PHYTOGEOGRAPHICAL RELATIONSHIPS AND ANALYSIS OF THE FLORA OF SOUTH TEXAS PLAINS, U.S.A.

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ABSTRACT

The southernmost tip of Texas is a part of the Tamaulipan Province of northeastern Mexico which some authors consider in the Madrean Subkingdom of the Holarctic Kingdom, while others the "Xerofitica Mexicana" of the Neotropical Kingdom. To shed more light on this question, a natural flora of fourteen counties in the S TX Plains ecoregion, South Texas Plains flora (S TX), was compiled, studied from a biogeographical perspective, and analyzed in this work. The analysis was based primarily on the species and genera distribution outlines. Phylogenetic literature was searched to find relationships, patterns of migrations, and geographical connections of the species of major clades. Taxonometric and geographic spectra of the S TX flora were obtained and compared with those of two other floras in southern Texas: SC Texas (EP, or Edwards Plateau) and Big Bend Region (BB). There are 1250 native species in 553 genera and 117 families in the S TX flora. These species were classified into 25 geographic (floristic) elements. Herein is presented a checklist of S TX accompanied by the geoelement descriptions, a comparison of geographical spectra of the species and genera in all three floras, and the biogeographical analysis of the S TX flora. South TX, having a flat topography and being on the crossroads of migration routes, has multiple connections with adjacent floristic centers. The Tamaulipan endemism is not particularly high (8% in S TX) in comparison with much higher Chihuahuan endemism in BB (23% in BB; 10% in S TX). Proportions of taxa of the largest families in the three southern Texas floras show much higher numbers of tropical-subtropical, Tamaulipan, Gulf Coast, and Mesoamerican (coastal) species in the S TX flora in comparison with those of EP and BB. North temperate, E North American, and Prairie species are best represented in EP (47%), followed by S TX (36%), with only 17% in BB. The majority of the BB differential species are in the Chihuahuan, SW N American, Sonoran/Apachian, and the Madrean geoelements. The genera of the largest family, Asteraceae, that are differential among the three floras show importance of the Mexican (Madrean) centers of diversity as well as migrations from the Tethyan Subkingdom in the assembly of the S TX flora. Tethyan connections are also evident among the Boraginaceae s. str. and some other groups found in the flora. The spectra of generic and specific geographical elements of S TX illustrate transitional position of its flora. It represents an ecotone between the Western (Madrean) and the Eastern (Atlantic and Gulf Coast) N American Regions, with a very high influence of the various Neotropical elements and a higher affinity to the EP flora than to that of BB.

RESUMEN

El extremo sur de Texas es una parte de la provincia Tamaulipana del noreste de Mexico que algunos autores consideran en el Subreino Madreano del Reino Holártico, y otros en la "Xerofítica Mexicana" del Reino Neotropical. Para arrojar más luz sobre esta cuestión, se compiló una flora natural catorce condados en la ecorregión Llanuras S TX, flora Llanuras Sur de Texas (S TX), se estudió desde una perspectiva biogeográfica, y se analizó en este trabajo. El análisis se basó en principio en los contornos de la distribución de especies and géneros. Se buscó bibliografía filogenética para encontrar relaciones, patrones de migraciones, y conexiones geográficas de las especies de los clados mayores. Los espectros taxonométricos y geográficos de la flora S TX se obtuvieron y compararon con los de otras dos floras del sur de Texas: SC Texas (EP, o Edwards Plateau) y Región Big Bend (BB). Hay 1250 especies nativas de 553 géneros y 117 familias en la flora S TX. Estas especies se clasificaron en 25 elementos geográficos (florísticos). Aquí se presenta un catálogo de S TX acompañado de descripciones de geoelementos, una comparación de espectros geográficos de las especies y géneros de las tres floras, y el análisis biogeográfico de la S TX flora. South TX, con una topografía plana y estando en la encrucijada de las rutas de migración, tiene múltiples conexiones con centros florísticos adyacentes. El endemismo Tamaulipano no es particularmente alto (8% in S TX) en comparación con el endemismo mucho mayor Chihuahuano en BB (23% in BB; 10% in S TX). Las proporciones de taxa de las grandes familias en las tres floras del sur de Texas muestran números mucho más altos de especies tropicales-subtropicales, Tamaulipanas, Gulf Coast, y Mesoamericanas (costeras) en la flora S TX en comparación con las de EP y BB. Las especies del Norte templado, E Norte Americano, y Pradera están mejor representados en EP (47%), seguidos por S TX (36%), con solo 17% en BB. La mayoría de las especies diferenciales BB están en los geoelementos Chihuahuano, SW N Americano, Sonorano/Apachiano, y el Madreano. Los géneros de la mayor familia, Asteraceae, que son diferenciales entre las tres floras muestran la importancia de los centros de diversidad mexicanos (Madreano) así como las migraciones desde el Subreino Tethyano en el conjunto de la flora S TX. Las conexiones Tethyanas también son evidentes entre las Boraginaceae s. str. y algunos otros grupos que aparecen en la flora. Los espectros de los elementos geográficos genéricos y específicos de S TX ilustran la position de transición de su flora. Esta representa un ecotono entre las regiones norteamericanas Oeste (Madreana) y la Este (Atlantica y Costa del Golfo), con una influencia muy grande de varios elementos Neotropicales y una afinidad más alta con la flora EP que con la de BB.

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INTRODUCTION AND ECOLOGICAL SETTING

To the south of the Texas Balconies Escarpment, between the Rio Grande and Western Gulf Coastal Plain, there are some 8 million hectares of subtropical dryland vegetation, consisting of extensive thornscrub and mesquite-grassland (Correll & Johnston 1970). This area of mostly sandy flats and sand hills in the Rio Grande Plain of south Texas, northernmost Tamaulipas, and adjacent Nuevo Leon are known as South Texas Plains. The rolling to level topography, ranging from sea level to 300 m, is dissected by streams and arroyos flowing into Rio Grande or the Gulf of Mexico. According to Robert Thorne, "This area of Texas and the coastal strip about Brownsville are of special interest to our study, for they accommodate representatives of genera and even families not found indigenous elsewhere in North America North of Mexico" (Thorne 1993). Its southernmost location in Texas and proximity to the Gulf of Mexico make the flora of this region informative for the purposes of floristic regionalization. It is considered to be a part of the Tamaulipan Subprovince (Fig. 1) of the Sonoran Province of the Holarctic Kingdom (Cronquist 1982; Takhtajan 1986), while other authors place it in the "Xerofitica Mexicana" (Morrone 2014) of the Neotropical Kingdom.

The southern tip of Texas is also on the crossroads of different migration routes. In order to better understand its chorionomic placement, one should study the influence of neighboring floristic provinces on its flora, specifically the proportions of the tropical, southeastern, and southwestern North American geographical elements (geoelements) in it. For this purpose, the flora of fourteen counties in the S TX Plains ecoregion is compiled and analyzed in this work. Our study area includes two parts of this ecoregion: Texas-Tamaulipan thornscrub and Rio Grande floodplain and terraces. I consider the flora of the following counties: Maverick, Zavala, Frio, Atascosa, Dimmit, La Salle, McMullen, Webb, Duval, Zapata, Jim Hogg, Brooks, Starr, and Hidalgo.

Another purpose of this paper is to compare three almost adjacent natural floras in southern Texas: the flora of South-Texas Plains (S TX), which is the primary subject of this study, the flora of adjacent South-Central Texas (EP) in the Edwards Plateau ecoregion, and the flora of Big Bend Region (BB), in the Chihuahuan Deserts ecoregion (Fig. 2) analyzed in Saghatelyan (2009, 2015). The flora and vegetation of S TX are well known (Clover 1937; Diggs et al. 2006; Crosswhite 1980; Lonard et al. 1991; MacRoberts & MacRoberts 2003, 2007, 2008; Everitt et al. 2002; Everitt et al. 2011; Rzedowski 1973, 1975, 1993; Webster & Conrad 2001). The region is characterized by plains of thorny shrubs and trees and scattered patches of palms and subtropical woodlands in the Rio Grande Valley. The plains were once occupied with open grasslands and a scattering of trees, and the valley woodlands once covered large areas. Today, the primary vegetation consists of thorny brush such as mesquite, acacia, and prickly pear mixed with areas of grassland.

The Mesozoic Era in Texas began about 245 million years ago when the European and African plates began to break away from the North American plate, producing a belt of elongate rift basins that extended from Mexico to Nova Scotia (www.beg.utexas.edu). Sediment from adjacent uplifts was deposited in these basins by streams. While Europe and Africa drifted farther away, the basins were buried beneath marine salt as the East Texas and Gulf Coast Basins were created. During the rest of the Mesozoic Era, broad limestone shelves were periodically buried by coastal plains and deltaic deposits as the Texas continental margin gradually shifted southeastward into the Gulf of Mexico. According to Graham (2011) the Early Cretaceous epicontinental sea was extending from the Arctic Ocean to the Gulf of Mexico. It began to drain in the Middle Cretaceous and by the Mid-Eocene (45 Ma) the margin of the sea ran from south of Laredo northward to just east of Austin, around the southern edge of Appalachian Mountains and northward along their eastern edge. By the beginning of the Pleistocene (2.6 Ma), the coastline had retreated to its approximate present position around Houston and New Orleans and fluctuated with the waxing and waning of glaciers.

When the Cenozoic Era dawned in Texas, about 66 million years ago, The East Texas Basin was filling with lignite-bearing deposits of river and delta origin.

Now, Cenozoic strata are exposed throughout East Texas and in broad belts in the coastal plain that become younger toward the Gulf of Mexico (www.beg.utexas.edu).

Soils of the region are alkaline to slightly acidic clays and clay loams. Also characteristic are sandy soils including areas of deep sand, and caliche limestone. The deeper soils support tall brush, such as mesquite and

Fig. 1. Floristic provinces/areas of endemism of North America. Regional schema adapted from Takhtajan (1986) as published in Thorne (1993). The areas were drawn in Photoshop by Alice Tangerini on a base map from ArcMap8.2 with a North American Lambert conformal conic projection. The map was published in Katinas et al. (2004) and is used with permission of Missouri Botanical Garden Press and the authors.

spiny hackberry, whereas short, dense brush grows in the shallow, caliche soils. The average annual rainfall is 500 to 800 mm with higher average rainfall as you go west to east. The average monthly rainfall is lowest during winter and highest during spring (May or June) and fall (September). Summer temperatures are high, with very high evaporation rates (worldwildlife.org/ecoregions/na0303; National Climate Data Center, U.S.A. Dept. of Commerce).

MATERIALS AND METHODS

A checklist of the flora of the above mentioned counties of S Texas Plains was compiled using primarily the Synthesis of the North American Flora (Kartesz 2016) with the non-native species excluded. Taxonomic

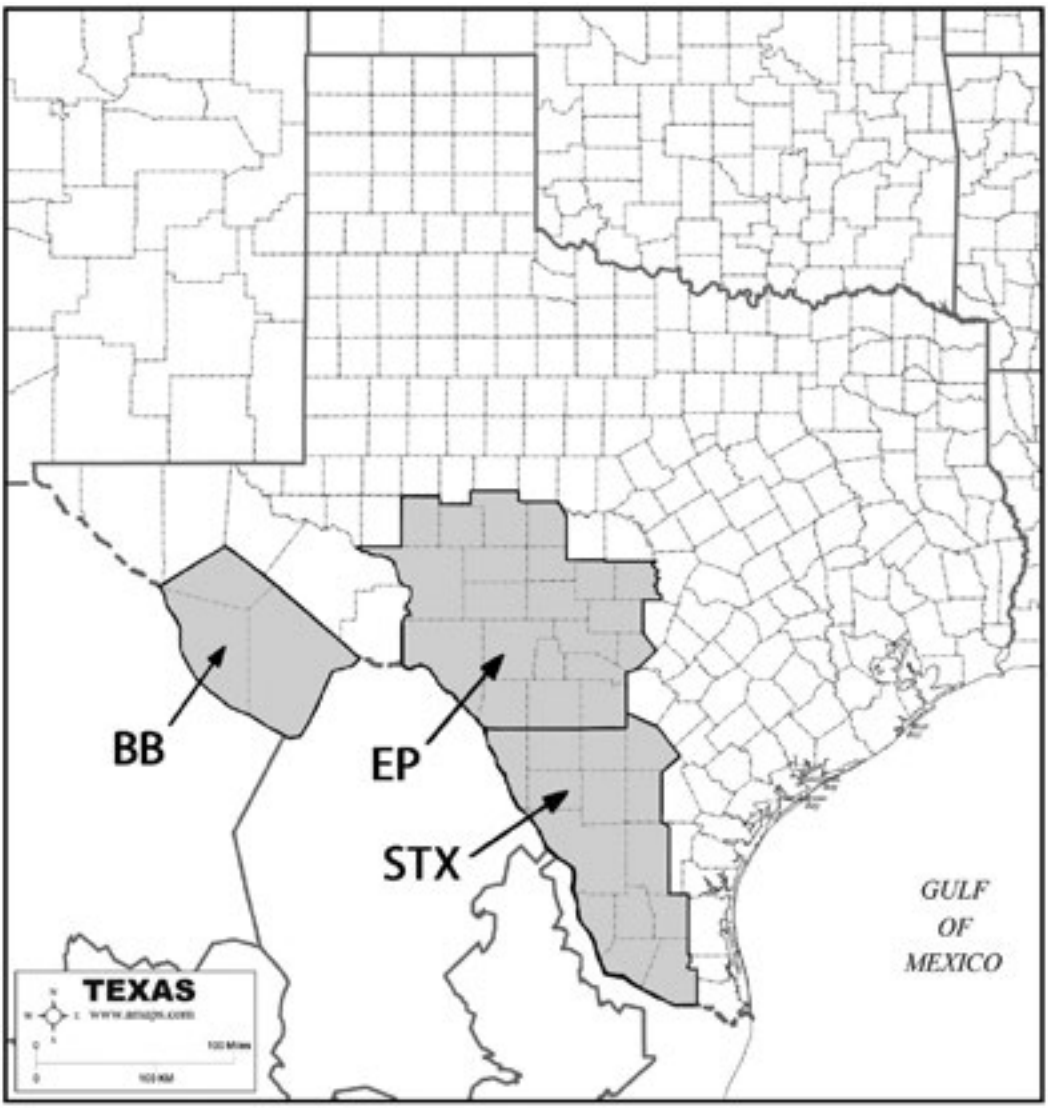

Fig. 2. Texas county map with the study area of the South Texas Plains flora (S TX), South Central Texas flora (EP), and the Big Bend area (BB) outlined by a bold contour. The map is courtesy of Texas Parks and Wildlife and was modified in Photoshop by Mike Karabegov.

spectra of the families, genera, and species were determined. Distributional and other data were obtained from the Synthesis of the North American Flora (Kartesz 2016), GBIF (gbif.org), TROPICOS (Tropicos.org.), Flora of North America (floranorthamerica.org), and Digital Flora of Texas (botany.csdl.tamu.edu/FLORA/) databases, literature on Texas flora (Correll & Johnston 1970; Turner et al. 2003; Diggs et al. 1999), and many online databases on different taxonomic groups, as well as other literature sources. After studying the general distribution outlines of all species in the flora, congruent distributions of two or more species were classified into geographical elements using the classification system by Saghatelyan (2009) which was developed on the example of the flora of Big Bend Region of Texas and used to classify geographic elements of SC TX (Saghatelyan 2015). Each species was included in a particular geographic element, or geoelement of the flora (Saghatelyan

1997, 2006). The distribution data on all genera of S TX were retrieved from FNA (http://floranorthamerica.org/), FOC (flora.huh.harvard.edu/china/), Wielgorskaya (1995), Mabberley (2008), as well as other online sources. The genera were classified into 23 geographic groups based on their distribution outlines. The species list (Appendix 1) for the above-mentioned counties was prepared with the major objective of defining the geoelements and mostly follows the nomenclature accepted in Kartesz (2016), except the Boraginales were kept in the checklist as two families for easier comparison to those in BB and EP, while the discussion follows most recent circumscription. The unidentifiable ranges of a few species are noted in the checklist with a question mark. After analyzing the S TX flora, its taxonomic and geographic composition was compared with those of the BB and EP floras.

RESULTS

Taxonometric analysis: Major families

There are 1250 species, 553 genera, and 117 families in the flora of S TX Plains (Appendix 1). The seventeen largest families with twenty or more species have 874 species or 70% of the flora. Of those, 717 species (57% of the flora) are in the leading ten families (Table 1).

The South Texas flora has 33 families represented by a single species with the following seven families absent from BB and/or EP: tropical American families Achatocarpaceae (only S TX Plains in the U.S.A.), Basellaceae and Turneraceae (only S TX Plains and FLA in the U.S.A.); pantropical families Bixaceae (only S TX Plains, S AZ, SW NM in the U.S.A.) and Arecaceae, as well as cosmopolitan families Droseraceae and Frankeniaceae—the latter, having tolerance to salt and gypsum, is disjunct in Mediterranean climates.

Table 2 presents a comparison of the large families' spectra of S TX, EP, and BB floras. Xerophytic groups of open landscapes are characteristic of all three floras, but especially BB and S TX. First three families, Asteraceae, Poaceae, and Fabaceae, usually leading in low latitude temperate floras of Northern Hemisphere, have comparable richness. However, they reveal different connections, with more species of tropical genera in S TX, and more temperate species in EP. Proximity to important centers of Asteraceae diversity in Mexico and SW U.S.A. (Schilling et al. 2015), especially in the Heliantheae Alliance and Eupatorieae (Turner & Nesom 1993), is pronounced in all three floras. Strongest differences among the three flora regions are connected to climatic differences correlated with their latitude, altitude, and edaphic conditions and are evident on the metacommunity level. Clades confined to low elevation flatlands, sandy and clay substrates are characteristic of the S TX Plains flora, while mountainous xerophytic groups are typical for BB. Many species in the S TX flora composition are in the temperate clades of mostly tropical families like Euphorbiaceae (4th place), Malvaceae (6th place), Verbenaceae (9th place), and Acanthaceae (14th place). The BB flora strongly represents south-western North American (including Mexico) xerophytic diversification in Cactaceae, Asteraceae, Nyctaginaceae, and Apocynaceae, as well as western North American lineages, whose ancestors arrived from the Tethyan Subkingdom via Beringia (like Polygonoideae, many Brassicaceae, Boraginaceae s. str, and Lamiaceae). Some of these most numerous in BB Tethyan based lineages are also present in EP but not in S TX. The more mesophyllous temperate nature of EP flora is evident from higher numbers of the Rosaceae and Apiaceae, and lower numbers of the Cactaceae and other southwestern N American groups. West to east increased humidity ensures highest placement of Cyperaceae in EP (4th place), followed by S TX (5th place), as opposed to their 7th place in BB.

