama: Chiriqui, Boquete Distr., corregimiento de Los Naranjos, El Pianista Trail to Culebra, 16.8.2008, *Cáceres & Pérez 3961* (FR, PMA); Gualaca Distr., Fortuna Dam region, along trail to Cerro Hornito (Pata de Macho), 17.1.1989, *McPherson 13562* (MO); Comarca Ngöbe Bugle, Nole Duima Distr., Cerro Colorado, along road between San Felix River and mining exploration camp, 7 mi W of Chami, 8.7.1988, *Croat 69176* (MO); Darien, Chepigana, Alto de Nique, southernmost peak of Pirre Massif, 19.4.1980, *Gentry & al. 28626* (MO).

Werauhia pedicellata (Mez & Wercklé) J. R. Grant – Lf: E, T; *Croat 48590* (MO), *McPherson 9390* (MO), *Cáceres & Pérez 3948* (FR, PMA).

Werauhia picta (Mez & Wercklé) J. R. Grant – Lf: E; En: CR, PA; *Hammel 7368* (MO), *Croat 37107* (MO), *Cáceres & Pérez 3952* (FR, PMA).

Werauhia pittieri (Mez) J. R. Grant – Lf: E; En: CR, PA;

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Zizka Z36 (FR), *Hammel 1420* (MO), *Luther 1115* (SEL).

Werauhia ringens (Griseb.) J. R. Grant – Lf: E; *Kennedy 2713* (MO), *Liesner 1082* (MO, PMA), *Cáceres & Pérez 3820* (FR, PMA).

Werauhia rubra (Mez & Wercklé) J. R. Grant – Lf: E, T; En: CR, PA; *Mori & Bolten* 7333 (MO), *Luther 1089* (SEL), *Cáceres & Pérez 3949* (FR, PMA).

Werauhia sanguinolenta (Linden ex Cogn. & Marchal) J. R. Grant – Lf: E, T, S; *Croat 15883* (MO, NY), *Carrasquilla 3067* (MO, PMA), *Cáceres & Pérez 3885* (FR, PMA).

Werauhia singuliflora (Mez & Wercklé) J. R. Grant – Lf: E; En: CR, PA; *Berg s.n.* (SEL).

Werauhia stenophylla (Mez & Wercklé) J. R. Grant – Lf: E, T; En: CR, PA; *Churchill & al. 4788* (MO), *Knapp & Sytsma 2642* (MO), *Sullivan 349* (MO).

Werauhia subsecunda (Wittm.) J. R. Grant – Lf: E; *Kirkbride & Duke 1228* (MO).

Werauhia umbrosa (L. B. Sm.) J. R. Grant – Lf: E, T; *McPherson 9940* (MO), *Croat 33469* (MO), *Mori & Kallunki 2344* (MO).

Werauhia viridiflora (Regel) J. R. Grant – Lf: E; *Dwyer & Gentry 9470* (MO), *Luther 1024 (*SEL), *Cáceres & Pérez 3896* (FR, PMA).

Werauhia viridis (Mez & Wercklé) J. R. Grant – Lf: E.
Distribution: Costa Rica, Panama (Fig. 1).
Panama: Chiriqui, Bugaba Distr., Las Nubes near Cerro Punta, 7.8.1974, *Croat 26471* (MO).

