AN ANNOTATED FLORA OF REED PLATEAU AND ADJACENT AREAS, BREWSTER COUNTY, TEXAS, U.S.A.

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ABSTRACT

Reed Plateau is a geographic feature in south Brewster County, Texas (U.S.A.) that exhibits a floral array characteristic of the northern Chihuahuan Desert region. Held as private property by many landowners, Reed Plateau and areas adjacent to it have never been the focus of a botanical study. A survey of Reed Plateau and adjacent areas was conducted from August 2004 through November 2007, with a total of 1065 specimens collected. The flora consists of 262 taxa, including 1 subspecies and 15 varieties, in 188 genera and 63 families. The best-represented families are the Asteraceae (33 species), Poaceae (23 species), Fabaceae (18 species), Cactaceae (17 species), and Euphorbiaceae (13 species). One federally listed threatened species, *Echinomastus mariposensis*, was identified within the study area. The only known U.S. populations of *Genistidium dumosum* occur on Reed Plateau. The occurrence of *Stemodia coahuilensis* represents a new county record, and a new *Hibiscus* hybrid was described. Two Big Bend and three Trans-Pecos endemics were documented. Four non-native species were collected, three of which are considered noxious or invasive. The vegetation associations found in the Reed Plateau study area strongly reflect the predominantly limestone substrate of the Terlingua-Solitario structural block. Diverse geographic factors within the relatively small study area support floral diversity patterns which are compared to studies from nearby Big Bend National Park and Big Bend Ranch State Park, as well as the Southwestern United States and the Chihuahuan Desert region.

RESUMEN

Reed Plateau es un elemento geográfico en el sur del condado Brewster, Texas, que exhibe una colección floral característica del norte del Desierto Chihuahuense. Compuesto de terrenos privados de muchos propietarios, Reed Plateau y sus alrededores nunca han sido el sujeto de un estudio botánico. Una investigación fue conducida entre agosto 2004 y noviembre 2007, con 1065 especímenes recogidos. La flora consiste en 262 especies, con una subespecie y 18 variedades, de 188 géneros y 63 familias. Las familias mejor representadas fueron las Asteraceae (33 especies), Poaceae (23 especies), Fabaceae (18 especies), Cactaceae (17 especies) y Euphorbiaceae (13 especies). Una especie amenazada en la lista federal, *Echinomastus mariposensis*, fue identificada dentro de la zona del estudio. Las únicas poblaciones de *Genistidium dumosum* conocidas en los E.U. ocurren en Reed Plateau. La ocurrencia de *Stemodia coahuilensis* representa una especie nueva para el condado de Brewster, y un híbrido nuevo de *Hibiscus* fue descrito. Dos especies endémicas de Big Bend y tres del Trans-Pecos fueron documentadas. Cuatro especies no nativas fueron recogidas, tres de ellas consideradas nocivas o invasivas. Las asociaciones vegetales encontradas en Reed Plateau reflejan fuertemente el sustrato predominantemente calizo del bloque estructural Terlingua-Solitario. Factores geográficos diversos dentro del área relativamente pequeña del estudio apoyan patrones de diversidad floral, los cuales se comparan con los patrones de diversidad encontrados en estudios que se han hecho en sitios cercanos, como el parque nacional de Big Bend y el parque estatal de Big Bend Ranch, y además con estudios del Suroeste de los E.U. y la región del Desierto Chihuahuense.

INTRODUCTION

Reed Plateau is a geographic feature located near Terlingua in southern Brewster County, Texas. Two protected areas flank Reed Plateau, Big Bend National Park (BBNP) to the east and Big Bend Ranch State Park (BBRSP) to the west (Fig. 1). While much floristic work has been done in the protected areas (Butterwick & Lamb 1976; Butterwick & Strong 1976a, 1976b, 1976c; Powell 1985; Worthington 1995; Louie 1996; Bartel 2002; Henklein 2003), Reed Plateau is held as private property in its entirety and has never been the focus of a botanical survey. The compilation of an annotated flora for Reed Plateau and adjacent areas (RP) was the primary objective of this study. In conjunction with the flora, we have described the vegetation associations in the study area. The species list generated by the current effort has been compared with the floras resulting from similar studies in the nearby protected areas (Hardy 1997; Fenstermacher 2008), as well as a Chihuahuan Desert (CD) flora (Henrickson & Johnston 2004) and a Southwest United States (SW) flora (McLaughlin 1986). The annotated RP list can be used as baseline information for future studies, as the level of human activity on and near RP changes.

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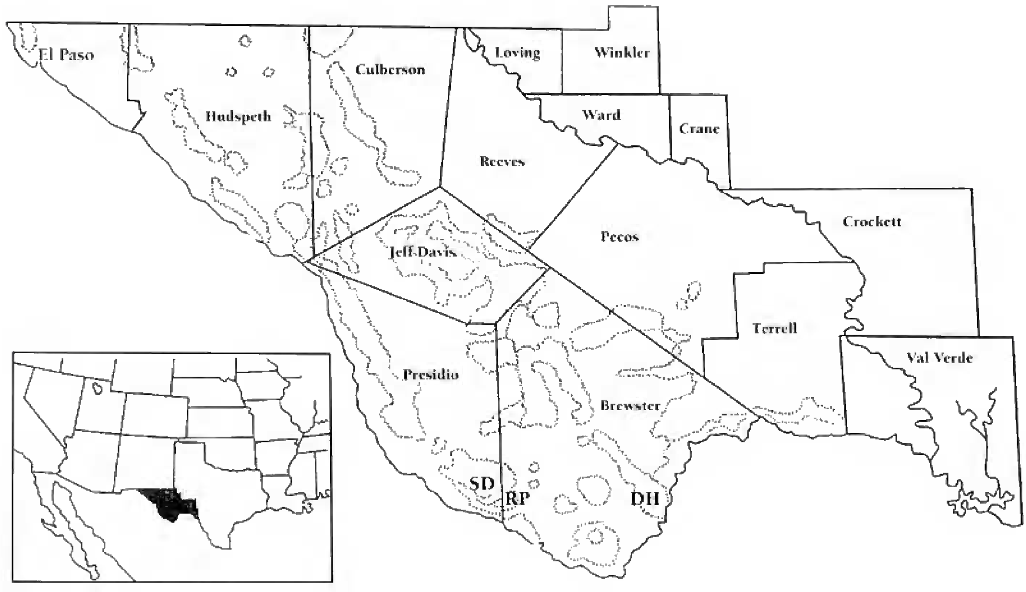

Fig. 1. Map of Trans-Pecos Texas with locations of Reed Plateau study area (RP), Solitario Dome (SD), and Dead Horse Mountains (DH) noted (courtesy of Sul Ross State University Department of Biology, with modifications.)

Site description

Physical features of the Terlingua-Solitario structural block (Erdlac 1990) define the study area: the Terlingua uplift, the Terlingua monocline and the Long Draw drainage. The portion of the Terlingua uplift that lies to the south of Highway 170 with a general east-west orientation is identified on United States Geologic Survey (USGS) topographic and geologic maps (USGS 1971a, 1971b; Barnes 1979) as Reed Plateau. North of Highway 170, the uplift continues uninterrupted in a more northwesterly direction to the point where Long Draw, from its origins in the vicinity of Black Mesa, cuts through the cliffs. The Terlingua uplift is seen as steep to near-perpendicular cliff faces cut by narrow drainages and canyons. The plateau rises 70–100 m (230–340 ft) in elevation above the surrounding desert floor, with a maximum elevation of 1012 m (3380 ft). Long Draw, a broad creek bed that is normally dry but sporadically flooded, follows the base of the cliff formed by the uplift until it cuts through the cliff once again to head in a southerly direction. The Terlingua monocline falls away to the south and west, with wide slopes and cliff faces that are less steep than those of the north side. The southern slopes and cliffs are cut by wide drainages and canyons or abruptly drop off with steep limestone outcrops.

The study area is approximately 3,237 ha (8,000 ac; 31 km^2; 12.5 sq mi). Long Draw forms the northern and eastern limits. The Terlingua monocline loosely delineates the southern and western boundaries of the study area; investigational forays into the lower elevations extended only to where there seemed to be no further variation in vegetation.

The east-west section of RP is 7.2 km (4.5 mi) from the eastern intersection of Long Draw and the Terlingua uplift to the Terlingua Sinkhole. Approximately 3.2 km (2 mi) to the northwest beyond the Terlingua sinkhole, Long Draw again cuts through the plateau, forming the northern boundary of RP. The study area is approximately 1.6 km (1 mi) wide, measuring from Long Draw to the elevations of the Terlingua monocline where no further variations in vegetation were observed.

RP experiences hot summers and cool winters. Temperatures range from 43°C (110°F) in midsummer to below freezing in winter. Average rainfall in the area varies from 16 to 28 cm (6 to 11 in), depending on elevation. Most precipitation occurs in late summer, as scattered afternoon downpours. There is a strong relation between the occurrence of high summer temperatures and the onset of the rainy season in late summer

(Schmidt 1986). Winter precipitation occurs infrequently, with intermittent snowfall more common in the higher elevations (pers. obs.; Arbingast et al. 1973; Morafka 1977; Schmidt 1979, 1986). During the course of the study, precipitation was above average for late summer 2004 and midsummer 2005 (unpublished data, BBNP and BBRSP).

The geology of RP is largely Cretaceous limestone. Across the Terlingua uplift, Lower to Upper Cretaceous formations are present (Erdlac 1990). The uplift is comprised of Buda limestone, Del Rio clay, and Santa Elena limestone (Barnes 1979). This stratigraphy is also found in BBNP (Maxwell et al. 1967) and in the Solitario of BBRSP (McCormick et al. 1996). Alluvium, colluvium, and surface caliche of Old Quaternary deposits are found in the drainages of and at the base of the Terlingua monocline (Barnes 1979). At the base of the Santa Elena limestone cliffs, the surface strata in Long Draw are identified as Young Quaternary deposits (Barnes 1979). An outcrop of the Pen Formation is located within the study area in Long Draw drainage near the Rainbow Mine, just west of the Terlingua Ghost Town.

