



A multivariate analysis of the *Pitcairnia palmeri* group (Bromeliaceae: Pitcairnioideae)

EDITH GONZÁLEZ-ROCHA¹, MANUEL ARNOLDO CASTILLO-RIVERA², ANA ROSA LÓPEZ-FERRARI² & ADOLFO ESPEJO-SERNA²

¹ Universidad Autónoma Metropolitana, División de Ciencias Biológicas y de la Salud, Programa de Doctorado en Ciencias Biológicas y de la Salud, Ciudad de México, México. E-mail: gore_1986@hotmail.com

² Departamento de Biología, División de Ciencias Biológicas y de la Salud, Universidad Autónoma Metropolitana Unidad Iztapalapa, Apartado Postal 55-535, 09340, Ciudad de México, México.

Abstract

A multivariate analysis of the *Pitcairnia palmeri* group are presented. Principal Components and Cluster analyses were performed in order to have more accurate information to delimit the species. The analyses showed that the specimens referred to *Pitcairnia palmeri* var. *longebracteata* are clearly delimited, while those identified as *P. palmeri* var. *palmeri*, *P. colimensis*, and *P. compostelae* have a greater overlap of morphological characters, but remain as separate entities. A discriminant analysis showed that morphological characters used have significant multivariate differences between the taxa ($P < 0.0005$), and that the most important variables in the differentiation of these taxa are the percentage of floral bracts that exceeds the length of the sepals, the length of the floral bracts, and the length of the peduncle. We conclude that *P. palmeri* var. *longebracteata* is clearly a different species, not a variety, therefore is described and illustrated as *P. robert-downsii*, and that *P. palmeri*, *P. compostelae* and *P. colimensis* maintain their taxonomic status.

Keywords: Durango, *Pitcairnia*

Resumen

Se presenta un análisis multivariado del grupo de *Pitcairnia palmeri*. Se realizaron análisis de componentes principales y de conglomerados con el propósito de obtener información más precisa para delimitar las especies. Dichos análisis mostraron que los especímenes referidos a *Pitcairnia palmeri* var. *longebracteata* están claramente delimitados, en tanto que los identificados como *P. palmeri* var. *palmeri*, *P. colimensis* y *P. compostelae* presentan una mayor superposición en sus caracteres morfológicos, aunque se mantienen como entidades separadas. Un análisis de discriminantes mostró que los caracteres morfológicos utilizados presentan diferencias significativas entre los taxa ($P < 0.0005$), y que las variables más importantes para diferenciarlos son el porcentaje de brácteas florales que sobrepasan el tamaño de los sépalos, el largo de las brácteas florales y el del pedúnculo. Se concluye que *P. palmeri* var. *longebracteata* es claramente una especie diferente, no una variedad, por lo que se describe e ilustra *P. robert-downsii* y que *P. palmeri*, *P. compostelae* y *P. colimensis* mantienen su estatus taxonómico.

Palabras clave: Durango, *Pitcairnia*

Introduction

Pitcairnia L'Heritier (1788: 5, t. 11), including *Pepinia* Brongn ex André (1870: 32, t. 5) (Pereira Saraiva *et al.* 2015), is the largest genus of the Pitcairnioideae (sensu Givnish *et al.* 2007) and comprises ca. 406 species (Gouda *et al.* cont. updated). The members of the genus are mostly terrestrial or saxicolous plants, with perfect and showy zygomorphic flowers, free convolute sepals, stamens subequal with linear anthers, capsular fruits, and bicaudate to winged seeds. In Mexico there are 50 taxa, 40 (80 %) of which are endemic (Espejo-Serna 2012; Espejo-Serna *et al.* 2017).

There are several Mexican species groups of the genus with problems of specific delimitation. This is the case of a group of endemic species distributed in the Sierra Madre Occidental, formed by: *Pitcairnia colimensis* Smith (1969:

139), *P. compostelae* McVaugh (1989: 27), and *P. palmeri* Watson (1887: 456) with two varieties: *P. palmeri* var. *longebracteata* Smith (1960: 65) and *P. palmeri* var. *palmeri*. All the members of the group are frequently confused, particularly in herbarium material, because they share morphological similarities: plants from 10–45 cm high that grow on rocky cliffs or slopes, showing pedicellate flowers with red-scarlet petals, 4–6 cm long, and floral bracts variable in length in relation to the length of pedicels and/or sepals.

Pitcairnia palmeri was published by S. Watson (1887), based on a specimen collected by E. Palmer (No. 16) in the vicinity of Río Blanco, Jalisco. In 1960, L.B. Smith proposed *P. palmeri* var. *longebracteata* as a new variety, based on material from Pueblo Nuevo, Durango (*H.S. Gentry & C.L. Gilly 10625*, LL!). Later in *Flora Neotropica*, Smith & Downs (1974) considered several specimens from the states of Chihuahua (*H. Leseur 1258*, GH!), Jalisco (*E. Holway No. A*, GH), Michoacán (*R.M. King & T.S. Soderstrom 4846*, US!), Morelos (*C.G. Pringle 9181*, GH!, US!), and Nayarit (*R. McVaugh 16496*, MICH!, US!) as *P. palmeri* var. *longebracteata*, which have later been identified as other species.

