Phytotaxa 454 (2): 145–152
https://www.mapress.com/j/pt/

Article

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.454.2.6

A new outstanding species and a new section of *Dalea* (Fabaceae: Papilionoideae) from central Mexico

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Abstract

We describe and illustrate *Dalea rubriflora* A.E. Estrada, J. Martínez-Ramírez, A. Mares & Ocampo as a new species from central Mexico. According to the morphology of its flower, this new species is included in a new section within subgenus *Parosela* because the shape of its keel, the innermost petals (which make the flower valvate) coherent along their external (dorsal) outer margins. However, this new species and new section have striking differences with the rest of the previously described taxa of subgenus *Parosela,* highlighting 1) the persistent red color of the flowers, not found in any section and species of *Dalea*, 2) the stamens are joined in a very long staminal column which are protruded from the keel petals for almost a third of its length, and 3) the blades of the epistemonous petals are not auriculated, instead, are truncated in the keel and absent in the wings. These main features, associated with more particular characteristics of other sections, allow us to recognize *Rubriflorae* as a new section and *Dalea rubriflora* as a new species into the subgenus *Parosela*.

Resumen

Se describe e ilustra *Dalea rubriflora* A.E. Estrada, J. Martínez, A. Mares & Ocampo como una especie nueva del centro de México. De acuerdo con la morfología de su flor, esta especie nueva es incluida en una sección nueva dentro del subgénero *Parosela* debido a la forma de su quilla, los pétalos más internos que constituyen la flor son valvados, connados a lo largo de su margen externo (dorsal). Sin embargo, esta especie y sección nuevas poseen marcadas diferencias con el resto de las especies y secciones descritas previamente para el subgénero *Parosela*, destacando 1) el color rojo persistente de sus flores, no presente en ninguna sección y especie de *Dalea*, 2) los estambres están unidos en una columna estaminal muy larga, la cual protruye los estambres de la quilla en al menos un tercio de su longitud total y 3) el limbo de los pétalos epistémonos no es auriculado, sino truncado en la quilla y ausente en las alas. Estas características asociadas con otras más particulares de las otras secciones, nos permite reconocer a *Rubriflorae* como una sección nueva al mismo tiempo que *Dalea rubriflora* como una especie nueva dentro del subgénero *Parosela.*

Keywords: Central Mexico, Leguminosae, sect. *Rubriflorae*, Sierra del Laurel, Zacatecas

Introduction

At present, approximately 175 species of *Dalea* Linnaeus (1758: 244) have been described. Two thirds (123 of the total species; Barneby, 1964), belong to the subg. *Parosela* Barneby (1964: 284) and they are distributed from southern USA throughout Mexico to Chile and Argentina; however, most of species are found in Mexico. Subgenus *Parosela* has five sections; two of them, sect. *Prosalea* Barneby (Barneby 1964: 285) (monotypic, *Dalea leucostachya* A. Gray (1849: 32)) and sect. *Viridalea* Barneby (1964: 289) (monotypic, *Dalea viridiflora* S. Watson 1886: 448)), are characterized by having protruding (exerted) stamens through the open ventral portion of the keel, coupled with all

Accepted by Rafael Pinto: 16 Jul. 2020; published: 29 Jul. 2020

its homochromatic petals, green-yellowish (sect. *Prosalea*) or white (sect. *Viridalea*). The other three sections, sect. *Parosela* (Cav.) Barneby (1964: 291), sect. *Psoropogon* (1964: 546), and sect. *Cylipogon* (Raf.) Barneby (1964: 560) include almost 130 species, which most of the time show the stamens immersed into the keel petals; in rare cases, there are species that have the stamens scarcely extruded from the keel petals, and the petals are purple. Two of these sections, *Cylipogon* (yellow petals) and *Psoropogon* (white or anthocyanic petals) have the mature pod with the ventral suture thickened, corneous and bicarinate under the style base; in section *Parosela*, the ventral suture of the pod is not thickened distally, below the base of the style, and when carinate it is always thin and simple.