Current classification of soils from the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) shows that the most common soil type on the uplands of Reed Plateau is the Blackgap-Rock outcrop complex. In Long Draw, the soils are identified as the Riverwash-Pantera complex. The Geefour silty clays complex is associated with the Del Rio and the Pen Formations, and is also found at the eastern end of the study area and in scattered pockets north of Hwy 170 (Web Soil Survey 2013).

Vegetation Associations

The vegetation associations of the Chihuahuan Desert region (CD) described by Henrickson and Johnston (1986) provide the basis for the description of the vegetation associations of RP. Communities are broadly categorized as desert scrub, woodland, grassland, and chaparral, with multiple subcategories and variations that reflect the complexity and diversity of CD vegetation patterns found on RP.

Cultural History

Substantial evidence of human habitation in the Terlingua area dates to the late Archaic Period, from approximately 1000 BC to AD 900 (Hudson 1976; Ing et al. 1996). In the Prehistoric Period (900 AD–1530 AD), evidence of permanent habitation and agriculture appears, especially in the area of the confluence of the Rio Grande and the Río Conchos (Ing et al. 1996). In the Historic Period (1530 AD to present), the sedentary peoples of the rivers and deserts came in contact with Spanish explorers; the Mescalero Apache, in their seasonal migration, moved through the area; and, later, Comanche groups supplanted the Apaches. The Comanche moved continually through the area until their complete subjugation by United States forces in the late 1880s (Ragsdale 1976).

The first geologic survey was conducted in the area in the 1880s. From that time until the 1920s ranching was the dominant way of life in the region. With little water and, reportedly, not much grass, Terlingua was the last area to be impacted by ranching.

An awareness of cinnabar in the area was longstanding, and in 1884 the first mercury mining claim was put into operation (Ragsdale 1976). The Colquitt Tigner Mine, still identified by name on the Amarilla Mountain topographic map (USGS 1971a), was in a drainage immediately to the west of the northern extent of the study area. The Waldrop Mine is within the study area of this project. The furnaces to process the cinnabar were fired with cottonwood and mesquite, gathered from the Rio Grande corridor, and probably Long Draw, to the point of being completely depleted by the 1930s (Ragsdale 1976).

The mercury was carted overland to Marfa. Two-track roads from Villa de la Mina, within the study area, and Lone Star Mine, to the west of RP, still exist that eventually reach Marfa (Ragsdale 1976). These old roads provided access to some of the more remote sections of the study area.

When the demand for mercury declined in the 1940s, the area population plummeted, and Terlingua became a ghost town (Ragsdale 1976). One activity that continued through the 1950s and into the 1970s was candelilla wax processing (B. Pittman, pers. comm.). *Euphorbia antisyphilitica* was harvested and processed for its wax, used in cosmetics. At least three processing sites were within RP. Another extractive activity from the 1970s that continues today is the removal of cacti and other succulents for commercial purposes (Harrington 1980).

In the late 1970s, the population of the area slowly began to increase. BBNP had been established in the 1940s, and it was a draw for outdoor adventurers. River-tour companies started providing guided trips on the Rio Grande. Current land division dates to that time, with home construction the predominant use of the land. The pace of development had been slow until approximately 10 years ago, when the rate of land sales and new home construction increased, compared to the previous twenty years.

MATERIALS AND METHODS

Herbaria search

Herbaria at Angelo State University (SAT), the Botanical Research Institute of Texas (BRIT), Texas A&M University (TAES and TAMU), and University of Texas Austin (TEX-LL) were contacted via email with requests for electronic searches. A manual search was conducted at the A. Michael Powell Herbarium at Sul Ross State University (SRSC). In addition, the Flora of Texas Consortium website was used for an online search of electronic databases (Texasflora.org 2003).

Field collections

Permission for access to the privately held lands of RP was documented with written statements from landowners. Variation in geology and terrain guided field efforts, in an attempt to find as much diversity within the study area as possible. USGS maps of the Amarilla Mountain, Texas (1971a), and Terlingua, Texas (1971b), quadrangles were references for elevation and topography. Access to portions of the study area was possible by vehicle along old two-track mining roads, but much of the study area is accessible only on foot. A modified meander-search method, based on Goff et al. (1982), was employed to collect enough specimens to reflect the diversity of plant life on RP. Specimens were collected from August 2004 through November 2007, with 127 days in the field. Collection effort, over 500 hours, was greatest in spring and early fall, especially after rains.

Principal sources for identification and nomenclature were Correll and Johnston (1970), Powell (1994, 1998), and Powell and Weedin (2004), as well as online sources (ITIS 2007; Tropicos.org 2014; USDA-PLANTS 2014). Access to Powell's key (in prep.) to Trans-Pecos non-woody plants was especially helpful. Billie L. Turner and A. Michael Powell verified specimen identifications. Taxonomy follows Evert and Eichhorn (2013) at the phyla level. Additional sources for identification and nomenclature were Jones et al. (2003), Turner et al. (2003), and Yarborough and Powell (2002). Warnock (1970, 1974, 1977) proved useful for visual identifications. Current nomenclature and authors were found on two online sources (Tropicos.org 2014; efloras.org 2014). Author abbreviations follow Brummitt and Powell (1992). A representative collection of each taxon is housed at SRSC, with selected duplicates sent to BRIT and TEX-LL.

RESULTS AND DISCUSSION

During the three-year study period, 1065 specimens were collected. The flora consists of 262 taxa, including 1 subspecies and 15 varieties, in 188 genera and 63 families. Phylum Anthophyta, with 254 species, forms 97% of the floral array. The families best represented in the flora are the Asteraceae (33 species), Poaceae (23 spp.), Fabaceae (18 spp.), Cactaceae (17 spp.), and Euphorbiaceae (13 spp.). These five families comprise 40% of the flora. Other well-represented families include the Boraginaceae, Solanaceae, Malvaceae, Nyctaginaceae, Verbenaceae, Brassicaceae, Pteridaceae, and Onagraceae, which together constitute 19% of the flora. Thirty-eight species are the sole representatives of their families on RP. Five species endemic to the Big Bend area or the Trans-Pecos region (*Kallstroemia perennans*, *Lycium puberulum* var. *berberioides*, *Lycium texanum*, *Chamaesyce perennans*, *Thelypodium texanum*) were documented. Four species with conservation status (*Genistidium dumosum*, *Oenothera boquillensis*, *Lycium texanum*, *Echinomastus mariposensis*) and four non-native species (*Cynodon dactylon*, *Salsola tragus*, *Tamarix chinensis*, *Pennisetum ciliare*) were identified. Further distributional data for RP, along with taxonomic distributions of the Dead Horse Mountains (DH) and Solitario Dome (SD) floras, are presented in Table 1.

Herbaria search

The amount of material from the study area previously disseminated to herbaria in Texas seems to be sparse,

Table 1. Taxonomic composition of three Big Bend floras [RP = Reed Plateau study area; DH = Dead Horse Mountains (Fenstermacher 2008); SD = Solitario Dome (Hardy 1997)].

Taxa	RP Families	RP Species	DH Families	DH Species	SD Families	SD Species
Lycopodiophyta	1	1	1	3	1	4
Monilophyta	1	6	2	20	1	16
Gnetophyta	1	1	1	3	1	2
Coniferophyta	0	0	2	4	1	2
Monocotyledones	4	29	10	107	10	74
Dicotyledones	56	225	75	525	72	434
Totals	63	262	91	662	86	532

which may be expected since RP has never been the sole focus of a floristic survey. In addition, limited availability of herbaria information in electronic format meant that online searches would be far from exhaustive. The electronic search of the TAMU database resulted in a list of over 6,000 records from Brewster County, with no feasible means of narrowing the search parameters. No further examination of that database was performed. No results from search requests were returned from BRIT or TAES since their collections were not completely accessioned electronically or not available via the Internet. The probability of locating other collections from RP and the Terlingua area in herbaria such as BRIT and TAES will increase when their collections are fully accessible in an electronic format. No information was available from the herbarium at Angelo State University (SAT).

The search of the University of Texas at Austin (TEX-LL) database resulted in a list of over 500 collections from the Terlingua area, including RP. A manual search of SRSC resulted in a number of collections from RP, some of which were duplicated in the TEX-LL list. Eleven collections of species not encountered during the current study are stored at SRSC and TEX-LL. These are included in the annotated species list for RP.

Taxonomic breakdown

A comparison of the RP flora with the DH (Fenstermacher 2008) and the SD (Hardy 1997) floras (Table 1) shows expected similarities in species diversity and taxonomic composition, with minor variations that can be explained by the differences in scope of study and geographic variability. The SD study area encompassed igneous as well as limestone substrates and canyon environments more developed than those seen in RP. The DH, with the inclusion of the Rio Grande corridor, presents a much greater range of elevation and habitat variation than either RP or SD. In addition to the riparian habitat included in DH, both DH and SD contain springs and seeps. There is no permanent aquatic habitat in RP.

The Gnetophyta are represented in the three study areas by the genus *Ephedra* (Ephedraceae). While several species were found on DH and SD, only *E. aspera* was found on RP. The relative homogeneity of the habitats on RP may account for *Ephedra* being represented by a single species. Of the Coniferophyta, species from two families were documented on the DH and the SD, but no conifers were documented from RP in this study.