Pitcairnia colimensis was published in 1969 by L.B. Smith based on material collected in Colima (*R. McVaugh 15509* (MICH!, US!), *H.H. Iltis et al. 676* (MICH!, US!)). Finally, McVaugh (1989) published *P. compostelae* based on specimens from the vicinity of Compostela, Nayarit (*Gentry & Gilly 10825*; *McVaugh 16496*) and Talpa, Jalisco (*R. González T. 428*), comparing it with *P. palmeri* var. *longebracteata* and *P. colimensis*. McVaugh commented that all the specimens that he included in *P. compostelae* had originally been identified as *P. palmeri* var. *longebracteata*, but differed from this taxon by the apparent absence of reduced spiny leaves, by the fasciculate and foliaceous basal peduncle bracts, and especially by the adaxial sepals with a thin dorsal wing. He also pointed out that the plants of *P. compostelae* are similar by the presence of inflorescences with secund and pedicellate flowers, like those of *P. palmeri* var. *palmeri*.

The delimitation of the species in the group have been complicated because they all have similar flowers and they differ in characteristics not easy to observe in herbarium material, such as the presence or not of a wing or carina in the sepals, the more or less secund flowered inflorescence, and the presence or not of spiny reduced leaves (Fig. 1). With the aim to have more accurate information that allow us to clarify the delimitation of the species, we conducted a multivariate analysis that included a representative sample of specimens and morphological variables of the group.

Materials and methods

Selection of specimens and characters

A total of 150 specimens were studied, including fresh specimens collected in the field and the type specimens of all the taxon names involved, from the following institutional collections: BM, BR, CHAPA, CORU, ENCB, FCME, GH, IBUG, IEB, K, LL, MEXU, MICH, MO, P, TEX, UAMIZ, UC, US, and XAL (Thiers, cont. updated). From the total examined specimens, only 59 (Appendix 1) presented the complete structures to carry out the multivariate analysis. Each specimen was treated as an operational taxonomic unit (OTU).

The measurements were obtained with a digital caliper directly from the specimens. In the case of the nomenclatural types, data were obtained from images displayed on the JSTOR Global Plants page (ITHAKA 2000–2017) or from author photographs captured by means of ImageJ software (Schneider *et al.* 2012).

Statistical analyses

Principal component analyses (PCA) were used to reduce the number of variables originally considered as well as multicollinearity. This procedure allowed to reduce, retaining the maximum of the original variability, the 45 morphological variables initially considered to 12. A final PCA analysis was also used to detect if the 12 retained variables showed a clear multivariate pattern related to the probable differentiation of OTUs (Hair *et al.* 2010; Tabachnick & Fidell 2012).

With the purpose of finding potential patterns of similarity between OTUs and the consequent formation of groups (McGarigal *et al.* 2000), a cluster analysis (CA) based on a matrix of Euclidean distances constructed with the 12 selected variables, was performed with the UPGMA fusion technique.



FIGURE 1. Herbarium specimens of A) *Pitcairnia palmeri*, B) *Pitcairnia robert-downsii*, C) *P. colimensis*, and D) *P. compostelae*.

In order to determine if there were statistically significant multivariate differences between the groups (species) founded, a discriminant analysis (DA) was applied. The morphological characters were used as discriminating variables and the grouping variable was the species. To measure the similarities or differences between the groups (species) the

Wilks's Lambda (λ) criterion was used, which is easy to interpret, because its values vary from 1 (total similarity) to 0 (total difference). Finally, to evaluate the importance of each morphological variable in the differentiation of the groups (species), the correlations between the original discriminatory variables and the corresponding derived discriminant functions were used; the larger each correlation coefficient is, the greater is the importance of each variable (Hair *et al.* 2010; Tabachnick & Fidell 2012). In all previously mentioned analyses, the variables were transformed to \log_2 . The PCA and CA analyses were carried out with the MVSP program (Kovach 2005) and the DA with the SPSS program (2013).