The composition of the order Boraginales in the three Texas floras is an example of how xerophytic lineages of the Madrean flora have assembled from different sources. Chacon et al. (2016) suggested a vicariant origin of two major clades of Boraginales, Bor I and Bor II, after the break-up of West Gondwana. According to Luebert et al. (2016), Bor II clade diversified from an American ancestor in the Early Paleogene. The early branching families of Bor II, Namaceae and Hydrophyllaceae, are most diverse in W and SW N America and may have remained restricted to the Americas since their origin in the middle Eocene (Luebert et al. 2016). These families are well represented in the southern Texas floras (16 sp. in BB, 7 sp. each in EP, and S TX). The Ehretiaceae with an amphitropical genus *Tiquilia* in the three floras (5 BB/3 EP/1 S TX), and its sister family

Table 1. Family spectrum of South Texas Plains flora.

Family	species (%)/genera (%)
Asteraceae	171 (13.6) / 89 (16.45)
Poaceae	163 (12.87) / 59 (19.9)
Fabaceae	95 (7.58) / 39 (7.2)
Euphorbiaceae	63 (5.13) / 11 (2.)
Cyperaceae	47 (3.79) / 10 (1.84)
Malvaceae	46 (3.64) / 24 (4.43)
Amaranthaceae	39 (3.09) / 13 (2.4)
Cactaceae	35 (2.77) / 17 (3.14)
Verbenaceae	29 (2.27) / 8 (1.48)
Boraginaceae	29 (2.28) /13 (2.40)

Table 2. Comparison of Edwards Plateau (EP), Big Bend (BB), and South Texas Plains (S TX) Flora's largest families. First number in each column is the place of the family in the flora with ten largest families in bold face. Percentages of species/genera in each flora are in the brackets.

Large Families	EP: nb. sp .(%)/gen.	BB: nb. sp (%)/gen.	S TX: nb. sp. (%)/gen. (%)
Asteraceae	**1. 232 (14.3) / 98**	**1. 230 (14.5) / 107**	**1. 172 (13.6) / 89 (16.45)**
Poaceae	**2. 199 (12.2) / 65**	**2. 202 (12.7) / 63**	**2. 163 (12.87) / 59 (19.9)**
Fabaceae	**3. 120 (7.4) / 41**	**3. 107 (7.1) / 37**	**3. 96 (7.58) / 39 (7.2)**
Cyperaceae	**4. 69 (4.2) / 11**	**7. 40 (2.5) / 10**	**5. 48 (3.79) / 10 (1.84)**
Euphorbiaceae	**5. 68 (4.1) / 12**	**4. 59 (3.7) / 10**	**4. 65 (5.13) / 11 (2.)**
Cactaceae	**6. 40 (2.5) / 13**	**4. 59 (3.7) /17**	**8. 35 (2.77) / 17 (3.14)**
Amaranthaceae	14. 25 (1.6) / 11	**6. 43 (2.7) / 13**	**7. 39 (3.09) / 13 (2.4)**
Verbenaceae	19. 13 (0.8) / 6	14. 21 (1.4) / 8	**9. 30 (2.27) / 8 (1.48)**
Brassicaceae	**7. 37 (2.3) / 14**	**6. 43 (2.7) / 21**	12. 26 (2.05) / 13 (2.40)
Lamiaceae	**8. 37 (2.3) / 10**	**8. 38 (2.4) / 11**	14. 21 (1.65) / 10 (1.85)
Plantaginaceae	**9. 32 (2.1) / 10**	12. 25 (1.6) / 9	16. 15 (1.2) / 8 (1.48)
Boraginaceae	**10. 29 (1.9) / 13**	**5. 48 (3.0) / 11**	**10. 29 (2.28) /13 (2.40)**
Solanaceae	11. 28 (1.7) / 10	**10. 32 (2.0) / 10**	11. 28 (2.21) / 8 (1.48)
Pteridaceae	12. 27 (1.7) / 7	**9. 33 (2.1) / 8**	18. 12 (0.94)/ 5 (0.82)
Rosaceae	13. 26 (1.6) / 10	19. 12 (0.8) / 9	21. 7 (0.55)/ 4 (0.74)
Malvaceae	15. 24 (1.5) / 12	13. 24 (1.5) / 12	**6. 46 (3.64) / 24 (4.43)**
Apiaceae	15. 24 (1.5) / 18	22. 7 (0.3) / 5	17. 13 (1.02) / 9 (1.67)
Onagraceae	15. 24 (1.5) / 3	11. 28 (1.8) / 4	12. 26 (2.05) / 2 (0.37)
Acanthaceae	17. 19 (1.2) / 7	16. 18 (1.2) / 8	13. 21 (1.55) / 9 (1.67)
Apocynaceae	16. 21 (1.3) / 4	**10. 31 (1.9) / 8**	14. 20 (1.56) / 6 (1.10)
Nyctaginaceae	18. 17 (1.1) / 6	9. 32 (2.0) / 11	14. 20 (1.56) / 9 (1.67)
Rubiaceae	18. 17 (1.1) /6	17. 17 (1.1) / 6	15. 18 (1.42) / 9 (1.67)

Cordiaceae, with a tropical woody genus *Cordia* (2 sp. in S TX and 1 sp. in southwesternmost EP), diversified to pantropical families since the Paleocene and Eocene respectively. Heliotropiaceae became cosmopolitan with the largest genus *Heliotropium* (8 sp. BB and S TX /5 sp. EP) in tropical to warm temperate regions. Thus Bor II clade shows S/N American connections after a rare case of West Gondwana vicariance.

The other, Bor I clade, diversified from a late Cretaceous African ancestor. Its two early branching lineages remained restricted to arid SW and NE Africa, while Boraginaceae s str. diversified into a subcosmopolitan family through a single colonization event from Africa into Eurasia during the Paleocene (Luebert et al. 2016). There were several colonization events into the New World from African and Eurasian ancestors during the Middle Eocene. At least 11 dispersal events between Eurasia and North America are inferred in the phylogeny of Boraginaceae s. str. by Weigend et al. (2013). The geographical distribution of major clades of Boraginaceae s. str. suggests that their species in the Tethyan, Madrean, and Boreal Subkingdoms of the Holarctic Kingdom of A. Takhtajan (1986) should be considered separately. This clade has long fascinated biogeographers in the Old World as an example of ancient xerophytic Tethyan diversification rooted in Africa with major centers

having about 80% of all species mostly in the Irano-Turanian, Mediterranean, and Madrean regions (Popov 1963; Kamelin 1973; 1998, 2010). In the phylogeny of Chacon et al. (2016) Echinochiloideae, the arid adapted sister clade to the remainder species of Boraginaceae s. str., has two genera in North Africa/ West Asia and genus *Antiphytum* in the New World, disjunctly distributed in mostly eastern Mexico and southeastern South America. In the U.S.A. it has only two species: in BB and Val Verde County of EP in TX and Hidalgo County in SW NM. This pattern points to a probable transatlantic long distance dispersal (LDD) from the Tethyan Subkingdom. The second subfamily of Bor I clade, Boraginoideae, is mostly Mediterranean/Irano-Turanian, with only one cosmopolitan genus *Lithospermum*. The latter has several species in the entire Boreal Subkingdom and a center of diversity in SW N America and Mexico. However, all American species of *Lithospermum* (which has 6 sp. in BB/7 in EP/4 in S TX) are nested among the Eurasian species of the phylogeny of Chacon et al. (2016). The third and largest, mostly Old World/Tethyan subfamily Cynoglossoideae has genus *Omphalodes* in the western hemisphere (in E Mexico and only in BB and Val Verde county of EP in U.S.A.). This might be another transatlantic LDD from W Europe/Mediterranean/ Frontal Asia, since early branching species in the above mentioned phylogeny are western Eurasian. The mostly Irano-Turanian (Frontal Asian/Central Asian) Rochelieae have two North temperate genera of the Old World origin in the three Texas floras: *Hackelia* (1 sp. in BB only) and *Lappula* (1 sp. in all three floras). The remaining species of the South African/Tethyan based tribe Cynoglossseae found in the three TX floras belong to the mostly western North American subtribe Amsinckiinae (10 BB/5 EP/4 S TX). Cohen (2015) proposed two new genera for the four North American species of *Cynoglossum* because they were resolved as early-diverging species of the clade that includes *Cryptantha* and its relatives. This clade was found to be distinct from the Old World species of *Cynoglossum* and relatives. Even though the majority of the Amsinckiinae are in the Madrean part of the California flora, this migration pattern from the Old World is of the Boreal Subkingdom type. Its early branching North American species are in the Pacific and Appalachian mountainous forests (Kartesz 2016). Since *Cynoglossum* is well represented in temperate mesic vegetation of Eurasia, Bering Land Bridge (BLB), as well as a transatlantic crossing could have served as its route of arrival from the Old World. Popov proposed in his 1949–1950 manuscript (Popov 1983) that *Lithospermum*, *Omphalodes*, and *Cynoglossum* entered North America in the Neogene simultaneously via the Atlantic and Pacific routes.

The distribution pattern of Boraginaceae s. str. is an example of Madro-Tethyan connections of two types: (1) subtropical transatlantic direct migrations connecting xeric Tethyan and Madrean Subkingdoms; (2) arrival to North America of more mesophilic, but Tethyan Subkingdom based, ancestors from northern Eurasia via more temperate higher latitudes routes, with subsequent southbound xerophytic radiation in the Madrean Subkingdom of the American Southwest.

Being more mountainous of the three floras, BB is richer in Pteridaceae and Fagaceae—the latter influenced by the major center of diversity of oaks in Mexico (Nixon 1993). Two thirds of the BB species of mostly western North American family Onagraceae are not found in S TX. These species have western N American or Chihuahuan ranges, while the ranges of S TX Onagraceae are in the Prairie Region or SC N America. The Onagraceae of EP have mostly E N American/prairie ranges.

Mesophytic and North temperate groups are more numerous in EP than in the other two floras, especially among the Cyperaceae, Rosaceae, and Apiaceae.

The largest family in all three floras is **Asteraceae** (Table 2): EP 232 sp./98 genera; BB 230 sp./107 genera; S TX 171 sp./89 genera. There are 158 species of the BB Asteraceae which are absent from S TX flora. The S TX flora has 55 differential species of that family, which are absent from BB. The ranges of S TX differential Asteraceae are in the Tamaulipas, SC N American, S TX Plain, S Prairie, E N American, and Gulf Coast geoelements. The majority of BB differential Asteraceae are in the SW N American, Madrean/Mesoamerican, Sonoran-Chihuahuan, and Apachian geoelements. Their species tracks frequently run along the mountains from SW U.S.A. to Sierra Madre Occidental/Del Sur and Trans Mexican Volcanic Belt in Mexico.

Table 3 summarizes differential genera of the Asteraceae in S TX, BB, and EP floras. Temperate differential genera or sections of the Asteraceae are mostly in EP, the Madrean differential genera are in BB, while tropical,

Table 3. Asteraceae and differential genera in S Texas Plains, Edwards Plateau, and Big Bend floras.

Genus, Geoelement	S TX	EP	BB	Ecology	Tribe
Trixis; C&S Amer	2	0	1	Sandy & rocky sites, thornscrub, roadside	Mutisioideae
Gochnatia; C&S Amer	1	1	0	Gravel & caliche soils in dry scrub	Mutiioideae
Hieracium; temperate	0	0	1: S Gr B-N Chih disj	Mont	Cichorieae
Lactuca; Cosm., not S Amer	0	3	2	Dry habitats	Cichorieae
Krigia; ENAmer (NM&AZ)	4	3	0	Sandy, clay, woods, prairies	Cichorieae
Stephanomeria; W N Amer	0	1	2	Sandy, gravely slopes, Juniper woodlands, etc	Cichorieae
Vernonia; Trop/Subtr	0	4	2	Serpentine, limestone, volcanic soils	Vernonieae
Conyza; Trop/Subtr	0	2: Amer, Prair	1 Amer	Disturbed sites	Astereae
Croptilon; E N Amer	2: SE TX, Tam	2: Gulf, Prair	0	Sand	Astereae
Dichaetophora; Tam-Chih Disj; 1 sp.	1: S TX	1: Tam (-Chich)	0	Sand	Astereae
Neonesomia; Tam; 2 sp.	1	1	0	Open flats to steep slopes in saline to sandy soils	Astereae
Rayjacksonia; W Prair, Gulf; 3 sp.	1	1	0	Sand or sandy loam, prairies	Astereae
Solidago; Temperate	0	7	5	Open sites	Astereae
Townsendia; W N Amer; 27 sp.	0	0	1	Mont	Astereae
Xanthocephalum; Madrean	0	0	1: Son-Chuh	Mont	Astereae
Xylorrhiza; SW N Amer	0	0	1: Chih		Astereae
Marshallia; E N Amer	0	1: Comanch	0	Limestone outcrops, sandy soils	Helenieae
Baileya; SW N Amer	0	1	1	Stony slopes, mesas, and sandy plains	Helenieae
Cosmos; Trop/Subtr Amer	0	0	1: Apach-Mex Highlands	Scrub, meadows	Coreopsideae
Heterosperma; W N Amer	0	0	1: Mesoam-Madr	Open rocky mount slopes	Coreopsideae
Ageratina; Amer, W Ind warm	0	2: E N Amer; E Madr-Caribb	3: Madr, Chih, Son-Chih	Rocky slopes	Eupatorieae
Trichocoronis; Chih, Son disjunctive; 1 sp.	1	0	0	Edges of ponds, streams, wet depressions	Eupatorieae
Stevia; Trop/Subtr Amer (WN Amer/S Amer)	0	0	2	Mont	Eupatorieae
Shinnersia; S TX-Coah; 1 sp.	1	1: Mexico (Coah, Nuevo Leon)	0	Water arising from calcareous outcrops	Eupatorieae
Mikania; Trop/Subtr Amer	1	1	0	Wet & calcareous areas, woodlands	Eupatorieae
Porophyllum; Trop/Subtr Amer	0	0	3	Rock & sand desert scrub	Tageteae
Clappia; Tam.; 1 sp.	1: Tam	0	0	Low, saline succulent	Tageteae
Dyssodia; W N Amer			1: Mesoam-N Amer	Grassland, open woodland, ruderal	Tageteae
Pseudoclappia; 2 sp. (Apachian)	0	0	1	Clays or gypseous-sandy soils	Tageteae
Tagetes; Tr/Subtr (Mex)	0	0	1: Mesoam-Madr	Mont	Tageteae
Psathyrotopsis; Chih; 3 sp.	0	0	1	Gypseous and calcareous soils in creosote bush scrub	Bahieae
Schkuhria; Amphitr.; 2 sp.	0	0	1	Mont	Bahieae
Encelia; Chih-Tam	0	0	1: N Chih	Rocky desert slopes	Heliantheae

Table 3. (continued)

Genus, Geoelement	S TX	EP	BB	Ecology	Tribe
Heliopsis; Mex to S Amer, S US	0	0	1: N Madr. Mont (Son Prov. Mont)	Open	Heliantheae
Leuciva; Chih; 1 sp.	0	0	1: Chih	Calcareous desert soils	Heliantheae
Lindheimera; 1 sp	1	1: SC N Amer (Comanch)	0	Sandstones, clays, alkaline	Heliantheae
Rudbeckia; E N Amer	1	1	0	Open woods, fields, roads	Heliantheae
Echinacea; E Prair	0	1: Prair	0	Dry prairies, open woods	Heliantheae
Eupatorium	1	1	0	Open temperate areas	Heliantheae

or E Mexican (Sierra Madre Oriental) differential groups are in S TX. Differences in generic composition correlate with soil types and altitudes. Subfamilies and tribes of the Compositae Metatree (Funk et al. 2009) have the following representatives in the S TX flora.

Subfamily Mutisioideae in S TX has 6 sp. of four South American-Madrean/Mesoamerican genera. *Trixis* is absent from EP and *Gochnatia* is absent from BB, while *Acourtia* and *Chaptalia* are found in all three floras. *Chaptalia* is an American member of the *Gerbera* complex that mirrors the historical biogeography of the entire Asteraceae (Funk et al. 2009; Baird et al. 2010). The S TX Plains *Chaptalia caduacea* is a member of an important radiation of the genus in the eastern Madrean/Mesoamerican Mountains (Nesom 1995).

Subfamily Cichorioideae. 8 sp. in S TX

Cichorieae species in S TX and EP have SE Prairie/SE N American ranges. All the principal American Cichorieae genera radiated from a single common ancestor *Phalacroseris* (Lee et al. 2003; Kilian et al. 2009), a monotypic local endemic genus in the wet meadows and upper montane forests of the Sierra Nevada Mountains. The latter authors recognize the American Cichorieae as a single subtribe *Microseridinae* which includes a W N American clade and a SE N American/Madrean clade. The western clade is absent from the S TX flora, but has genus *Stephanomeria* in BB and EP. To the contrary, the SE N American/Madrean clade is absent from BB, but has a SE N American genus *Krigia* (Table 3) in S TX (4 sp.) and in EP (2 sp.). Genus *Krigia* branches basally to the clade with an N Coahuila local gypsum endemic and a Chihuahuan/Madrean/Mesoamerican mostly montane genus *Pinaropappus* (found in all three floras). Most interesting in the analysis of Kilian et al. (2009) is that the sister to all American Cichorieae genus *Phalacroseris* is nested within the Cichoriinae where it branches basally to a clade with a genus from the Horn of Africa and a mostly Mediterranean-Frontal Asian genus *Cichorium*. This clade is sister to a clade of three African/European genera with a local monospecific endemic genus from Spain in the basal position. This Chichorieae diversification pattern points to a possible transatlantic LDD.

Vernonieae with large radiations of genera and species from southern Argentina to the eastern United States and the West Indies are typically found on soils such as serpentine, limestone, volcanic and others that are rich in metals (Keeley & Robinson 2009). *Vernonia*, a genus diverse in EN America, is absent from S TX, but has 4 species in EP and 2 species in BB (Table 3).

Subfamily Asteroideae, 44 sp. in S TX

Astereae. Basal grade of Astereae is comprised of South American and Old World taxa (Brouillet et al. 2009). The South American group has two tropical/subtropical American genera *Baccharis* and *Laennecia* in all three floras (6 sp. in S TX, 5 sp. in EP, and 8 sp. in BB). The remaining 15 genera of the Astereae are in various subclades of the North American clade. Solidagininae, with 11 species in EP, have only five of these species in S TX. They belong to the mostly W N American/Mexican genus *Heterotheca* and an N American genus

Symphiotrichum. These genera have six more species with prairie ranges in EP and 5 other species with W N American ranges in BB. According to Brouillet (2007), boreal NW American monotypic genus *Canadanthus* was confirmed in the basal position in subtribe Symphyotrichinae. *Canadanthus* has been associated also with circumpolar/boreal species *Eurybia sibirica*. Another temperate genus *Solidago* has 7 sp. in EP and 5 sp. in BB, but is absent from S TX. The North American clade of Astereae has 9 differential genera (Table 3) with several edaphic endemics on sandy lands in the Tamaulipas Province (these species are found only in S TX) and species of some western genera which are only present in BB.