While all species of the Monilophyta of RP are also found on both DH and SD, there are additional species from this group in DH and SD that do not occur in RP. The taxonomic breakdown of the RP flora shows a lower percentage of ferns and fern allies, as well as a lower proportion of the monocots, with a concomitant slightly higher proportional representation of the eudicots, when compared to the other Big Bend floras (Table 1). Additional representation among the ferns and monocots on SD and DH, with their springs and riparian habitats, is especially notable at the family level. The monocot families Amaryllidaceae, Orchidaceae, Commelinaceae, Juncaceae, and Typhaceae are represented on both SD and DH. The absence of these families from RP may explain the seemingly anomalous dominance of the eudicots on RP. One possible explanation for this is the lack of mesic habitats on RP. There are species from these families present in the SD and DH that require moister habitats than are found on RP. The ferns and fern allies show this same trend. Another contributing factor to the lower percentage of monocots could be the under-representation of the family Poaceae in the RP flora.

Table 2. Taxonomic breakdown of families and species of local and regional [SW = Southwest U.S. (McLaughlin 1986); CD = Chihuahuan Desert region (Henrickson pers. comm.); DH = Dead Horse Mountains (Fenstermacher 2008); SD = Solitario Dome (Hardy 1997); RP = Reed Plateau study area].

Taxonomic Group	RP	%	DH	%	SD	%	CD	%	SW	%
Families										
Ferns and fern allies	2	3.2	3	3.3	2	2.3	11	7.3	9	7.0
Gymnosperms	1	1.6	3	3.3	2	2.3	4	2.7	3	2.4
Monocots	5	6.3	10	11.0	10	11.6	21	14.0	10	7.9
Eudicots	55	88.9	75	82.4	75	83.7	114	76.0	105	82.7
Species										
Ferns and fern allies	7	2.7	23	3.5	20	3.8	94	2.9	120	2.2
Gymnosperms	1	0.4	7	1.1	4	0.8	35	1.1	36	0.7
Monocots	29	11.1	107	16.2	74	13.9	515	15.9	723	13.2
Eudicots	225	85.9	525	79.3	734	81.6	2588	80.0	4579	83.9

In a regional context (Table 2), trends emerge in the broad scope of their relationships to each other and to floras of the SW (McLaughlin 1986) and the CD (Henrickson & Johnston 2004). The taxonomic distribution of the DH, easternmost of the three Big Bend study areas, shows influences from the Great Plains and the Chihuahuan Desert. The SD flora aligns more closely with the SW flora. RP, closer geographically to the SD than to the DH, but in between the two, presents influences from both regions. The gymnosperms are poorly represented on RP when compared to regional as well as local floras. The representation of gymnosperms for DH is the same as that for the CD, and the SD shows similar proportions to those of the SW.

In contrast to the lack of gymnosperms on RP, ferns and fern allies are represented in the RP flora at a level commensurate with their representation in the CD. Both DH and SD show greater percentages of ferns and fern allies in their floras, more than either regional flora as well.

The percentage of monocots in the CD flora is higher than that of the SW flora. The greater number of graminoid species, as a reflection of the influence of the grasslands to the east of the CD, has been proposed as the point of departure (Fenstermacher 2008). As with the local comparisons of monocots and eudicots, RP does not support the level of diversity of monocot families seen in the SW or CD, given its relatively small area, the limited range of habitat variability, and the lack of permanent water.

Life forms

The most common life forms found on RP are, in order of decreasing abundance, perennial herbs, shrubs, subshrubs, and annual herbs. Vines, trees, and semi-succulents make up less than 4% each of the flora. The life form categories used in the Big Bend studies and the SW are not identical, but regrouping some of the data allows for an indirect comparison (Weckesser 2008). No summary of life forms from the CD is available. Perennial herbs are the dominant life forms for the three Big Bend study areas, as well as in the SW flora. Annual herbs constitute the next most dominant form on DH, SD, and the SW. In contrast, the shrubs are more abundant than annual herbs in RP. With its dry, rocky ridges and gullies, RP supports more shrub species throughout the year than annual herbs in season.

Six species in RP are categorized as trees. Two species (*Acacia roemeriana* and *Prosopis glandulosa*) that can grow to tree form in appropriate conditions are most commonly found as shrubs on RP. *Quercus vaseyana* is usually found as a major shrub component of the chaparral association, but on RP it occurs, unexpectedly, as a glade of trees in a steep-sided, narrow canyon. All of the tree species encountered on RP are also found on DH and SD.

Floral diversity

The most abundant families, i.e., those represented by the greatest proportion of species in each flora, are the Asteraceae, Poaceae, Fabaceae, Cactaceae, and Euphorbiaceae. The Asteraceae are most numerous in each study area. But on DH, the Asteraceae and Poaceae are of nearly equal abundance, reflecting the influence of the proximity to the Great Plains (Fenstermacher 2008). The Fabaceae comprise the third most abundant family in both DH and RP floras. The Tamaulipan thornscrub vegetation zone, to the east and south of the Big Bend region, apparently influences the make-up of the flora of the DH in this regard (Fenstermacher 2008), and this influence may extend to RP. The Poaceae constitute the second most abundant family in each of the three floras, but on RP the family makes up a smaller portion of the flora than seen in DH or SD. This may be a result of the greater range of elevation in the DH and a wider range of habitat on SD, or it may be due to under-representation of grasses in the RP collections.

In the context of the Big Bend region, the family representations in the floras of RP and SD seem to have more in common with each other than with DH, and this fits with the proximity of RP to SD and their common geologic past. The variations in habitat within these two study areas are not as extreme as those in the DH, with range in elevation, perhaps, being the most significant physical difference.

In contrast, fifty-one species from the RP flora were not documented on SD, which is to say that nearly 20% of the RP flora is distinct from the SD flora. Thirty species, over 10% of the RP flora, were not found in the DH. Nine species from RP were not found on either SD or DH. Four of these species are endemic to the immediate vicinity of RP. Three of these species are associated with gypsiferous soils. Of these species unique to RP, 11 not on SD are known or suspected gypsophiles. Eight known or suspected gypsophiles are documented on RP that are not found on DH.

When looking at the taxonomic make-up of the three Big Bend floras in the context of the CD and SW floras (Table 2) it is clear that the DH, at the species level, shows a stronger affinity for the CD flora than for the SW flora. The SD shows a slightly greater affinity for the floral assemblage of the SW than for that of the CD. RP also shows a slightly greater affinity for the SW flora, even as its dominant shrub component reflects the influence of the Tamaulipan thornscrub vegetation zone.

Noteworthy Collections, Rare Taxa, Non-natives

Many species of concern have been identified in the protected areas of BBNP and BBRSP. For example, *Echinocereus chisoensis* var. *chisoensis* is endemic to one locale within BBNP and is federally listed as a threatened species (Louie 1996). *Echinomastus mariposensis*, found in both parks, is listed as threatened, according to both state and federal criteria. *Quercus hinckleyi* is known from only two areas in the United States: Shafter, Texas, and the Solitario Dome in BBRSP (Hardy 1997; Powell 1998). In contrast, plant life on the greater expanses of private land is less well understood, due to limited access and scarce funding for research on private lands. However, as a result of change in land ownership, work on private land to the west of Terlingua has uncovered a species not previously described (Turner & Nesom 2003). This brings to light the importance of work by trained botanists on private property. For example, communication among local botanists about the presence of *Stemodia coahuilensis* on RP enabled recognition of the species when it was subsequently recognized in BBNP. In other regions of the country, similar work is being done to compare the floras of adjacent protected and private lands (Chester 2003). Expanding field effort on private lands with owners increasingly aware of conservation issues will only increase our understanding of the botanical resources of the Chihuahuan Desert.

Stemodia coahuilensis is a new record for Brewster County. It had been considered a strictly Mexican species, but work in recent years has resulted in collections in Presidio and Jeff Davis counties (*Worthington 25254* SRSC, *Turner 24-492B* SRSC). The existence of a fourth Texas *S. coahuilensis* population has been strongly suggested by a photograph taken by Roy Morey in the Ernst Tinaja area on the east side of BBNP (Fig. 2).

A new naturally occurring hybrid between *Hibiscus coulteri* and *H. denudatus* has been described and named *H.* × *sabei* (Weckesser 2011). It has been documented in four sites in the Big Bend area. In habit it resembles *H. coulteri* (Fig. 3), but all specimens consistently differ from both parent species in flower color and several vegetative characters (Fig. 4).

The endemic flora of gypseous deposits in the Chihuahuan Desert is one of the largest but least studied restricted floras in North America (Moore & Jansen 2007). The Pen formation, described as gypsiferous (Maxwell et al. 1967), is exposed within the study area along a stretch of the Long Draw drainage. It supports populations of several gypsophilous taxa: *Anulocaulis leiosolenus* var. *lasianthus*, *A. eriosolenus*, *Acleisanthes parvifolius*, *Tiquilia gossypina*, and *T. hispidissima*. *Xylorhiza wrightii*, common on the clay flats of the Pen Formation

Fig. 2. ***Stemodia coahuilensis*, near Ernst Tinaja, Big Bend National Park, Texas (photograph by Roy Morey).**

and on other known gypsiferous sites in the Big Bend area, is a suspected gypsophile (M. Powell, pers. comm.). The ubiquitous nature of gypsum in clay soils of RP is demonstrated by the distribution of gypsophiles on soils not otherwise identified as gypsiferous. Known gypsophiles were found in the Long Draw drainage, on the Del Rio clay, and on other clayey soils. These include *Mentzelia mexicana*, *Psathyrotopsis scaposa*, and *Haploesthes greggii* var. *texana*.

Over 50% of the species included in the proceedings of the Texas Plant Conservation Conference (Clary et al. 2002) are found in Trans-Pecos Texas. Several species from the current work are endemic to the Trans-Pecos or to the Big Bend Region and are of special conservation concern.