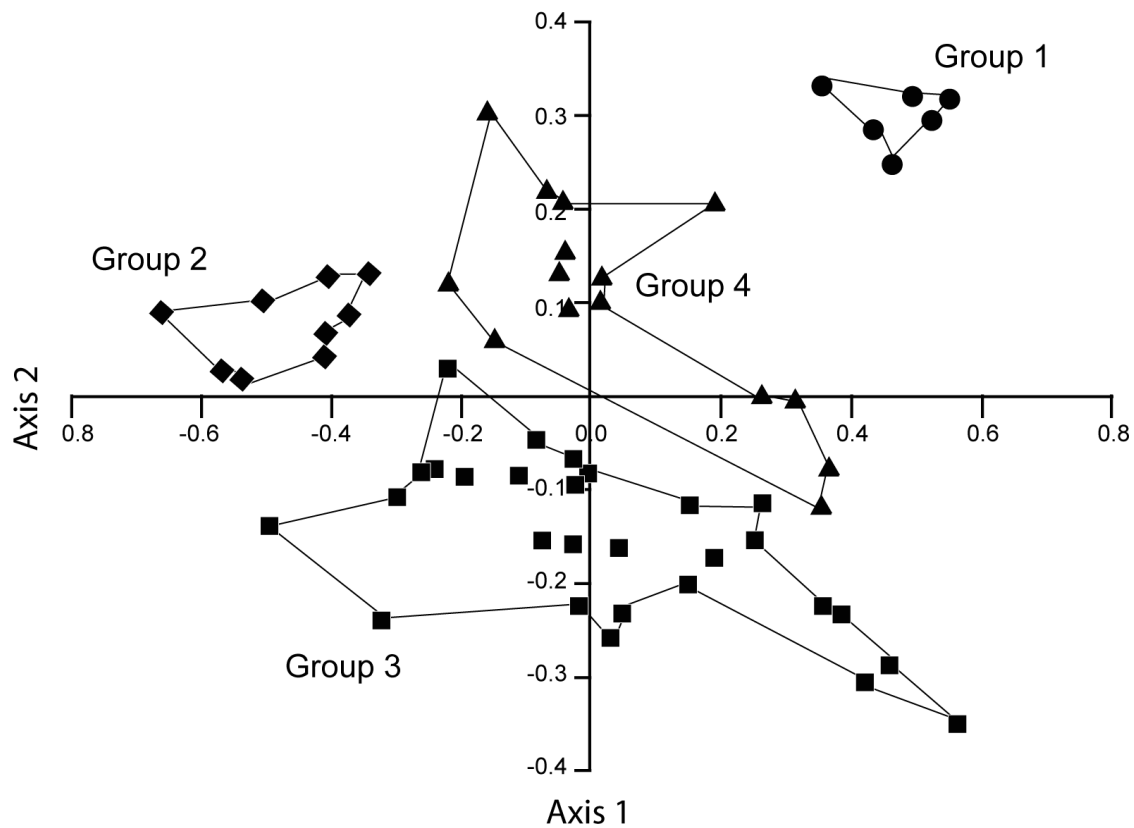


FIGURE 2. Scatterplot between the first two axes (cumulative variance of 66.7 %) derived from the principal component analysis applied to 12 morphological variables transformed to \log_2 . The symbols correspond to *Pitcairnia colimensis* (◆), *P. compostelae* (▲), *P. palmeri* var. *longibracteata* (●) and *P. palmeri* var. *palmeri* (■).

Results

According to the PCA, the first axis explained 50.42 % of the total variance and the second explained 16.28 %, with a total of 66.7 % in the first two axes. The scatterplot between these two axes (Fig. 2) clearly shows that, based on the morphological variables considered, four groups are formed: the first clearly separated from the rest of the OTUs, and conformed by specimens from the state of Durango that can be referred to Smith's *Pitcairnia palmeri* var. *longibracteata* (●, positive values for both axes), the second formed by specimens identified as *P. colimensis* (◆), the third formed by a large group of specimens identified as *P. palmeri* var. *palmeri* (■) and the fourth group formed by specimens identified as *P. compostelae* (▲).

The dendrogram derived from the CA shows also four principal groups (Fig. 3). The first one integrated exclusively OTUs referred to *Pitcairnia palmeri* var. *longibracteata*, which agrees with the results of the PCA. The second including OTUs identified as *P. colimensis*, the third formed by OTUs of *P. palmeri* var. *palmeri*, and the fourth constituted by OTUs referable to *P. compostelae* and some of *P. palmeri* var. *palmeri*. The high value of the cophenetic correlation of this analysis (0.878) shows that the resolution of the CA (i.e. dendrogram) faithfully represents the structure of the original data set.

The results of the DA indicate that the first function conserved 97.9 % of the total variance, with a Wilks's Lambda

value very low, which is highly significant (Table 1). This implies that, based on the 12 morphological variables analyzed, there are significant multivariate differences between the groups considered. According to the correlations between the original discriminatory variables and the corresponding discriminant functions derived from the DA. The most important variables in the differentiation of the groups were, for the first function, the percentage of floral bracts that exceeds the length of the sepals (0.939), the length of the basal floral bract with respect to the length of the basal pedicel (0.069), while for the second function the most important variable was the ratio between the length of the basal peduncle bract and the length of the flowering plant (0.620).

TABLE 1. Results of the discriminant analysis applied to the morphological variables (discriminatory variables) and to the species (classificatory variables).

Discriminant function	Percentage of variance	Percentage of accumulated variance	Wilks's Lambda	P
1	97.9	97.9	<0.0005	<0.0005
2	1.5	99.4	0.002	<0.0005
3	0.6	100	0.041	<0.0005

Discussion

Both, the PCA and the CA, clearly separate four main groups (Table 2): the first formed by all the OTU's with at least a third of their floral bracts longer than the sepals and by the length of its apical floral bract of 1.5–1.9 cm (i.e. *Pitcairnia palmeri* var. *longebracteata* = *Pitcairnia robert-downsii* nom. et stat. nov.); the second group formed by the OTU's with all their floral bracts shorter than the sepals and by its longer peduncles (23–39 cm; i.e. *Pitcairnia colimensis*); the third formed by the OTU's of *P. palmeri* var. *palmeri* with all their floral bracts shorter than the sepals, by its less wide apical (1–3 mm) and basal (2–5 mm wide) peduncle bracts; the fourth constituted by the OTU's referable to *P. compostelae* and some identified as *P. palmeri* var. *palmeri* with its longer basal peduncle bracts (11–42 cm long).

