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Geographic distribution and endemism of Bromeliaceae from the Western Sierra-Coast region of Jalisco, Mexico

Distribución geográfica y endemismo de las Bromeliaceae de la región Sierra-Costa Occidental de Jalisco, México

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Abstract
Background: Bromeliaceae are widespread in Mexico and present in all types of vegetation. A high number of species are restricted to the country. Jalisco is the fifth Mexican state regarding Bromeliaceae richness and 18 % of its species are state endemics.
Questions and / or Hypotheses: How bromeliads are distributed in Western Sierra-Coast region of Jalisco? What is the endemism status of bromeliads in the region?
Studied species: Native Bromeliaceae of WSC.
Study site and dates: WSC region in Jalisco, collections from 1926 to 2020.
Methods: Data were obtained by herbarium material revision and field expeditions. We analyzed life form, distribution by vegetation type, altitudinal range, and recollection activity per year. A richness map was generated. To determine the affinity of the bromeliad flora with other regions of the state, a cluster analysis was performed using UPGMA method.
Results: We found nine genera and 53 species, richest genera were *Tillandsia* and *Pitcairnia*. Epiphyte was the commonest life form. Oak forest had the highest species number, most taxa were found between 250-750 m asl. Most collections come from the municipality of Cabo Corrientes accounting for 66 % of total species in WSC. The study area hosts six species of endemic bromeliads.
Conclusions: Despite to their restricted distribution, none of the endemic species from WSC are listed under special protection. The WSC should be considered for conservation. The tourism development, deforestation and climate change could have a negative impact on bromeliads, especially epiphytes that depend entirely on the host trees.
Keywords: Cabo Corrientes, conservation, deforestation, epiphyte, *Tillandsia*.

Resumen
Antecedentes: Las Bromeliaceae están distribuidas en todo México y en todos sus tipos de vegetación. Muchas de sus especies se restringen al país, siendo Jalisco el quinto estado más rico; 18 % son endémicas al estado.
Preguntas y / o Hipótesis: ¿Cómo se distribuyen las bromeliáceas en la Sierra-Costa Occidental de Jalisco? ¿Cuál es el nivel de endemismo de las bromeliáceas en la región?
Especies de estudio: Bromeliaceae nativas presentes en la región.
Sitio y años de estudio: Región SCO Jalisco, datos de 1926-2020.
Métodos: Los datos se obtuvieron mediante la revisión de herbarios y expediciones de campo. Se analizó la forma de vida, la distribución por tipo de vegetación, rango altitudinal, y actividad de colecta por año. Se generó un mapa de riqueza. Para determinar la afinidad de la flora de Bromeliaceae con la de otras regiones se realizó un análisis de conglomerados empleando el método UPGMA.
Resultados: Se encontraron nueve géneros y 53 especies, siendo *Tillandsia* y *Pitcairnia* los más ricos. Las epífitas fueron la forma de vida predominante. Los encinares presentaron el mayor número de especies y éstas fueron más abundantes entre 250-750 m snm. Las colectas proceden mayormente del municipio Cabo Corrientes, representando 66 % de las especies de la SCO. El área alberga seis especies endémicas.
Conclusiones: Ninguna especie endémica está protegida. La SCO debería considerarse área de conservación. El desarrollo turístico, la deforestación y el cambio climático podrían tener un impacto negativo en las bromeliáceas, especialmente las epífitas, que dependen de sus forófitos.
Palabras clave: Cabo Corrientes, conservación, deforestación, epífita, *Tillandsia*.

The Bromeliaceae in Mexico are represented by 19 genera and 450 species, occupying the eleventh place regarding angiosperm richness and the third place among monocots, after Orchidaceae and Poaceae (Espejo-Serna & López-Ferrari 2018 with updates). A high number of bromeliad species (346) are restricted to the country, representing 77.23 % of all the taxa of the family (Espejo-Serna 2012). The family is widespread in all the Mexican territory and is present in all its types of vegetation (Rzedowski 2006). Some vegetative characteristics that contribute to the success of the species of this family are their adaptations to environmental stress conditions, like tank rosettes, the small herbaceous body of some species, presence of specialized trichomes, and xeromorphic physiological features like CAM (crassulacean acid metabolism) photosynthesis (Benzing 2000). Epiphytes have a high number of representatives in the vascular flora of Mexico (Espejo-Serna *et al.* 2021), many members of *Tillandsia*, the richest bromeliad genus in the country, present this habit (Benzing 2012, Espejo-Serna & López-Ferrari 2018, Espejo-Serna *et al.* 2021, Zotz *et al*. 2021). Bromeliads can be used as ornamental plants, living fences, fodder, food, medicine, and for fiber production, while many species, particularly of *Tillandsia,* are used in religious ceremonies carried out by several ethnic groups from Mexico (Haeckel 2008, Hornung-Leoni 2011, Méndez-García *et al.* 2011, Hernández-Cárdenas *et al.* 2014, Mondragón 2015, Krömer *et al.* 2018, Jiménez-López *et al.* 2019).

Jalisco is the fifth Mexican state in regard of bromeliad richness with 85 species, 15 of them endemic (Espejo-Serna & López-Ferrari 2018 updated here). So far, the most complete catalog of Bromeliaceae for Jalisco is the Flora Novo-Galiciana (McVaugh 1989) with 50 species. Besides that, Magaña-Rueda (1986) made a floristic inventory of the bromeliads from the coastal region of Jalisco that included 25 species. Several inventories from natural protected areas like Reserva de la Biósfera Chamela-Cuixmala (Lott 1985), Reserva de la Biósfera Sierra de Manantlán (Vázquez-García *et al.* 1995), Área de Protección de Flora y Fauna Bosque la Primavera (SEMARNAT 2000 with updates), Área de Protección de Flora y Fauna Sierra de Quila (Flores-Argüelles *et al.* 2020b), and some regional studies like those of Jalisco-Costa Norte (Vázquez-García *et al.* 2000), northern Jalisco and adjacent areas (Vázquez-García *et al.* 2004), and San Sebastián del Oeste (Harker *et al.* 2017) also included the family.