Genistidium dumosum (Fig. 5) is a monotypic genus, endemic to the Chihuahuan Desert (Correll & Johnston 1970). *Genistidium dumosum* has been documented on only three sites in the U.S., all located on RP (Poole 1992), and five populations have been recorded in Mexico (Clary et al. 2002). It is ranked G1S1 by NatureServe (2013) and it is under review for threatened or endangered status by the USFWS (2009). Attempts to relocate the RP populations have had mixed results. Three previously documented populations were not relocated. A population reported to have approximately 100 plants (M. Powell, pers. comm.) was not located. However, in the search for that population, a population of 12 plants was located.

Kallstroemia perennans is an endemic of the Trans-Pecos, its range limited to the western Edwards Plateau near Langtry, Texas, southwest Brewster County, and adjacent areas of Presidio County (Fig. 6). It is ranked G1S1 by NatureServe (2013) due to its limited distribution.

Chamaesyce perennans (Fig. 7) is a Big Bend endemic, restricted to the Terlingua-Lajitas area and adjacent Chihuahua, Mexico. It is ranked G3S3 (NatureServe 2013) due to its limited distribution.

Lycium puberulum var. *berberidoides* (Fig. 8) and *Lycium texanum* (Fig. 9) are endemic to Trans-Pecos Texas. *Lycium texanum* is considered a species of concern and is ranked G2S2 (NatureServe 2013).

Fig. 3. *Hibiscus × sabei* in flower, Highway 170 at Pepper's Hill. Reed Plateau study area, Brewster County, Texas.

Thelypodium texanum (Fig. 10) is endemic to the Big Bend region. Given its restricted distribution, it is considered vulnerable and ranked G3S3 by NatureServe (2013).

Oenothera boquillensis (Fig. 11) is ranked as G3S2 (NatureServe 2013). Its range is limited to Brewster and Presidio counties in Texas and the Mexican states of Chihuahua, Coahuila and Nuevo Leon. *Oenothera boquillensis* was also found in the Dead Horse Mountains of BBNP (Fenstermacher 2008), and though Hardy (1997) did not find it in the SD, she noted that it was previously observed or collected there.

Echinomastus mariposensis (Fig. 12) was listed as a threatened species under the federal Endangered Species Act in 1979 and was listed in Texas in 1983 (NatureServe 2013). Its range is limited to Cretaceous limestone in the Big Bend area and in Coahuila, Mexico; it is common and locally abundant in the Terlingua area.

The non-native species of RP were initially encountered on or near roadways, homes, or construction sites. Since the study period, the spread of invasive exotics such as *Salsola tragus* and *Pennisetum ciliare* is increasing dramatically, with highway and canyons serving as vectors from roadways and human habitation into desert terrain.

Salsola tragus is common along the dirt road at the east end of RP that leads onto the plateau. It is abundant along the shoulders of Highway 170 and at the construction site near Villa de la Mina. *Salsola tragus* is spreading along the drainages and dirt roads throughout RP and the drainages that cut across the highway.

Pennisetum ciliare was observed on the south slopes of the east end of RP and in Coultrin's Canyon, a large canyon that drains to the south of RP. It is common and abundant in the channels and gullies of Long Draw, having spread from Hwy 170 after construction in 2003. Dense stands of *P. ciliare* have spread to the north past

Fig. 4. *Hibiscus* × *sabei* buds and leaves. Highway 170 at Pepper's Hill, Reed Plateau study area, Brewster County, Texas. Note length of bracts in relation to length of sepals and color of petals in bud (photograph by Betty Alex).

Fig. 5. *Genistidium dumosum*, in recently discovered population on Reed Plateau study area, Brewster County, Texas.

Villa de la Mina, following the 2-track road and spreading into the drainages that cross the road. This hardy non-native grass, difficult to manage once established, has a high degree of reproductive vigor, a wide range of adaptability, and few pests and predators (NatureServe 2013).

Tamarix chinensis is common in the Big Bend region. *Tamarix chinensis* is established but not yet a dominant species in Long Draw. It has also appeared in the right-of-way of Highway 170 since the road construction in 2003.

Sorghum halepense is established in thick stands where roads cross low, wide gullies or drainages in the Terlingua area. Though not collected, it was found in a construction site on RP.

Cynodon dactylon is a competitive, invasive weed (NatureServe 2013). Once established, it is difficult to remove. It does not spread, though, beyond a water supply, so it remains restricted to irrigated, landscaped home sites, or over septic systems.

Vegetation Associations

The topographic variation of RP—hills, ridges, drainages, arroyos, canyons, flats, gradual and steep slopes, and cliffs—sets the stage for vegetation associations typical of the Chihuahuan Desert. In Henrickson and Johnston's scheme (1986) topography plays a significant role in defining some of the associations (e.g., sandy arroyo, canyon, or dune associations), and Butterwick and Lamb (1976) and Butterwick and Strong (1976a, 1976b, 1976c) based their vegetation associations on type of terrain in BBRSP. Fenstermacher (2008), also referring to Henrickson and Johnston (1986), added elevation to the criteria used to describe the vegetation associations of the DH. But in these works the mosaic patterns of the assemblages of plants is stressed; trends and patterns

Fig. 6. ***Kallstroemia perennans*****, endemic to Trans-Pecos Texas. Reed Plateau study area, Brewster County, Texas.**

exist and associations form with predictability, especially in topographically distinct areas, but there are not always clear demarcations between adjacent associations.

The vegetation of RP closely follows the association descriptions outlined by Henrickson and Johnston (1986), with some variations and modifications. The Mixed Desert Scrub association is widespread, intergrading with *Larrea* Scrub, Lechuguilla Scrub, Gypsophilous Scrub, Sandy Arroyo Scrub, and Canyon Scrub associations.

The *Yucca* Woodland or *Dasylirion* Scrub association of Henrickson and Johnston (1986) refers to extensive areas dominated, at least visually, by *Yucca* spp. or *Dasylirion* spp. with a mixed grass-shrub understory. No extensive area of RP is truly dominated by *Yucca* spp. or *Dasylirion* spp., but on some of the slopes and higher ridges of RP there are stands of numerous *Y. torreyi* (Fig. 13) or *D. leiophyllum* (Fig. 14).

With changes in surface features and elevation, the grasses, especially *Bouteloua ramosa*, can dominate a slope or a ridge top, forming a Grama Grassland association (Fig. 15). *Bouteloua ramosa* is by far the most plentiful grass on RP. The presence of this association demonstrates that a Grama Grassland association need not be restricted to coarse, sandy soils of volcanic origin, as stated by Hendrickson and Johnston (1986).

Chaparral and Oak Woodland associations are not to be expected in low, desert terrain, yet elements of these higher-elevation associations are combined here in one intriguing site, the previously mentioned canyon that drains to the north into Long Draw (Fig. 16). Amidst the expected vegetation of the Canyon Scrub association (Henrickson & Johnston 1986) there is one anomalous addition: a stand of *Quercus vaseyana* trees, with a dense *Q. vaseyana* shrub understory. A species normally associated with shrub-dominated Montane Chaparral, *Q. vaseyana* reaches the height of 3–4 m (10–12 ft) in this canyon. The presence of *Q. vaseyana* as

Fig. 7. ***Chamaesyce perennans*****, endemic to Big Bend region, Texas. Reed Plateau study area, Brewster County, Texas (photograph by Betty Alex).**

woodland trees as well as chaparral shrubs speaks to the unique conditions in that canyon, especially deep and narrow with sheer rock walls, unlike other canyons on RP. While it could be a relictual population, this seems unlikely given its proximity to Villa de la Mina and the wood-fired mercury processing furnace in operation during the first half of the last century (Ragsdale 1976). The stand may represent new growth in the last 70 years.

A similar situation was encountered in SD (Hardy 1997), where elements of higher elevation and mesic associations were encountered at lower elevations in protected canyons. In several small canyons, *Quercus grisea*, also identified with the Chaparral association, approaches the tree form expected in the Oak Woodland association, along with *Juniperus pinchotii* of the Pinyon-Juniper association.

An especially diverse blend of associations occurs along portions of Long Draw, where the main course of the dry stream bed butts against the base of the cliffs of the Terlingua monocline. The monocline is a generally north-facing escarpment, irregularly cut by numerous canyons, drainages, and pour-offs. The water channeled over the cliffs and the north exposure creates a community comprised of elements of the Sandy Arroyo and Canyon Scrub associations (Henrickson & Johnston 1986). At the base of the cliffs, fairly steep scree slopes of Santa Elena limestone breakdown, strewn with boulders, have become overgrown with large shrubs and several tree species. There is a dense understory of smaller shrubs, subshrubs, and perennial herbs in the resulting soils, high in organic matter, and a number of annuals present after summer rains. Several species normally associated with the more mesic habitats in canyons or at higher elevations are intermixed with species expected in the dry arroyos of Mixed Desert Scrub and Sandy Arroyo associations. This particular assemblage is another example of the overlap and intergradation of the vegetation associations of the CD.

Fig. 8. ***Lycium puberulum*** **var.** ***berberidoides*****, endemic to Trans-Pecos Texas. Reed Plateau study area, Brewster County, Texas.**

An additional association not described by Henrickson and Johnston merits consideration. In several locations in the Big Bend area, including RP, stands of *Fouquieria splendens* (ocotillo) are so dense as to create the appearance of a forest. In the *F. splendens* associations of RP, the understory varies, from sparse vegetation of widely scattered shrubs to dense vegetation with shrubs and grasses from the desert scrub associations, *Larrea tridentata* often appearing as a co-dominant. A recent vegetation survey in BIBE has generated descriptions of vegetation associations, including a series of associations with *F. splendens* as a nominal component (Lea 2014). The Ocotillo-Creosotebush-Lechuguilla Desert Scrub association describes the most common association on RP, with a significant variation. As with the Grama Grassland association of Henrickson and Johnston (1986), the occurrence of the Ocotillo-Creosotebush-Lechuguilla Desert Scrub association on RP demonstrates that this association is not restricted to non-calcareous substrates, as described for BIBE. Further description and delineation of the Desert Scrub vegetation association continuum on RP is warranted.