Heliantheae Alliance

Helenieae. The tribe Helenieae of Baldwin and Wessa (2000) is comprised of 13 genera, six of which have **17 species** in the S TX flora. It evolved in southwestern and southeastern/southcentral North America, including Sonoran and Chihuahuan deserts of Mexico (Turner 2013). Sister to the rest of Helenieae, mesophytic EC/SE North American genus *Marshallia*, is present only in EP. Two genera of subtribe Gaillardiinae, *Gaillardia* and *Helenium*, have three S TX Plain/Coahuila endemic species and three southeast North American species in S TX and EP floras. The only differential species of Gaillardinae in BB is a North Chihuahuan gypsopyte of the southwestern radiation. There are three more widespread species that are shared by all three floras. However, only BB has an endemic monotypic N Chihuahuan desert genus *Plateilema* which is sister to the Gaillardinae. The third genus of Gaillardinae, *Balduina*, is not found in Texas. It grows in southeasternmost N America. Although the diversity of Helenieae is highest in arid and semiarid ecosystems of western North America, *Balduinia* and most species of *Helenium* have a strong affinity to wet soils (Tiley et al. 2016). Another differential genus *Baileya* is also found in BB, where it has one Sonoran Province species absent from S TX and EP (except Val Verde county, which is in the Sonoran Province). *Baileya* is sister to the southwestern genus *Hymenoxis* with one widespread species *H. odorata* in all the three floras. Remaining genera of Helenieae, *Amblyolepis, Psilostrope,* and *Tetraneuris,* are shared among the three floras, but have several differential species in them. In general, south-central and south-eastern subclades of the Helenieae are found in EP and S TX, while the southwestern groups are in the BB flora.

Coreopsideae 12 sp. in S TX

Coreopsideae is a small tribe with centers of diversity in the New World and especially in Mexico (Mort et al. 2008). Only the BB flora has one species in each of two differential genera, *Heterosperma* and *Cosmos* which have Madrean connections. The first species *Heterosperma pinnatum* is sister to *Coreopsis cyclocarpa* from Trans Mexican Volcanic belt; the second, an Apachian-Mexican Highlands species *Cosmos parviflorus,* is the only representative of this Madrean/Mesoamerican genus in the U.S.A. According to Crawford and Mort (2005) and Crawford et al. (2014), the two largest genera of the tribe, *Bidens* and *Coreopsis*, are nonmonophyletic. *Coreopsis* is now strictly a New World genus with centers of diversity in southern Mexican and Central American mountains, the Andes, and eastern North America. The majority of species of this tribe in S TX and EP belong to the latter, eastern North American, center of diversity of *Coreopsis*. The genus *Thelesperma* was placed as sister to a clade containing North American *Bidens* and *Coreopsis* (Crawford & Mort 2005). Six of the ten species of SC/SWC U.S.A.-Chihuahuan-Tamaulipan genus *Thelesperma* are in S TX, with 5 sp. in EP and BB, including *T. megapotamicum,* which was placed at the base of the phylogeny of these authors. The largest in eastern North America section of *Coreopsis* has species of all of its subclades in S TX and EP, including some basally branching species.

Tageteae 11 sp. in S TX

The center of diversity for Tageteae is in the xeric highlands of Mexico. The tribe originated in Mexico, followed by three separate introductions into South America and a single colonization into Cuba (Loockerman 2003). The Tageteae have four differential genera in BB, which are absent from S TX (Table 3). Their species ranges are in SW North America, mostly in the mountains of the Apachian chorion. *Thymophylla tephroleuca* is endemic to the South Texas Plains. *Clappia suaedifolia* is endemic to the Tamaulipan Subprovince, occurs in South Texas, Tamaulipas, and Nuevo Leon.

Bahieae 11 sp. in S TX

Among the Bahieae, only BB flora has two small differential genera, a Chihuahuan genus *Psathyrotopsis* and an amphitropical genus *Schkuhria*.

Heliantheae 33 sp., 20 gen. in S TX

The large tribe Heliantheae is represented in southern Texas by many species of the Atlantic and Gulf Coast, E, or SC North American geoelements. It has three differential genera in BB, all of them being mountainous SW N American/Mexican desert genera. To the contrary, E N American genera *Rudbeckia* and *Lindheimera* are absent from BB, and an E Prairie genus *Echinacea* is only found in EP.

Eupatorieae 16 sp. in S TX

Eupatorieae is a large New World tribe with its base in Mexico and repeated dispersals to South America and North America (Funk et al. 2009). *Brickellia* (100 sp. total) has almost all its species level diversity in northwestern Mexico and the southwestern U.S.A. (Schilling et al. 2015). As with other genera with more western ranges, it has 8 species in BB, 4 sp. in EP, and only 2 sp. in S TX. Two of the BB differential species are in the section *Xerobrickellia*. This section has a Baja California-Sonoran distribution with one disjunctive species in Central Mexico. That species was placed as sister to the remainder of *Brickellia*. The third differential species is from the mostly mountainous Mexican section *Brickellia,* which had invaded higher latitudes in southwestern U.S.A., rather than upper elevations (Schilling et al. 2015). One widespread species of *Brickellia* is shared among the three floras, and two differential sub endemic species of that genus are found in EP. A W N American-S American mountainous genus *Stevia* is only present in BB. S TX flora has three differential genera not found in BB, only two of which are also in EP. *Shinnersia* (Table 3) is monotypic with narrow ranges in Texas and N Mexico. EP has only one differential genus, an E N American-Asian genus *Eupatorium*. Schilling and Panero (2016) proposed that dispersal of *Eupatorium* from New World to Old World went first to Africa.

Thus, the genera of Asteraceae that are different among the three floras show importance of more recent connections between Old World and New World, especially between Madrean and Tethyan subkingdoms via LDDs. Their geographic patterns represent western/ south-western N American radiations in BB and south-eastern N American/ E Mexican radiations in S TX flora. They also show that in Asteraceae composition S TX is closer to EP than to BB. This might be due more to the ecological differences among these regions rather than to the barriers to migration.

Temperate clades, like some of the North American Astereae, are two or more times richer in the EP than in S TX flora, where they are either absent or weakly represented by only widespread species.

The S TX Asteraceae show strong southern connections to the Mexican centers of diversity, like the center of the genus *Chaptalia* in eastern and southern Madrean Mountains. Other examples come from the Eastern North American clade of the Mexican based radiation in Coreopsideae, the Tageteae, and southwestern N American-NW Mexican based Eupatorieae, which have mountainous groups in BB and low elevation Tamaulipan edaphic endemics in S TX. The Helenieae have south-eastern/south-central North American subclades in S TX/ EP, and southwestern subclades only in BB. This Asteraceae composition of S TX flora does not support its placement in the Sonoran Province sensu Takhtajan.

Second largest family **Poaceae** has 163 sp. and 59 gen. in S TX flora. Tropical to warm temperate latitude subfamilies, like Chloridoideae (71 sp.) and Panicoideae (45 sp.) have the majority of the species in S TX Poaceae composition. North temperate Pooideae have 29 sp. in EP, which is three times more than the Pooideae in the S TX flora.

Third largest family **Fabaceae** has 95 sp. and 39 gen. in S TX flora.

There are more species of tropical/subtropical genera among the legumes in S TX than among those in EP and BB. Seven such genera are only found in S TX: *Vigna, Stylosanthes, Caesalpinia,* and *Aeschynomene* with one tropical/subtropical species each, and three genera, *Ebenopsis, Havardia,* and *Coursetia,* with one Gulf-Tamaulipan species each. Similar ranges have the five S TX species of the caesalpinioid genus *Chamaecrista,* which is absent from BB and has only one E N American species in EP.

The BB flora has only five differential legume genera. They are in the Faboideae: a monospecific Chihuahuan endemic genus *Genistidium* and tropical/subtropical American genera *Brongniartia, Cologania*, and *Nissolia*.

In EP the only three differential legume genera are cesalpinioid Lauroasian relictual genera *Cercis* and *Gleditsia,* with one E N American species each, and a phaseoloid genus *Clitoria*.

The subfamilies of Fabaceae have the following proportions in S TX. There are 7 genera/20 species of Caesalpinioideae (five of those species are absent from EP); 27 species of Mimosoideae (two of them are absent from EP, where the Mimosoideae have seven differential species); and 21 genera /49 species of Faboideae (four of these genera are absent from EP, where the Faboideae have 84 species in total).

There are 53 of the S TX Fabaceae species which are absent from BB. Sixteen of them are in the Tamaulipan/E Madrean geoelemet, ten in the American Tropic/Subtropical, and eight species each in the Gulf and SE Texas geoelements. In BB there are 60 differential species of legumes, which are in the Chihuahuan (17 sp.), Sonoran (8 sp.), SWC U.S.A./Apachian (10 sp.), and Mesoamerican-Madrean (9 sp.) geoelements.

These proportions of the legumes show the differences among the three TX floras: southwestern N American groups/connections along the mountains prevail in BB; southern (eastern) N American groups/ tropical connections via the Gulf of Mexico, as well as E Madrean connections are stronger in S TX; and eastern groups/temperate connections across the Atlantic are prevalent in EP.

Fourth place in S TX flora is occupied by **Euphorbiaceae** with 63 species in 11 genera. Twenty one of these species are absent from the EP flora. They are in the Tamaulipan, Gulf Coast-Caribbean, Mesoamerican-Madrean, S TX Plains, and E Madrean-Tamaulipan geoelements. The EP flora has 11 differential species of Euphorbiaceae, which are in the Chihuahuan, E Prairie, E N American, and Edwards Plateau geoelements. S TX flora has two American tropic/subtropical genera: *Adelia*, found nowhere else in the U.S.A. and *Manihot,* absent from EP and present in only one county of BB.

Thus the proportions of taxa in the spectrum of the largest families show much higher numbers of tropical-subtropical, Tamaulipan/E Madrean, Gulf Coast, and Mesoamerican coastal species in the S TX flora in comparison with the flora of EP. North temperate, E N American, and Chihuahuan species are fewer in S TX than in EP. The majority of the BB differential species are in the Chihuahuan, SW N American, Sonoran/ Apachian, and the Madrean geoelements.

Taxonometric analysis: Major genera

The large and middle sized genera of S TX flora are listed in Table 4. The spectra of largest genera in each of the three floras are compared in the right half of Table 4. *Euphorbia* (23 sp. S TX/ 30 sp. EP/ 39 sp. BB) is the largest genus in all three floras, with arid adapted southwestern North American subgenus *Chamaesyce* accounting for the higher number of its species in BB. Second largest in BB and EP amphitropical genus *Muhlenbergia* is most diverse in high-plateau grasslands in north central Mexico, the southwestern United States, and, to a lesser extent, along the Andean Cordillera of South America (Peterson et al. 2010). It has 24 sp. in BB, 16 in EP, but only 1sp. in S TX flora, which is outside of the mountainous Western Region. Muhlenbergiinae originated in North America and had multiple radiations to the Andean S America and a recent colonization event in southeastern Asia (Peterson et al. 2010). The next several genera of the spectrum show similar tendency of southwestern North American/ Madrean/ S American groups being most abundant in BB, having fewer species in EP, and just a few in S TX flora. Mostly montane genus *Quercus* has 20 sp. in BB, 17 in EP, and 5 in S TX. *Asclepias* is more diverse in BB (12 sp.) and EP (11 sp.), than in S TX (5 sp.). EP has more wetland (*Eleocharis*) and temperate mesophyllous genera. Mostly cold and temperate genus *Juncus* has 16 sp. in EP, 8 sp. in BB, but only 4 sp. in S TX. *Carex* also has more species in EP (13) than in BB (9) and S TX (7). To the contrary, tropical genera are richer in S TX: *Croton* (18 sp. S TX/ 9 sp. EP/ 7 sp. BB), *Amaranthus* (12 sp. S TX/ 7 sp. EP/ 11sp. BB), and *Sporobolus* (12 sp. S TX/ 9 sp. EP/ 7 sp. BB/).

Table 4. Species in large and middle genera of S TX Plains flora (left) and numbers of species in large and middle genera of BB and EP compared to S TX (right).

Genus	No. Species	Genus	BB	EP	S TX
Euphorbia (cosmopolitan)	23	*Euphorbia*	39	30	23
Oenothera (American temperate/subtropical)	22	*Muhlenbergia*	24	16	1
Cyperus (tropical to warm temperate)	18	*Oenothera*	23	20	22
Croton (tropical/subtropical)	18	*Quercus*	20	17	5
Dalea (Mexico, sw N America)	16	*Dalea*	18	21	16
Eragrostis (tropical to warm temperate)	14	*Bouteloa*	15	14	10
*Amaranthus (*tropical to warm temperate)	12	*Croton*	7	9	18
Sporobolus (tropical to warm temperate)	12	*Cyperus*	14	20	18
Paspalum (tropical to warm temperate)	11	*Eragrostis*	10	9	14
Bouteloua (American, esp. central and southern America)	10	*Sporobolus*	7	9	12
Eleocharis (cosmopolitan, wetland)	9	*Paspalum*	2	5	11
Physalis (American temperate/subtropical)	8	*Eleocharis*	7	15	9
Echinocereus (Mexico, S U.S.A., S America)	8	*Physalis*	5	7	8
Panicum (tropical to warm temperate)	8	*Salvia*	12	12	4
Setaria (tropical to warm temperate)	8	*Asclepias*	12	11	5
Verbena (American)	7	*Aristida*	11	9	6
Heliotropium (tropical to warm temperate)	7	*Cheilanthes*	11	11	0
*Carex (*cosmopolitan)	7	*Astragalus*	10	11	6
Abutilon (tropical to warm temperate)	7	*Senna*	10	6	5
Plantago (cosmopolitan)	7	*Cryptantha*	9	4	6
Digitaria (tropical to warm temperate)	7	*Penstemon*	9	10	0
Solanum (cosmopolitan)	7	*Carex*	9	13	7
Linum, Thelesperma, Gaillardia, Atriplex, Matelea, Physaria	6	*Acacia*	9	9	9
Coryphantha, Opuntia, Tragia, Astragalus	6	*Phacelia*	9	4	3
Mimosa, Quercus, Mentzelia, Oxalis, Aristida, Eriogonum	6	*Amaranthus*	11	7	12
Asclepias, Chenopodium, Baccharis, Celtis, Paronychia, Senna	5	*Tradescantia*	4	12	3
Sisyrinchium, Sphaeralcea, Chamaecrista, Passiflora, Chloris	5				
Dichanthelium, Tridens, Persicaria, Myriopteris, Houstonia	5				

GENERIC GEOELEMENTS

The genera of the S TX, EP, and BB floras have been classified to the following major geographical groups (Table 5). The numbers of species in the three floras are given in the brackets. More detailed descriptions of groups of genera are given in the previous version of this classification in Saghatelyan (2009).

Broadly Distributed Temperate North/South Hemisphere Old World-New World Genera: 16 sp. S TX/ 39 sp. EP/ 58 sp. BB. Four S TX species of this group are in *Salvia,* two in *Stachys*. Several genera of the Pooideae, like *Bromus* (1 S TX/2 EP/7 BB) and *Poa* (0 S TX/2 EP/4 BB) are absent or have just one species in S TX.

North Temperate Old World Genera: 23 sp. S TX / 39 sp. EP/ 50 sp. BB. These genera are most diverse in the Tethyan Subkingdom, have majority of their North American species in the western/southwestern states (*Juniperus*). Many of them arrived via the Bering Land Bridge (*Astragalus*, *Allium,* and *Artemisia*). A few genera had LDD across the Atlantic (*Linum, Helianthemum*).

North Temperate Genera with Major Centers in Eurasia or Eastern Asia and Disjunctly Distributed Woody North Temperate Genera: 64 sp. S TX/ 162 sp. EP/ 122 sp. BB. Examples are: woody, like *Quercus* (6 S TX/17 EP/20 BB), *Clematis* (/3 S TX/2 EP /3 BB), *Prunus* (3 S TX /9 EP/4 BB), and *Mahonia* (2/2/2); wetland (*Typha, Potamogeton*), and cold adapted (*Draba, Castilleja*) genera. This group includes East Asia-E N American disjunct genera with only two species in S TX, one of *Ampelopsis* and one of *Toxicodendron;* six species in BB, and 15 species in the EP flora.

North American Genera: 74 sp. S TX/ 122 sp. EP/ 86 sp. BB. This group has many temperate Asteraceae (*Ratibida, Erigeron,* and *Helianthus*) and North temperate genera from different families, like *Monarda, Triodanis, Lechea, Amsonia,* and *Heuchera.*

East North American Genera: 32 sp. S TX/ 47 sp. EP/ 9 sp. BB. Majority of these genera in S TX flora are from Asteraceae (*Rudbeckia, Liatris,* and *Krigia*); a few are from other families, like *Brazoria*, *Yeatesia*, and *Taxodium* (the latter persists only along the Rio Grande River in S TX).

Western and Southwestern North American Genera: 55 sp. S TX/ 87 sp. EP/ 148 sp. BB. These genera evolved in southwestern U.S.A. and Mexico mostly in the Madro-Tertiary Geoflora of D. Axelrod (1975).

Table 5. Numbers of Species in Different Generic Geoelements (Geographical Groups of Genera) in Big Bend, Edwards Plateau, and S Texas floras.

Generic Geoelement	BB	EP	S TX
1. North Temperate Old World	50	39	23
2. Relictual and Cold North Temperate (incl. E North Amer-E Asian: 6 BB/15 EP/3 S TX)	122	162	64
3. Temperate N/S Hemisp. Old/New World	58	39	16
4. North American	86	122	74
5. East North American (to Central America)	9	47	34
Total in Temperate Genera	**325**	**409**	**211**
6. West/Southwest North American (incl. Mexico)	148	87	54
7. W&SW U.S.A., (N) Mexico, TX (S U.S.A.)	78	48	35
8. Amphitropical	69	58	26
9. Apachian	8	4	2
10. Chihuahuan/Tamaulipan	17	10	17
11. Sonoran Province Wide	5	3	5
12. Madrean	11	6	5
Total in Western N American Genera	**336**	**216**	**144**
13. Madro-Tethyan	14	14	12
14. Tropico/Subtropical	137	143	165
15. Tropical to Warm Temperate	171	209	191
16. American African	71	79	66
17. Mexico, S US to S Amer or to Mesoam/W Indies	114	93	92
18. Tropical/Subtropical American	69	62	75
19. Pantropical	19	16	21
20. American, especially Central & S American	50	44	42
Total in Tropical/Subtropical	**631**	**646**	**652**
21. American Temp/Subtrop N&S Hemisphere	67	75	80
22. Temp & Subtrop N & S Hemisphere	42	34	25
23. Cosmopolitan	181	214	143

Some xerophytic genera of this group in S TX are on eastern margins of their ranges. This group includes just a few species of mostly large western N American genera, like *Eriogonum, Sphaeralcea, Nama, Cryptantha,* and *Phacelia*. Other genera that are highly diverse in western states, especially the mountainous ones (like *Ribes* and *Penstemon*) are found in BB and even EP, but not in S TX. Typical dominants of the Chihuahuan and Sonoran deserts from this group, like *Dasylirion* or *Nolina*, are also absent from S TX.