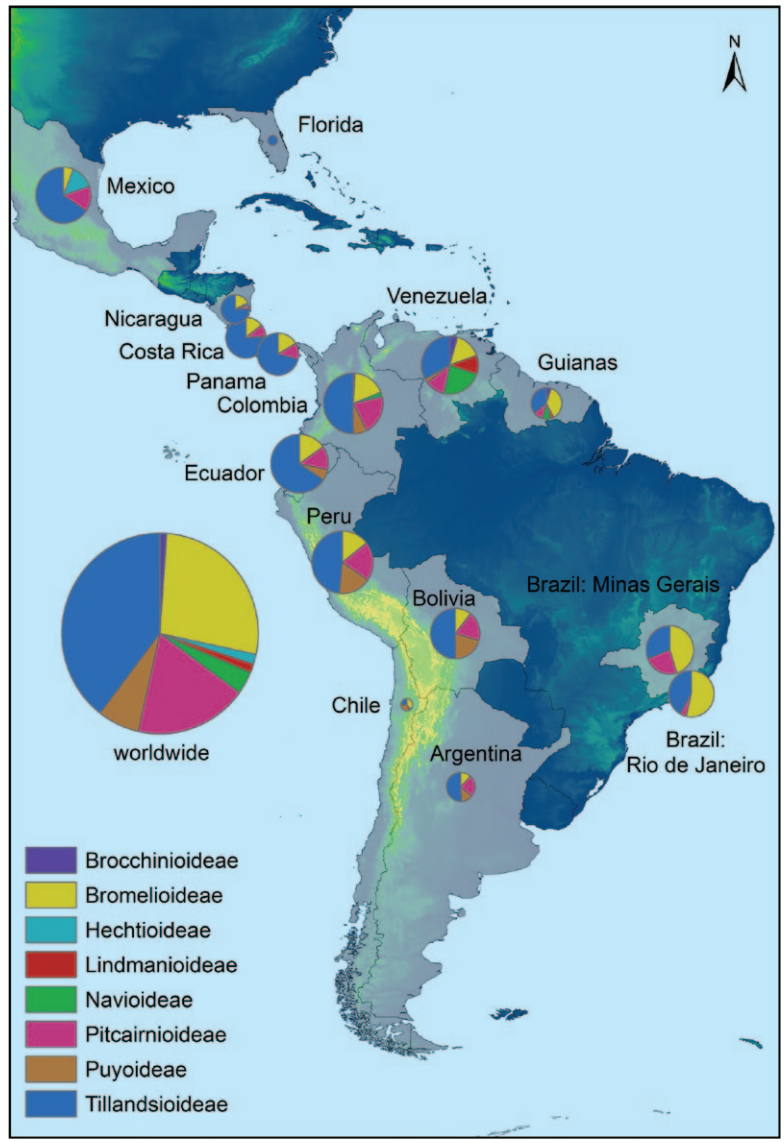


Fig. 3. Systematic diversity of bromeliad floras. – Pie charts show subfamily composition, size corresponds to total number of species per selected area or country, respectively, in Central and South America.

Werauhia vittata (Mez & Wercklé) J. R. Grant – Lf: E; *Croat & Folsom 33912* (MO), *Pierce 6* (PMA, SEL), *Cáceres & Pérez 3963* (FR, PMA).

Werauhia werckleana (Mez) J. R. Grant – Lf: E, T; *Liesner 708* (MO, PMA), *Grant 00-3672* (SEL), *Cáceres 4106* (FR, PMA).

Werauhia williamsii (L. B. Sm.) J. R. Grant – Lf: E; *Knapp 1632* (MO), *Sytsma 1864* (MO), *Cáceres 4085* (FR, PMA).

Werauhia woodsoniana (L. B. Sm.) J. R. Grant – Lf: E; En: PA; *Woodson Jr & al. 1029* (MO, holo).

Species erroneously reported for Panama

Catopsis brevifolia Mez & Wercklé (= *Catopsis morreniana* Mez) – The species was reported for Panama based on *H. von Wedel 233* from Bocas del Toro (MO) by Utley (1994) and Correa & al. (2004). We revised the specimen as *Guzmania donnellsmithii* Mez ex Donn. Sm. Utley, and Correa probably referred to another specimen, *H. von Wedel 2233* (MO), also from Bocas del Toro. That one, however, represents *Catopsis sessiliflora*.

Guzmania sibundoyorum L. B. Sm. – The report by D'Arcy (1987) and Correa & al. (2004) was based on *K. Utley 5643* (DUKE) and *Folsom & Page 5941* (MO). We revised these specimens as *Guzmania circinnata*.

Guzmania tarapotina Ule – Listed by D'Arcy (1987) and Correa & al. (2004) based on *Tyson, Dwyer & Blum 3208* (MO, SCZ). This collection represents *Guzmania calamifolia*.