Section *Parosela* is by far the section with higher number of species within subgen. *Parosela*, with almost 119 species, and includes almost all new species described for Mexico after Barneby´s work (1964). The section includes *Dalea cora* Barneby (1980: 392), *D. illustris* Barneby (1980: 393), *D. sousae* Barneby (1980: 395), *D. acracarpica* Barneby (1990: 89), *D. ruperti* A.E. Estrada, Villarreal & M. González-Elizondo (2004: 67), *D. conetensis* A.E. Estrada, Villarreal & L. López-E. (2011: 465), *D. emmae* Rzed. & Calderón (2015: 4), *D. estoraxana* Rzed. & Calderón (2015: 7), *D. rosarum* Rzed. & Calderón (2015: 13), *D. rupertiana* Rzed. & Calderón (2015; 16), and *D. jaliscana* A.E. Estrada & Villarreal (2016: 90). The new species proposed here strongly contrasts with the features that define the circumscription of sections and species within subg. *Parosela*. Therefore, based on morphological characters and consulting the most specialized literature to identify the species of *Dalea* in Mexico (Barneby 1977), western-central Mexico (McVaugh 1987), and north of Mexico (Shreeve & Wiggins 1964, Estrada *et al.* 2014), this new species do not fit within any of the five sections of subgen. *Parosela* classified and recognized by Barneby (1964). Consequently, here we present a description of a new species along with a description of a new section based on androecium, either exerted or included in the keel petals, type of inflorescence, flower color, type of thickening of the ventral suture in the fruit below the style, and presence/absence of auricles in the basal part of the blade of the epistemonous petals.

Material and methods

Materials collected in the mountains of the southern part of the Mexican state of Zacatecas, locally known as “Sierra del Laurel” were morphologically studied. Two specimens were dissected and examined by using an Olympus SZ-11 Stereo Microscope with 110X magnifications.

Results

The specimens from the Sierra del Laurel did not match with any of the previously known species of *Dalea* or with any other related genera in the Tribe. The characters shown in Table 1 allowed us to recognize a new section and a new species; both are formally described herewith.

Taxonomic treatment

Dalea* sect. *Rubriflorae A.E. Estrada, *sect. nov*.

Type:—*Dalea rubriflora* A.E. Estrada, J. Martínez-Ramírez, A. Mares & Ocampo.

Herbaceous, perennial. **Stems** several from the base, radiating and forming a mat up to 1.6 m diameter. **Leaves** imparipinnate, leaflets 23–33, oblong-elliptic to elliptic-obovate, glabrate homochromous. **Inflorescences** long pedunculated, terminal, erect, continuous with the mains stem axes, the spikes oblong to ovoid-oblong, dense. **Bracts** deciduous, elliptic-obovate, its body abruptly narrow apically and ending in a subulate awn. **Flowers** 1.4 cm long, sessile, with the stamens and style exerted, protruding a third or a quarter of its length far beyond the keel petals. **Calyx** pilose to densely pilose, ribbed, the ribs green, including the teeth, intercostal spaces with a row of 3–7 translucent or honey-colored glands; the teeth triangular-lanceolate, with two glandiform spurs. **Petals** red, remaining the same color until dry, epistemonous petals emerging below the middle of the staminal tube, the banner 10–11.2 mm long, ovate-deltate, plane, basally cordate, long unguiculate, the claw 6.7–7 mm long; the wings 10–10.4 mm long, the claw 4–4.1 mm long, not auriculate, with few tiny spherical glands basally; the keel 11.9–12.2 mm long, its blades valvately

coherent by their outer edges, the claw 6–6.2 mm long, the blade basally truncate. **Stamens** 10-merous, 12–12.5 mm long, the filaments free for 2.5–4 mm long; fruit ovate, immersed in the calyx; ovules 2.

TABLE 1. Main morphological characteristics of the three sections of subg. *Parosela* with androecium exerted far beyond the keel petals.