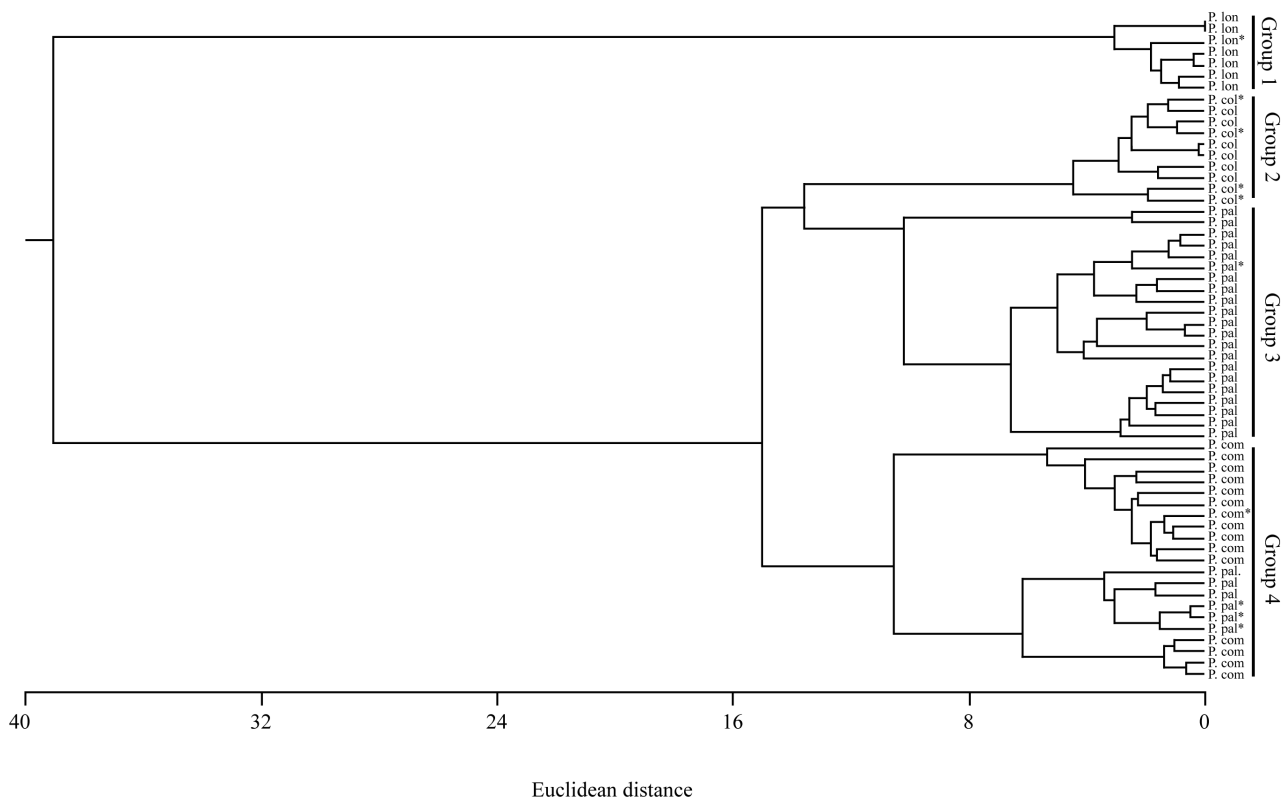


FIGURE 3. Dendrogram of the cluster analysis applied to the Euclidean distance matrix (data transformed to \log_2) of 12 morphological variables, grouped by the UPGMA fusion technique. The abbreviations correspond to: P. col: *P. colimensis*, P. com: *P. compostelae*, P. lon: *Pitcairnia palmeri* var. *longebracteata* and P. pal: *P. palmeri* var. *palmeri*. * Indicates the nomenclatural types.

According to the DA, the multivariate morphological differences were highly significant, and it is concluded that *P. palmeri* var. *longebracteata* should be considered on species level like the other taxa in the group, as proposed here. The epithet '*longebracteata*' is already occupied on species level in *Pitcairnia* and therefore cannot be used. Groups 2, 3 and 4 obtained in the PCA correspond to *Pitcairnia colimensis*, *P. palmeri* and *P. compostelae* respectively. The comparative characters of these species are showed in Table 2. In the dendrogram (Fig. 3), some specimens of *P. palmeri* are included in group 4, that corresponds with *P. compostelae*. We think that this may be due to the fact that some of the dried specimens used in the analyses were incomplete or depauperate. However, it is important to mention that, as part of the doctoral project of the first author, the study of this group includes other methodological tools, such as the use of molecular characters, which will probably help to have more accurate results for this species group.

TABLE 2. Comparative variables of *Pitcairnia robert-downsii*, *P. palmeri*, *P. colimensis*, and *P. compostelae*.