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Pitcairnia attenuata L. B. Sm. – The records by D'Arcy (1987) and Correa & al. (2004) are based on the collection *Mass, Berg & Dressler 2780* (MO, PMA, SCZ). This collection belongs to *Pitcairnia multiflora*.

Tillandsia acostae Mez & Tonduz – The records by D'Arcy (1987) and Correa & al. (2004) are based on *Woodson Jr. & Schery 823* (MO) collected in 1940. The specimen belongs to *Tillandsia compressa*.

Tillandsia lampropoda L. B. Sm. – Listed by Correa & al. (2004) based on Utley (1994). The specimen cited, *Croat 26951* (MO) from 1974, actually represents *Tillandsia multicaulis*.

Discussion

Endemism — The comprehensive study of herbarium specimens from Panama and Costa Rica revealed not only additions to the bromeliad flora of Panama and some erroneous records but also provided some insight into the species endemism of bromeliads in Panama. Previously, 43 species were regarded to be endemic to Costa Rica (Morales 2003: 22.1 % of the total bromeliad flora) and 17 species to Panama (Correa & al. 2004: 9.6 % of bromeliad flora). Our results now give a different picture, with 33 species endemic to Panama, 32 species endemic to Costa Rica (own unpublished data) and 34 species occurring only in both countries. Seen in comparison to land surface area, the bromeliad endemism is considerably high in Panama. Western Panama with its higher geodiversity and altitudinal range of 0–3475 m displays higher endemism per area than eastern Panama.

In Panama, endemism in the family *Bromeliaceae* is distributed among the subfamilies as follows: the *Tillandsioideae* comprise most endemics (22 species (66.7 %), followed by *Pitcairnioideae* with 7 species (21.2 %) and *Bromelioideae* with 4 species (12.1 %) (Table 1).

Systematic diversity — The systematic diversity of the Panamanian bromeliad flora is confined to three subfamilies, with by far the highest diversity found in *Tillandsioideae* (147 species, *Bromelioideae:* 34 species, *Pitcairnioideae:* 25 species). The five other currently recognised bromeliad subfamilies (*Brocchinioideae, Lindmanioideae, Hechtioideae, Navioideae* and *Puyoideae;* Givnish & al. 2007, 2011) are not represented in the Panamanian flora. Table 2 gives a brief summary of the species diversity of subfamilies in selected areas respective countries. A strong dominance of *Tillandsioideae* can also be found in Costa Rica (Morales 2003), Mexico (Espejo-Serna & al. 2004), Colombia (Holst 1994), Ecuador (Holst 1994), Peru (Holst 1994) and Bolivia (Krömer & al. 1999). This can thus be regarded as characteristic for Central American bromeliad floras and those of South American countries comprising considerable parts of the Andes. The bromeliad flora of the Guianas (Gouda 1999) includes 6 subfamilies, *Bromelioideae* and *Tillandsioideae* comprising the greatest number of species with each being similarly diverse.

In the state of Minas Gerais, Brazil, the data present a different picture (Versieux & Wendt 2006). There the *Bromelioidea*e are most diverse (120 species) followed by *Tillandsioideae* (82 species) and *Pitcairnioideae* (63 species) (Fig. 3, Table 2). There is a similar situation in

Table 2. *Bromeliaceae* diversity (subfamilies and total) in selected political units; BRC = *Brocchinioideae,* BRO = *Bromelioideae,* HEC = *Hechtioideae,* LIN = *Lindmanioideae,* NAV = *Navioideae,* PIT = *Pitcairnioideae* s.str., PUY = *Puyoideae,* TIL = *Tillandsioideae.* – Data: [1] this publication; [2] Utley & al. (2001); [3] Morales (2003); [4] Espejo-Serna & al. (2004); [5] Holst (1994); [6] Gouda (1999); [7] Krömer & al. (1999); [8] Versieux & Wendt (2006); [9] Fontoura & al. (1991); [10] Morrone & Zuloaga (1996); [11] Zizka & al. (2009); [12] Luther & Benzing (2009). Size of countries taken from Wikipedia (2011).

