SENEGALIA BERLANDIERI, S. GREGGII AND S. WRIGHTII HYBRIDS (FABACEAE: MIMOSOIDEAE) IN TEXAS AND ADJACENT MEXICO

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ABSTRACT

Principal component (PCA) and principal coordinate analyses (PCoA) suggest that Senegalia x emoryana is of hybrid origin, the probable parents being S. berlandieri and S. greggii. Many individuals and populations involving the parental species and F₁ hybrids, as well as backcrosses to either of the two parents, have been observed by the authors and others. This hybrid occasionally dominates disturbed habitats, becoming more common than the parental species. A hybrid morphologically similar to S. x emoryana involving S. berlandieri and S. wrightii is also discussed. The hybrid between S. berlandieri and S. wrightii (herein described as Senegalia x turneri Seigler & Ebinger), in contrast to Senegalia x emoryana, does not appear to be common; we have found relatively few individuals, mostly in association with the parents. Phytologia 94(3):439-455 (December 1, 2012).

KEY WORDS: Senegalia, hybrids, Senegalia x emoryana, Senegalia x turneri, S. berlandieri, S. greggii, S. wrightii
The genus *Senegalia* is a segregate of plants from *Acacia* s.l. with woody prickles scattered on the stem and commonly the leaf petiole and rachis, and flowers with a ring of glands at the base of the long-stalked ovary. The genus consists of 100 species in New World tropical and subtropical areas ranging from the southwestern United States south to Argentina and in the West Indies (Seigler et al. 2006). Nearly 100 additional species are found in the Old World tropics and subtropics of Asia, Africa, and Australia.

Only rarely have hybrids between New World species of *Senegalia* been reported (Britton and Rose 1928, Turner 1959, Correll and Johnston 1970, Johnson 1974). In our experience, all observed hybrids in this genus involve *S. berlandieri* (Benth.) Britt. & Rose as one of the parents and either *S. reniformis* (Benth.) Britt. & Rose, *S. crassifolia* (A. Gray) Britt. & Rose, *S. greggii* (A. Gray) Britt. & Rose or *S. wrightii* (Benth.) Britt. & Rose as the other parental species. These hybrids are restricted to the southwestern United States and northern Mexico (Maslin and Stirton 1997, Seigler et al. 2006) and are usually associated with disturbance, normally being found in pastures, edges of roads, and other disturbed sites. The present study was undertaken to examine the morphological differences of hybrids and hybrid populations involving *S. berlandieri* and the apparently related species *S. greggii* and *S. wrightii*. These three species are common components of thorn-scrub communities in large parts of the southwestern United States and adjacent Mexico.

**MATERIALS AND METHODS**

Three separate analyses were conducted, one involving *Senegalia berlandieri*, *S. greggii* and their suspected hybrids, the other involving *S. berlandieri*, *S. wrightii* and their suspected hybrids, and a third including all three species and their suspected hybrids. These analyses were based on herbarium specimens of the putative parents and hybrids from Texas and adjacent Mexico (Appendix I). Many of the specimens used were collected by the authors, but other materials were also included.

The study involving the *Senegalia berlandieri* x *S. greggii* population was undertaken using specimens collected by the authors at
the Chaparral Wildlife Management Area near Artesia Wells, Dimmitt and LaSalle Counties, Texas, in the northern half of the South Texas Plains ecological region (Correll and Johnston 1970). This management area is deer-proof fenced, about 6,150 ha in size, and utilizes a high intensity, low frequency rotational grazing system with stocking rates of one animal unit per 12 ha (Ruthven 2001). The study involving the *Senegalia berlandieri* x *S. wrightii* population was undertaken using specimens collected by the authors at the Harris Ranch, near Cline, 20 miles W of Uvalde, Uvalde County, Texas at the northern edge of the South Texas Plains ecological region. Managed by the Texas A & M University, Agricultural Research and Extension Center, Uvalde, the ranch is not deer-proof fenced, about 6,764 ha in size, and utilizes a cattle stocking rate of one animal unit to 35 ha (Cooper et al. 2008).

Initially, the specimens were separated into taxonomic groups based on overall morphological similarity and scored for 13 characters (Appendix II). These data served as the source of characters for principal component (PCA) and principal coordinate analyses (PCoA). Three or more measurements were made for each continuous character of each specimen. These values were then plotted to confirm that gaps in the data exist.