Land-use change is considered the principal cause of biodiversity loss worldwide (Wilson *et al.* 2016). Tropical forests are usually the most affected and, even though they contain more than a half of the world flora, their coverage is less than 7 % of the Earth surface (Sodhi *et al.* 2008). Consequently, species with a smaller distribution range tend to be more vulnerable to human disturbance (Leão *et al.* 2014). Bromeliads with a water-holding rosette play a crucial role in the dynamics of the biological communities because they collect rainwater and store decaying organic matter (Corbara *et al*. 2019, Ladino *et al.* 2019); they are also home for many arthropods, amphibians and reptiles as they provide shelter against predation, and they are a water source and breeding grounds for many organisms (Lima-Santos *et al*. 2009, Sabagh & Rocha 2014, Zotz & Traunspurger 2016, Sabagh *et al.* 2017). However, their vulnerability to land-use change is high, especially for epiphytes since they depend on trees and the micro-environmental conditions these provide (Krömer *et al.* 2014, Zizka *et al.* 2020).

Materials and methods

Study Site. The Western Sierra-Coast (WSC) region is situated southwest of the neighboring state of Nayarit in the western part of Jalisco (Figure 1). The Mexican biogeographic provinces Pacific Lowlands, the northern limit of Sierra Madre del Sur and a small portion of Transmexican Volcanic Belt (Morrone 2017) are part of this area. The municipalities that are included in the study area are Cabo Corrientes, Mascota, Puerto Vallarta, San Sebastián del Oeste, and Talpa de Allende (Figure 1) with a total surface of 7,095 km^2. Atenguillo, Guachinango and Mixtlán are also part of this region, but since they have few to no bromeliad collections, they were excluded. Mountains are common in this area and serve as moisture capture systems during the rainy season; the altitudinal range in the region is from sea level to 2,760 m asl and presents principally a warm semi-humid climate characterized by its dry seasons on winter and rainy seasons in summer, and a temperate semi-humid climate at higher elevations. The average annual temperature is 19.7 ºC and ranges from 31.6 °C near the coast, to 9.1 °C in the mainland, and the average annual precipitation is 1,221 mm (IIEG 2018). There are six principal types of vegetation: tropical deciduous forest, tropical subdeciduous forest, riparian forest, oak forest, pine-oak forest, and cloud forest (Figure 2). The tropical subdeciduous forest dominates in the lower elevations and the mountain tops are composed of oak and pine-oak forests, with cloud forests in the gorges. However, species of oak and pine also can be found in around 300 m asl, making an interesting mixture with the tropical species (Vázquez-García *et al.* 2000).

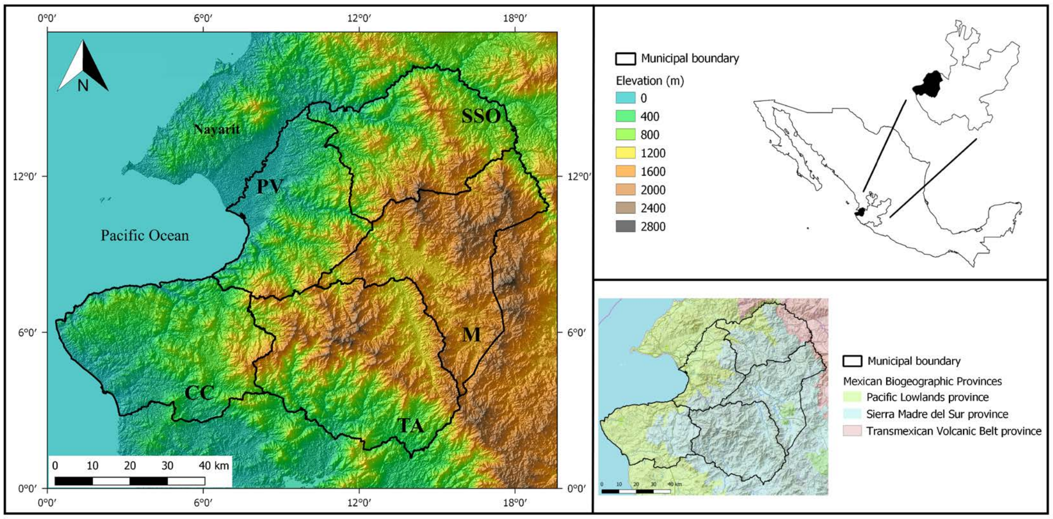

Figure 1. Location of the Western Sierra-Coast region in the state of Jalisco. Municipalities: CC = Cabo Corrientes; M = Mascota; PV = Puerto Vallarta; SSO = San Sebastián del Oeste; TA = Talpa de Allende.

This region is considered to host a great biodiversity and has a high level of endemism (Vázquez-García *et al.* 2000). Recently, many new species have been described from the region: *Miconia vallartensis* Zabalgoitia, Figueroa & Muñiz-Castro (Zabalgoitia *et al*. 2020), *Manfreda santana-michelii* Art. Castro, Aarón Rodr. & P. Carrillo (Castro-Castro *et al*. 2018), and the bromeliads *Aechmea novoae* Flores-Arg., Espejo & López-Ferr. (Flores-Argüelles *et al.* 2020a), *Hechtia ibugana* Flores-Arg., Espejo & López-Ferr. (Flores-Argüelles *et al.* 2019), *Pitcairnia abscondita* Flores-Arg., López-Ferr., Gonz.-Rocha & Espejo (Flores-Argüelles *et al.* 2022b), and *Pitcairnia singularis* Flores-Arg., Espejo & López-Ferr. (Flores-Argüelles *et al.* 2017).