ANNOTATED CHECKLIST OF THE SPECIES OF REED PLATEAU AND ADJACENT AREAS

The annotated species list for RP is arranged phylogenetically following Evert and Eichhorn (2013), with Phylum Anthophyta divided into Monocotyledones and Eudicotyledones. Family, genus, species, and lower rankings are listed alphabetically. All collections of the first author cited in the list, designated *WW*, are housed at SRSC. Taxa previously collected on RP, as documented by voucher specimens in SRSC and TEX-LL, are included in the list with collector and herbarium information. Taxa observed but not collected during the current study are included in the list and noted as such.

Fig. 9. *Lycium texanum*, endemic to Trans-Pecos Texas. Reed Plateau study area, Brewster County, Texas.

The information for each species includes scientific name and authorship, common name, nativity, special status, abundance, habitat, and the author's collection number of a representative specimen. Where applicable, notations for status for invasive, threatened, or endangered species are also included. Significant additional information is included at the end of the description. Native species are noted with N; non-native species with I (TexasInvasives.org 2008). Species endemic to Trans-Pecos Texas (E-TP) or to the Big Bend Region (E-B) are noted (Correll & Johnston 1970; Clary et al. 2002; TAM-BWG 2007). Species ranked for conservation purposes, with state or federal protection status, are also noted (USDA-PLANTS 2014; NatureServe 2013).

Habitat terms are general descriptions of common habitat for a given species. Habitat descriptors used in the species list are: alluvium – sand and/or gravel with organic debris in arroyos, drainages or canyon bottoms; arroyo – dry wash or stream bed, seasonally flooded; drainage – cut in side of slope, with varying width and steepness; canyon – vertical-sided cut through limestone; clay flat – flat to gentle slope of clay substrate; cliffs – sheer-faced limestone, as seen in the Terlingua uplift or in canyons; disturbed site – current home site or historically disturbed areas; ridges – top of slopes, knife-edge summits, or saddles between higher hills; roadside – along dirt roads or on shoulders of paved highway; rock outcrop – exposed rock surface or blocks; slope – relatively smooth terrain tilted with varying aspect and degrees of steepness; ubiquitous – occurs in most or all habitats throughout study area.

A scheme to describe abundance was derived from Palmer et al. (1995). Determination of abundance was based on field observations during the course of the study. The terms used here are: rare (R); uncommon (U); occasional (O); common (C); and abundant (A).

Fig. 10. ***Thelypodium texanum*** **(white flowers), endemic to the Big Bend Region, Texas, with** ***Nama havardii*** **(pink flowers), along Highway 170. Reed Plateau study area, Brewster County, Texas.**

LYCOPODIOPHYTA

Selaginellaceae

Selaginella lepidophylla (Hook. & Grev.) Spring, Resurrection fern, N, A, slopes, canyons, ridges, open rocky areas, *WW 184*

MONILOPHYTA

Pteridaceae

Argyrochosma microphylla (Mett. ex Kuhn) Windham, Littleleaf cloakfern, N, U, sheltered rock outcrops, *WW 79A*

Astrolepis cochisensis (Goodd.) D.M. Benham & Windham, Cochise scaly cloakfern, N, U, sheltered rock outcrops, *WW 78*

Astrolepis integerrima (Hook.) D.M. Benham & Windham, Wholeleaf cloakfern, N, U, sheltered rock outcrops, *WW 77*

Cheilanthes alabamensis (Buckley) Kunze, Alabama lipfern, N, sinkhole, *Barbee & Powell 4*, SRSC

Cheilanthes horridula Maxon, Rough lipfern, N, U, sheltered rock outcrops, *WW 675*

Fig. 11. *Oenothera boquillensis*, found in Long Draw at base of cliffs, Reed Plateau study area, Brewster County, Texas.

Cheilanthes villosa Davenp. ex Maxon, Villous lipfern, N, U, sheltered rock outcrops, *WW 679*

GNETOPHYTA

Ephedraceae

Ephedra aspera Engelm. ex S. Watson, Rough jointfir, N, C, ubiquitous, *WW 369*

ANTHOPHYTA, Monocotyledones

Agavaceae

Agave lechuguilla Torr., Lechuguilla, N, A, ubiquitous, *WW 1004*

Bromeliaceae

Hechtia texensis S. Watson, Texas false agave, N, C, limestone outcrops, slopes, *WW 433*

Cyperaceae

Eleocharis montevidensis Kunth, Sand spikerush, N, R, drainage, one population was found after significant rain at the edge of a water-filled earthen tank, *WW 1008*

Liliaceae

Allium kunthii G. Don, Kunth onion, N, U, north-facing gravelly slopes, *WW 34*

Dasylirion leiophyllum Engelm. ex Trel., Sotol, N, O, slopes, drainages, *WW 804A*

Yucca torreyi Shafer, Torrey yucca, N, O, slopes, drainages, *WW 276*

Poaceae

Aristida purpurea var. *longiseta* (Steud.) Vasey, Red three-awn, N, O, gravelly slopes, *WW 750*

Aristida purpurea var. *purpurea* Nutt., Purple three-awn, N, O, slopes, ridges, *WW 761*

Aristida purpurea var. *nealleyi* (Vasey) Allred, Blue three-awn, N, O, slopes, ridges, *WW 606*

Bothriochloa barbinodis (Lag.) Herter, Cane bluestem, N, *D.S. Correll & M.C. Johnston 24466* TEX-LL

Bothriochloa laguroides (DC.) Herter var. *torreyana* (Steud.) M. Marchi & Longhi-Wagner, Silver bluestem, N, U, drainage, disturbed site, *WW 575*

Bouteloua barbata Lag., Six-week grama, N, U, drainage, disturbed site, *WW 571*

Bouteloua curtipendula (Michx.) Torr., Side-oats grama, N, O, gravelly drainage, clay, *WW 731*

Bouteloua ramosa Scribn. ex Vasey, Chino grama, N, A, ubiquitous, *WW 601*

Bouteloua trifida Thurb., Red grama, N, O, gravelly slopes, *WW 605*

Cathestecum erectum Vasey & Hack., False grama, N, slopes, alluvium, *Hughes 337* SRSC

Fig. 12. ***Echinomastus mariposensis*** **in flower with** ***Bahia absinthifolia*** **var.** ***dealbata*****, near Villa de la Mina. Reed Plateau study area, Brewster County, Texas.**

Cynodon dactylon (L.) Pers., Bermuda grass, I, U, disturbed sites, *WW 568*

Dasyochloa pulchella (Kunth) Willd. ex Rydberg, Fluff grass, N, A, ubiquitous, *WW 565A*

Digitaria californica (Benth.) Henrard, California cottontop, N, clay flats with gravel, *Powell 5362* SRSC

Digitaria cognata (Schult.) Pilg., Fall witchgrass, N, O, gravelly drainage, *WW 825*

Enneapogon desvauxii P. Beauv., Feather pappusgrass, N, O, slopes, drainages, *WW 820*

Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult., Tanglehead, N, C, ridges, slopes, drainages, *WW 789*

Muhlenbergia porteri Scribn. ex Beal, Bush muhly, N, U, drainages, canyon slopes, *WW 1046*

Panicum hallii Vasey, Hall panicgrass, N, U, gravelly slopes, *WW 1003*

Pappophorum vaginatum Buckley, Whiplash pappusgrass, N, O, disturbed clay flats, drainages, *WW 573*

Pennisetum ciliare (L.) Link, Buffelgrass, I, C, roadside, disturbed sites, drainages, spreading into canyons and drainages since 2003 road construction, *WW 574*

Pleuraphis mutica Buckley, Tobosa grass, N, O, disturbed slopes, limestone and clay, *WW 1009*

Poa bigelovii Vasey & Scribn., Bigelow bluegrass, N, O, canyons, drainages, *WW 163*

Setaria macrostachya Kunth, Streambed bristlegrass, N, O, canyon, drainages, clay flats, *WW1015*

Sporobolus pyramidatus (Lam.) Hitch., Madagascar dropseed, N, O, disturbed sites, clay flats, *Weckesser 572*

Tridens muticus (Torr.) Nash, Slim tridens, N, O, canyon bottom, drainages, *Weckesser 947A*

ANTHOPHYTA, Eudicotyledones

Acanthaceae

Carlowrightia arizonica A. Gray, Arizona carlowrightia, N, U, steep slopes, *WW 415*

Ruellia parryi A. Gray, Parry wild petunia, N, C, slopes, drainages, canyon, *WW366*

Stenandrium barbatum Torr. & A. Gray, Shaggy stenandrium, N, O, restricted to rock outcrops, *WW 237*

Amaranthaceae

Iresine leptoclada (Hook. f.) Henrickson & S.D. Sundb., Texas shrub, N, base of cliffs, *D.S.Correll 30709* TEX-LL

Tidestromia carnosa (Steyerm.) I.M. Johnst., Fleshy tidestromia, N, U, gravelly slopes, *WW 755*

Tidestromia lanuginosa var. *lanuginosa* (Nutt.) Standl., Wooly tidestromia, N, C, gravelly slopes, *WW 59*

Tidestromia suffruticosa (Torr.) Standl., Shrubby honeysweet, N, C, gravelly slopes, alluvium, *WW 85*