	Sect. *Prosalea*	Sect. *Viridalea*	Sect. *Rubriflorae*
Growth habit	Shrubs, up to 6 m tall	Herbaceous, up to 1 m tall	Herbaceous, up to 1 m tall
Intrapetiolular glands	Setiform	Elliptic, prominent	Spherical, minute
Leaves length	2.5–9.5 cm	1.2–3.5 cm	(1.3–)8–9.5 cm
Leaflets per leaf	7–15	15–23	23–33
Inflorescences	Paniculate	Spikes single, terminal	Spikes single, terminal
Peduncles length	0–3 cm	0.5–4 cm	Up to 11.5 cm
Spike	5–7.5 mm	9.5–12 mm	12–13 mm
Spike length	1–8 cm	1.5–7 cm	3–3.2 cm
Flower bracts	Caducous, 1.2–2.5 mm long, brown to purple	Persistent, 3–5 mm long, brown	Early caducous, 6–6.6 mm long, white with green tones
Calyx total length	2.1–4 mm	4.2–5 mm	6.2–6.6 mm
Calyx tube length	1.7–2.5 mm	3–4.1 mm	3.5–3.8 mm
Calyx teeth length, shape	0.4–1.5 mm, deltate to triangular	0.4–1 mm, broadly deltate	2.7–3 mm, lanceolate to triangular-lanceolate
Petals color	White	Yellow-green	Ruby-red
Banner length, shape	4.5–7.2 mm, ovate-cordate	5–6.5 mm, ovate to deltate-ovate	10–11.2 mm, ovate-deltate to flabellate, trilobate in appearance
Banner claw length	1.5–3.2 mm	2.7–3.6 mm	6–6.7 mm
Banner blade (length × width)	2.6–4 × 1.2–3 mm	2.3–3.2 × 2.4–4 mm	4.5 × 4.9 mm
Wing length	3.4–7 mm	4.1–4.7 mm	10–10.4 mm
Wing claw length	0.7–2 mm	1.7–1.9 mm	4–4.1 mm
Wing blade (length × Width)	2.5–5.5 × 1.2–3 mm	2.9–3.5 × 1.1–1.5 mm	6.2–6.5 × 2.2–2.5 mm
Keel length, shape	3.2–7.7 mm, oblong-elliptic	4.6–5.3 mm, obovate-oblong	11.9–12.2 mm, elliptic
Keel claw length	0.7–3 mm	1.4–2.1 mm	6–6.2 mm
Keel blade (length × width)	2.7–5 × 1.1–2.8 mm	3–3.8 × 1.4–2 mm	6–6.2 × 3–3.2 mm
Androecium (staminal column) length; free portion length; 3–5 mm protruded from keel	4.5–7.5 mm; free portion 2.3–3.6 mm; 1 mm or less	6.7–8.8 mm; free portion 2.7–3.5 mm; 1 mm or less	12–12.5 mm; free portion 2.5–4 mm; 3–5 mm.
Anthers length; color	0.4–0.7 mm; golden-yellow	0.6–0.8 mm; yellowish	1 mm; purple to brown-purple

Ethymology:—The name *Rubriflorae* of this monotypic section is derived from the red color (permanent ruby red color, even when dried) of its flowers. We added a key to recognize and to differentiate sect. *Rubriflorae* from the sections recognized by Barneby (1964).

Identification key to sections of subgen. *Parosela*, genus *Dalea*, with the androecium exerted far beyond the keel petals. Key adapted from Barneby (1964)

1. Epistemonous and banner petals greenish-yellow, basally auriculate; Chihuahua, Durango, and Zacatecas.....sect. *Viridalea*
- Epistemonous and banner petals white or red, not or obscurely auriculate or the base truncate basally.....2
2. Petals white; inflorescences ament-like, flexuous, paniculately arranged at the tips of the branches, the inflorescence suggesting an *Eysenhardtia* species; suffrutescent and arborescent plants; west and south of Mexico ..... sect. *Prosalea*
- Petals red; inflorescences in single spikes, non-paniculated, arranged at the tip of the branches; herbaceous plants branched from the base; central Mexico, Zacatecas .....sect. *Rubriflorae*