Data Collection. The following herbaria were revised: CHAP, CIIDIR, ENCB, F, GH, HEM, IBUG, IEB, K, MEXU, MICH, MO, SEL, UAMIZ, UC, US, WU, XAL, and ZEA (according to Thiers 2021 continuously updated). Several field expeditions were conducted by the authors in previous years, and more recently (2018-2020) for the master's thesis project of the first author, that resulted in a list of angiosperm epiphytes, included species of Bromeliaceae (Flores-Argüelles 2020). Information of some localities were included based on visual records of the species. Taxonomic determinations follow Espejo-Serna & López-Ferrari (2018), as well as the geographical distribution and endemism data. Information about endangered species was obtained from the list of species at risk in the Mexican Official Standard NOM-059-SEMARNAT-2010 (SEMARNAT 2010) and the International Union for Conservation of Nature (IUCN 2021) Red List of Threatened Species. A total of 277 bromeliad collections from the WSC region of Jalisco were revised.

We analyzed the life form (epiphytic, rupicolous, and terrestrial), the distribution by vegetation type and altitudinal range divided in belts of 250 m each, as well as the recollection activity per year. To analyze the distribution of the species in the study area, we used the geographic location of the labels of the herbarium specimens and in case there was no information available, the coordinates were obtained by using topographic maps of the municipalities from IIEG (n.d.) and Google Earth Pro (2020). A map of known richness was generated with this information and was quantified with 5 × 5 km cells using the Biodiverse Software (Laffan *et al.* 2010). We also calculated the specific richness of the study area and other regions of the state, dividing the number of species recorded by the surface of the region multiplied by 100. To determine the affinity of the bromeliad flora with other regions of the state, a cluster analysis was performed using the UPGMA (Unweighted Pair Group Method using Arithmetic averages) method based on the presence/absence of the species in each region, with the NCSS (2018) statistical program.

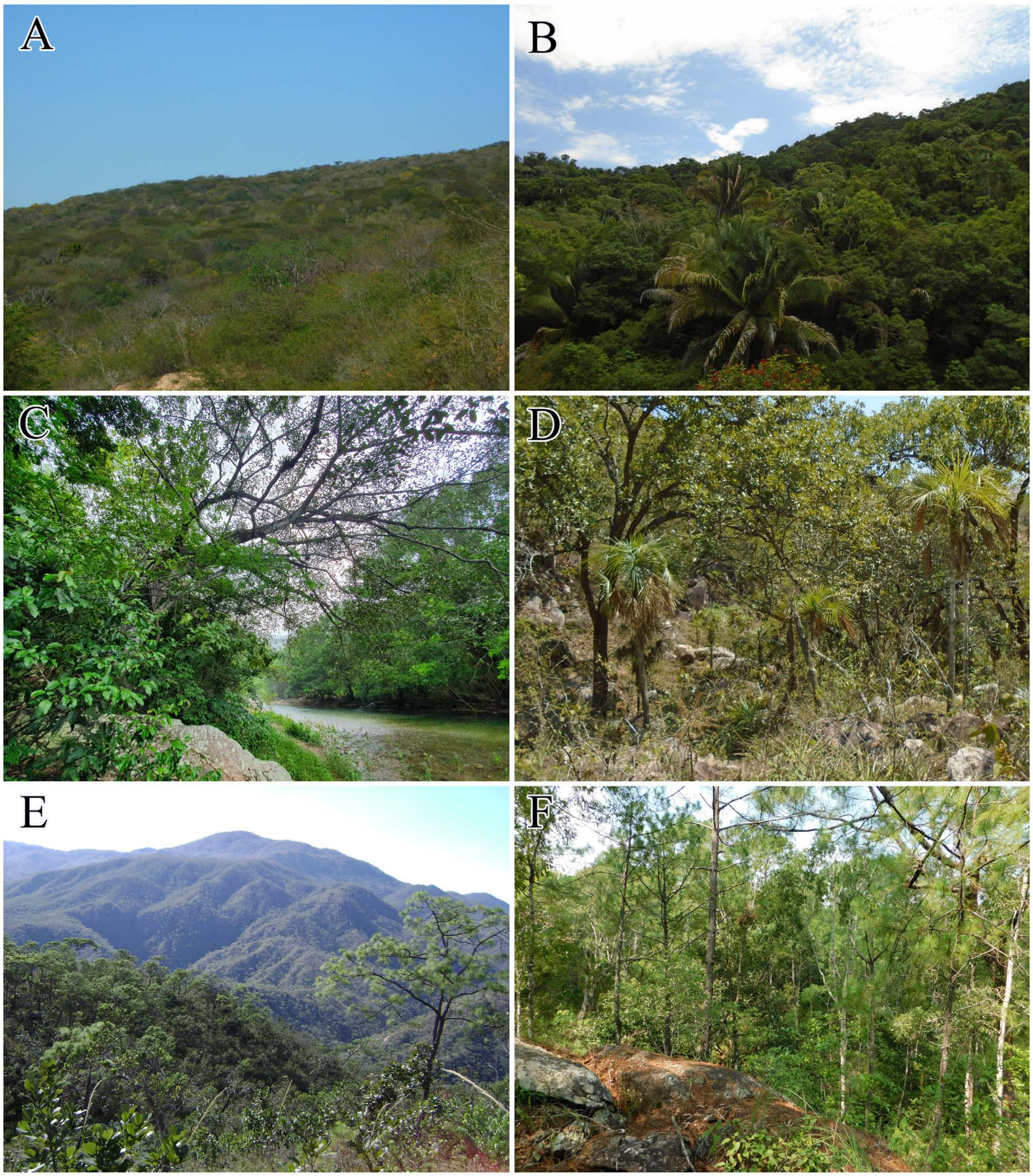

Figure 2. Vegetation types present in the Western Sierra-Coast region. A) tropical deciduous forest, B) tropical subdeciduous forest, C) riparian forest, D) oak forest, E) pine-oak forest, and F) a gorge of cloud forest.