A few species of *Senegalia* have short shoots at many of the nodes on which clusters of leaves occur. Short shoot leaves, are usually smaller, have fewer pinna pairs, and smaller leaflets than the solitary or primary leaves found on the nodes of new growth. Primary leaves are larger, but rare or not present on many herbarium specimens. Of the species and hybrids studied in this paper, both *S. greggii* and *S. wrightii* have short shoots on which these smaller leaves are common. All measurements of *S. greggii* and *S. wrightii* used in these analyses were taken from short shoot leaves.

A PCA to identify groupings of the specimens examined was carried out. For this analysis, the data were first standardized and a correlation matrix, eigenvalues, and eigenvectors were calculated using NTSYS-pc version 2.1 (Rohlf 2000). Eigenvectors were scaled by the square root of \( \lambda \). The axes were rotated and the resulting loading values graphically represented as both two- and three-dimensional plots.
To carry out PCoA analyses, Gower’s resemblance coefficients were calculated (Legendre and Legendre 1983; Podani 1999; Dickinson 2000). The nature of each character was designated by binary, multistate, or quantitative descriptors and all characters were weighted equally (Dickinson 2000). The data matrix was transformed by the DCENTER algorithm using distances squared and eigenvectors and eigenvalues calculated with NTSYS-pc version 2.1 (Rohlf 2000). Eigenvectors were scaled by the square root of $\lambda$. The resulting loading values were graphically represented as both two- and three-dimensional plots.

Figure 1 (facing page). A. Three-dimensional plot for the principal component analysis using the 13 characters (Appendix II) of 16 specimens of *Senegalia berlandieri* (B01-B16), 13 specimens of *S. greggii* (G01-G13), and 14 specimens of probable hybrids (*S. x emoryana*) (E01-E14) from Chaparral Wildlife Management Area, Dimmitt and LaSalle Counties, Texas.

B. Three-dimensional plot for the principal component analysis using the 13 characters (Appendix II) of 16 specimens of *Senegalia berlandieri* (B01-B16), 16 specimens of *S. wrightii* (W01-W16), and 7 specimens of probable hybrids (*S. berlandieri* x *S. wrightii = S. x *turneri*) from Harris Ranch, Uvalde County, Texas (X01-X07).

C. Three-dimensional plot for the principal component analysis using 13 characters (Appendix II) of 16 specimens of *Senegalia berlandieri* (B01-B16), 13 specimens of *S. greggii* (G01-G13), 16 specimens of *S. wrightii* (W01-W16), 14 specimens of *S. x emoryana* (E01-E14), and 7 specimens of *S. berlandieri* x *S. wrightii* (*S. x turneri*) (X01-X07) collected from throughout the range of *S. berlandieri* (Appendix I).
RESULTS

Senegalia berlandieri and S. greggii: The analysis involved 16 specimens of Senegalia berlandieri, 13 specimens of S. greggii and 14 probable hybrids collected at Chaparral Wildlife Management Area. The PCA based on 13 characters (Appendix II), and a PCoA based on Gower’s similarity coefficients proved to be similar (Figure 1A). In the PCA, the first three principal components accounted for 94% of the total variance. Leaflet pairs/pinna (Lep), pinna length (Pil), and petiole gland length (Gll) (characters 10, 7, and 3) were most important for determining the component score of the first axis; leaflet length (Lel), leaflet shape (Les), and gland shape (Gls) (characters 13, 11, and 4) were most important for determining the second axis. The specimens used in this analysis represented distinct groupings in both PCA and PCoA. The clusters for each of the parental species were well separated from each other and the cluster corresponding to hybrids was spatially located between the putative parental species (Figure 1A).