Variable	<i>P. robert-downsii</i>	<i>P. palmeri</i>	<i>P. colimensis</i>	<i>P. compostelae</i>
1. Width of the bulbous stem (cm)	2.8–3.9	1.2–2.5	1.3–3–2	1.5–2.7
2. Width of the basal floral bract (cm)	0.6–1.1	0.2–0.4	0.2–0.5	0.4–0.9
3. Width of the distal peduncle bract (cm)	0.5–1.2	0.1–0.3	0.2–0.5	0.3–0.6
4. Width of the basal peduncle bract (cm)	0.7–1.4	0.2–0.5	0.5–1.2	0.5–1.1
5. Ratio between number of floral bracts that exceed the sepals and the total number of flowers (%)	24–34 %	0%	0%	0%
6. Length of the apical floral bract (cm)	1.5–1.9	0.4–0.8	0.5–0.8	0.9–2.4
7. Length of the basal floral bract (cm)	4.6–5.8	1.1–2.8	1–1.8	1.6–3.1
8. Length of the bulbous stem (cm)	4.2–4.9	1.8–3.8	3–4.5	2.5–6
9. Length of the apical peduncle bract (cm)	5.3–7.5	1.3–3.4	1–2–2.6	2.6–5.5
10. Length of the basal peduncle bract (cm)	5.3–11.2	2.2–8.6	22–44	11–42
11. Length of the peduncle (cm)	12–17	3–18	23–39	13–26.5
12. Diameter of the peduncle (cm)	0.3–0.4	0.1–0.2	0.2–0.4	0.2–0.3

Taxonomy

Identification key to the species of *Pitcairnia palmeri* group

1. Flowers secund2
1. Flowers not secund3
2. Reduced and prickly dark brown leaves absent; leaves blades 10–18 mm wide; basal peduncle bracts foliaceous, 11–42 cm long..*P. compostelae*
2. Reduced and prickly dark brown leaves present; leaves blades 3–8 mm wide; basal peduncle bracts not foliaceous, 2.2–8.6 cm long *P. palmeri*
3. Peduncle 23–39 cm long; floral bracts 0.5–1.8 cm long; inflorescence 8–21 flowered*P. colimensis*
3. Peduncle 12–17 cm long; floral bracts 1.5–5.8 cm long; inflorescence 19–30 flowered *P. robert-downsii*

Pitcairnia robert-downsii González-Rocha, Espejo, López-Ferr. & M. Castillo, *stat. et nom. nov.* (Figs. 4A–D).
Pitcairnia palmeri var. *longebracteata* L.B. Sm., *syn. nov.*, *Wrightia* 2: 64. 1960, Type: MEXICO. Durango: Municipio de Pueblo Nuevo, 15–17 miles northeast of Palmito along highway from Mazatlán to Durango, 7000–7500 ft, pine-oak forest, June 16, 1951 (fl), *H.S. Gentry & C.L. Gilly 10625* (holotype LL!).