Western and Southwestern United States, N Mexico and Texas (southern United States) Genera: 35 sp. S TX/ 48 sp. EP/ 78 sp. BB. S TX flora has only 17 southwestern desert genera, predominantly of the Cactaeae, a few of Asteraceae and Malvaceae, as opposed to higher diversity of this group in BB (*Glossopetalon*, *Cercocarpus, Choyzia,* and *Haplophyton*), which is in part influenced by the elevation differences among the two flora regions.

Amphitropical Genera: 26 sp. S TX/ 58 sp. EP/ 69 sp. BB. *Larrea, Koeberlinia, Krameria, Tiquilia, Hedeoma, Talinum, Argemone*, and *Thelesperma* are among the seventeen genera with disjunctive distribution in N and S American temperate deserts found in the three TX floras. This group is more characteristic for BB flora, and includes its second largest genus *Muhlenbergia* (25 sp. BB/16 sp. EP/1sp. S TX). The role of amphitropical genera decreases in southern Texas from West to East. There are five of these genera that are found in BB and absent from S TX.

Apachian Genera also decrease in species numbers from West to East. They have three species in S TX (of *Berlandiera, Fallugia,* and *Engelmannia*), four sp. in EP and 8 sp. in BB (*Fendlera*).

Chihuahuan/Tamaulipan Genera: 17 sp. S TX/ 10 sp. EP/ 17 sp. BB. There are nine monospecific genera in S TX endemic to the Tamaulipan (*Clappia, Lenophyllum, Neonessomia,* and *Tamaulipa*) or Chihuahuan-northern Tamaulipan Subprovinces (*Amblyolepis, Dichaetopappa, Jefea, Varilla, Lophophora,* and *Ariocarpus*). All but the last two Cactaceae genera are from Asteraceae. BB has nine genera of this group, including five Chihuahuan endemic genera that are absent from S TX (*Allolepis, Emorya, Talinopsis, Plateilema,* and *Psathyrotopsis*).

Sonoran Province Wide Genera. These genera span all three subprovinces of the Sonoran Province. They have five species in S TX and BB, and three species in EP. Two genera of this peculiar desert group,

Phaulothamnus and *Trichocoronis,* are only found in S TX; *Mortonia* is only in S TX and BB, *Fouqueria* is only in BB and EP, while *Dermatophyllum* and *Chilopsis* are native in all three floras.

Madrean/Mesoamerican Genera: 5 sp. S TX/ 6 sp. EP/ 11 sp. BB. Their ranges extend North from Mexico/ Mesoamerica to southernmost U.S.A. in Texas and Arizona (*Amoreuxia*, *Telosiphonia, Margaranthus*, and *Astrophytum*) or farther North to southwestern U.S.A. (*Pericome*).

Madro-Tethyan Genera—disjunctly distributed in the Tethyan and Madrean Subkingdoms: 12 sp. S TX/ 14 sp. EP/ 14 sp. BB. Examples are: *Ephedra*, *Oligomeris*, *Paronychia*, *Malvella,* and *Corispermum*. Two genera of this group, *Styrax* and *Arbutus*, are found only in EP and BB; *Peganum* is only in BB, while *Cotinus* is found only in EP. A disjunctive genus *Cotinus* has a Comanchian (Submadrean) rather than Madrean distribution type in N America and a Tethyan/Submediterranean range in the Old World.

Tropical/Subtropical Genera. This group has **84 gen. /165 sp. S TX, 69 gen. /143 sp. EP, and 63 gen. /137 sp. BB.** Largest genera are *Croton* (18 sp. S TX/ 9 sp. EP/ 7 sp. BB) and *Acacia* (9 sp. in each flora). However, only S TX has 23 differential tropical/subtropical genera which are found in the U.S.A. only in S TX Plains (*Bastardia* and *Wissadula*), or in S TX Plains and Florida (*Tournefortia*, *Capraria*, *Chiococca*, and *Corchorus*). A few genera are found in S TX and in southernmost Arizona (*Pisonia* and *Walteria*) or New Mexico (*Priva*).

Tropical to Warm Temperate Genera: 191 sp. S TX/ 209 sp. EP/171 sp. BB. These are widely distributed large genera of mostly tropical subfamilies, including ten genera of grasses (*Panicum, Digitaria*), three of Malvaceae (*Sida*), and single genera from other families (*Eryngium, Passiflora, Cocculus, Cynanchum*).

American-African Genera: 66 sp., 21 gen. S TX/ 79 sp., 22 gen. EP/ 71 sp., 30 gen. BB. This is a group of mostly tropical/subtropical genera of S American (*Kallstroemia*), SW N American (*Acleisanthes*), or African (*Lupinus*) origin with mostly LDD accounting for their disjunctive pattern of distribution in southwestern North /South America and Africa. *Acleisanthes,* for example, currently is a genus of 16 species, all in southwestern U.S.A. and Mexico, except for *A. somalensis* in Somalia (Levin 2000; Levin 2002). This pattern is especially characteristic for representatives of the succulent biome of Lavin et al. (2004) and Schrire et al. (2005) as in several legume genera (*Pomaria, Parkinsonia, Calliandra,* and *Mimosa*). Another American-African succulent biome genus *Thamnosma* is a member of Clade 2 of the phylogeny of Ruteae (Appelhans et al. 2016), which has geographic origin in Southern Asia. BLB migration from Asia to W N America was proposed for the ancestor of *Thamnosma*. Early diverging clades of *Thamnosma* are found in SW N America and may have been members of the arid Neogene Madro-Tertiary geoflora (Thiv et al. 2011). From there, *Thamnosma* had a LDD across the Atlantic to Africa during the Miocene. In Africa *Thamnosma* has an "African arid corridor" disjunction pattern: SW/SE Africa—Horn of Africa/S Arabia/Socotra. This Rand Flora pattern was described for numerous arid adapted genera (Bellstedt et al. 2012; Mairal et al. 2017), including some other American-African genera found in southern Texas flora, like *Sideroxylon*.

Mexico and South U.S.A. to South America (Mega-Mexico III of J. Rzedowski 1993) or to Mesoamerica and West Indies Genera: 92 sp. S TX / 93 sp. EP/ 114 sp. BB. Their ranges are mostly in Mexico, extending to southern U.S.A. as well as to tropical Central and northern South America or to Mesoamerica and West Indies. The latter subgroup includes several tropical genera only found in U.S.A. in S TX (*Ebenopsis* and *Adelia*), in BB and S TX (*Hechtia*), or S TX and S Florida (*Quadrella*). This group includes important vegetation dominants like *Agave, Leucophyllum*, *Garrya*, *Dalea,* and *Sabal*.

Tropical-Subtropical American Genera: 75 sp. S TX/ 62 sp. EP/ 69 sp. BB. Some of these genera in the U.S.A. are only in S TX (*Helietta*), or only in one or more of the three TX floras and Florida (*Petiveria, Guajacum, Citharexylum*), or in S TX and S AZ (*Coursetia*). Some other genera extend farther north in the southeastern (*Mikania, Stylosanthes*) and/or southwestern (*Funastrum*) U.S.A.

The remaining genera in Table 5 are of broad distribution:

Pantropical: 21 sp. S TX/ 16 sp. EP/ 19 sp. BB (*Senna, Sesuvium*).

American Genera, especially central and South American: 42 sp. S TX/ 44 sp. EP/ 50 sp. BB (*Baccharis, Nothoscordum, Sisyrinchium*).

American Genera, Temperate plus North and South Subtropics: 80 sp. S TX / 75 sp. EP / 67 sp. BB (*Aloysia, Verbena, Sphaeralcea*).

Temperate and Subtropical North and South Hemisphere Genera: 25 sp. S TX / 34 sp. EP / 42 sp. BB (many grasses, *Lycium, Urtica, Hypericum*).

Cosmopolitan Genera: 143 sp. S TX / 214 sp. EP / 181 sp. BB (many ferns and hydrophytes, *Plantago, Lepidium,* etc).

Combined generic elements are presented in Table 6. Majority of species in all the three floras are in tropic-subtropical genera, especially those in S TX, where they have more than a half of all species of the flora (51.5%). In both other floras tropic-subtropical genera have 40% of their species composition. The species of temperate genera weigh more in EP (25.4% of the flora) than in BB (20.4%), and especially in S TX (16.5%). The species of western/southwestern N American genera which are best represented in BB (21% of the flora) become less numerous in EP (13.4%) and even fewer in S TX (11.5%). These numbers show dissimilarity of S TX flora to BB and question its placement in the Sonoran Province. The proportions of the generic geoelements in the composition of southern Texas floras reflect latitudinal position and elevational differences of the three regions. Humidity and minimum temperature are often recognized as major ecological factors. Another important parameter, illustrated by many examples discussed above, is the distance from the centers of origin of the genera, their age and size.

GEOGRAPHIC ELEMENTS OF THE FLORA

Detailed descriptions of the geographic elements of south Texas flora are given in Saghatelyan (2009, 2015). Below are brief descriptions and sample taxa for each geoelement found in the S TX Plains flora. The geographic spectrum of the flora is illustrated by Tables 7 and 8. All phytochoria are assumed within the boundaries of the Takhtajan System (Takhtajan, 1986).

Polichorous: wide distribution on several continents; 21 species (1.6% of the flora). These are wetland, aquatic, and weedy species of cosmopolitan herbaceous genera (*Zannichellia palustris, Veronica peregrina*).

Holarctical: wide ranges in north temperate latitudes of the New and Old World; 8 species (0.6% of the flora). These are hydrophytic (*Eleocharis palustris*) and riparian (*Populus deltoides*) species.

Tropical/Subtropical: wide distribution in tropical and subtropical latitudes; 59 species (6% of the flora). Among them are many species of tropical grasses, sedges, Malvaceae, etc. **Trop/Subtr /Warm Temperate subelement:** mostly in subtropical and warm temperate regions (*Bacopa monnieri*) or extending from tropical to warm temperate latitudes (*Adiantum capillus-veneris*).

American Tropical/Subtropical: 91 species (7.3% of the flora). These are American species of tropical genera of Cyperaceae, Euphorbiaceae, Fabaceae; broadly tropical American genera, like *Mecardonia* and *Tillandsia*, pantropical genera (*Cissus*), tropical/subtropical genera (*Zanthoxylum* and *Boerhavia*), or cosmopolitan genera (*Eleocharis*). More species are in the Poaceae and Cyperaceae.

American: wide distribution in the Americas; 31 species (2.5% of the flora). Many of them are aquatic and wetland plants (*Wolffia columbiana, Bidens laevis,* and *Lindernia dubia*) or grow on different types of habitats (*Heliotropium curassavicum*, *Plantago patagonica*). Grasses and sedges (*Bouteloa curtipendula*) have many species in this group.

North American: wide ranges in temperate regions of North America; 93 species (7.5% of the flora). Among them are many hydrophytic and mesophytic species of cosmopolitan genera. *Euphorbia*, grasses, Asteraceae, sedges, and rushes predominate in this geoelement.

East North American: wide ranges in the Atlantic North American Region; 95 species (7.5% of the flora). Among them are 16 species of **SE North American subelement** with more narrow southern ranges. It has some tree species (five species of *Quercus,* three of *Celtis*, *Rhus copallinum*, *Morus rubra*) and vines (*Ampelopsis arborea, Clematis crispa, Melothria pendula*). But unlike EP flora, which has 60 woody species in this geoelement, in S TX herbaceous species prevail. More numerous are grasses (17 sp.), Asteraceae (10 sp.), and Cyperaceae (8 sp.).

Gulf Coast: 62 species (5% of the flora) with ranges in the Atlantic and Gulf Coastal Plain Province. Here are 10 species of grasses, 8 species each of Amaranthaceae and Asteraceae, six species each of Euphorbiaceae and Fabaceae. EP has only 13 species of this geoelement, all common with S TX, while BB has no species of this group.

Prairie: wide ranges in the North American Prairies Province-84 species (6.8% of the flora). All but 7 species are herbaceous with the Asteraceae being most diverse (22 sp.), followed by 10 species of grasses and 6 of Euphorbiaceae.

Comanchian/ SC US: Edwards Plateau, extending northward into central Oklahoma/ Ozark Plateau, southward into northeastern Mexico and western Louisiana; 23 species (1.8% of the flora). This is just one third of the Comanchian geoelement in EP, with most of the species in common among the two floras. However, there are five species with more western ranges among the comanchian species in S TX (*Matelea cynanchoides, Iva asperifolia*), which are absent from EP.

Table 6. Total Combined Generic Geoelements (Numbers of species and their percentage in each flora).

Generic Geoelement	Big Bend	Edwards Plateau	S Texas Plains
Total in Temperate Gen.	325 (20.4%)	409 (25.4%)	211 (17%)
Total in W N American Gen.	336 (21%)	216 (13.4%)	144 (11.5%)
Madro-Tethyan	14 (0.9%)	14 (0.9%)	12 (0.96%)
Total in Tropical/Subtropical	631 (39.5%)	646 (40.2%)	652 (52%)
Amer. Temp/Subtr N & S Hem.	67 (4.2%)	75 (4.7%)	80 (6.4%)
Temp/Subtr N & S Hem.	42 (2.6%)	34 (2.1%)	25 (2%)
Cosmopolitan	181 (11.3%)	214 (13.2%)	143 (11.4%)
Total generic geoelements	1596 sp.	1608 sp.	1250 sp.

Table 7. Geographical spectrum of South Texas Plains flora. Specific Geoelements.

Geoelement	Number of species
Chihuahuan	127
Sonoran	25
Tamaulipan	82
S TX Plains/S TX	83
S TX/S TX-Coahuila	23
SC USA/SC N Amer./SEC N Amer.	76
Comanchian	23
Edwards Plateau	5
E Texas	23
Gulf	61
Madrean	74
Mesoamerican/Madrean	64
Trop/Subtr; Amer. Trop/Subtr; Trop/Subtr/Warm	150
E N American	93
Prairie	82
Amer; N Amer.; W N Amer.; SW N Amer.; SWC N Amer.	213
Amphitropical	12
Polichorous	20
Holarctical	8
Madro-Tethyan	1
? Not Established	5
Total	1250

SC U.S.A. / SC North American: from Central and South Texas extending northward to adjacent states and southward to northern Mexican Plateau; 76 species (6.1% of the flora). Among them are Asteraceae (16 sp.), Poaceae (8 sp.) and genera of different families with just 1–2 species each (*Plantago, Lechea, Phyllanthus, Sisyrinchium,* and *Salvia*).

Tamaulipan: from south-eastern and south-central Texas into northeastern Mexico in the state of Tamaulipas, and small parts of adjacent Mexican states; 82 species (6.4% of the flora). More species are in Asteraceae (12), Cactaceae (9), and Fabaceae (7). Majority of the remaining species are in tropical/subtropical (*Ehretia, Sesbania* or tropical to warm temperate (*Cynanchum*) genera. A few are in north temperate (*Crataegus*) and amphitropical (*Krameria*) genera. Most genera are represented by 1 or 2 species in the flora except *Echinocereus* (4 sp.).

Edwards Plateau (Endemic): endemic or subendemic to Edwards Plateau; 4 species (*Brickellia dentata, Triodanis coloradoensis, Argemone aurantiaca, Buddleja racemosa, Prunus minutiflora*).

East Texas: endemic or subendemic to southeastern or east-central Texas; 22 species (1.8% of the flora). Majority of them are in American-African (*Lupinus subcarnosus*), Mexican-Mesoamerican (*Argythamnia simulans*), or tropical to warm temperate (*Ruellia drummondiana*) genera.

W North American: wide ranges in entire western North America or its parts, mostly north of Mexico; 33 species (2.4% of the flora). They belong to mostly cosmopolitan (*Chenopodium,* 4 species), north temperate (*Draba, Lappula*), W N American (*Gutierrezia sarothrae*), or tropical to warm temperate (*Sesuvium*) genera.

Table 8. Comparison of Geographical spectra of Edwards Plateau (EP), Big Bend (BB), and S TX Plains (S TX) floras. Specific Geoelements.

Geoelement	EP sp. /%	BB sp. /%	S TX sp. /%
Of Broad Distribution—119 sp. (9.5% of S TX flora)			
Polichorous	26 / 1.6	14 / 0.8	20 / 1.6
Holarctical	14 / 0.8	22 / 1.3	8 / 0.6
Tropical/Subtropical/ (Warm)	30 / 1.8	32 / 2	60 / 4.7
American wide	74 / 4.5	71 / 4.4	31 / 2.5
Holarctic Subkingdom/N America Atlantic Region—458 sp. (36.2% of S TX flora)			
North American	149 / 9.2	98 / 6.2	95 / 7.5
E N American/ SE N American	238 / 14.6	37 / 2.3	93 / 7.6
Gulf Coast	14 / 1	—	61 / 5
Prairie	159 / 9.8	84 / 5.4	82 / 6.8
Comanchian	63 / 3.9	46 / 2.9	23 / 1.8
SC U.S.A./SC/SEC North American	64 / 4	—	76 / 6.1
Edwards Plateau	71 / 4.3	0	5 / 0.2
East Texas	—	—	23/ 1.8
Madrean Subkingdom/Western N America—514 sp. (41.2% of S TX flora)			
W North American	58 / 3.6	86 / 5.4	33/ 2.4
SW North American	35 / 2.2	85 / 5.4	10 / 0.8
WC North American		29/ 1.9	9 / 0.7
SWC North American/Apachian	48 / 2.8	64/ 4	34 / 2.7
Amphitropical	10 / 0.6	19 / 1.2	12 / 0.97
Sonoran	36 / 2.2	82 / 5.2	25 / 2.3
Chihuahuan	194 /12	378 / 23.7	127 / 10.4
Including Chihuahuan-Tamaulipan	66 /4.1	45 / 2.8	71 / 5.8
Including Sonoran-Chihuahuan	18 / 1.1	80 / 4.1	18 / 1.5
South Texas /Coahuila Endemic	72 / 4.4	103 / 6.5	106 / 8.3
Including South TX Plains	—	—	82 / 6.4
Tamaulipan	33 / 2	5 / 0.3	83 / 6.4
Madrean	102 / 6.2	192 / 12.1	74 / 6.3
Including E Madrean	35 / 2.1	16/ 1	26 / 2.2
Madro-Tethyan	—	1	1
Neotropical Kingdom—154 sp. (12.7% of S TX flora)			
Mesoamerican/Madrean/ (Carib)	61 / 3.7	83 / 5.3	64 / 5.2
American Tropical/Subtropical	52 / 3.2	30 / 1.9	90 / 7.3
Not Established	9 / 1.1	32 / 2	5 / 0.4

Of Broad Distribution
- 119 sp. (9.5% of S TX flora)
- 143 sp. (8.8% of EP flora)
- 138 sp. (8.7% of BB flora)

Holarctic Subkingdom/N Amer. Atl. Region
- 458 sp. (36.6% of S TX flora)
- 758 sp. (46.8% of EP flora)
- 266 sp. (16.8% of BB flora)

Madrean Subkingdom/Western N America
- 514 sp. (41% of S TX flora)
- 555 sp. (34% of EP flora)
- 1043 sp. (65.7% of BB flora)

Neotropical Kingdom
- 154 sp. (12.3% of S TX flora)
- 113 sp. (6.9% of EP flora)
- 114 sp. (7% of BB flora)

Flora Total

BB--- 1596 sp. / S TX--- 1250 sp. / EP—1608 sp.