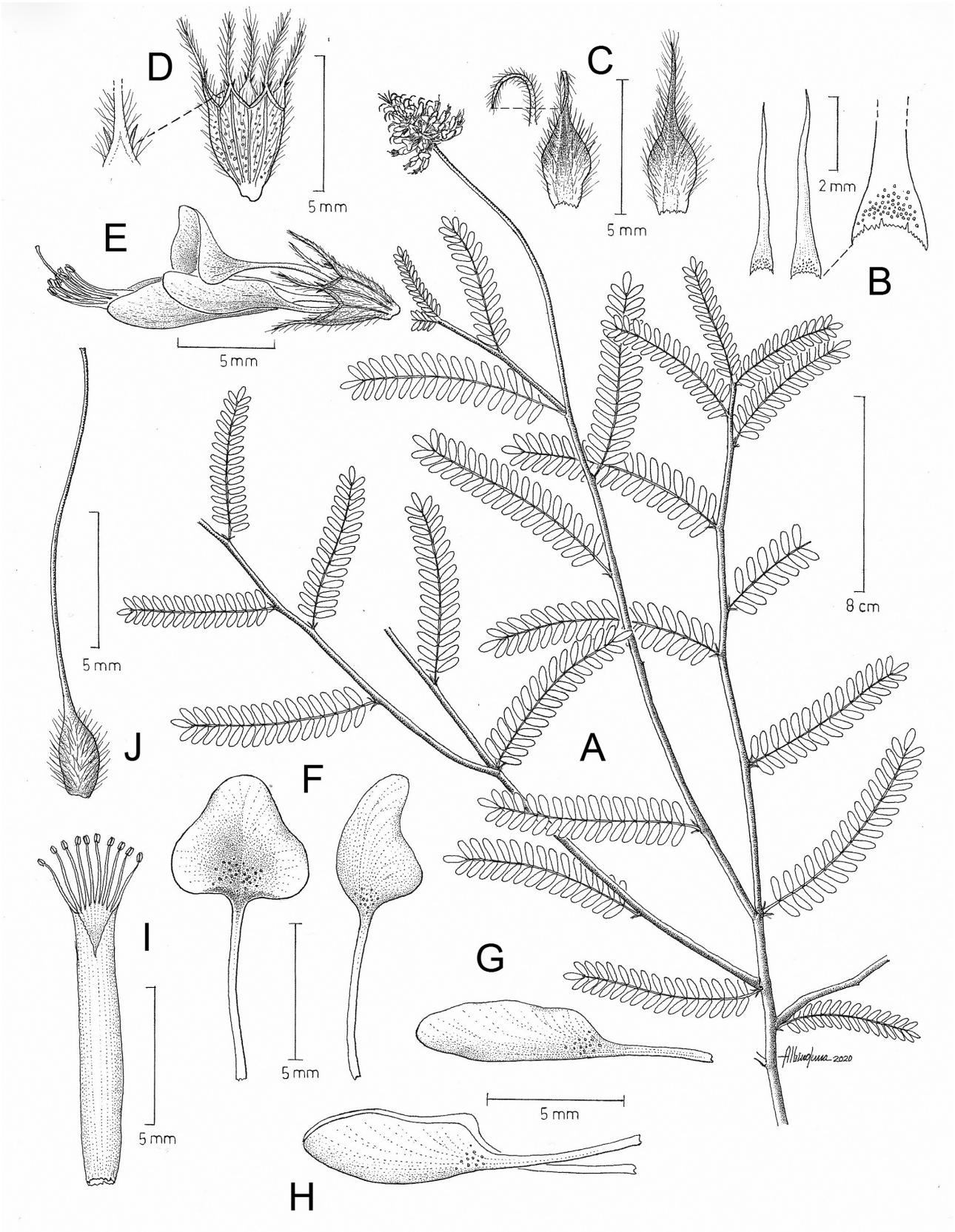

FIGURE 1. *Dalea rubriflora*, A) Flowering habit. B) Leaf stipules. C) Bracts, left side, adaxial view, with the apex curved inward; right side, abaxial view, with the apex straight D) Whole calyx showing glandiform spurs, one on each side at the base of each tooth. E) Whole flower showing the stamens protruding 3–5 mm from keel. F) Banner front view (left) and profile (right). G) Wing. H) Keel. I) Stamens. J) Gynoecium.