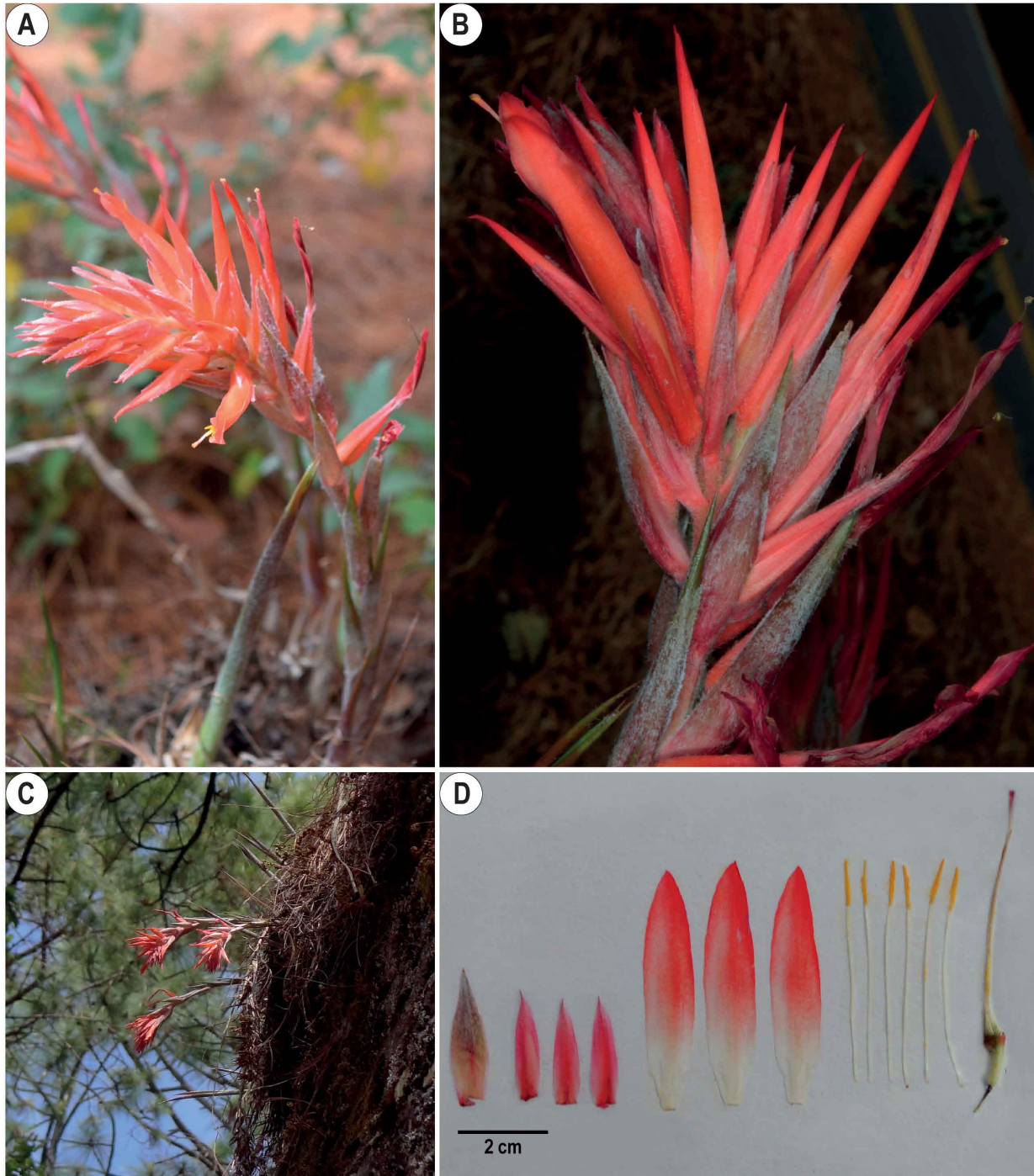


FIGURE 4. *Pitcairnia robert-downsii* González-Rocha, Espejo, López-Ferr. & M. Castillo, *nom. et stat. nov.* A–B) Detail of the inflorescence, C) habitat and D) dissected flower.

The new species differs from *Pitcairnia palmeri* by its longer peduncle bracts (5.3–11.2 cm long vs. 1.3–8.6 cm), by the length of its floral bracts (1.5–5.8 cm vs. 0.4–2.8 cm), by its densely white-lepidote leaves (vs. scarcely lepidote), by the number of flowers per inflorescence (19–30 vs. 3–21) and by its polystichously (vs. secund) flowers.

Type:—MEXICO. Durango: Municipio de Pueblo Nuevo, carretera libre El Salto-Mazatlán, 4 km antes de llegar al Espinazo del Diablo viniendo de El Salto, 0.4 km al NW de Los Bancos, 2500 m, taludes rocosos con bosque de pino-encino, 23° 39' 09" N; 105° 44' 19.6" W, May 29, 2016 (fl), *L.J. Hernández-Barón, A. Espejo-Serna, A.R. López-Ferrari* y *R. Cerros-Tlatilpa 183* (holotype: UAMIZ!, isotypes: CIIDIR!, MEXU!).

Plant saxicolous, perennial, acaulescent, cespitose, 24–36 cm high in flower. **Roots** fibrous. **Stem** bulbous, 4.2–4.9 cm long, 2.8–3.9 cm wide. **Leaves** not petiolate; **sheaths** widely ovate, 2.5–3 cm long, 1.8–2.7 cm wide at widest

point, dark brown abaxially, brown adaxially; **leaf blades** of three kinds: the first ones foliaceous, green, linear, ca. 40 cm long, 8–15.5 mm wide, entire, conspicuously nerved, glabrous adaxially, white lepidote abaxially, deciduous and absent during the dry flowering season; the second reduced ones persistent, sheath-like, light brown to straw-colored, papyraceous, oblong, 5–9.5 cm long, 1.4–1.6 cm wide, entire, acuminate, conspicuously nerved, glabrous adaxially, lepidote abaxially; the third reduced ones persistent, dark brown, awl shaped to linear, 2–7.4 cm long, ca. 2 mm wide, margin with brown, 1.5 mm long, retrorse spines, scarcely lepidote on both surfaces. **Inflorescence** terminal, simple, racemose, erect to slightly curved; **peduncle** green, terete, 12–17 cm long, 2.7–3.2 mm in diameter when dry, densely white lepidote; **peduncle bracts** foliaceous, green, narrowly triangular, 5.3–11.2 cm long, 5–14 mm wide, entire, the basal ones sometimes with some retrorse spines, glabrous adaxially, densely white lepidote abaxially, longer than the internodes; **raceme** 11.5–16 cm long, with 19–30 polystichously arranged flowers; **rachis** densely white lepidote; **floral bracts** cardinal red, greenish toward the apex, the basal ones short or narrowly triangular, in basal third surpassing the sepals, 4.6–5.8 cm long, 6–11.2 mm wide, the apical one elliptic to lanceolate, 1.5–1.9 cm long, 3–4.6 mm wide, entire, acuminate, glabrous adaxially, densely white lepidote abaxially, longer than the pedicel; **flowers** ascending at anthesis, zygomorphic, pedicellate; **pedicels** slender, 4–13 mm long, densely white lepidote; **sepals** free, cherry colored, narrowly triangular, 2.3–3 cm long, 3.2–5 mm wide, acute, scarcely lepidote, the two adaxial ones carinate, free; **petals** without appendages, scarlet, oblong, shortly unguiculate, 4.6–5.8 cm long, 8.8–12.2 mm wide, acute, glabrous; **stamens** equal in length; **filaments** white, filiform, 4–4.3 cm long; **anthers** yellow, linear-sagittate, 9.8–11.4 mm long; **ovary** green, ovoid, 5–7.5 mm long, 2.4–3.7 mm in diameter; **style** white, slender, 4.8–5.4 cm long; **stigma** conduplicate-spiral, lobes red. **Capsules** ovoid, trigonous, 1.4 cm long, 9 mm in diameter, apex rostrate; **seeds** not seen.