SW North American/ SW U.S.A.: southern part of the Rocky Mountain Province, Colorado Plateau, southern and eastern Great Basin, and Sonoran Province eastward through New Mexico to southwestern Texas and southward to adjacent northern Mexico; 10 species. These are species of W N American genera

(*Hymenoxis, Physaria,* and *Sphaeralcea*), Central and S American (*Baccharis*), temperate/subtropical (*Mentzelia*), or tropical to warm temperate (*Sporobolus*) genera.

SWC North American/ SWC U.S.A.: more eastern than the previous geoelement including western part of the Prairie Province; 34 species (2.4% of the flora). Most numerous in this group are 19 species of tropical/subtropical to warm temperate (*Senna, Hybanthus, Convolvulus*) and tropical American (*Funastrum, Bouteloa*) genera. Six species are of W/SW N American (*Nama, Chamaesaracha*) genera, one of American-African (*Pomaria*), and two species of SWC N American genera (*Giliastrum* and *Quincula*). Poaceae, with 9 species, is largest family in this group. This geoelement exhibits southern connections along the western mountainous ranges.

WC North American: similar to the previous geoelement, but with wider ranges in the north; 9 species (0.7% of the flora) of American, mostly western, genera. Among them are *Oenothera*, southwestern N American (*Chamaesyce, Ipomopsis,*), amphitropical (*Hedeoma*), Mexican-S American (*Erioneuron*) genera, and *Astragalus*—a genus of the Old World origin.

Amphitropical: disjunctive ranges in warm temperate deserts of the western N and S America; 12 species of peculiar desert genera, like *Larrea*, *Aloysia,* and *Kallstroemia*.

Sonoran: embracing all three, or mostly Sonoran, subprovinces of the Sonoran Province; 27 species (2.3% of the flora). These are xerophytic species and many of them are desert dominants from different families, including woody species *Karwinskia humboldtiana* and *Phaulothamnus spinescens*. The latter is only found in S TX in the U.S.A. A wetland species *Nama stenocarpum* is only found in S TX and southern California.

Chihuahuan: ranges in the Chihuahuan Subprovince including Trans-Pecos and Edwards Plateau; 127 species (10.4% of the flora). Among them are 24 species of Asteraceae, 18 of cacti, 15 of legumes, 12 of grasses, and xerophytic genera from other families. **Chihuahuan-Tamaulipan subelement** has ranges in the Chihuahuan Subprovince extending eastward to the Tamaulipan Subprovince. It is a larger group with 71 species in the chihuahuan geoelement of S TX (*Cordia podocephala, Senegalia berlandieri*). **Sonoran-Chihuahuan subelement** has main ranges in the Sonoran and Chihuahuan Subprovinces and has only 18 species in S TX (*Koeberlinia spinosa, Rhus microphylla*).

Madrean: ranges embracing the Madrean Region, or mostly mountains of Mexico; 78 species (6.3% of the flora). This group has 9 species each of the legumes (*Calliandra*) and Euphorbiaceae (*Jatropa*), and many species of diverse tropical/subtropical genera. The Madrean element has different subelements, North, South, West, and East. The largest in S TX, **East Madrean subelement,** has 28 species: mostly in the Sierra Madre Oriental Province of Morrone et al. (1999) extending northward to the Edwards Plateau and mountains in Trans-Pecos (*Helietta parviflora, Croton incanus*).

Mesoamerican/Madrean: wide ranges in Mesoamerica, Mexico, and Caribbean Region extending to southern United States and northern South America; 65 species (5.2% of the flora). Many are in tropical or tropical to temperate genera (*Passiflora, Neptunia,* and *Hechtia*). **Caribbean** subelement extends to SE North America and has 10 species in S TX (*Anredera vesicaria*).

South Texas Endemic: 24 species (1.9% of the flora). This element is closest to the Chihuahuan or Tamaulipan geolement with narrow ranges in different parts of southern Texas or SW Texas-Edwards Plateau and Coahuila (Nuevo-Leon) of northern Mexico. This element includes 3 species of **SC Texas/SEC Texas Endemic** (*Cryptantha texana*) and 7 species of **South Texas-Coahuila** (*Frankenia johnstonii*) subelements.

South Texas Plains Endemic: extends south of Edwards Plateau to the Rio-Grande Valley and to N Tamaulipan Subprovince in Mexico; 81 species (6.4% of the flora). The species are from xerophytic genera of different families and mostly have southern connections. Twenty two species are in tropical to warm temperate genera, ten in W/SW N American, and seven in temperate/subtropical genera. Among them are three species of endemic Tamaulipan (*Lenophyllum, Vaseyochloa*) and Chihuahuan/Tamaulipan (*Dichaetophora*) genera. Asteraceae, with 19 species, is largest family in this group.

Combined specific geoelements are summarized in the lower part of Table 8. Species of broad distribution comprise 9.5% of the S TX flora. This number is slightly higher than in EP and BB which might be related to the abundance of riparian/lowland habitats in S TX.

The Holarctic Subkingdom/N American Atlantic Region species comprise 37% of the S TX flora. This percentage is higher in EP (47% of EP flora), but much lower in BB (9% of BB flora). The following geoelements contribute to this group in each flora: E/SE N American species in EP and S TX; Prairie/Comanchian species in EP; and Prairie/SC/SEC N American, as well as Gulf Coast species, in S TX. They show a closer affinity of S TX flora to that of EP, than to BB flora.

The Madrean (sunsu Takhtajan) Subkingdom/Western N America have 41% of the S TX flora, which is the largest group in this flora. The high weight of this group in BB (66% of the flora) and its low weight in EP (34% of the flora) confirm the position of these two floras in different floristic regions. The S TX flora occupies intermediate position among the other two floras. It is noteworthy that this group of geoelements in S TX has a half of its species in various parts of the Tamaulipan Subprovince. The Tamaulipan geoelement includes 15% of the S TX flora. Another 6.3% are common with Chihuahuan Subprovince. The largest contribution to the Madrean/W N American group in BB comes from the species of the Chihuahuan Subprovince, which has 31% of BB flora. The Madrean geoelement illustrates connections along the western mountain ranges and consequently is two times richer in BB than in the other two floras.

The Neotropical group of elements comprises 13% in the S TX flora, as opposed to 7% in the other two floras. More southern and eastern location of S TX Plains and their proximity to the Gulf of Mexico is responsible for higher numbers of Neotropical, Gulf coastal, as well as other tropical/subtropical species in S TX. The generic and specific geographical spectra illustrate a transitional position of the S TX flora, which represents an ecotone between the Madrean (Western) and the N American Atlantic (Eastern) Regions, with very strong influence of the Neotropical flora.

CONCLUSIONS

The proportions of taxa of the largest families in the three southern Texas floras show much higher numbers of tropical-subtropical, Tamaulipan, Gulf Coast, and Mesoamerican (coastal) species in the S TX flora in comparison with the flora of EP. North temperate, E North American, and Chihuahuan species are fewer in S TX than in EP. The majority of the BB differential species are in the Chihuahuan, SW N American, Sonoran/ Apachian, and the Madrean geoelements.

The genera of the largest family, Asteraceae, that are differential among the three floras show importance of transatlantic LLD migrations of their ancestors connecting Madrean and Tethyan subkingdoms. Their geographic patterns represent western N American radiations in BB and eastern N American/ E Mexican radiations in S TX flora. For example, south-central and southeastern subclades of the Helenieae are found in EP and S TX, while the southwestern groups are in the BB flora.

The Asteraceae differential genera composition also shows that S TX is closer to EP than to BB. However, temperate clades, like some of the North American Astereae, are two or more times richer in the EP than in S TX flora, where they are either absent or weakly represented by only widespread species. This might be due to the ecological differences among the three regions rather than to the barriers to migration.

The S TX Asteraceae show strong southern connections to the Mexican centers of diversity, like the center of the genus *Chaptalia* in eastern and southern Madrean Mountains. Other examples come from the eastern North American clade of the Mexican based radiation in Coreopsideae, the Tageteae, and southwestern N American-NW Mexican based Eupatorieae, which have mountainous groups in BB and low elevation Tamaulipan edaphic endemics in S TX. The Helenieae have south-eastern/south-central North American subclades in S TX/ EP, and southwestern subclades only in BB. This Asteraceae composition of S TX flora does not support its placement in the Sonoran Province sensu Takhtajan. Among the grasses tropical groups have absolute majority in S TX. Proportions of the third largest family, Fabaceae, show the differences among the three southern TX floras: southwestern N American groups/connections along the mountains prevail in BB; southern (eastern) N American groups/tropical connections via the Gulf of Mexico, as well as E Madrean connections are stronger in S TX; and eastern groups/temperate connections across the Atlantic are prevalent in EP.

Many species in the remaining families of S TX spectrum are in warm temperate clades of mostly tropical families, like Euphorbiaceae (4th place), Malvaceae (6th place), Verbenaceae (9th place), and Acanthaceae (13th place). Mesophytic and North temperate groups are more numerous in EP than in the other two floras, especially among the Cyperaceae, Rosaceae, and Apiaceae.

Connections to the Tethyan Subkingdom played an important role in the assembly of the S TX Flora. The distribution pattern of Boraginaceae s. str. is an example of the Neogene Madro-Tethyan connections of two

types: (1) subtropical transatlantic direct migrations connecting xeric Tethyan and Madrean Subkingdoms; (2) arrival to North America of more mesophilic, but Tethyan Subkingdom based, ancestors from northern Eurasia via more temperate higher latitudes routes, with subsequent southbound xerophytic radiation in the Madrean Subkingdom of the American southwest.

Majority of species in all the three floras are in tropic-subtropical genera, especially of those in S TX, where they have more than a half of the species of the flora (51.5%). In BB and EP floras tropic-subtropical genera have 40% of their species composition. The species of temperate genera weigh more in EP (25.4% of the flora) than in BB (20.4%), and have even lower numbers in S TX (16.5%). The species of western/southwestern N American genera which are best represented in BB (21% of the flora) become less numerous in EP (13.4%) and even fewer in S TX (11.5%). Thus, the proportions of the generic geoelements in the composition of southern Texas floras reflect latitudinal position and elevational differences of the regions. Humidity, which increases in southern Texas from west to east, and temperature, which increases to the south, are often recognized as major ecological factors, might be reflected in these proportions. Another important parameter, illustrated by many examples discussed above, is the distance from the centers of origin of the genera, their age and size. More southern and eastern location of S TX Plains and their proximity to the Gulf of Mexico is responsible for higher numbers of Neotropical, Gulf coast-Caribbean, as well as other tropical/subtropical species in S TX.

The species of the Holarctic Subkingdom/N American Atlantic Region comprise 36% of the S TX flora, which is four times more than in the BB flora. The following geoelements contribute to this group in S TX flora: SE N American, Prairie/SC/SEC N American, as well as Gulf Coast. They show a closer affinity of S TX flora to that of EP, than to BB flora.

The Madrean Subkingdom/Western N America has 41% of the S TX flora, which is the largest group in this flora. Half of the species ncluded here are in the Tamaulipan and Chihuahuan-Tamaulipan geoelements (15% and 6.3% of the S TX flora respectively). To the contrary, the high weight of this group in BB (66% of the flora) and its lower weight in EP (34% of the flora) is mostly due to the Chihuahuan geoelement, which has 31% of the BB flora versus 10% in S TX.

The spectra of generic and specific geographical elements of S TX illustrate transitional position of its flora. It represents an ecotone between the Western (Madrean) and the Eastern (Atlantic and Gulf Coast) N American Regions, with a very high influence of the various Neotropical elements and a much higher affinity to the EP flora than to that of BB.

APPENDIX 1. Flora of South Texas Plains

Counties: Atascosa, Brooks, Dimmit, Duval, Frio, Hidalgo, Jim Hogg, La Salle, McMullen, Maverick, Starr, Webb, Zavala, Zapata

Checklist and area diagnoses of the flora of South Texas Plains. The following list of species was extracted mostly from the Synthesis of the North American Flora (Kartesz 2016) and it follows, with few exceptions, all the nomenclatural combinations as well as author citations of this source. The families of vascular plants are arranged in alphabetical order as are genera and species. Numbers by each family name indicate species/genera ratios in the family. The ranges of some species could not be referred to a particular geoelement. These are noted with a question mark in the checklist and are omitted from the analysis.

Abbreviations:

adv els—adventive elsewhere
Afr—African
Amphitrop—Amphitropical
Amer—American
Apach—Apachian
AZ—Arizona
Carib—Caribbean
C—central
c—county
Chih—Chihuahuan
Coah—Coahuila
CO—Colorado
Comanch—Comanchian
disj—disjunctive
E—East
Edw Plat—Edwards Plateau
FL—Florida
Gr—Great Basin
Gulf—Atlantic & Gulf Coastal Plain
intr els—introduced elsewhere
Madr—Madrean
Mesoam—Mesoamerican
Mont—montane
N—North
nat—naturalized
NM—New Mexico
OK—Oklahoma
Polichor—polichorous
Prair—Prairie
Roc Mt—Rocky Mountains Province
S—South
SC—south-central
sec. dist.—second distribution
Son—Sonoran Province
S. str.—sensu stricto
Tam—Tamaulipan Province
Temp—temperate
Trop/Subtr—tropical/subtropical
TX—Texas
U.S.A.—United States of America
W—West

ACANTHACEAE 21 sp. 9 gen.
Anisacanthus quadrifidus Chih
Carlowrightia parviflora Chih-Tam
Carlowrightia texana Chih
Carlowrightia torreyana SC TX-Coah
Dicliptera sexangularis Amer Trop
Dyschoriste crenulata Tam
Dyschoriste linearis SC U.S.A.
Elytraria bromoides Mesoam-Madr
Justicia americana E N Amer
Justicia pacifica Mesoam-Madr
Justicia pilosella Chih-Tam
Justicia turneri Tam
Ruellia corzoi Chih
Ruellia davisiorum Tam
Ruellia drummondiana EC TX Endem
Ruellia malacosperma Mesoam-Madr
Ruellia nudiflora Mesoam-Madr
Ruellia occidentalis E Madr+S Madr
Ruellia yucatana Tam
Stenandrium dulce Amer Trop/Subtr
Yeatesia platystegia Tam

ACHATOCARPACEAE 1 sp. 1 gen.
Phaulothamnus spinescens Son (Son-Tam, disj)

AGAVACEAE 9 sp. 3 gen.
Agave americana var. protamericana Tam
Agave univittata Tam
Manfreda longiflora Tam
Manfreda maculosa S TX Plain
Manfreda sileri S TX Plain
Yucca arkansana Comanch
Yucca constricta SC TX-S TX Plain Endem
Yucca torreyi Chih
Yucca treculeana Chih-Tam

AIZOACEAE 3 sp. 2 gen.
Sesuvium portulacastrum Polichor
Sesuvium verrucosum W N Amer (W & SC)
Trianthema portulacastrum Trop/Subtr

ALISMATACEAE 5 sp. 3 gen.
Echinodorus berteroi N Amer-C Amer
Echinodorus cordifolius E N Amer-Carrib
Helanthium tenellum Trop/Subtr Amer
Sagittaria longiloba W N Amer
Sagittaria platyphylla E N Amer

ALLIACEAE 2 sp. 2 gen.
Allium elmendorfii S TX Endem
Nothoscordum bivalve N Amer (E&S)-Mesoam

AMARANTHACEAE 39 sp.13 gen.
Achyranthes aspera Trop/Subtr
Alternanthera paronychioides Trop/Subtr
Amaranthus albus Polichor
Amaranthus arenicola Prair wide
Amaranthus australis Gulf-Carrib
Amaranthus blitoides N Amer with sec. distr.
Amaranthus greggii Gulf
Amaranthus palmeri N Amer
Amaranthus polygonoides Carib-E Gulf
Amaranthus powellii N Amer (W)
Amaranthus scleropoides Chih-Tam
Amaranthus ×texensis S TX Plains
Amaranthus tuberculatus N Amer (EC)
Amaranthus wrightii Son-Chih (N)
Atriplex acanthocarpa Tam
Atriplex canescens N Amer (W)
Atriplex klebergorum S TX Plains
Atriplex mucronata Atl-Gulf
Atriplex texana Tam (+Chih)
Atriplex wrightii Son-Chih-(E Gulf)
Blitum (Monolepis) nuttalliana W N Amer
Celosia nitida E Gulf-Carib (Subtr)
Celosia palmeri E Madr
Chenopodium berlandieri N Amer
Chenopodium desiccatum W N Amer
Chenopodium incanum W N Amer
Chenopodium leptophyllum W N Amer
Chenopodium pratericola W N Amer
Corispermum americanum N Amer
Froelichia drummondii S TX Plains-Comanch
Froelichia floridana N Amer (Prair-SE)
Froelichia gracilis N Amer
Froelichia texana Chich-Tam
Gomphrena nealleyi S TX Plains-W Gulf
Gossypianthus lanuginosus N Amer (SC +Carib)
Suaeda conferta W Gulf-Carib
Suaeda linearis Atl-Gulf-Carib
Suaeda tampicensis W Gulf-Carib
Tidestromia lanuginosa SC N Amer

AMARYLLIDACEAE 3 sp. 2 gen.
Cooperia chlorosolen SC U.S.A.-Carib
Cooperia pedunculata SEC U.S.A.
Zephyranthes pulchella W Gulf-Carib

ANACARDIACEAE 5 sp. 2 gen.
Rhus aromatica var. trilobata W N Amer+W Prair
Rhus copallinum E N Amer
Rhus microphylla Son-Chih
Rhus virens Madr (E Madr+Son)
Toxicodendron radicans ssp. eximium SW-C TX

APIACEAE 16 sp. 10 gen.
Ammoselinum butleri E N Amer
Ammoselinum popei S Prair
Bowlesia incana Amer (Warm-Temp)
Centella asiatica Trop/Subtr
Chaerophyllum tainturieri E N Amer
Daucus pusillus N Amer
Eryngium diffusum Comanch
Eryngium nasturtiifolium Mesoam-Madr
Eurytaenia texana SC U.S.A.
Hydrocotyle bonariensis Trop/Subtr littorale
Hydrocotyle prolifera N Amer
Hydrocotyle umbellata Amer
Limnosciadium pinnatum SEC N Amer
Spermolepis diffusa SEC N Amer
Spermolepis echinata N Amer (S)
Spermolepis inermis Prair

APOCYNACEAE 20 sp. 6 gen.
Asclepias emoryi Tam
Asclepias linearis W Gulf-Tam
Asclepias oenotheroides Mesoam (+SC U.S.A.)
Asclepias prostrata Tam
Asclepias viridis SE N Amer (+Prair)
Cynanchum barbigerum Tam
Cynanchum maccartii Tam
Cynanchum racemosum var. unifarium Chih-Tam (mainly Edw Plat)
Funastrum angustifolium Atl-Gulf-Carib