Figure 3. Distribution of the Bromeliaceae in the Western Sierra-Coast region of Jalisco. A) *Aechmea bracteata,* B) *A. novoae,* C) *Billbergia pallidiflora,* D) *Bromelia karatas,* E) *B. pinguin,* F) *Catopsis nutans,* G) *Hechtia ibugana,* H) *Pitcairnia abscondita,* and I) *P. compostelae.* (Photographs A, B, and F by A. Espejo-Serna; C, D, E, G, H, and I by A. Flores-Argüelles).

Results

Bromeliaceae in the WSC region of Jalisco are represented by nine genera, 53 species (Figures 3 and 4, Supplementary material), and four subfamilies; most of the species belonging to Tillandsioideae (Figure 5A). The richest genera were *Tillandsia* with 30 species (56.6 %) followed by *Pitcairnia* with 12 species (22.6 %). The epiphytic life form

Figure 4. Distribution of the Bromeliaceae in the Western Sierra-Coast region of Jalisco. A) *Pitcairnia heterophylla,* B) *P. singularis,* C) *Tillandsia intermedia,* D) *T. jaliscomonticola,* E) *T. mooreana,* F) *T. polystachia,* G) *T. rothii,* H) *T. schiedeana,* and I) *Ursulaea tuitensis.* (Photographs D by A. Espejo-Serna; A, B, C, E, F, G, H, and I by A. Flores-Argüelles).

is the most common among the bromeliads of the WSC region, all species of the genera *Aechmea*, *Billbergia*, *Catopsis*, and *Tillandsia* are epiphytic which encompass 66 % of all recorded species diversity, although some of them have the alternative rupicolous habit. All *Pitcairnia* and *Ursulaea* species are rupicolous and they comprise 24 % of all taxa. The genera *Bromelia*, *Fosterella*, and *Hechtia* were exclusively terrestrial with five species in total (Figure 5B, Supplementary material). The specific richness of WSC is 0.7470 (Table 1). However, almost all species occur in the municipality of Cabo Corrientes with a richness value of 2.4759 and they are concentrated principally along the Puerto Vallarta-Manzanillo Highway and in the road to El Cuale, which is a small area (Figure 6). Compared to the bromeliad composition of other regions of Jalisco such as the North Jalisco (NJ) region and the natural protected areas of Bosque la Primavera (BP), Chamela-Cuixmala (CH), Sierra de Manantlán (SM), and Sierra de Quila (SQ), the WSC is floristically the least similar (Figure 7A).