Senegalia berlandieri and S. wrightii: The analysis involved 16 specimens of Senegalia berlandieri, 16 specimens of S. wrightii and 7 probable hybrids (S. berlandieri x S. wrightii) collected at Harris Ranch. The PCA based on all 13 characters (Appendix II) and a PCoA based on Gower’s similarity coefficients for species scored proved to be similar (Figure 1B). In the PCA, the first three principal components accounted for 96% of the total variance. Leaflet distance (Led), pinna pair number (Pip), and rachis length (Ral) (characters 9, 6, and 5) were most important for determining the component score of the first axis; leaflet apex shape (Lea), leaflet shape (Les), and petiole gland shape (Gls) (characters 8, 11, and 4) were most important for determining the second axis. The specimens used in this analysis represented distinct groupings in both PCA and PCoA. The clusters for each of the parental species were well separated from each other and the cluster corresponding to hybrids was spatially located between the putative parental species (Figure 1B).

Senegalia berlandieri, S. greggii, and S. wrightii: This analysis used herbarium specimens from throughout the range of these three species in south central and southern Texas and adjacent northern Mexico. The analysis involved 16 specimens of Senegalia berlandieri,
13 specimens of *S. greggii*, 16 specimens of *S. wrightii*, 14 specimens of *S. berlandieri x S. greggii* (*S. x emoryana*), and seven specimens of *S. berlandieri x S. wrightii* (Appendix I). No specimens of suspected backcrosses to either parent were included in the analysis. The PCA based on 13 characters (Appendix II), and a PCoA based on Gower’s similarity coefficients for species scored proved to be similar (Figure 1C). In the PCA, the first three principal components accounted for 96% of the total variance. Short shoots (Shs), petiole gland shape (Gls), leaflet apex shape (Lea), and leaflet shape (Les) (characters 1, 4, 8, and 11) were most important for determining the component score of the first axis; leaflet length (Lel), leaflet distance (Led), and leaflet width (Lew) (characters 13, 9, and 12) were most important for determining the second axis. The specimens used in this analysis represented distinct groupings in both PCA and PCoA. The clusters for each of the parental species were well separated from each other and the clusters corresponding to hybrids were spatially located between the respective putative parental species (Figure 1C).

**DISCUSSION**

*Senegalia berlandieri* and *S. greggii*: Of these two taxa, *Senegalia greggii* has the most extensive distribution, known from southern California east through extreme southern Nevada and Utah, most of Arizona and New Mexico, through southern Texas, and south into Mexico in the states of Baja California Sur, Sonora, Chihuahua, Durango, Coahuila, Nuevo León and Tamaulipas. *Senegalia berlandieri*, in contrast, has a more restricted distribution in the United States, occurring in south central and southern Texas, and farther south than *S. greggii* in the states of Chihuahua, Durango, Zacatecas, Coahuila, Nuevo León, San Luis Potosí, Hidalgo, Guanajuato, Querétaro, and Tamaulipas, Mexico. The hybrid, *S. x emoryana*, is restricted to areas in which the parental species have an overlapping distribution, mostly in south central and southern Texas, and the states of Chihuahua, Coahuila, Durango, and San Luis Potosí, Mexico.

*Senegalia x emoryana* can easily be separated from both *S. berlandieri* and *S. greggii* using many of the characteristics listed in Appendix II. The most obvious and commonly used characteristics include: short shoot at most nodes of *S. greggii*, but are absent on *S. x
emoryana and S. berlandierii; most leaves with 1-3 pinna pairs in S. greggii, 4-8 in S. x emoryana, and 9-15 on S. berlandierii; and many leaflets obovate to oblanceolate in S. greggii, and most leaflets linear to oblone in S. berlandierii and S. x emoryana. In floral material the globose inflorescence of S. berlandierii separates this species from S. x emoryana which has an elongated inflorescence that is less than twice as long as wide, and S. greggii which has an elongated inflorescence more than twice as long as wide. Backcrossed individuals are more difficult to identify, but these were only rarely encountered. The most common backcrossed specimens observed were between S. berlandierii x S. x emoryana. Separation was usually easy because S. berlandierii average 25 to 55 leaflets/pinna, whereas S. x emoryana averages 15 to 20 leaflets/pinna.