Funastrum clausum Amer Trop/Subtr
Funastrum crispum SWC U.S.A.
Funastrum cynanchoides Madr (mostly W&N)
Gonolobus suberosus SC-SE N Amer
Matelea brevicoronata S TX Plains
Matelea cynanchoides Comanch
Matelea parviflora S TX Plains
Matelea radiata S TX Plains
Matelea reticulata Chih-Tam (mainly Edw Plat)
Matelea sagittifolia S TX Endem
Telosiphonia lanuginosa E Madr

ARACEAE 4 sp. 2 gen.
Lemna aequinoctialis Trop/Subtr
Lemna obscura N Amer-Mesoam
Wolffia columbiana Amer
Wolffiella oblonga Amer

ARECACEAE 1 sp. 1 gen.
Sabal mexicana Mesoam-Madr (Hidalgo c)

ARISTOLOCHIACEAE 2 sp. 1 gen.
Aristolochia erecta S TX Plains
Aristolochia pentandra Gulf-Carib

ASPLENIACEAE 1 sp. 1 gen.
Asplenium resiliens N Amer

ASTERACEAE 171 sp. 90 gen.
Acourtia runcinata Chih-Tam
Acourtia wrightii Son-Chih
Amblyolepis setigera Chih-Tam
Ambrosia artemisiifolia Amer (mostly E)
Ambrosia confertiflora SWC N Amer
Ambrosia psilostachya N Amer (Polichor)
Ambrosia trifida N Amer (mostly Prair+E)
Amphiachyris dracunculoides Prair
Aphanostephus ramosissimus var. ramosissimus Chih-Tam
Aphanostephus riddellii Chih
Aphanostephus skirrhobasis SC N Amer
Artemisia ludoviciana N Amer
Astranthium ciliatum SE Prair-Tam
Baccharis neglecta Chih-Tam
Baccharis salicifolia Amer Trop/Subtr
Baccharis salicina SW N Amer
Baccharis texana Prair
Baccharis wrightii Son-Chih
Bahia absinthifolia Son-Chih
Berlandiera texana Comanch
Bidens laevis Amer
Borrichia frutescens Atl-Gulf
Brickellia dentata Edw Plat (+ E TX)
Brickellia eupatorioides N Amer
Calyptocarpus vialis Mesoam-Carib
Chaptalia carduacea S TX Plains (N Tam?)
Chaetopappa asteroides var. asteroides SC N Amer
Chaetopappa asteroides var. grandis S TX
Chaetopappa bellioides Chih-Tam
Chaetopappa imberbis SE TX Endem
Chloracantha spinosa Mesoam-Madr
Chromolaena odorata W Gulf-Carib
Cirsium texanum SC N Amer
Clappia suaedifolia Tam
Conoclinium betonicifolium Gulf-E Madr
Conoclinium coelestinum E N Amer
Conoclinium dissectum Chih-Tam
Coreopsis basalis SC U.S.A. (C & E TX)
Coreopsis nuecensis Tam (SE TX)
Coreopsis tinctoria N Amer
Croptilon hookerianum var. hookerianum SE TX
Croptilon rigidifolium Tam (SE TX)
Diaperia candida SC N Amer (SE TX-W LA)
Diaperia prolifera Prair (W)
Diaperia verna var. drummondii S TX Plains
Diaperia verna var. verna SW N Amer
Dichaetophora campestris S TX Plains
Eclipta prostrata Amer with irradiations
Engelmannia peristenia SC N Amer
Erigeron geiseri Comanch
Erigeron procumbens Gulf
Erigeron strigosus N Amer, adv. els
Erigeron tenellus Tam
Eupatorium capillifolium E N Amer
Euthamia gymnospermoides Prair
Flaveria brownii W Gulf (SE TX)
Flaveria trinervia Mesoam-Madr wide
Fleischmannia incarnata E N Amer
Florestina tripteris Chih-Tam
Gaillardia aestivalis E N Amer (Prair-SE N Amer)
Gaillardia amblyodon S TX Plains
Gaillardia coahuilensis SC TX-Coah
Gaillardia pinnatifida SW N Amer (Maverick, Atascosa c)
Gaillardia pulchella N Amer (mostly SC)
Gaillardia suavis S Prair
Gamochaeta purpurea E N Amer
Gochnatia hypoleuca Chih-Tam
Grindelia lanceolata Comanch
Grindelia microcephala S TX Plains Endem
Grindelia pusilla S TX Plains
Gutierrezia microcephala Madr
Gutierrezia sarothrae W N Amer
Gutierrezia texana SC N Amer
Gymnosperma glutinosum Mesoam
Haploesthes greggii SW Prair-Chih
Helenium amarum SE N Amer
Helenium linifolium S TX Plains Endem
Helenium microcephalum SC N Amer (+ SW)
Helianthus angustifolius E N Amer (Hidalgo c)
Helianthus argophyllus W Gulf
Helianthus ciliaris SC N Amer
Helianthus debilis Atl & Gulf
Helianthus occidentalis ssp. plantagineus Comanch?
Helianthus praecox S TX Plains
Heterotheca canescens Prair (SC-SW)
Heterotheca subaxillaris N Amer
Hymenopappus artemisiifolius var. riograndensis S TX Plains Endem
Hymenopappus carrizoanus EC TX Plains Endem
Hymenopappus scabiosaeus Prair
Hymenopappus tenuifolius Prair
Hymenoxys odorata SW N Amer
Isocoma coronopifolia Tam
Isocoma drummondii W Gulf
Iva annua Prair (E + E N Amer)
Iva asperifolia Comanch (SEC N Amer)
Jefea brevifolia Chih-Tam
Krigia caespitosa E Prair-E N Amer
Krigia dandelion E Prair-E N Amer
Krigia occidentalis E Prair
Krigia wrightii Comanch
Laennecia coulteri N Madr
Liatris elegans var. carizzana S TX Plains Endem

Liatris elegans var. elegans SE N Amer
Liatris punctata Prair
Lindheimera texana SC N Amer (Comanch)
Lygodesmia texana S Prair-Chih
Melampodium cinereum Chih-Tam
Mikania scandens E N Amer
Neonesomia palmeri Tam (S TX Plains-Tam)
Packera tampicana SC U.S.A.-Gulf
Palafoxia hookeriana S TX Plains
Palafoxia rosea Prair
Palafoxia texana Tam
Parthenium confertum Chih-Tam
Parthenium incanum Madr wide
Pectis angustifolia SWC N Amer
Pectis cylindrica Son-Chih (Starr c, rare)
Pinaropappus roseus Madr-Mesoam
Plectocephalus americanus SC N Amer
Pluchea odorata Amer (Mesoam-Warm)
Pseudognaphalium austrotexanum S TX Plains-W Gulf
Pseudognaphalium obtusifolium E N Amer
Pseudognaphalium stramineum W N Amer
Psilostrophe gnaphalodes Chih-Tam
Psilostrophe tagetina SW US-Chih (Maveric c)
Psilostrophe villosa SW Prair
Pterocaulon virgatum Amer Trop/Subtr
Pyrrhopappus grandiflorus S Prair
Pyrrhopappus pauciflorus SW-SC N Amer
Ratibida columnifera Prair wide
Ratibida peduncularis Gulf-Tam
Rayjacksonia phyllocephala Gulf
Rudbeckia hirta E N Amer wide
Sanvitalia ocymoides Tam
Sclerocarpus uniserialis Mesoam-Madr
Senecio ampullaceus Comanch
Senecio flaccidus SW N Amer-Madr (Maverick c)
Senecio riddellii SW & SC N Amer
Shinnersia rivularis S TX-Coah (Zavala c)
Silphium radula E Prair (SC U.S.A.)
Simsia calva Chih-Tam
Symphyotrichum ericoides N Amer
Symphyotrichum praealtum Prair wide
Symphyotrichum subulatum Amer coastal
Tamaulipa azurea Tam
Tetragonotheca repanda S TX Plains Endem
Tetragonotheca texana Chih-Tam
Tetraneuris linearifolia SC N Amer
Tetraneuris scaposa SWC N Amer
Tetraneuris turneri S TX Plains
Thelesperma ambiguum Tam (Chih-Tam)
Thelesperma burridgeanum S TX Plains Endem
Thelesperma filifolium Prair
Thelesperma megapotamicum Prair-SW US
Thelesperma nuecense S TX Plains Endem
Thelesperma simplicifolium Chih-Tam
Thymophylla micropoides Chih (Maverick c)
Thymophylla pentachaeta Madr
Thymophylla tenuiloba Tam, adv els
Thymophylla tephroleuca S TX Plains Endem
Trichocoronis wrightii Tam
Trixis californica N Madr (Maverick, Starr c)
Trixis inula Mesoam-Carib
Varilla texana Tam
Verbesina encelioides Amer
Verbesina microptera Tam
Viguiera stenoloba Madr (Chih wide)
Wedelia acapulcensis Mesoam-Madr
Xanthisma spinulosum W N Amer
Xanthisma texanum ssp. texanum S TX Plains
Zinnia austrotexana S TX Plains Endem

BASELLACEAE 1 sp. 1 gen.
Anredera vesicaria Mesoam-Madr-Carib

BERBERIDACEAE 2 sp. 1 gen.
Mahonia swaseyi SC TX Endem
Mahonia trifoliolata Son

BIGNONIACEAE 2 sp. 2 gen.
Chilopsis linearis Son wide
Tecoma stans Amer Trop/Subtr

BIXACEAE 1 sp. 1 gen.
Amoreuxia wrightii Amer Trop/Subtr

BORAGINACEAE 10sp. 4 gen.
Cryptantha albida Son-Chih (Dimmit c)
Cryptantha mexicana Chih (+Tam)
Cryptantha palmeri Chih
Cryptantha texana SEC TX Endem
Lappula redowskii W N Amer-W Prair
Lithospermum incisum N Amer(C)
Lithospermum matamorense Tam (W Chih)
Lithospermum mirabile S TX Endem
Lithospermum parksii SW-SC TX
Myosotis macrosperma E N Amer (Webb c)

BRASSICACEAE 26 sp. 13 gen.
Descurainia pinnata N Amer
Draba cuneifolia W N Amer (W& WC N Amer)
Draba platycarpa W N Amer (W& WC disj)
Lepidium austrinum SC N Amer
Lepidium densiflorum N Amer (W&C)
Lepidium lasiocarpum W N Amer
Lepidium virginicum N Amer
Nerisyrenia camporum Chih
Paysonia grandiflora SEC TX Endem
Paysonia lasiocarpa Tam
Phravenia viereckii Tam
Physaria argyraea Chih-Tam
Physaria fendleri SW N Amer
Physaria gordonii Son (+ SW Prair)
Physaria gracilis ssp. gracilis Prair (S)
Physaria lindheimeri Tam
Physaria thamnophila S TX Plains Endem (Zapata, Starr c)
Planodes virginicum E N Amer
Rorippa curvipes W N Amer
Rorippa sessiliflora E Prair (+ E N Amer)
Rorippa teres Gulf
Selenia grandis S TX Plains Endem
Selenia jonesii S WC TX Endem
Streptanthus petiolaris EP Endem
Synthlipsis greggii S TX Endem
Thelypodiopsis shinnersii Tam

BROMELIACEAE 4 sp. 2 gen.
Hechtia glomerata Mesoam-E Madr
Tillandsia baileyi W Gulf (Tam)
Tillandsia recurvata Amer Trop/Subtr
Tillandsia usneoides Amer Trop/Subtr

CACTACEAE 35 sp. 17 gen.
Acanthocereus tetragonus Mesoam-E Madr-Carib
Ancistrocactus scheeri Tam

Ariocarpus fissuratus Chih-(Tam)
Astrophytum asterias Tam
Coryphantha echinus Chih (Maverick c)
Coryphantha macromeris var. runyonii S TX Endem (Starr, Hidalgo, Cameron c)
Coryphantha nickelsiae Tam (Webb c)
Coryphantha pottsiana Chih-Tam disj
Coryphantha robustispina Son-Chih (Maverick c)
Coryphantha sulcata SC N Amer
Cylindropuntia leptocaulis Chih-Tam
Echinocactus horizonthalonius Chih
Echinocactus texensis Chih-Tam (SC N Amer)
Echinocereus berlandieri Tam
Echinocereus coccineus SW N Amer
Echinocereus enneacanthus Chih-Tam
Echinocereus papillosus Tam
Echinocereus pectinatus Chih-Tam (Maverick c)
Echinocereus pentalophus Tam
Echinocereus poselgeri Tam
Echinocereus reichenbachii SC N Amer
Echinocereus roetteri Chih-Tam
Echinocereus stramineus Chih (Dimmit c)
Escobaria emskoetteriana E Chih-Tam
Ferocactus hamatacanthus Chih-Tam
Glandulicactus uncinatus Chih
Grusonia schottii Chih-Tam
Hamatocactus bicolor Tam
Lophophora williamsii Chih-Tam
Mammillaria heyderi Son wide (Son-Chih-Tam)
Mammillaria prolifera var. texana Chih-Tam
Mammillaria sphaerica Tam
Opuntia aciculata S TX Plains (Webb c)
Opuntia engelmannii Son wide
Opuntia humifusa E N Amer

CAMPANULACEAE 5 sp. 2 gen.
Lobelia berlandieri Madr
Triodanis coloradoensis Edw Plat
Triodanis holzingeri Prair
Triodanis perfoliata N Amer
Triodanis texana Comanch

CANNABACEAE 5 sp. 1 gen.
Celtis ehrenbergiana Amer Trop/Subtr
Celtis laevigata E N Amer
Celtis occidentalis C & NE N Amer (McMullen c)
Celtis reticulata W N Amer
Celtis tenuifolia E N Amer (McMullen c)

CAPPARACEAE 3 sp. 3 gen.
Quadrella incana Mesoam-Madr-W Gulf
Cleomella angustifolia Prair
Polanisia dodecandra N Amer

CARYOPHYLLACEAE 9 sp. 4 gen.
Arenaria benthamii SC N Amer
Paronychia congesta S TX Plains (Jim Hogg c)
Paronychia drummondii Comanch
Paronychia jonesii S TX Plains Endem
Paronychia maccartii S TX Plains (Webb c)
Paronychia setacea EC TX Endem
Silene antirrhina N Amer
Spergularia marina Polichor (wetlands)
Stellaria cuspidata Mesoam (+Andean)

CELASTRACEAE 2 sp. 2 gen.
Mortonia greggii Tam
Schaefferia cuneifolia Chih-Tam (+Son)

CISTACEAE 3 sp. 2 gen.
Crocanthemum georgianum E N Amer
Lechea mucronata E N Amer
Lechea san-sabeana Comanch

COMMELINACEAE 7 sp. 4 gen.
Callisia micrantha S TX Plains
Commelina diffusa var. diffusa Trop/Subtr
Commelina erecta N Amer & C Amer
Tinantia anomala S TX (Edw Plat)
Tradescantia buckleyi Tam
Tradescantia humilis SE TX
Tradescantia occidentalis Prair + SW N Amer

CONVOLVULACEAE 12 sp. 7 gen.
Convolvulus carrii S TX Plains
Convolvulus equitans SWC N Amer
Cressa nudicaulis Amer Trop/Subtr
Cressa truxillensis Madr
Cuscuta legitima Son-Chih
Dichondra carolinensis SE N Amer
Dichondra micrantha Trop/Subtr (Subtr)
Evolvulus alsinoides Madr
Evolvulus nuttallianus WC N Amer
Evolvulus sericeus Amer Trop/Subtr
Ipomoea costellata Son
Merremia dissecta Trop/Subtr

CRASSULACEAE 1 sp. 1 gen.
Lenophyllum texanum S TX Plains Endem

CUCURBITACEAE 4 sp. 3 gen.
Cayaponia quinqueloba E N Amer (Atacosta c)
Ibervillea lindheimeri SC N Amer-Gulf
Ibervillea tenuisecta Chih (Atacosta & Dimmit c)
Melothria pendula E N Amer

CUPRESSACEAE 3 sp. 2 gen.
Juniperus ashei Comanch (Zavala c)
Juniperus pinchotii SWC U.S.A.
Taxodium distichum var. mexicanum (Hidalgo, Starr c) Mesoam-Madr

CYPERACEAE 47 sp. 10 gen.
Bulbostylis capillaris Amer (Amphipacific)
Carex crus-corvi E Prair-E N Amer
Carex frankii E N Amer
Carex leavenworthii E Prair-E N Amer
Carex muehlenbergii E Prair-E N Amer
Carex perdentata Comanch
Carex planostachys SC N Amer
Carex tetrastachya SC N Amer (Comanch)
Cladium mariscus Subtr
Cyperus acuminatus N Amer
Cyperus articulatus Trop/Subtr
Cyperus digitatus Trop/Subtr
Cyperus elegans Mesoam/S Amer
Cyperus erythrorhizos N Amer
Cyperus floribundus Tam
Cyperus hystricinus SE N Amer
Cyperus lentiginosus Mesoam-W Gulf
Cyperus ochraceus Amer Trop/Subtr
Cyperus odoratus Amer
Cyperus polystachyos Trop/Subtr
Cyperus pseudovegetus E N Amer-C Amer
Cyperus retroflexus S N Amer

Cyperus setigerus S Prair (Comanch)
Cyperus squarrosus Amer-Afr
Cyperus surinamensis Amer Trop/Subtr/Warm
Cyperus thyrsiflorus Amer Trop/Subtr
Cyperus virens Amer Trop/Subtr/Warm
Eleocharis albida Atl & Gulf-Carib
Eleocharis atropurpurea Trop/Subtr/Warm
Eleocharis geniculata Amer-Afr
Eleocharis interstincta Amer Trop/Subtr
Eleocharis montevidensis Amer (N & C Amer)
Eleocharis palustris Holarct
Eleocharis parvula Holarct
Eleocharis quadrangulata N Amer (E)
Eleocharis ravenelii S TX Plains-W Gulf (TX)
Fimbristylis vahlii Amer Trop/Subtr
Fuirena simplex S N Amer-Mesoam
Fuirena squarrosa E N Amer
Rhynchospora colorata Mesoam-Gulf-Carib
Rhynchospora corniculata E N Amer
Schoenoplectiella saximontana N Amer
Schoenoplectus californicus Amer
Schoenoplectus maritimus W N Amer
Schoenoplectus pungens Polichor
Schoenoplectus tabernaemontani Polichor
Scleria ciliata E N Amer-Meoamer-Carib

DROSERACEAE 1 sp. 1 gen.
Drosera brevifolia SE N Amer

EBENACEAE 1 sp. 1 gen.
Diospyros texana Chih-Tam

ELATINACEAE 1 sp. 1 gen.
Bergia texana? W N Amer-Prair

EPHEDRACEAE 2 sp. 1 gen.
Ephedra antisyphilitica Chih-Tam (+ NE TX, OK)
Ephedra pedunculata Chih-Tam