Anacardiaceae

Rhus microphylla Engelm., Littleleaf sumac, N, O, canyons, drainages, alluvium, *WW 471*

Fig. 13. ***Yucca torreyi*, Reed Plateau study area, Brewster County, Texas.**

Rhus virens Lindh. ex A. Gray, Evergreen sumac, N, U, steep sided canyons, *WW 553*

Apocynaceae

Amsonia longiflora Torr., Tubular slimpod, N, U, clay flats, drainages, canyons, *WW 199*

Mandevilla macrosiphon (Torr.) Pichon, Rocktrumpet, N, C, slopes, drainages, alluvium, *WW 585*

Aristolochiaceae

Aristolochia coryi I.M. Johnst., Dutchman's pipe, N, R, drainage, one population found at the edge of a water filled earthen tank after significant rain, *WW 903*

Asclepiadaceae

Asclepias asperula (Decne.) Woodson, Antelope-horns milkweed, N, U, slopes, drainages, *WW 375*

Asclepias oenotheroides, Schltdl. & Cham., Zizotes milkweed, N, U, gravelly ridges, *WW 805*

Funastrum crispum (Benth.) Schltr., Wavyleaf twinevine, N, R, gravelly slope, *WW 486*

Funastrum torreyi (A. Gray) Schltr., Soft twinevine, N, R, canyons, *WW 907*

Matelea parvifolia (Torr.) Woodson, Spearleaf milkvine, N, R, rock crevices, *WW 395*

Asteraceae

Artemisia ludoviciana Nutt., White sagebrush, N, U, alluvium, *WW 1049*

Bahia absinthifolia var. *dealbata* (A. Gray) A. Gray, Dealbata bahia, N, C, slopes, drainages, ridges, *WW 213*

Chaetopappa bellioides (A. Gray) Shinners, Manyflower leastdaisy, N, O, slopes, drainages, *WW 465*

Cirsium turneri Warnock, Turner thistle, N, U, restricted to cliff faces of canyons, *WW 930*

Conoclinium dissectum A. Gray, Palm-leaf mistflower, N, R, canyon, *WW 816*

Dyssodia acerosa DC., Prickleleaf dogweed, N, C, slopes, ridges, *WW 831*

Dyssodia pentachaeta (DC.) B.L. Rob., Prickly dogweed, N, A, slopes, ridges, alluvium, drainages, *WW 60*

Erigeron bigelovii A. Gray, Bigelow fleabane, N, slopes, ridges, along cliffs, *Worthington 968* TEX-LL

Erigeron tracyi Greene, Running fleabane, N, C, slopes, ridges, drainages, *WW 664*

Gymnosperma glutinosum (Spreng.) Less., Tatalencho, N, C, ubiquitous, *WW 76*

Haploesthes greggii var. *texana* (J.M. Coult.) I.M. Johnst., False broomweed, N, O, clay flats, alluvium, slopes, drainages, *WW 58*

Helenium microcephalum var. *ooclinium* (A. Gray) Bierner, Sneezeweed, N, R, drainage, one population found at the edge of a water filled earthen tank after significant rain, *WW 905*

Fig. 14. *Dasylirion leiophyllum*, Reed Plateau study area, Brewster County, TX.

Heterotheca fulcrata (Greene) Shinners, Rocky goldaster, N, U, north-facing canyon, *WW 929*

Jefea brevifolia (A. Gray) Strother, Shorthorn zexmenia, N, O, canyon sediment, *WW 657*

Melampodium leucanthum Torr. & A. Gray, Blackfoot daisy, N, O, drainages, canyons, slopes, *WW 536*

Parthenium confertum A. Gray, Lyreleaf parthenium, N, O, alluvium, gravelly slopes, *WW 9*

Parthenium incanum Kunth, Mariola, N, C, ubiquitous, *WW 592*

Perityle parryi A. Gray, Heartleaf rockdaisy, N, U, restricted to cliff face, *WW 1053*

Perityle vaseyi J.M. Coult., Margined perityle, N, U, restricted to gypseous clay, *WW 847*

Porophyllum scoparium A. Gray, Shrubby Poreleaf, N, O, gravelly slope, canyon, *WW 393*

Psathyrotopsis scaposa (A. Gray) H. Rob., Naked brittlestem, N, U, restricted to gypseous clay, *WW 193*

Psilostrophe tagetina (Nutt.) Greene, Wooly paperflower, N, A, ubiquitous, *WW 141*

Stephanomeria pauciflora (Torr.) A. Nelson, Brownplume wirelettuce, N, U, drainage, alluvium, *WW 71*

Thelesperma longipes A. Gray, Longstalk greenthread, N, O, slopes, drainages, *WW 90*

Thelesperma megapotamicum (Spreng.) Kuntze var. *megapotamicum*, Rayless greenthread, N, C, slopes, drainages, canyon bottom, *WW 890*

Trixis californica Kellogg, American trixis, N, O, drainages, canyons, *WW 73*

Viguiera dentata (Cav.) Spreng., Sunflower goldeneye, N, U, alluvium, *WW 1050*

Viguiera stenoloba S.F. Blake, Skeletonleaf goldeneye, N, A, ubiquitous, *WW 22*

Xanthisma spinulosum var. *chihuahuanum* (B.L. Turner & R.L. Hartm.) D.R. Morgan & R.L. Hartm., Lacy tansyaster, N, O, disturbed sites, clay flats, *WW 212*

Xanthium strumarium L., Cocklebur, N, R, alluvium, *WW 95*

Xylorhiza wrightii (A. Gray) Greene, Gyp daisy, N, U, restricted to gypseous clays; *WW 377*

Xylothamia triantha (S.F. Blake) G.L. Nesom, Trans-Pecos desert goldenrod, N, R, clay flats with limestone gravel, *WW 578*

Zinnia acerosa (DC.) A. Gray, Spinyleaf zinnia, N, C, slopes, ridges, drainages, canyons, *WW 456*

Berberidaceae

Mahonia trifoliolata Moric., Agerita, N, R, canyons, deep drainages, *WW 283*

Bignoniaceae

Chilopsis linearis (Cav.) Sweet, Desert willow, N, U, alluvium, *WW 1035*

Tecoma stans (L.) Juss. ex Kunth, Trumpetflower, N, O, slopes, drainages, canyons, *WW 19*

Fig. 15. South-facing slope dominated by *Bouteloua ramosa*. Reed Plateau study area, Brewster County, Texas.

Boraginaceae

Cryptantha coryi I.M. Johnst., Cory cryptantha, N, R, north-facing slopes, gravel and clay, *WW 206*

Cryptantha mexicana (Brandegee) I.M. Johnst., Mexican cryptantha, N, O, ubiquitous, *WW 385*

Heliotropium powelliorum B.L. Turner, Powell heliotrope, N, C, slopes, drainages, arroyos, *WW 513*

Lappula redowskii (Hornem.) Greene, Flatspine stickseed, N, U, alluvium, *WW 164*

Omphalodes aliena A. Gray ex Hemsl., Mexican navelwort, N, U, rocky slopes, canyons, *WW 114*

Tiquilia canescens (A. DC.) A.T. Richardson, Woody crinklemat, N, A, ubiquitous, *WW 582*

Tiquilia gossypina (Wooton & Stand.) A.T. Richardson, Texas crinklemat, N, U, clay and gravel, slopes, ridges, *WW 569*

Tiquilia greggii (Torr. & A. Gray) A.T. Richardson, Plumed tiquilia, N, C, slopes, arroyos, *WW 493*

Tiquilia hispidissima (Torr. & A. Gray) A.T. Richardson, Rough coldenia, N, O, slopes, ridges, clay flats, drainages, *WW 734*

Tiquilia mexicana (S. Watson) A.T. Richardson, Mexican crinklemat, N, C, ubiquitous, *WW 406*

Brassicaceae

Descurainia pinnata (Walter) Britton, Tansymustard, N, R, alluvium, *WW 151*

Draba cuneifolia Nutt. ex Torr. & A. Gray, Whitlow-wort, N, R, alluvium, *WW 115*

Nerisyrenia camporum (A. Gray) Greene, Bicolor mustard, N, A, ubiquitous, *WW 175*

Physaria fendleri (A. Gray) O'Kane & Al-Shehbaz, Fendler bladderpod, N, C, slopes, drainages, alluvium, *WW 109*

Streptanthus carinatus C. Wright ex A. Gray, Lyreleaf twistflower, N, U, north-facing rocky slopes, alluvium, *WW 166*

Thelypodium texanum (Cory) Rollins, Texas thelypody, N, C, E-BB, slopes, canyon bottoms, alluvium, clay flats, *WW 120*

Cactaceae

Ariocarpus fissuratus (Englem.) K. Schum., Living rock cactus, N, C, slopes, drainages, *WW 80*

Coryphantha echinus (Engelm.) Britton & Rose, Sea-urchin cactus, N, O, slopes, ridges, *WW s.n.*, photographic record only

Coryphantha sneedii var. *albicolumnaria* (Hester) A.D. Zimmerman, Silverlace cactus, N, U, G2G3S2S3, slopes, ridges north end of RP, *WW s.n.*, photographic record only

Echinocactus horizonthalonius Lem., Eagle claw cactus, N, C, slopes, ridges, arroyos, *Weckesser s.n.*, photographic record only

Echinocereus dasyacanthus Engelm., Rainbow cactus, N, C, slopes, ridges, arroyos, *WW 475*

Echincereus enneacanthus Engelm., Strawberry cactus, N, O, slopes, drainages, *WW 997*

Fig. 16. Tree form of *Quercus vaseyana* in steep-sided limestone canyon. Reed Plateau study area, Brewster County, Texas.