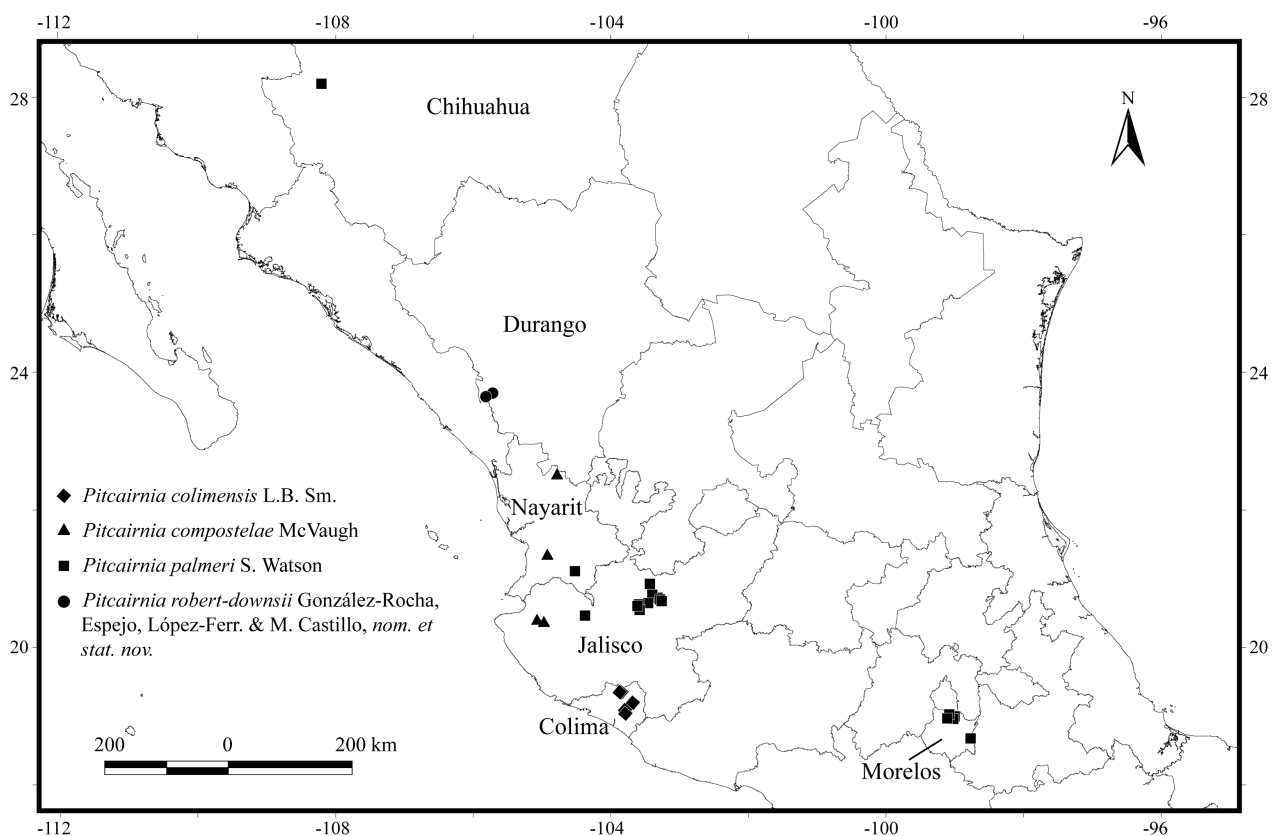


FIGURE 5. Known distribution of *Pitcairnia robert-downsii* González-Rocha, Espejo, López-Ferr. & M. Castillo.

Etymology:—The specific epithet honors the American botanist Robert Jack Downs (1923-2015), who, in collaboration with Lyman B. Smith, published the monograph of the Bromeliaceae for the Flora Neotropica. For his essential contribution to the studies in Bromeliaceae.

Distribution, habitat and phenology:—*Pitcairnia robert-downsii* is only known from the state of Durango, in the municipality of Pueblo Nuevo (Fig. 5). It grows on cliffs or rocky slopes in pine-oak forests, at elevations between 1900 and 2500 m. It flowers from May to July.

Paratypes:—MEXICO. Durango: Municipio de Pueblo Nuevo, 4.5 km después de la Ermita, km 163 de la carretera Durango-Mazatlán, 9.3–10.5 km al NE de El Palmito, 2590 m, bosque de pino-encino, June 17, 1993 (fl), A.R. López-Ferrari y A. Espejo 1803 (UAMIZ).