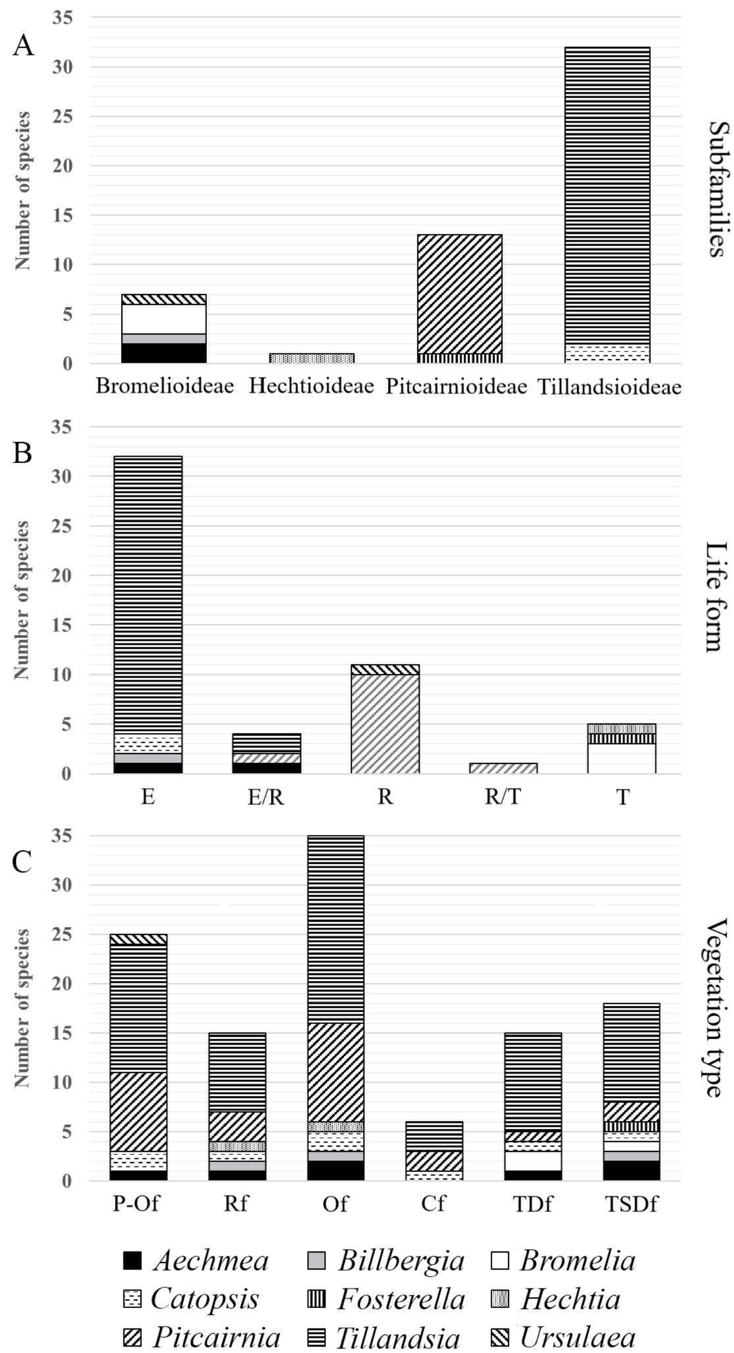

Figure 5. Distribution of the Bromeliaceae in the Western Sierra-Coast region of Jalisco by A) subfamilies; B) life form: E = epiphyte, E/R = epiphyte and rupicolous, R = rupicolous, R/T = rupicolous and terrestrial, T = terrestrial; C) vegetation type: P-Of = Pine-Oak forest, Rf = Riparian forest, Of = Oak forest, Cf = Cloud forest, TDf = Tropical Deciduous forest, TSDf = Tropical Subdeciduous forest.

The oak forest has the highest number of bromeliads with 35 species and six genera. *Bromelia* and *Fosterella*, are exclusive to tropical forests, and *Ursulaea* is restricted to the pine-oak forests (Figure 5C). The cloud forest has the lowest representation, with only six species. *Catopsis*, *Pitcairnia*, and *Tillandsia* are present in all vegetation types. The most common species are *Aechmea bracteata* (Sw.) Griseb., *Catopsis nutans* (Sw.) Griseb., and *Tillandsia caput-medusae* E. Morren, growing in five of the six types of vegetation present in the region (Supplementary material). On the other hand, twenty-one taxa inhabit exclusively one of the six types of vegetation, the rest of the species are present in two or more types of vegetation.

Most species are found between 250 and 750 m asl while richness decreases drastically above 2,000 m asl (Figure 8). *Tillandsia* species are present in the entire altitudinal range, but most of them showed preference for lower elevations (0-750 m asl). The genera *Bromelia*, *Fosterella*, and *Hechtia* exhibited preference for low elevations (0-1,000 m asl), and *T. sessemocinoi* López-Ferr., Espejo & P. Blanco, and *Ursulaea tuitensis* (Magaña & E. J. Lott) Read & Baensch are only distributed above 2,000 m asl. *Tillandsia caput-medusae* had the widest altitudinal range, since it was found from very low elevations to around 1,500 m asl.

Cabo Corrientes municipality has the highest number of species (35), as well as records of herbarium specimens (164) (Figure 9), while Mascota and San Sebastián del Oeste have the lowest records of species, with 22 each, as well as herbarium specimens, with 23 and 18 respectively. More than half of the species (56 %) were only located in one municipality, where Cabo Corrientes has the highest number of exclusive species (16), and *Pitcairnia abscondita* Flores-Arg., López-Ferr., Gonz.-Rocha & Espejo (Flores-Argüelles *et al.* 2022b) was the only taxon found in all municipalities (Supplementary material). The oldest collection recorded for the region was made in 1926 by the Mexican American Ynes Mexia and it was a specimen of *Aechmea bracteata*. In the decade of the 80s the largest number of collections were made, with 1985 excelling with almost all the records, mainly done by Magaña-Rueda (1986) (Figure 9). The decade of the 2010s has the second highest collection activity and the highest number of species with 25.

Of the 53 species recorded, 14 are endemic to Mexico, nine to the western portion of Mexico and nine to Jalisco, six of them restricted to the study region (*Hechtia ibugana*, *Pitcairnia abscondita*, *P. loki-schmidtii* Rauh & Barthlott, *P. singularis*, *Tillandsia loma-blancae* Ehlers, and *T. pacifica* Ehlers, see Figure 6). *Tillandsia seleriana* Mez is the only species listed in the Mexican Official Standard (SEMARNAT 2010) as Threatened (A), and *T. usneoides* L. (L.) in the IUCN (2021) Red List of Threatened Species as Least Concern (LC).

Discussion

The study area contains 62 % of the 85 species of Bromeliaceae known from Jalisco and 60 % of the 15 state-owned endemic species, where 40 % are restricted to the WSC region (Espejo-Serna 2012, Espejo-Serna & López-Ferrari 2018 with updates). Compared to other floristic studies made within the WSC, we found in our study a higher number of taxa; Ramírez-Delgadillo & Cupul-Magaña (1999) and Magaña-Rueda (1986) each recorded nine species for the municipalities of Cabo Corrientes and Puerto Vallarta, while we found 42 taxa for these two municipalities. Additionally, Vázquez-García *et al.* (2000) reported 25 species for all the municipalities included in this study, compared to the 53 found in the present study. Also, we found twice the species (12) compared to the floristic study of Harker *et al.* (2017) in San Sebastián de Oeste.

Even though the WSC is the least similar to the other regions, it shares a significant number of species with the protected areas SM and CH, probably because most of the shared species are mainly distributed across the Sierra Madre del Sur (Figure 7B). Our study area has a low richness value (0.7470) compared to the other regions (Table 1), potentially due to its ample surface (7,095 km^2). The highest specific richness belongs to the reserva de la biósfera Chamela-Cuixmala; that shares almost 90 % of its species with the WSC region.