EQUISETACEAE 1 sp. 1 gen.
Equisetum laevigatum N Amer

EUPHORBIACEAE 63 sp. 11 gen.
Acalypha monostachya Madr (E & S)
Acalypha ostryifolia Amer
Acalypha poiretii Amer Trop/Subtr/Warm
Acalypha radians S TX Plains
Adelia vaseyi Tam
Argythamnia argyraea EC TX Endem
Argythamnia humilis S Prair
Argythamnia mercurialina var. pilosissima SE TX
Argythamnia neomexicana N Madr
Argythamnia simulans Edw Plat Endem
Bernardia myricifolia? Son
Cnidoscolus texanus SC U.S.A. disj
Croton argyranthemus Gulf-Carib
Croton capitatus E Prair-E N Amer
Croton ciliatoglandulifer Mesoam-Madr
Croton cortesianus Mesoam-Madr
Croton coryi S TX Plains Endem
Croton dioicus Chih-Tam-Mex High
Croton glandulosus Amer Trop/Subtr
Croton heptalon Tam
Croton humilis Gulf-Carib
Croton incanus E Madr +Tam
Croton leucophyllus Tam + E Chih
Croton lindheimeri SC-SE N Amer
Croton lindheimerianus S Prair
Croton monanthogynus E N Amer
Croton parksii S TX Plains Endem
Croton pottsii Son-Chih
Croton punctatus Atl & Gulf Coast
Croton texensis var. texensis Prair
Euphorbia (Chamaesyce) albomarginata Madr
Euphorbia antisyphilitica Madr
Euphorbia bombensis (Chamaesyce) Gulf (Mesoam-Gulf)
Euphorbia cinerascens (Chamaesyce) Chih-Tam
Euphorbia cordifolia Atl & Gulf Coast
Euphorbia cyathophora N Amer
Euphorbia dentata N Amer (+ C Amer)
Euphorbia fendleri WC U.S.A.
Euphorbia glyptosperma N Amer
Euphorbia helleri S TX Plains
Euphorbia heterophylla N Amer Euphorbia hypericifolia Amer Trop/Subtr
Euphorbia innocua S TX Plains (W Gulf) Endem
Euphorbia laredana Tam
Euphorbia maculata E N Amer
Euphorbia micromera N Madr
Euphorbia missurica Prair
Euphorbia nutans (Chamaesyce) N Amer
Euphorbia peplidion S TX Plains Endem
Euphorbia prostrata N Amer
Euphorbia serpens N Amer
Euphorbia serrula (Maverick c) Son-Chih
Euphorbia spathulata N Amer
Jatropha cathartica Chih-Tam
Jatropha dioica Madr
Manihot walkerae Tam
Stillingia sylvatica SE-SC N Amer
Stillingia treculiana E Madr-Tam
Tragia amblyodonta Son wide
Tragia betonicifolia S Prair
Tragia brevispica Comanch
Tragia ramosa SWC U.S.A.
Tragia glanduligera Madr coastal

FABACEAE 95 sp. 39 gen.
Acaciella angustissima Amer Trop/Subtr
Aeschynomene viscidula Amer Trop/Subtr
Amorpha fruticosa N Amer
Amorpha roemeriana EC TX Endem
Astragalus brazoensis S TX-Coah (S TX Plains)
Astragalus emoryanus S Gr Bas-N Chih-Tam disj
Astragalus lotiflorus Prair
Astragalus nuttallianus WC N Amer
Astragalus pleianthus EC TX Endem (Comanch)
Astragalus reflexus EC TX Endem (Comanch)
Bauhinia lunarioides Chih
Caesalpinia caudata Tam
Caesalpinia phyllanthoides Tam
Calliandra conferta Madr (S, C, and E)
Centrosema virginianum Amer Trop/Subtr (Mesoam-S Amer)
Chamaecrista calycioides Amer Trop/Subtr (Mesoam-S Amer)
Chamaecrista chamaecristoides W Gulf-Pacific
Chamaecrista fasciculata E N Amer
Chamaecrista flexuosa Amer Trop/Subtr (Mesoam-S Amer)
Chamaecrista nictitans Amer Trop/Subtr/Warm
Coursetia axillaris Tam
Dalea aurea Prair
Dalea austrotexana S TX Plains Endem
Dalea ceciliana S TX Plains
Dalea compacta Comanch

Dalea emarginata Tam
Dalea formosa SWC N Amer
Dalea frutescens E Madr
Dalea lasiathera S TX-Coah
Dalea multiflora Prair
Dalea nana Son wide
Dalea neomexicana N Son-Chih
Dalea obovata S TX Plains (TX Endem)
Dalea phleoides Comanch
Dalea pogonathera Son wide
Dalea scandens Mesoam-Madr
Dalea wrightii Son-Chih (Webb c)
Dermatophyllum secundiflorum Madr E
Desmanthus obtusus Chih
Desmanthus velutinus Chih
Desmanthus virgatus Amer
Desmodium paniculatum E N Amer
Ebenopsis ebano Gulf (W&S)-Tam
Eysenhardtia texana E Chih-Tam
Galactia canescens EC TX – S TX Plains (N Tam)
Galactia heterophylla S TX Plains-E Edw Plat Endem
Galactia marginalis Amer Trop/Subtr
Havardia pallens W Gulf-E Madr
Hoffmannseggia drummondii SEC TX
Hoffmannseggia glauca Amphitrop
Hoffmannseggia oxycarpa Chih
Indigofera miniata Mesoam-Carib
Lathyrus pusillus?
Leucaena pulverulenta E Madr (Tam)
Lupinus subcarnosus SE TX
Lupinus texensis SC N Amer
Mimosa asperata Amer-Afr (Trop)
Mimosa latidens SE TX (W Gulf)
Mimosa malacophylla Tam
Mimosa roemeriana Comanch
Mimosa strigillosa Amphitrop (Gulf-S S Amer)
Mimosa texana Chih
Neptunia lutea SE Prair (+ Gulf)
Neptunia microcarpa Mesoam-Madr
Neptunia pubescens Mesoam (+ Gulf)
Parkinsonia texana S TX Plains (+ Val Verde, Cameron, Kenedy, Kleberg c)
Pediomelum rhombifolium SC U.S.A.
Pomaria austrotexana S TX Plains-N Tam
Pomaria jamesii SWC U.S.A.
Prosopis glandulosa SWC N Amer
Prosopis reptans var. cinerascens Tam
Rhynchosia americana Gulf-Tam (Pacif)
Rhynchosia minima Trop/Subtr
Senegalia berlandieri Chih-Tam
Senegalia greggii Madr
Senegalia roemeriana Chih-Tam
Senegalia wrightii Tam
Senna bauhinioides Madr
Senna durangensis S Chih-Tam
Senna lindheimeriana Chih-Tam
Senna pumilio Chih
Senna roemeriana SWC U.S.A. (NM & W TX)
Sesbania drummondii Gulf-Tam
Sesbania herbacea Mesoam
Stylosanthes viscosa Amer Top/Subtr
Tephrosia lindheimeri S TX Plains Endem
Tephrosia onobrychoides SEC N Amer
Vachellia bravoensis S TX Plains
Vachellia constricta Madr wide
Vachellia farnesiana Trop/Subtr
Vachellia rigidula Chih-Tam
Vicia ludoviciana N Amer (S)
Vigna luteola Trop/Subtr
Zornia bracteata Atl & Gulf
Zornia gemella Amer Trop/Subtr

FAGACEAE 5 sp. 1 gen.
Quercus fusiformis SC N Amer
Quercus macrocarpa E N Amer (Atacosta c)
Quercus margarettae E N Amer
Quercus marilandica E N Amer
Quercus virginiana E N Amer

FRANKENIACEAE 1 sp. 1 gen.
Frankenia johnstonii S TX-Coah

FUMARIACEAE 4 sp. 1 gen.
Corydalis aurea WC N Amer
Corydalis curvisiliqua SC N Amer
Corydalis micrantha ssp. australis E Prair-SE N Amer
Corydalis micrantha ssp. texensis S TX Plains

GENTIANACEAE 4 sp. 3 gen.
Eustoma exaltatum Mesoam-N Amer
Sabatia arenicola Gulf
Sabatia campestris E Prair
Zeltnera calycosa E Madr

GERANIACEAE 1 sp. 1 gen.
Erodium texanum SWC U.S.A.

HYDROCHARITACEAE 2 sp. 1 gen.
Najas guadalupensis Amer
Najas marina Polichor

HYDROPHYLLACEAE 18 sp. 7 gen.
Cordia boissieri Tam
Cordia podocephala Chih-Tam
Ehretia anacua Tam
Heliotropium angiospermum Amer Trop/Subtr
Heliotropium confertifolium Chih (+Tam)
Heliotropium curassavicum Amer
Heliotropium procumbens Amer Trop/Subtr
Heliotropium racemosum S TX Plains
Heliotropium texanum Tam (S TX Plains)
Heliotropium torreyi Chih-Tam
Nama hispidum SWC N Amer
Nama parvifolium Chih-Tam
Nama stenocarpum Son wide disjunct
Nemophila phacelioides Comanch
Phacelia austrotexana S TX Plains
Phacelia congesta SC N Amer
Phacelia laxa SEC TX Endem
Tiquilia canescens Madr

HYPERICACEAE 1 sp. 1 gen.
Hypericum pauciflorum Madr

IRIDACEAE 7 sp. 3 gen.
Alophia drummondii Gulf-Atl S Amer
Herbertia lahue SEC N Amer-S Amer
Sisyrinchium biforme W Gulf
Sisyrinchium chilense S Amer- SC N Amer
Sisyrinchium langloisii SEC N Amer
Sisyrinchium minus SEC N Amer
Sisyrinchium pruinosum Prair SE

JUGLANDACEAE 3 sp. 2 gen.
Carya illinoinensis E N Amer
Carya texana E Prair
Juglans microcarpa SC N Amer

JUNCACEAE 4 sp. 1 gen.
Juncus interior Prair
Juncus marginatus Amer
Juncus scirpoides E N Amer
Juncus torreyi N Amer

KOEBERLINIACEAE 1 sp. 1 gen.
Koeberlinia spinosa Son wide

KRAMERIACEAE 2 sp. 1 gen.
Krameria lanceolata SC N Amer
Krameria ramosissima Tam

LAMIACEAE 21 sp. 10 gen.
Brazoria arenaria S TX Plains
Brazoria truncata S TX Plains
Clinopodium brownei Amer Trop/Subtr
Hedeoma drummondii WC N Amer
Monarda citriodora N Amer (Prair-SWC)
Monarda clinopodioides Prair (Comanch?)
Monarda fruticulosa S TX Plains Endem
Monarda punctata E N Amer
Physostegia correllii S TX + SE LA + N Tam, rare
Salvia ballotiflora E Madr
Salvia coccinea Polichor
Salvia farinacea SC U.S.A.
Salvia texana SC N Amer
Scutellaria drummondii SC N Amer
Scutellaria muriculata S TX Plains
Scutellaria texana Chih
Stachys crenata Gulf-Madr (SC-SE N Amer)
Stachys drummondii W Gulf-Tam
Tetraclea coulteri Son wide
Teucrium canadense N Amer-Mesoam
Teucrium cubense Amphitrop (Amer Subtr)

LENTIBULARIACEAE 1sp. 1 gen.
Utricularia gibba Amer-Afr (Trop)

LINACEAE 6 sp. 1 gen.
Linum alatum Tam
Linum berlandieri Prair (SC)
Linum elongatum S TX Plains Endem
Linum hudsonioides S Prair
Linum imbricatum SC U.S.A.
Linum lundellii S TX Plains Endem

LINDERNIACEAE 1 sp. 1 gen.
Lindernia dubia Amer

LOASACEAE 9 sp. 3 gen.
Cevallia sinuata Son wide
Eucnide bartonioides Chih-Tam
Eucnide lobata E & S Madr
Mentzelia albescens Amphitrop
Mentzelia hispida Mesoam-Madr
Mentzelia incisa Mesoam-Madr
Mentzelia lindheimeri Chih-Tam
Mentzelia nuda W Prair
Mentzelia oligosperma Prair

LYTHRACEAE 5 sp. 5 gen.
Ammannia coccinea Mesoam-N Amer
Heimia salicifolia Mesoam-S Amer
Lythrum californicum W N Amer
Nesaea longipes N Chih-Tam
Rotala ramosior Amer

MALPIGHIACEAE 3 sp. 3 gen.
Callaeum septentrionale E Madr
Galphimia angustifolia E & W Madr
Malpighia glabra Trop/Subtr

MALVACEAE 46 sp. 24 gen.
Abutilon abutiloides Mesoam-Madr-Carib
Abutilon berlandieri Madr
Abutilon fruticosum Trop/Subtr
Abutilon mollicomum Madr
Abutilon parvulum Son
Abutilon trisulcatum Mesoam-Madr-Carib
Abutilon wrightii Chih-Tam
Allowissadula holosericea Chih-Tam
Allowissadula lozanii Tam
Anoda pentaschista Madr
Ayenia limitaris Tam
Ayenia pilosa Chih-Tam
Bastardia viscosa Amer Trop/Subtr
Billieturnera helleri Tam
Callirhoe involucrata Prair
Callirhoe leiocarpa Prair
Corchorus hirtus Amer Trop
Herissantia crispa Trop/Subtr
Hermannia texana E Chih-Tam
Hibiscus martianus Madr (E + Tam)
Malachra capitata Trop/Subtr
Malvastrum americanum Trop/Subtr
Malvastrum coromandelianum Trop/Subtr
Malvaviscus arboreus Trop/Subtr (Amer)
Malvella lepidota Son
Malvella sagittifolia Son
Melochia pyramidata Trop/Subtr
Melochia tomentosa Trop/Subtr (Amer)
Meximalva filipes Tam
Pseudabutilon umbellatum Mesoam-Madr
Rhynchosida physocalyx Amer Trop/Subtr
Sida ciliaris Amer Trop/Subtr
Sida cordifolia Trop/Subtr
Sida lindheimeri SE TX-W Gulf
Sida rhombifolia Trop/Subtr/Warm
Sida spinosa Trop/Subtr
Sida tragiifolia Son (Son-Chih-Tam)
Sidastrum paniculatum Amer Trop/Subtr
Sphaeralcea angustifolia Madr
Sphaeralcea digitata Chih (+S Gr Basin)
Sphaeralcea hastulata SW N Amer
Sphaeralcea lindheimeri S TX Plains Endem
Sphaeralcea pedatifida Tam
Waltheria indica Trop/Subtr
Wissadula amplissima Trop/Subtr
Wissadula parvifolia S TX Plains Endem

MARSILEACEAE 2 sp. 1 gen.
Marsilea macropoda SE N Amer disj
Marsilea vestita N Amer (+Peru)

MARTYNIACEAE 3 sp. 1 gen.
Proboscidea louisiana N Amer (mostly S)
Proboscidea parviflora N Madr
Proboscidea sabulosa Chih

MELANTHIACEAE 1 sp. 1 gen.
Schoenocaulon ghiesbreghtii W Gulf-Mesoam

MENISPERMACEAE 1 sp. 1 gen.
Cocculus diversifolius Madr

MONTIACEAE 4 sp. 3 gen.
Claytonia virginica E N Amer (La Salle c)
Phemeranthus aurantiacus Madr
Phemerantus parviflorus Prair
Talinum polygaloides Amphitrop

MORACEAE 1 sp. 1 gen.
Morus rubra E N Amer

NELUMBONACEAE 1 sp. 1 gen.
Nelumbo lutea E N Amer-Mesoam

NYCTAGINACEAE 18 sp. 9 gen.
Abronia ameliae S TX Plains Endem
Acleisanthes anisophylla Tam
Acleisanthes crassifolia S TX-Coah
Acleisanthes longiflora Son wide
Acleisanthes obtusa E Madr (+Tam)
Allionia choisyi Amphitrop (Madr)
Allionia incarnata Amer (SW, N & C Amer)
Boerhavia coccinea Trop/Subtr
Boerhavia erecta Amer Trop/Subtr
Boerhavia linearifolia Chih
Boerhavia triquetra Son
Commicarpus scandens Amer Trop/Subtr
Cyphomeris crassifolia Tam
Mirabilis albida N Amer
Mirabilis austrotexana S TX Plains Endem
Mirabilis linearis W N Amer (+Prair)
Nyctaginia capitata Chih
Pisonia aculeata Trop/Subtr

NYMPHAEACEAE 2 sp. 1 gen.
Nymphaea elegans Mesoam-Gulf
Nymphaea mexicana Subtr

OLEACEAE 5 sp. 3 gen.
Forestiera angustifolia Chih-Tam
Fraxinus berlandieriana Madr
Fraxinus pennsylvanica E N Amer
Menodora heterophylla S TX (SW/SC/SE TX)
Menodora longiflora SC N Amer

ONAGRACEAE 24 sp. 2 gen.
Ludwigia octovalvis Polichor
Ludwigia peploides Amer
Oenothera berlandieri SC U.S.A.
Oenothera calcicola E Madr
Oenothera cinerea SC U.S.A.?
Oenothera curtiflora WC N Amer
Oenothera drummondii Gulf
Oenothera falfurriae S TX Plains Endem
Oenothera filiformis E Prair
Oenothera grandis Prair
Oenothera hartwegii SWC N Amer
Oenothera kunthiana Mesoam-Madr
Oenothera laciniata N Amer
Oenothera macrocarpa Prair
Oenothera mckelveyae S TX Plains
Oenothera mexicana S TX Plains
Oenothera patriciae S TX Plains-Comanch
Oenothera rosea Trop/Subtr/Warm
Oenothera serrulata Prair wide
Oenothera sinuosa Comanch with sec. distr.
Oenothera speciosa N Amer-Mesoam
Oenothera suffrutescens WC N Amer
Oenothera tetraptera Mesoam-Madr, nat. in S Amer, South Africa, Australia, Asia, and Europe
Oenothera triloba SWC N Amer (Prair)

OROBANCHACEAE 10 sp. 5 gen.
Agalinis homalantha SEC N Amer
Agalinis strictifolia W Gulf-Tam
Bacopa monnieri Trop/Subtr/Warm
Bacopa rotundifolia Amer Temp
Buchnera americana E N Amer
Buchnera floridana?
Castilleja citrina (Maverick c) WC Prair
Castilleja indivisa SE Prair
Castilleja purpurea S Prair
Orobanche ludoviciana N Amer

OXALIDACEAE 6 sp. 1 gen.
Oxalis dichondrifolia E Madr
Oxalis dillenii N Amer
Oxalis drummondii Son-Chih
Oxalis frutescens Amer Trop/Subtr
Oxalis intermedia Amer Trop/Subtr
Oxalis neaei Mesoam-Madr

PAPAVERACEAE 4 sp. 1 gen.
Argemone aenea Chih-Tam
Argemone albiflora ssp. texana SC U.S.A.
Argemone aurantiaca (Maverick c) EC TX Endem
Argemone sanguinea E Chih-Tam

PASSIFLORACEAE 5 sp. 1 gen.
Passiflora ciliata Mesoam-Carib
Passiflora filipes Mesoam-Madr
Passiflora foetida Trop/Subtr
Passiflora suberosa Amer Trop/Subtr
Passiflora tenuiloba Tam (+ N Chih)

PETIVERIACEAE (Phytolaccaceae) 2 sp. 2 gen.
Petiveria alliacea Amer Trop/Subtr
Rivina humilis Amer Trop/Subtr