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APPENDIX 1. Specimens revised and included in the study.

***Pitcairnia colimensis*: Colima:** Municipio de Colima, steep bluffs above río Salado, 5 miles south of Colima, *R. McVaugh 15509* (Holotype of *Pitcairnia colimensis*: MICH, Isotypes: MEXU, US). Municipio de Comala, 15–16 km al NO de Colima, 2–3 km al SE de Campo Cuatro, camino Juluapan-Campo Cuatro, *F.J. Santana M., J.A. Vázquez G. & L. Guzmán H. 5289* (IBUG, IEB); sierra de Manantlán, brecha a Campo Cuatro, *R. Ramírez D., E. Salcedo P. & F. Zamora N. 2186* (CHAPA, IBUG, MEXU). Municipio de Tecomán, 8 km adelante de Los Asmoles, carretera Colima-Manzanillo, *A.R. López-Ferrari & A. Espejo 916* (UAMIZ, MEXU!). Sin municipio, entre Armería y Colima, a 4 km de Los Asmoles, *A. Delgado S. & R. Hernández 377* (CHAPA, ENCB, MICH).

***Pitcairnia compostelae*: Jalisco:** Municipio de Mixtlán, mountain summits about 25 km west of Ameca, between La Estanzuela and Mixtlán, locally abundant on step side of arroyo 4 miles south of Estanzuela de Oro, *R. González T. 428* (ENCB, IEB, MEXU); arroyo El Salto, brecha Cuale-Talpa, *A. Rodríguez C., R. Ramírez D. & J. García-Cruz 2210* (IEB, IBUG). **Nayarit:** Municipio de Xalisco, fifteen miles south of Tepic along highway to Compostela, *H.S. Gentry & C.L. Gilly 10825* (Holotype of *Pitcairnia compostelae*: MICH); mountains 9 miles north of Compostela, *R. McVaugh 16496* (MICH, MEXU); rumbo a Compostela, 3.5 km adelante de Tepic, *A. Espejo & A.R. López-Ferrari 5250* (UAMIZ); in the Sierra Madre, near Santa Teresa, territorio de Tepic, *J.N. Rose s.n.* (US).

***Pitcairnia palmeri*: Chihuahua:** Municipio de Ocampo, ca. 5 km N of Basaseachi up the río Basaseachi, on summit of ridge W of river, on open E-facing rock, *R. Spellenberg & P. Martin 10803* (CIIDIR). **Jalisco:** Municipio de Guadalajara, barranca de Huentitán, *J.J. Guerrero N. 837* (XAL). Municipio de Zapopan, Río Blanco, *E. Palmer 16* (Holotype of *Pitcairnia palmeri*: GH; Isotypes: BM, MEXU, NY (specimen of the right side of the sheet), USx2); cerro El Diente, al norte del poblado de Río Blanco, *A. Espejo, A.R. López-Ferrari & J. García-Cruz 4969* (UAMIZ); brecha a Huaxtla, a partir de la carretera Tesistán-San Cristóbal de la Barranca, *A.R. López-Ferrari & A. Espejo 2097* (UAMIZ); cerro del Colli, orilla oeste de Guadalajara, *M. Cházaro B., R. Acevedo R. & E. Lomeli M. 6974* (XAL); verge of cliffs, barranca near Guadalajara, *C.G. Pringle 2552* (GH); on ledges and banks near Guadalajara, *C.G. Pringle 7559* (ENCB); cerro de Colli, west edge of Guadalajara plain, about 1 mile west of Ciudad Granja, a few miles west of Guadalajara, *D.P. Gregory & G. Eiten 147* (MEXU); sierra de la Primavera, *S. Zamudio R. 7886* (IEB). **Nayarit:** Municipio de Jala, volcán Ceboruco, sobre la brecha de Jala a la estación de Microondas, *M. Cházaro B., R. Acevedo R. & E. Lomeli M. 6961* (MEXU!). **Morelos:** Municipio de Tepoztlán, sendero a la zona arqueológica del Tepozteco, *E. González-Rocha & F. Bonilla 114* (UAMIZ); cerca de El Parque (sierra Tepoztlán), *F. Miranda 177* (MEXU); cima de los cerros al E de San Juan Tlacotenco, *A. Espejo, A.R. López-Ferrari, J. Ceja & A. Mendoza R. 6089* (UAMIZ). Municipio de Tlayacapan, barrancas al N de San José de los Laureles, *V. Sánchez C., A. Espejo, M. Flores C., G. Barroso Ch. & E. Bobadilla 23* (UAMIZ, MEXU); barranca Tepecapa, *R. Hernández-Cairdenas, R. Cerros T. & A. Flores-Morales 329* (UAMIZ). Municipio de Jantetelco, en el peñón de Chalcatzingo, ladera E, *G.M. Hernández-Barón & R. Cerros-Tlatilpa 110* (UAMIZ).

***Pitcairnia robert-downsii*: Durango:** Municipio Pueblo Nuevo, 15–17 miles northeast of Palmito along highway from Mazatlán to Durango, *H.S. Gentry & C.L. Gilly 10625* (Holotype of *Pitcairnia palmeri* var. *longibracteata*: LL).