Tillandsia is the richest genus and the one with the widest distribution, since it is present in all vegetation types, altitudinal ranges, and municipalities. The morphological and physiological adaptations present in the members of this taxon allows them to survive in different environments. There are xeromorphic species with atmospheric rosettes, abundant foliar trichomes, and CAM photosynthesis (Wolf 2005, Reyes-García *et al.* 2008), which helps them to survive conditions of dry air and high temperatures in the tropical areas of the region. On the other hand, there are some species of *Tillandsia* with large size tank rosettes that are instead adapted to survive in temperate areas (Benzing 2012). The wide distribution of *Tillandsia caput-medusae* could be attributed to that its plants can live both in fully exposed environments and partially exposed environments, due to its small size densely covered with trichomes that increases the absorption surface area of the leaves (Stefano *et al.* 2007). It has also been found that many species of this genus benefit from disturbance (Krömer *et al.* 2014, Flores-Argüelles *et al*. 2022a). According to Espejo-Serna *et al*. (2021), 52 % of the Mexican bromeliads are epiphytes and *Tillandsia* includes most of these species. This was also observed in our study area and is a pattern also common in Mexican tropical forests (Reyes-García *et al.* 2008, Menini-Neto *et al*. 2009, Ochoa-López 2009).

Table 1. Species richness of the Bromeliaceae by region. BP = Bosque La Primavera; CC = Cabo Corrientes; CH = Chamela-Cuixmala; NJ = North Jalisco; SM = Sierra de Manantlán; SQ = Sierra de Quila and WSC = Western Sierra-Coast.

Region	Species number	Surface (km^2)	Richness ($sp/km^2 \times 100$)
WSC	53	7,095	0.7470
CC	36	1,454	2.4759
BP	18	305	5.9016
CH	24	131.42	18.2621
NJ	17	10,305.63	0.1650
SM	38	1,395.77	2.7225
SQ	21	141.69	14.8211

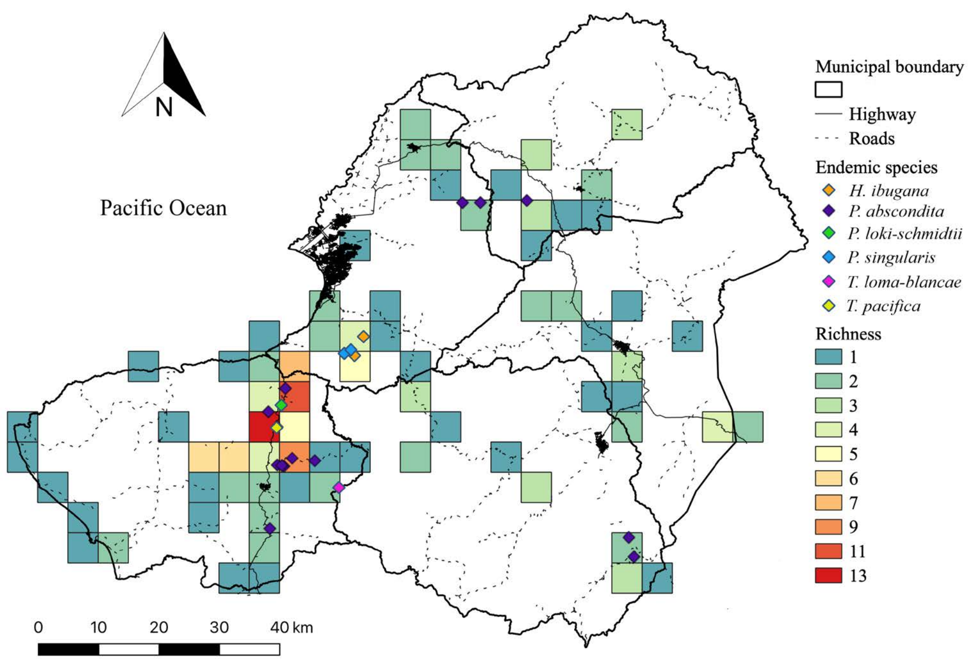

Figure 6. Richness of the Bromeliaceae in the Western Sierra-Coast region of Jalisco. The cell size is 5 × 5 km. Endemic species records (*Hechtia ibugana*, *Pitcairnia abscondita*, *P. loki-schmidtii*, *P. singularis*, *Tillandsia lomablancae*, and *T. pacifica*) are included.

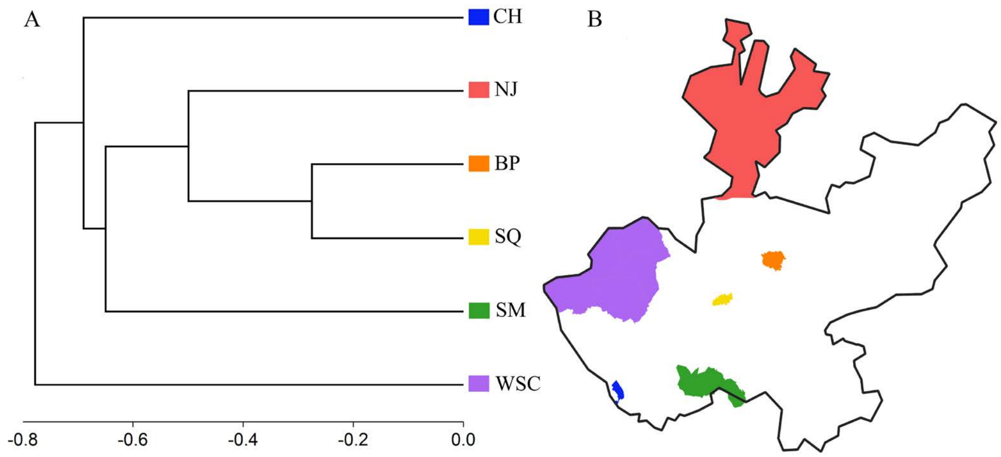

Figure 7. Affinity of the bromeliad flora from the Western Sierra-Coast region of Jalisco with other regions of the state. A) Cluster analysis (UPGMA); B) location of the regions along Jalisco state. BP = Bosque La Primavera; CH = Chamela-Cuixmala; NJ = North Jalisco; SM = Sierra de Manantlán; SQ = Sierra de Quila and WSC = Western Sierra-Coast.