**Senegalia berlandierii and S. wrightii:** Of these two taxa, *Senegalia wrightii* has a more extensive distribution in the United States than *S. berlandierii*, being known from southern Nevada and Arizona, and east through most of southern Texas (Little 1979). In Mexico, we have found specimens of *S. wrightii* from Baja California Sur, east through Chihuahua, Coahuila, Nuevo León, and Tamaulipas. It may occur further south into central Mexico but we have been unable to locate specimens. We have few specimens of the hybrid between these two taxa (*Senegalia berlandierii* and *S. wrightii*). In order to distinguish this hybrid from other taxa in the group it is important to select mature vegetative material; in particular, flowering material with immature leaflets often falls below 5.5 mm in length. In the original analysis, all of the proposed hybrid specimens were from the population at Harris Ranch near Cline, Texas. Presently, we have located additional specimens of this proposed hybrid, all from the South Texas Plains ecological region in southern Texas (Correll and Johnston 1970). Based on these specimens the proposed new hybrid is described. This hybrid is named after Dr. Billie L. Turner (Director Emeritus, University of Texas Herbarium) who has studied the *S. berlandierii*, *S. greggii*, *S. x emoryana* species complex and has annotated many specimens of this species complex at TEX (Turner 1959).
**Senegalia x turneri** Seigler, Ebinger, & Glass nothomorph nov.

TYPE: UNITED STATES. TEXAS: Uvalde Co.: Harris Ranch near Cline, 20 miles W of Uvalde on Rt. 90, 29°N 14’ 38”; 100°W 06’ 02”, 18 Aug 2003, D. S. Seigler & J. E. Ebinger 15815 (Holotype: ILL). Putative hybrid between *Senegalia berlandieri* and *Senegalia wrightii*.

**Shrub** or small **tree** to 5 m tall. Bark light to dark brown, shallowly furrowed. Twigs dark grayish brown, straight, usually puberulent. Short shoots mostly absent. Prickles brown below, apex dark brown, flattened, usually slightly recurved, woody, 1-5 x 1-5 mm at the base, usually glabrous, persistent, scattered along the twig, sometimes rare to absent. **Leaves** alternate, 25-70 mm long. Stipules light to dark brown, narrowly triangular to linear, symmetrical, flattened, straight, herbaceous, 0.5-2.1 x 0.3-1.1 mm near the base, puberulent, tardily deciduous. Petiole adaxially grooved, 5-20 mm long, puberulent; petiolar gland solitary, located on the upper half of the petiole, sessile in the expanded petiole groove with the margins raised, orbicular to elliptic, 0.8-2.1 long, apex depressed, glabrous. Rachis adaxially grooved, 15-45 mm long, puberulent, an oval to orbicular gland 0.4-1.2 mm long between the upper pinna pair, apex depressed, glabrous. Pinnae 2 to 7 pairs per leaf, 20-45 mm long, 4-14 mm between pinna pairs; paraphyllidia 0.2-0.5 mm long; petiolule 1.1-3.1 mm long. Leaflets 13 to 21 pairs per pinna, opposite, 0.6-2.1 mm between leaflets, oblong, 5.1-9.3 x 0.7-2.6 mm, glabrous to lightly appressed puberulent on both surfaces, lateral veins obvious, 1 to 4 veins from the base, base oblique and obtuse, margins ciliate, apex acute, midvein submarginal. **Inflorescence** a densely 35- to 85-flowered subglobose head, slightly longer than wide, 8-13 mm wide, usually solitary in the leaf axil. Peduncles 7-25 x 0.5-0.8 mm wide, puberulent; receptacle elongated, slightly enlarged. Involucre a single small bract on the upper half of the peduncle, early deciduous. Floral bracts linear to spatulate, 0.9-1.7 mm long, puberulent, early deciduous. **Flowers** sessile, white; calyx 5-lobed, 1-2 mm long, puberulent; corolla 5-lobed, 2-3 mm long, puberulent, lobes one-quarter the length of the corolla; stamen filaments 5-7 mm long, distinct; anther glands absent; ovary lightly pubescent, stipe to 0.6 mm long. **Legumes** light to dark...
brown, straight to slightly curved, flattened, usually constricted between some seeds, oblong, 40-160 x 20-35 mm, coriaceous, lightly transversely striated, puberulent, eglandular, dehiscent along both sutures; stipe 5-20 mm long; apex obtuse, short beaked to lacking a beak. **Seeds** uniseriate, no pulp, brown, orbicular, flattened, 8-12 x 5-8 mm, smooth; pleurogram U-shaped, 1-3 mm across.