PHYLLANTHACEAE (Euphorbiaceae) 3 sp. 1 gen.
Phyllanthus abnormis SC N Amer (+FLA)
Phyllanthus evanescens Mesoam (W Gulf-Pacific)
Phyllanthus polygonoides SC N Amer

PLANTAGINACEAE 15 sp. 8 gen.
Callitriche terrestris E N Amer (Dimmit c)
Leucospora multifida E Prair (+ E N Amer)
Maurandella antirrhiniflora Mesoam-Madr
Mecardonia procumbens Amer Trop/Subtr
Nuttallanthus texanus N Amer
Plantago helleri SC U.S.A.
Plantago heterophylla Amer Temp
Plantago hookeriana SC U.S.A.
Plantago patagonica Amer
Plantago rhodosperma Prair
Plantago virginica E N Amer
Plantago wrightiana N Amer
Stemodia lanata W Gulf-Pacific
Stemodia schottii SC N Amer
Veronica peregrina Polichor

PLUMBAGINACEAE 1 sp. 1 gen.
Plumbago zeylanica Amer Trop/Subtr

POACEAE 163 sp. 59 gen.
Agrostis hyemalis N Amer
Alopecurus carolinianus N Amer
Andropogon gerardii N Amer
Andropogon glomeratus Mesoam
Andropogon virginicus E N Amer (+ C Amer)
Aristida adscensionis Polichor
Aristida desmantha SC U.S.A.
Aristida longespica E N Amer
Aristida oligantha N Amer
Aristida purpurascens N Amer
Aristida purpurea N Amer (W/C)
Bothriochloa barbinodis Amer Trop/Subtr
Bothriochloa hybrida? (SC TX + SE U.S.A.)
Bothriochloa laguroides Amer Trop/Subtr
Bothriochloa longipaniculata Amer Trop/Subtr
Bouteloua aristidoides Amer Trop/Subtr (Subtr)
Bouteloua barbata Amer Trop/Subtr (Subtr)
Bouteloua curtipendula Amer
Bouteloua dactyloides Prair wide
Bouteloua gracilis WC N Amer
Bouteloua hirsuta Prair-N Madr
Bouteloua hirsuta ssp. pectinata Comanch
Bouteloua repens Amer Trop/Subtr
Bouteloua rigidiseta S Prair
Bouteloua trifida N Madr
Bromus texensis SEC TX Endem
Cenchrus echinatus Trop/Subtr
Cenchrus incertus?
Cenchrus myosuroides Amer Trop/Subtr (Subtr)
Chasmanthium latifolium E N Amer
Chloris andropogonoides Tam-E Madr
Chloris barbata Trop/Subtr
Chloris ciliata Amer Subtr
Chloris cucullata SC N Amer
Chloris verticillata Prair (+ W N Amer)
Coelorachis cylindrica SE N Amer
Coleataenia anceps E N Amer
Dichanthelium acuminatum N Amer (Mesoam)
Dichanthelium dichotomum E N Amer (+ Mesoam)
Dichanthelium nodatum SEC TX Endem
Dichanthelium oligosanthes N Amer
Dichanthelium sphaerocarpon E N Amer (+ Mesoam)
Digitaria californica Amphitrop
Digitaria cognata E N Amer
Digitaria filiformis Amer Trop/Subtr/Warm
Digitaria insularis Amer Trop/Subtr
Digitaria patens SWC N Amer
Digitaria pubiflora SWC N Amer
Digitaria texana Gulf (E TX, FLA)
Disakisperma dubium SWC N Amer
Distichlis littoralis Gulf-Pacific
Distichlis spicata Amer
Echinochloa crus-pavonis Trop/Subtr/Warm
Echinochloa muricata N Amer
Elionurus tripsacoides Amer Trop/Subtr
Elymus canadensis N Amer
Elymus macgregorii E N Amer
Elymus virginicus E N Amer
Enteropogon chlorideus Mesoam
Eragrostis curtipedicellata SC N Amer
Eragrostis hirsuta E N Amer
Eragrostis hypnoides Amer
Eragrostis intermedia SWC N Amer
Eragrostis pectinacea Amer
Eragrostis refracta SE N Amer
Eragrostis reptans Prair-E N Amer
Eragrostis secundiflora Amer Trop/Subtr/Warm
Eragrostis sessilispica S Prair
Eragrostis silveana W Gulf-Tam-E Madr
Eragrostis spectabilis N Amer
Eragrostis spicata Amer Subtr
Eragrostis swallenii S TX Endem
Eragrostis trichodes N Amer (mostly Prair)
Eriochloa contracta N Amer
Eriochloa punctata Amer Trop/Subtr
Eriochloa sericea Prair (S)
Erioneuron pilosum WC N Amer
Eustachys petraea Amer Trop/Subtr
Heteropogon contortus Trop/Subtr
Hilaria belangeri Chih
Hopia obtusa SWC N Amer
Hordeum pusillum N Amer
Leersia monandra Amer Trop/Subtr (Mesoam-Carib + Brazil)
Leptochloa crinita Amphitrop
Leptochloa fusca Polichor
Leptochloa nealleyi Gulf-Pacific
Leptochloa panicea Trop/Subtr (Amer-Asian)
Leptochloa pluriflora Amer Trop/Subtr
Leptochloa virgata Amer Trop/Subtr
Limnodea arkansana SC N Amer -Gulf
Melica nitens E Prair-SC N Amer
Muhlenbergia porteri Madr (N&WC)
Nassella leucotricha SC N Amer
Oplismenus hirtellus Trop/Subtr
Panicum capillare N Amer (+ Temp S Amer)
Panicum capillarioides Tam-E Madr
Panicum dichotomiflorum Amer
Panicum diffusum W Gulf-E Madr-Carib
Panicum ghiesbreghtii Mesoam-Madr
Panicum hallii SWC N Amer (+ Madr)
Panicum hirsutum Mesoam-S Amer
Panicum virgatum N Amer
Pappophorum bicolor E Madr
Pappophorum vaginatum Amphitrop
Paspalidium geminatum Trop/Subtr
Paspalum acuminatum Amer Trop/Subtr
Paspalum botterii Gulf-Mesoam
Paspalum denticulatum Amer Trop/Subtr
Paspalum distichum Trop/Subtr/Warm
Paspalum hartwegianum Amer Trop/Subtr
Paspalum monostachyum Gulf
Paspalum plicatulum Amer Trop/Subtr
Paspalum pubiflorum E N Amer-Mesoam
Paspalum repens E N Amer
Paspalum setaceum N Amer-Mesoam
Paspalum vaginatum Trop/Subtr
Phalaris caroliniana N Amer (coastal)
Phragmites karka Trop/Subtr (Paleotropical)
Piptochaetium avenaceum E N Amer
Pleuraphis mutica Son wide
Schedonnardus paniculatus Prair
Schizachyrium littorale Atl & Gulf
Schizachyrium sanguineum Trop/Subtr
Schizachyrium scoparium N Amer
Scleropogon brevifolius Madr (wide)-Mesoam (+Argentina) (La Salle)
Setaria grisebachii Madr-Mesoam

Setaria leucopila SWC N Amer (+ E Madr)
Setaria macrostachya Amer Trop/Subtr
Setaria parviflora Trop/Subtr/Warm
Setaria reverchonii SC N Amer
Setaria scheelei Chih-Tam
Setaria texana Tam
Setaria villosissima Chih
Spartina spartinae Gulf-Mesoam-S Amer
Sporobolus airoides W N Amer
Sporobolus buckleyi W Gulf-Tam
Sporobolus compositus N Amer
Sporobolus contractus SW N Amer
Sporobolus cryptandrus Amer Temp
Sporobolus flexuosus SW N Amer
Sporobolus junceus Atl & Gulf Coast (+S Amer)
Sporobolus purpurascens Amer Trop/Subtr
Sporobolus pyramidatus Amer
Sporobolus texanus SWC US
Sporobolus virginicus Trop/Subtr
Sporobolus wrightii Madr
Steinchisma hians Amer Trop/Subtr (+Afr, Austr)
Trachypogon spicatus Trop/Subtr (Amer-Afr)
Trichoneura elegans SC TX-Tam
Tridens albescens S Prair (SC N Amer)
Tridens eragrostoides Gulf-Tam
Tridens flavus E N Amer
Tridens muticus SWC N Amer
Tridens texanus Tam (SC TX)
Triplasis purpurea N Amer-Mesoam
Tripsacum dactyloides E N Amer
Trisetum interruptum SWC N Amer
Urochloa ciliatissima SC N Amer
Urochloa fusca Amer Trop/Subtr
Urochloa platyphylla Amer Subtr/Warm
Urochloa texana SC N Amer
Vaseyochloa multinervosa S TX Plains Endem
Vulpia octoflora N Amer

POLEMONIACEAE 6 sp. 3 gen.
Giliastrum ludens S TX Plains Endem
Giliastrum rigidulum SWC N Amer
Ipomopsis pumila WC US
Phlox drummondii SC N Amer
Phlox glabriflora S TX Plains Endem
Phlox pilosa E Prair-E N Amer

POLYGALACEAE 6 sp. 3 gen.
Hebecarpa greggii S TX Plains (N Tam)
Hebecarpa macradenia Son (+ E Madr)
Hebecarpa ovatifolia S TX Plains (N Tam)
Polygala alba Prair-Madr wide
Rhinotropis lindheimeri Son-Chih
Rhinotropis nitida Chih-Tam

POLYGONACEAE 13 sp. 3 gen.
Eriogonum abertianum SW N Amer (Son-Chih)
Eriogonum annuum Prair
Eriogonum greggii Chih-Tam
Eriogonum multiflorum SC U.S.A.
Eriogonum rotundifolium Chih
Eriogonum tenellum S Rock Mont-Chih
Persicaria amphibia Holarct
Persicaria hydropiperoides N Amer
Persicaria lapathifolia Polichor
Persicaria pensylvanica N Amer-Mesoam
Persicaria punctata Amer
Polygonum parksii EC TX Endem
Polygonum striatulum C, S, E TX Endem

POLYPODIACEAE 1 sp. 1 gen.
Pleopeltis polypodioides Amer

PONTEDERIACEAE 3 sp. 1 gen.
Heteranthera dubia N Amer
Heteranthera limosa Amer
Heteranthera mexicana?

PORTULACACEAE 2 sp. 1 gen.
Portulaca pilosa Trop/Subtr
Portulaca umbraticola Amer Trop/Subtr

POTAMOGETONACEAE 6 sp. 3 gen.
Potamogeton foliosus N Amer
Potamogeton illinoensis Amer
Potamogeton nodosus Polichor
Potamogeton pusillus Polichor
Stuckenia pectinata Polichor
Zannichellia palustris Polichor

PRIMULACEAE 2 sp. 1 gen.
Samolus ebracteatus Mesoam-Madr
Samolus valerandi Polichor

PTERIDACEAE 12 sp. 5 gen.
Adiantum capillus-veneris Trop/Subtr/Warm
Astrolepis cochisensis Madrean wide
Astrolepis integerrima Madrean wide
Astrolepis sinuata Amer Trop/Subtr/Warm
Myriopteris aemula Tam
Myriopteris alabamensis E N Amer
Myriopteris lindheimeri Madr
Myriopteris scabra SWC N Amer
Myriopteris tomentosa S & SE N Amer
Notholaena nealleyi E Madr?
Pellaea atropurpurea N Amer-Mesoam
Pellaea wrightiana? (N Amer sporadic)

RANUNCULACEAE 7 sp. 5 gen.
Anemone berlandieri Amer (SE N Amer/S S Amer) (Frio c)
Clematis crispa SE N Amer
Clematis drummondii Son
Clematis pitcheri E N Amer (EC N Amer)
Delphinium carolinianum Prair (+SE N Amer)
Myosurus minimus Holarct (La Salle c)
Ranunculus sceleratus Holarct (Polichor)

RESEDACEAE 1 sp. 1 gen.
Oligomeris linifolia Madro-Tethyan

RHAMNACEAE 5 sp. 4 gen.
Colubrina texensis Chih-Tam
Condalia hookeri Tam
Condalia spathulata Chih-Tam
Karwinskia humboldtiana Mesoam-Madr
Ziziphus obtusifolia Madr

ROSACEAE 7 sp. 4 gen.
Fallugia paradoxa Madr
Petrophytum caespitosum W N Amer
Prunus angustifolia SE N Amer
Prunus minutiflora Edw Plat (SC TX Endem)
Prunus texana SEC TX Endem
Rubus riograndis SEC TX Endem
Rubus trivialis SE N Amer

RUBIACEAE 18 sp. 9 gen.
Cephalanthus occidentalis N Amer (not C)
Cephalanthus salicifolius Madr (+ Mesoam)
Chiococca alba Amer Trop/Subtr
Diodia teres Amer
Galium aparine Holarct
Galium proliferum N Madr
Galium texense Comanch?
Galium virgatum SC U.S.A. (Comanch?)
Houstonia correllii S TX Plains Endem
Houstonia croftiae S TX Plains Endem
Houstonia micrantha SEC N Amer
Houstonia pusilla E N Amer
Houstonia subviscosa SC/SE TX Endem
Randia rhagocarpa Tam
Richardia tricocca Madr (mostly E)
Spermacoce glabra Amer Trop/Subtr
Spermacoce tenuior Trop/Subtr (mostly Mesoam-Carib)
Stenaria nigricans Prair/E N Amer

RUPPIACEAE 2 sp. 1 gen.
Ruppia cirrhosa Holarct/S Temp
Ruppia maritima Polichor

RUTACEAE 6 sp. 4 gen.
Amyris madrensis Madr (E Madr-Son)
Amyris texana Tam
Helietta parvifolia E Madr
Thamnosma texana N Son
Zanthoxylum fagara Amer Trop/Subtr
Zanthoxylum hirsutum SC U.S.A.

SALICACEAE 5 sp. 2 gen.
Populus deltoides Holarct
Salix caroliniana E N Amer-Mesoam
Salix exigua W N Amer
Salix gooddingii N Madr
Salix nigra E N Amer

SALVINIACEAE 1 sp. 1 gen.
Azolla microphylla Amer Trop/Subtr

SANTALACEAE 1 sp. 1 gen.
Phoradendron leucarpum N Amer

SAPINDACEAE 6 sp. 4 gen.
Cardiospermum dissectum Chih-Tam
Cardiospermum halicacabum Trop/Subtr
Sapindus saponaria Trop/Subtr
Serjania brachycarpa Madr (S&E)
Ungnadia speciosa Chih wide?
Urvillea ulmacea Amer Trop/Subtr

SAPOTACEAE 2 sp. 1 gen.
Sideroxylon celastrinum Mesoam-Madr-Carib
Sideroxylon lanuginosum SEC/SW N Amer

SCROPHULARIACEAE 4 sp. 3 gen.
Buddleja racemosa S Edw Plat (+ E Madr?)
Buddleja sessiliflora Madr
Capraria biflora Trop/Subtr (mostly Amer)
Leucophyllum frutescens Chih-Tam

SELAGINELLACEAE 1 sp. 1 gen.
Selaginella corallina SEC US

SIMAROUBACEAE 1 sp. 1 gen.
Castela erecta Carib-Mesoam-Madr

SMILACACEAE 1 sp. 1 gen.
Smilax bona-nox SE N Amer (+ E Madr)

SOLANACEAE 27 sp. 8 gen.
Chamaesaracha arida SW N Amer
Chamaesaracha edwardsiana S TX-Coah
Chamaesaracha sordida SWC N Amer
Chamaesaracha texensis SWC N Amer
Chamaesaracha villosa Chih
Datura wrightii N Amer (mostly W)
Lycium berlandieri Son-Chih
Lycium carolinianum Gulf-Pacific
Margaranthus solanaceus Madr
Nicotiana obtusifolia Madr
Nicotiana repanda Chih-Tam
Physalis angulata Amer Trop/Subtr
Physalis cinerascens SC N Amer-Mesoam
Physalis hederifolia SWC N Amer
Physalis heterophylla N Amer
Physalis longifolia N Amer
Physalis pubescens Amer (Polichor)
Physalis spathulifolia W Gulf
Physalis viscosa Trop/Subtr esp. Amer
Quincula lobata SWC N Amer
Solanum americanum Trop/Subtr/Warm (Amer)
Solanum douglasii Amer Trop/Subtr
Solanum elaeagnifolium Amer
Solanum ptychanthum N Amer (mostly E)
Solanum rostratum Prair (+ W N Amer)
Solanum tenuipes (Maverick c) Chih
Solanum triquetrum Chih-Tam

TETRACHONDRACEAE 1 sp. 1 gen.
Polypremum procumbens Mesoam-Carib (Trop/Subtr, mostly Amer)

TURNERACEAE 1 sp. 1 gen.
Turnera diffusaAmer Trop/Subtr (Mesoam-Carib-E Brazil)

TYPHACEAE 2 sp. 1 gen.
Typha domingensis Trop/Subtr
Typha latifolia Polichor

ULMACEAE 1 sp. 1 gen.
Ulmus crassifolia SC U.S.A.

URTICACEAE 3 sp. 2 gen.
Parietaria floridana Amer Trop/Subtr/Warm
Parietaria pensylvanica N Amer
Urtica chamaedryoides SE N Amer

VERBENACEAE 29 sp. 8 gen.
Aloysia gratissima Amphitrop
Aloysia macrostachya E Madr
Aloysia wrightii Son
Citharexylum berlandieri Madr
Citharexylum brachyanthum E Madr
Glandularia bipinnatifida Prair
Glandularia canadensis Prair-E N Amer
Glandularia delticola E Madr
Glandularia polyantha Tam
Glandularia pumila SC N Amer
Glandularia quadrangulata Chih-Tam
Glandularia wrightii SWC N Amer
Lantana achyranthifolia Mesoam-S Amer
Lantana canescens Mesoam-S Amer
Lantana urticoides Madr with sec. distr.
Lantana velutina Amer Trop/Subtr

Lippia alba Trop/Subtr mostly Amer
Lippia graveolens Mesoam-Madr
Phyla cuneifolia Prair (WC U.S.A.)
Phyla fruticosa Amer Trop/Subtr
Phyla nodiflora Amer Trop/Subtr
Priva lappulacea Amer Trop/Subtr
Verbena canescens Madr (SC N Amer)
Verbena cloverae S TX Plains Endem
Verbena halei E Madrean-Gulf
Verbena plicata SWC U.S.A.
Verbena runyonii Tam?
Verbena urticifolia E N Amer
Verbena xutha SEC N Amer

VIOLACEAE 1 sp. 1 gen.
Hybanthus verticillatus SWC N Amer (+ W Prair)

VITACEAE 5 sp. 3 gen.
Ampelopsis arborea SE N Amer
Cissus trifoliata Mesoam (+S N Amer)
Cissus verticillata Amer Trop/Subtr
Vitis cinerea E N Amer
Vitis mustangensis SC N Amer

ZYGOPHYLLACEAE 5 sp. 3 gen.
Guaiacum angustifolium Chih-Tam
Kallstroemia californica Madrean N & W
Kallstroemia hirsutissima Son-Chih
Kallstroemia parviflora Amphitrop (Madr)
Larrea tridentata Amphitrop (Madr wide)

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