WSC concentrates 86 % of the *Pitcairnia* species registered for Jalisco and all the endemic species for the state are restricted to the study area (Flores-Argüelles *et al.* 2022b), whose great representation reflects the geographic complexity of this region, since it is in the convergence of three biogeographic provinces (Pacific Lowlands, Sierra Madre del Sur, and Transmexican Volcanic Belt) offering different environments and topographic conditions, like the rocky areas where they live. WSC bromeliads that inhabit rocky areas, including all *Pitcairnia* species, are distributed in the more temperate zones and grow preferentially at intermediate altitudes (Figure 8). Such rupicolous bromeliads must not only be tolerant to water stress, since the species that inhabit rocky substrates in locations with high elevations, are also exposed to other factors, such as the duration of insolation, the intensity of irradiation, the diurnal oscillation of temperature and relative atmospheric humidity, and the increase in atmospheric transparency (Rzedowski 2006). The rocky areas present in this region can cause a geographic isolation between populations that limits pollen and seed dispersal, which could have promoted speciation in some genera with many micro endemic species like *Pitcairnia* (Flores-Argüelles *et al.* 2022b) or the presence of species with disjunct populations as in the case of *Ursulaea tuitensis* (Mota *et al.* 2020).

The preference of Bromeliaceae in WSC for low elevations (250-750 m asl) can be explained by the heterogeneity of environments that are present in this altitudinal range, all types of vegetation are found here except the cloud forest. This pattern tends to occur in mountainous regions with marked seasons where most bromeliad species are drought tolerant (Krömer *et al.* 2006). The high richness of bromeliads in oak forest is common, especially when species of epiphytic life form dominate (Pulido-Esparza *et al.* 2004, Espejo-Serna & López-Ferrari 2018, Gomez-Escamilla *et al.* 2019), the rugose bark of the dominant *Quercus* trees offers porosity with higher humidity due to its high-water retention capacity, which also helps to anchor the seeds (Callaway *et al*. 2002). In the case of tropical subdeciduous forests, some of the most important phorophytes are the members of the genus *Ficus*; these are generally tall trees and some of these species have also rough bark and thick branches that provide appropriated sites for the anchorage and survival of epiphyte seedlings (Trejo-Cruz *et al.* 2021).

The high concentration of bromeliad species and collections in the municipalities of Cabo Corrientes and Puerto Vallarta can be explained for several reasons: because of the variety of vegetation types and ecotones present due to the proximity to the coast and the mountains, and to the availability of road connections (IIEG 2018). As can be seen in Figure 6, most of the collections have been made along the principal roads, leaving a significant portion of the region unexplored. Additionally, many of the explorations were made three or more decades ago, so the current conditions of this areas are unknown. Although in recent years, a reasonable number of specimens have been collected, at least 13 species have not been collected since 2000, and for 15 species there exists only one single herbarium specimen available.