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**Figure 2** *Senegalia x turneri* Seigler, Ebinger & Glass. A: Twig with prickles (*E. J. Palmer 12330*). B. Habit sketch with inflorescences (*Seigler & Ebinger 15815*). C. Fruits (*Seigler & Ebinger 15815*). D. Leaflet (adaxial surface) (*Seigler & Ebinger 15799*). E. Leaf with petiolar gland (*Seigler & Ebinger 15799, 15808*). F. Inflorescence (*Seigler & Ebinger 15799, 15815*). G. Flower (*Seigler & Ebinger 15799, 15815*).
Flowers: April-June.

Distribution: Limestone outcrops in gravely, calcareous, and disturbed soils between sea level and 1700 m in southern Texas.

Key to the species and hybrids examined:
1. Short shoots present at many nodes, these with clusters of leaves; inflorescence a spike more than twice as long as wide.
   2. Most leaflets less than 5.5 mm long (2.8-5.5 by 0.9-3.2 mm); flower stalks 0-0.6 mm long..................Senegalia greggii
   2. Most leaflets more than 5.5 mm long (5.5-9.2 by 2.2-4.5 mm); flower stalks mostly more than 0.7 mm long…Senegalia wrightii
1. Short shoots mostly absent; inflorescence globose or a short spike less than twice as long as wide.
   3. Most leaves with 9-15 pinna pairs; most pinnae with 30-55 pairs of leaflets; inflorescence globose…………….Senegalia berlandieri
   3. Most leaves with fewer than 9 pinna pairs; most pinnae with 2-25 pairs of leaflets; inflorescence a short spike less than twice as long as wide.
      4. Most fully expanded mature leaflets more than 5.5 mm long (5.1-9.3 mm by 0.7-2.6 mm)………Senegalia x turneri
      4. Most fully expanded mature leaflets less than 5.4 mm long (3-6 by 0.7-1.7 mm)…………….Senegalia x emoryana

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LITERATURE CITED


Turner, B. L. 1959. The Legumes of Texas. University of Texas Press, Austin, Texas.
Appendix I. Specimens examined and scored for the 13 characters used in this study.


Appendix II. Characters scored for the principal component (PCA) and principal coordinate analyses (PCoA) of the *Senegalia berlandieri*, *S. greggii*, and *S. wrightii* species complex.

1. **Short shoots (Shs)**: 1 = absent or nearly so, 2 = common at stem nodes.
2. **Petiole length in mm (Pel).**
3. **Petiole gland length in mm (Gll).**
4. **Petiole gland shape (Gls)**: 1 = elliptic, 2 = round or nearly so.
5. **Rachis length in mm (Ral).**
6. **Pinna pair number (Pip).**
7. **Pinna length in mm (Pil).**
8. **Leaflet apex shape (Lea)**: 1 = acute, 2 = obtuse.
9. **Leaflet distance in mm (Led).**
10. **Leaflets pairs/pinna (Lep).**
11. **Leaflet shape (Les)**: 1 = nearly all linear to oblong, 2 = many obovate to oblanceolate.
12. **Leaflet width in mm (Lew).**
13. **Leaflet length in mm (Lel).**
Here are the types of trees that we plant in Texas: 1) Huajillo (aka Acacia berlandieri) An important honey-tree in Texas that is planted in. 2) Devil's Claw (aka Acacia greggii var. wrightii). Stems were used in construction and tool making. 3) Torchwood (aka Amyris texana). A densely branched shrub whose foliage and flowers smell like citrus when bruised. 4) La Coma (aka Sideroxylon celastrina). This plant is known as a first choice deer feed. A species of flowering plant in the pea family, Fabaceae, that is native to the coastal plain of southern Texas in the United States. The post types of trees we plant in the USA appeared first on tentree. ten trees planted for every item purchased. At tentree, our goal is to become the most environmentally progressive brand on the planet. Senegalia (from Senegal and Acacia senegal (L.) Willd.) is a genus of flowering plants in the legume family, Fabaceae. It belongs to the subfamily Mimosoideae. Until 2005, its species were considered members of Acacia. The genus is still considered polyphyletic and will require further division. Senegalia can be distinguished from other acacias by its spicate inflorescences and non-spinescent stipules. Senegalia comprises the following species: Senegalia adenocalyx (Brenan & Exell) Kyal. & Boatwr.