Echinocereus stramineus (Engelm.) F. Seitz, Strawberry pitaya, N, A, slopes, ridges, drainages, arroyos, *WW s.n.*, photographic record only

Echinomastus mariposensis Hester, Mariposa cactus, N, U, G2S2, LT/T, slopes, ridges, drainages, *WW 996*

Epithelantha bokei L.D. Benson, Boke's button cactus, N, U, gravel-covered flat to gently sloping rock outcrops, *WW 564A*

Ferocactus hamatacanthus (Muehlenpf.) Britton & Rose, Giant fish-hook cactus, N, U, slopes, ridges, arroyos, canyons, *WW s.n.*, photographic record only

Glandulicactus uncinatus var. *wrightii* (Engelm.) Backeb., Eagleclaw cactus, N, U, slopes, ridges, *WW s.n.*, photographic record only

Mammillaria lasiacantha Engelm., Golfball cactus, N, U, slopes, ridges, *WW 565*

Mammillaria pottsii Scheer ex Salm-Dyck, Rattail mammillaria, N, C, slopes, ridges, clay flats, drainages, *WW 563*

Opuntia aggeria Ralston & Hilsenb., Dog cholla, N, C, ubiquitous, *WW 476*

Opuntia camanchica Engelm. & J.M. Bigelow, Comanche pricklypear, N, A, drainages, arroyos, slopes, ridges, *WW 923*

Opuntia engelmannii Salm-Dyck ex Engelm., Engelmann pricklypear, N, O, slopes, drainages, arroyos, *WW 1058*

Opuntia leptocaulis DC., Christmas cactus, N, O, drainages, slopes, arroyos, *WW 848A*

Opuntia rufida Engelm., Blind pricklypear, N, C, drainages, slopes, arroyos, canyons, *WW 995*

Celastraceae

Mortonia scabrella A. Gray, Tickbush, N, O, clay flats, drainages, *WW 497*

Chenopodiaceae

Atriplex canescens (Pursh.) Nutt., Four-wing saltbush, N, O, alluvium, drainages, *WW 643*

Salsola tragus L., Tumbleweed, I, C, roadsides, arroyos, drainages, spreading into canyons and drainages following road construction in 2003, *WW 848*

Convolvulaceae

Bonamia repens (I.M. Johnst.) D.F. Austin & Staples, Creeping lady's nightcap, N, O, rock outcrops, rocky slopes, *WW 804*

Convolvulus equitans Benth., Texas bindweed, N, O, disturbed sites, clay and gravel, *WW 950*

Evolvulus alsinoides (L.) L., Ojo de vibora, N, A, slopes, drainages, canyons, *WW 988*

Ipomoea costellata Torr., Crestrib morning glory, N, R, sediments of canyon bottom, *WW 648*

Cucurbitaceae

Ibervillea tenuisecta (A. Gray) Small, Slimlobe globeberry, N, O, arroyos, alluvium, drainages, *WW 609*

Ebenaceae

Diospyros texana Scheele, Texas persimmon, N, O, deep drainages, arroyos, canyons, *WW 669*

Euphorbiaceae

Bernardia obovata I.M. Johnst., Myrtlecroton, N, O, ridges, gravelly slopes, *Weckesser 688*

Chamaesyce albomarginata (Torr. & A. Gray) Small, Whitemargin sandmat, N, gravelly slope, disturbed site, *Bennack 108B* SRSC

Chamaesyce perennans Shinners, Perennial sandmat, N, C, E-BB, ubiquitous, *WW 738*

Chamaesyce serrula (Engelm.) Wooton & Standl., Sawtooth sandmat, N, gravelly slope, disturbed site, *Bennack 108A* SRSC

Chamaesyce stictospora (Engelm.) Small, Slimseed spurge, N, U, arroyo, *WW 632*

Croton fruticulosus Engelm. ex Torr., Bush croton, N, U, canyons, steep drainages, *WW 660*

Croton pottsii (Klotzsch.) Müll. Arg., Leatherweed Croton, N, A, ubiquitous, *WW 964*

Argythamnia neomexicana Müll. Arg., New Mexico wild mercury, N, O, drainages, canyons, *WW 904*

Euphorbia antisyphilitica Zucc., Candelilla, N, A, ubiquitous, *WW 966*

Euphorbia exstipulata Engelm., Squareseed spurge, N, base of cliff, arroyo, *Bennack 112* SRSC

Jatropha dioica var. *graminea* McVaugh, Leatherstem, N, A, ubiquitous, *WW 985*

Phyllanthus polygonoides Nutt. ex Spreng., Knotweed leafflower, N, C, drainages, arroyos, canyons, *WW 104*

Tragia amblyondonta (Müll. Arg.) Pax & K. Hoffm., Dogtooth noseburn, N, U, shaded arroyo, *WW 1048*

Tragia ramosa Torr., Branched noseburn, N, O, drainages, arroyos, canyons, *WW 49*

Fabaceae

Acacia greggii A. Gray, Catclaw acacia, N, C, slopes, drainages, ridges, *WW 458*

Acacia neovernicosa Isely, Varnished acacia, N, C, slopes, drainages, ridges clay flats, *WW 43*

Acacia roemeriana Scheele, Roemer acacia, N, O, ubiquitous, *WW 891*

Acacia schottii Torr., Schott acacia, N, U, slopes, *WW 1010*

Calliandra iselyi B.L. Turner, False mesquite, N, O, ubiquitous, *WW 584*

Dalea formosa Torr., Feather dalea, N, O, ubiquitous, *WW 309*

Dalea neomexicana (A. Gray) Cory, New Mexico dalea, N, O, slopes, ridges, *WW 398*

Dalea pogonathera A. Gray, Bearded dalea, N, U, canyon, *WW 328*

Dalea wrightii A. Gray, Wright dalea, N, C, ubiquitous, *WW 15*

Desmanthus glandulosus (B.L. Turner) Luckow, Bundleflower, N, slopes, drainages, canyon, *WW 663*

Genistidium dumosum I.M. Johnst., Johnston bushpea, N, R, G1S1, rocky slopes, only known populations in U.S.A., *WW 946*

Mimosa emoryana Benth., Emory mimosa, N, O, drainages, canyons, *WW 436*

Mimosa texana (Gray) Small, Catclaw mimosa, N, O, slopes, canyons, disturbed sites, *WW 429*

Pomaria melanosticta S. Schauer, Parry holdback, N, O, slopes, drainages, canyons, *WW 5*

Prosopis glandulosa Torr., Mesquite, N, C, ubiquitous, *WW 856*

Senna lindheimeriana (Scheele) H.S. Irwin & Barneby, Lindheimer senna, N, C, ubiquitous, *WW 524*

Senna pilosior (B.L. Rob. ex J.F. Macbr.) H.S. Irwin & Barneby, Trans-Pecos senna, N, O, drainages, arroyos, slopes, *WW 590*

Vicia ludoviciana Nutt. ex Torr.& A. Gray, Deer pea vetch, N, U, arroyos, *WW 162*

Fagaceae

Quercus vaseyana Buckley, Sandpaper oak, N, R, restricted to one narrow, steep-sided canyon, *WW 517*

Fouquieriaceae

Fouquieria splendens Engelm., Ocotillo, N, C, slopes, ridges, drainages, *WW 405*

Gentianaceae

Zeltnera arizonica (A. Gray) A. Heller, Arizona centaury, N, R, shaded slope, one population found after significant rain, *WW 357*

Hydrophyllaceae

Nama havardii A. Gray, Havard nama, N, C, ubiquitous, *WW 220*

Nama hispida A. Gray, Rough nama, N, U, alluvium, canyon bottom, *WW 179*

Phacelia congesta Hook., Bluecurls, N, U, shaded alluvium, canyons, *WW 165*

Krameriaceae

Krameria erecta Willd. ex Schult., Range ratany, N, C, slopes, ridges, arroyos, canyons, *WW 403*

Krameria grayi Rose & Painter, White ratany, N, C, slopes, ridges, arroyos, canyons, *WW 69*

Lamiaceae

Hedeoma drummondii Benth., Drummond pennyroyal, N, R, alluvium, found once on gravel bar in dry wash, *WW 865*

Hedeoma nana (Torr.) Briq., Dwarf false pennyroyal, N, U, slopes, drainages, ridges, canyons, *WW 129*

Linaceae

Linum berlandieri Hook., Berlandier flax, N, C, ubiquitous, *WW 110*

Linum rupestre (A. Gray) Engelm. ex A. Gray, Rock flax, N, U, canyons, *WW 714*

Loasaceae

Cevallia sinuata Lag., Stinging cevallia, N, O, slopes, drainages, disturbed areas, *WW 914*

Eucnide bartonoides Zucc., Yellow rocknettle, N, R, restricted to rock walls of steep drainages and canyons, *WW 447*

Mentzelia mexicana H.J. Thomps. & Zavort., Mexican blazingstar, N, O, slopes, drainages, ridges, arroyos, *WW 839*

Mentzelia pachyrhiza I.M. Johnst., Coahuila blazingstar, N, R, slope, *WW 1044*

Loganiaceae

Buddleja marrubiifolia Benth., Butterfly bush, N, C, arroyos, drainages, canyons, *WW 670*

Malpighiaceae

Janusia gracilis A. Gray, Helicopter bush, N, U, canyons, steep drainages, *WW 958*

Malvaceae

Abutilon crispum (L.) Medik., Netvein mallow, N, slopes, drainages, *Powell 3185* SRSC

Abuliton fruticosum Guill. & Perr., Pelotazo, N, C, slopes, drainages, canyons, *WW 490*

Abutilon malacum S. Watson, Yellow indian mallow, N, U, disturbed site, *WW 1041*

Abutilon wrightii A. Gray, Wright abutilon, N, U, cliff face in steep canyon, *WW 327*