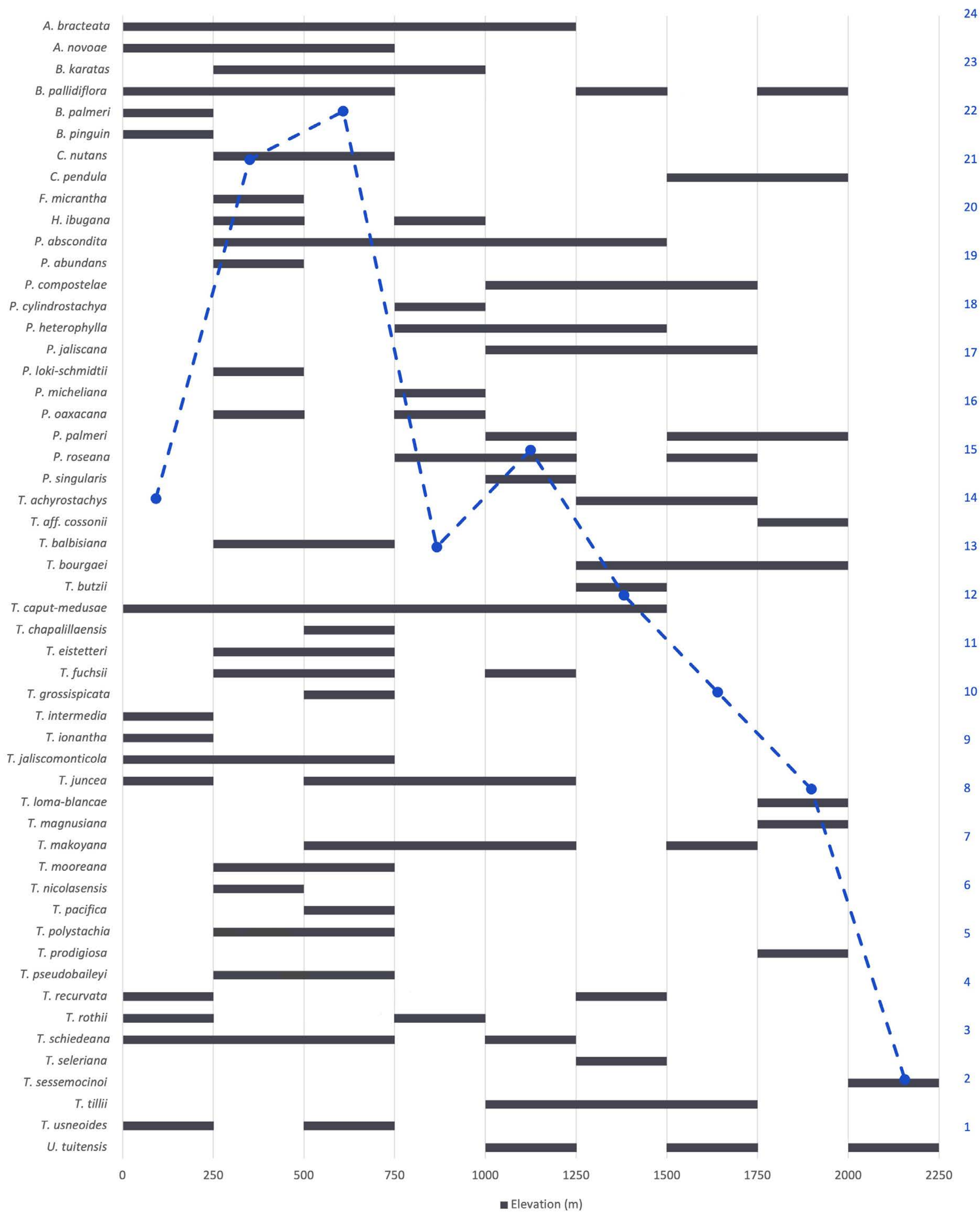

Figure 8. Distribution of the Bromeliaceae in the Western Sierra-Coast region of Jalisco by altitudinal range (the blue line indicates the total number of species in each altitudinal belt of 250 m).

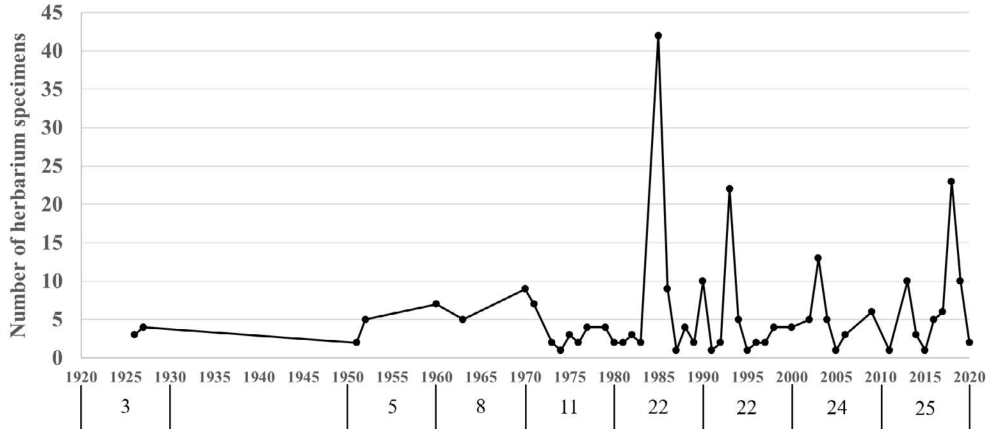

Figure 9. Collection activity of the Bromeliaceae from the Western Sierra-Coast region of Jalisco (the numbers bellow indicates the total number of species collected in each decade).

Some genera from other plant families also have a high diversity and endemism in the WSC region, like *Cosmos* (Vargas-Amado *et al.* 2019), *Quercus* (González-Villarreal 2003, 2018), and *Salvia* (González-Gallegos *et al.* 2013), to mention some. Five of the six endemic bromeliads to this region are only found in CC and PV, which are part of Sierra el Cuale. This area has a great floristic richness and probably is the one with the highest endemism of the state (Hernández-López 1995). Sierra el Cuale has also been proposed as a natural protected area (SEMADET 2016), unfortunately without success. Several other non-bromeliad species have been described within the last decade and are also concentrated in this area: *Hyptis cualensis* J.G. González & Art. Castro (González-Gallegos *et al*. 2014), *Miconia vallartensis* (Zabalgoitia *et al*. 2020), *Magnolia vallartensis* A. Vázquez & Muñiz-Castro (Vázquez-García *et al.* 2012), *Manfreda santana-michelii* (Castro-Castro *et al*. 2018), and *Pinus vallartensis* Pérez de la Rosa & D. Gernandt (Pérez de la Rosa & Gernandt 2017). Despite the considerable endemism of bromeliads in WSC, only two have been listed under special protection, one in NOM-050-SEMARNAT-2010 and the other in IUCN, none of them endemic to Mexico.

Even though there is not a negative impact due to exploitation of the bromeliads in this region, like some documented cases in other states (Flores-Palacios & Valencia-Diaz 2007, Krömer *et al.* 2014, 2018) the accelerated urban growth due to tourism development, in addition to other activities such as agriculture, livestock farming and illegal logging are actual threats to the members of this family, especially in CC and PV municipalities, were many of the bromeliad species are distributed (Arriaga *et al.* 2000, SEMADET 2016). Most of the bromeliads of the WSC are epiphytes, which are considered as the slowest plants to recolonize regenerating ecosystems (Fernández-Barrancos *et al*. 2017), as they depend entirely on the host trees and sometimes of specific host taxa that are present in an area (Reyes-García *et al.* 2008, Ochoa-López 2009). The deforestation and climate change could have had a negative impact in these species and in other vascular epiphytes, from affecting their distribution range to promoting its disappearance from some regions (Krömer *et al*. 2014), causing a reduction of the introduction of nutrients, the availability of habitats for animals, including pollinators, as well as a reduction of the general biomass of the forests (Cach-Pérez *et al*. 2014).

It is important to consider the WSC for its conservation, especially those areas with high concentration of richness and endemism. Additional filed work and ecological studies are needed to have a better knowledge of the distribution and conservation status of the bromeliads and other epiphytes, that are present in this region, to have more informed arguments to propose their inclusion in the Mexican Official Standard and the Red List of threatened species.

Supplementary material

Supplemental data for this article can be accessed here: https://doi.org/10.17129/botsci.3169

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