Country	BRC	BRO	HEC	LIN	NAV	PIT	PUY	TIL	Total	Size (km²)
Panama[1]		34				25		147	206	75 517
Panama: W Panama[1]		23				22		121	167	28 789
Nicaragua[2]		19	3			4		81	107	129 494
Costa Rica[3]		28				19	2	147	105	50 660
Mexico[4]		21	49			48		224	342	1 964 375
Colombia[5]	4	70			10	82	29	196	391	1 141 748
Venezuela[5]	17	56		38	84	41	8	120	364	916 445
Guianas[6]	6	46		4	11	12		44	123	214 970
Ecuador[5]		56				48	22	242	368	283 561
Peru[5]		59				83	70	199	411	1 285 215
Bolivia[7]		30				53	57	141	281	1 098 581
Brazil: Minas Gerais[8]		120				63		82	265	588 528
Brazil: Rio de Janeiro[9]		131				11		103	245	43 766
Argentina[10]		14				26	14	56	110	2 766 400
Chile[11]		9				1	7	6	23	756 096
U.S.A.: Florida[12]								16	16	170 305

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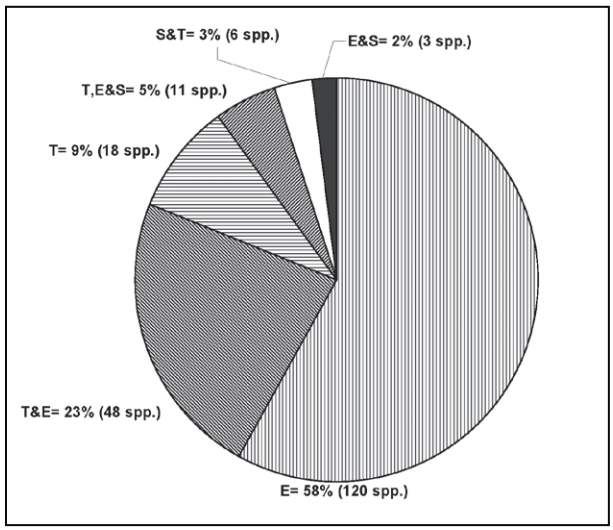


Fig. 4. *Bromeliaceae* of Panama: life form spectrum. E: epiphytic, T: terrestrial, S: saxicolous.

the bromeliad flora of Río de Janeiro: *Bromelioideae* (131 species), *Tillandsioideae* (102 species) and *Pitcairnioideae* (11 species) (Fontoura & al. 1991) (Fig. 3, Table 2). This is in line with the reconstruction of the evolution of the *Bromelioideae,* which underwent recent and massive radiation in the coastal forests of Brazil (Schulte & al. 2005; Schulte & Zizka 2008).

The bromeliad flora of Chile is much poorer (23 species) with *Bromelioideae, Puyoideae* and *Tillandsioideae* being the most diverse subfamilies (Zizka & al. 2009) (Fig. 3, Table 2). The bromeliad flora of Venezuela, putative cradle of the family, is more diverse and varied with 7 subfamilies being represented, probably due to the variety of habitats, including the geologically ancient table mountains: *Tillandsioideae* (120 species), *Navioideae* (84), *Bromelioideae* (55), *Pitcairnioideae* (41), *Lindmanioideae* (38), *Brocchinioideae* (16) and *Puyoideae* (8) (Holst 1994) (Fig. 3, Table 2).

***Life form* —** Fig. 4 sums up the life-forms of bromeliads in Panama. 120 species grow epiphytically and 18 as terrestrials. 48 species can be found both as epiphytic or terrestrials (e.g. *Pitcairnia heterophylla, P. valerioi, Werauhia rubra*), 11 additionally as saxicoles, 3 species were found growing both as epiphytes and saxicoles. Of the 206 reported species, 182 (88.4 %) are obligatory or facultative epiphytes. 83 species (40.3 %) are found exclusively or facultatively growing in soil or on rocks. The high proportion of epiphytes in the flora of Panama can be best explained by the natural vegetation of the country, which consisted of different types of tropical forest throughout the majority of its land area.

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