Hibiscus coulteri Harv. ex A. Gray, Desert rosemallow, N, O, slopes, ridges, *WW 61*

Hibiscus × sabei Weckesser, Ken's rosemallow, N, R, roadside, *WW 645*

Hibiscus denudatus Benth., Paleface rosemallow, N, O, slopes, flats, drainages, *WW 97*

Sida abutifolia Mill., Spreading sida, N, O, slopes, drainages, rock outcrops, *WW 12*

Sida longipes A. Gray, Stockflower fanpetals, N, O, slopes, drainages, clay flats, *WW 216A*

Nyctaginaceae

Acleisanthes angustifolia (Torr.) R.A. Levin, Narrowleaf moonpod, N, O, slopes, drainages, ridges, clay flats, *WW 721*

Acleisanthes longiflora A. Gray, Angel trumpets, N, O, drainages, canyons, *WW 770*

Acleisanthes parvifolia (Torr.) R.A. Levin, Small leaf moonpod, N, U, restricted to gypseous clay, *WW 36*

Allionia incarnata L., Trailing four-o'clock, N, A, ubiquitous, *WW 639*

Anulocaulis eriosolenus (A. Gray) Standl., Big Bend ringstem, N, R, restricted to gypseous clay, *WW 1045*

Anulocaulis leiosolenus var. *lasianthus* I.M. Johnst., Ringstem, N, U, restricted to gypseous clay flats, *WW 1042*

Cyphomeris gypsophiloides (M. Martens & Galeotti) Standl., Birdfruit, N, R, cliff base, *WW 1055*

Mirabilis texensis (J.M. Coult.) B.L. Turner, Texas mirabilis, N, R, cliff base, *WW 1056*

Oleaceae

Forestiera angustifolia Torr., Desert olive, N, C, ubiquitous, *WW 318*

Menodora longiflora Engelm. ex A. Gray, Twinpod, N, U, arroyo, *WW 102*

Menodora scabra A. Gray, Rough menodora, N, O, ubiquitous, *WW 35*

Onagraceae

Oenothera boquillensis (P.H. Raven & D.P. Greg.) W.L. Wagner & Hoch, Boquillas gaura, N, R, G2S2, arroyo margin, *WW 1054*

Oenothera brachycarpa A. Gray, Shortpod evening primrose, N, slopes, drainages, clay flats, disturbed areas, *WW 723*

Oenothera hartwegii Benth., Hartweg sundrops, N, U, arroyos, *WW 1032*

Oenothera kunthiana (Spach) Munz, Kunth sundrops, N, shaded slope, drainage, *Hughes s.n.*, SRSC

Oenothera rosea L'Her. ex Aiton, Rose sundrops, N, U, drainages, slopes, disturbed areas, *WW 256*

Oenothera triloba Nutt., Stemless evening primrose, N, U, slopes, clay, *WW 226*

Orobanchaceae

Castilleja rigida Eastw., Broadbract paintbrush, N, O, slopes, drainages, canyons, *WW 778*

Orobanche multicaulis Brandegee, Spiked broomrape, N, R, alluvium, drainage, middle of a gravelly wash, *WW 462*

Phytolaccaceae

Rivina humilis L., Pigeonberry, N, R, one plant at cliff base, *WW 1047*

Plantaginaceae

Penstemon baccharifolius Hook., Baccharis-leaf penstemon, N, R, restricted to crevices in canyon walls and bottoms, *WW 899*

Plantago helleri Small, Heller plantain, N, U, shaded alluvium, slopes, *WW 299*

Stemodia coahuilensis (Henrickson) B.L. Turner, Coahuila twintip, N, R, canyon bottom, alluvium, new Brewster County record, *WW 690*

Polemoniaceae

Gilia rigidula subsp. *acerosa* A. Gray, Blue gilia, N, O, ridges and slopes of Santa Elena limestone, *WW 136*

Gilia purpusii subsp. *stewartii* (I.M. Johst.) J.M. Porter, Stewart gilia, N, C, ubiquitous, *WW 81*

Polygalaceae

Hebecarpa barbeyana (Chodat) J.R. Abbott, Narrowleaf milkwort, N, C, arroyos, drainages, canyons, *WW 26*

Hebecarpa macradenia (A. Gray) Abbott, Glandleaf milkwort, N, C, rock outcrops, *WW 491*

Rhinotropis lindheimeri var. *parvifolia* (Wheelock) R.R. Abbott, Shrubby milkwort, N, R, gravelly clay flats, *WW 881*

Polygala scoparioides Chodat, Broom milkwort, N, C, arroyos, drainages, canyons, slopes, *WW 724*

Portulacaceae

Portulaca pilosa L., Kiss me quick, N, O, ridges, slopes, flats with gravel surface, *WW 961*

Ranunculaceae

Clematis drummondii Torr. & A. Gray, Virgin's bower, N, C, drainages, arroyos, canyons, *WW 94*

Resedaceae

Oligomeris linifolia (Vahl) Macbride, Desert spike, N, C, drainages, arroyos, canyons, *WW 911*

Rhamnaceae

Condalia ericoides (A. Gray) M.C. Johnst., Javelinabush, N, O, ubiquitous; *WW 473*

Condalia warnockii M.C. Johnst., Warnock condalia, N, *Powell 3633* SRSC

Ziziphus obtusifolia (Hook. ex Torr. & A. Gray) A. Gray, Lotebush, N, O, ubiquitous, *WW 894*

Rosaceae

Fallugia paradoxa (D. Don) Endl. ex Torr., Apache plume, N, O, arroyos, drainages, canyons, *WW 105A*

Amelanchier denticulata (Kunth) K. Koch, Serviceberry, N, R, drainage, northern-most extent of Long Draw, *WW 279*

Purshia ericifolia (Torr. ex A. Gray) Henrickson, Heath cliffrose, N, R, cliff faces of canyons and steep drainages, *WW 949*

Rubiaceae

Galium proliferum A. Gray, Limestone bedstraw, N, U, slopes, drainages, *WW 263*

Hedyotis nigricans (Lam.) Fosberg, Prairie Bluet, N, O, drainages, slopes, canyons, especially in rock crevices, *WW 43*

Rutaceae

Thamnosma texanum (A. Gray) Torr., Dutchman's britches, N, C, ubiquitous, *WW 140*

Sapindaceae

Ungnadia speciosa Endl., Mexican buckeye, N, R, arroyos and canyons, *WW 319*

Scrophulariaceae

Leucophyllum minus A. Gray, Big Bend silverleaf, N, C, slopes, drainages, arroyos, *WW 960*

Maurandella antirrhiniflora Humb. & Bonpl. ex Willd., Snapdragon vine, N, O, shaded arroyo, base of cliff, *WW 530*

Solanaceae

Chamaesaracha pallida Averett, False nightshade , N, O, slopes, ridges, *WW 238*

Chamaesaracha coniodes Britton, Hairy false nightshade, N, O, slopes, ridges, clay flats, *WW 413*

Lycium berlandieri Dunal, Berlandier wolfberry, N, O, ridges, clay flats, *WW 753*

Lycium puberulum var. berberidoides (Correll) F. Chiang, Downy wolfberry, N, O, E-TP, slopes, clay flats, *WW 392*

Lycium texanum Correll, Texas wolfberry, N, R, G2S2, E-TP, slope, *WW 1029*

Nicotiana obtusifolia M. Martens & Galeotti, Desert tobacco, N, O, ubiquitous, *WW 74*

Physalis hederifolia A. Gray, Heartleaf groundcherry, N, O, drainages, canyons, disturbed sites, *WW 210*

Physalis lobata (Torr.) Raf., Purple groundcherry, N, O, clay flats, arroyos, disturbed areas, *WW 62*

Solanum elaeagnifolium Cav., Silverleaf nightshade, N, O, clay flats, disturbed sites, *WW 381*

Sterculiaceae

Ayenia microphylla A. Gray, Dense ayenia, N, C, ubiquitous, *WW 539*

Tamaricaceae

Tamarix chinensis Lour., Saltcedar, I, U, arroyos, roadsides, *WW 906*

Ulmaceae

Celtis iguanaea (Jacq.) Sarg., Spiny hackberry, N, U, canyon, drainages, *WW 526*

Urticaceae

Parietaria pensylvanica Muhl. ex Willd., Pennsylvania pellitory, N, R, shaded base of cliff, *WW 160*

Verbenaceae

Aloysia gratissima (Gillies & Hook.) Tronc., Beebrush, N, O, arroyos, drainages, *WW 620*

Aloysia wrightii A. Heller, Oreganillo, N, U, rocky slopes, drainages, *WW 703*

Bouchea linifolia A. Gray ex Torr., Groovestem bouchea, N, O, drainages, canyons, *WW 51*

Glandularia bipinnatifida (Nutt.) Nutt. var. *ciliata* (Benth.) Turner, Dakota mock vervain, N, R, drainage, northern-most extent of Long Draw, *WW 280*

Glandularia quadrangulata (A. Heller) Umber, Beaked verbena, N, R, drainage, *WW 146*

Lantana achyranthifolia Desf., Veinyleaf lantana, N, O, drainages, arroyos, canyons, *WW 656*

Tetraclea coulteri A. Gray, Stinkweed, N, O, gravelly slopes, *WW 389*

Vitaceae

Cissus incisa Des Moul., Ivy treebine, N, R, arroyo, *WW 641*

Zygophyllaceae

Guaiacum angustifolium Engelm., Guayacan, N, C, ubiquitous, *WW 868*

Kallstroemia perennans B.L. Turner, Turner's desert poppy, N, R, E-TP clay flats or Del Rio clay outcrops, *WW 33*

Larrea tridentata (Sessé & Moc. ex DC.) Coville, Creosotebush, N, A, ubiquitous, *WW 855*

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