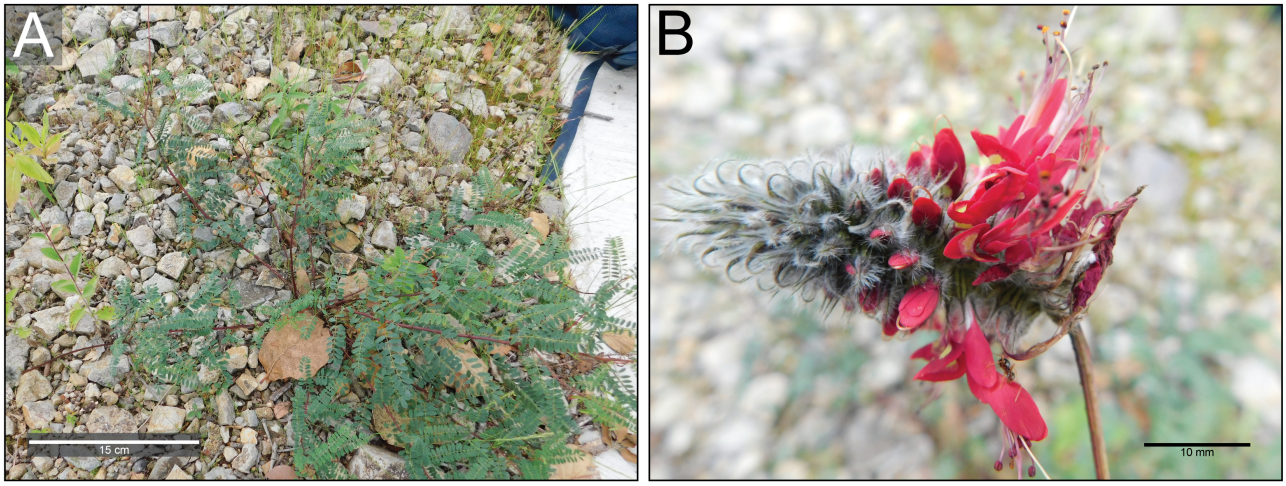

FIGURE 2. *Dalea rubriflora,* A) Habit. B) Inflorescence showing its bracts, red flowers, and protruded stamens.

Dalea rubriflora A.E. Estrada, J. Martínez-Ramírez, A. Mares & Ocampo, *sp. nov.* (Figs. 1 & 2)

Morphologically similar to *Dalea viridiflora* S. Watson (1886: 448) in growth form and single terminal spiked inflorescences; however, *D. rubriflora* has higher number of leaflets (11–16 vs. 7–11 pairs), much longer peduncles (11.5 cm long vs. 0.5–4 cm long), caducous bracts (persistent in *D. viridiflora*), and longer flower structures (calyx, banner, wings, keel, staminal tube, filaments, and anthers).

Type:—MEXICO. Zacatecas (municipio de Nochistlán de Mejía), 18 km en línea recta de Jalpa, Bosque de encino, 21.64747°N, 102.79560°W, elev. 2590 m, 4 Oct 2017, *J. Martínez-Ramírez* 3458, *G. Ocampo, R. Rivera* (Holotype HUAA!; isotypes IBUG!, IEB!, MEXU!).

Perennial plant, herbaceous, up to 80 cm long. **Stems** several, diffuse, trailing, irregularly forked and radiating from the root crown, only the tips of the branches ascending (inflorescences), forming mats 1–1.6 m diameter, green to dark green, striate with dark yellow to brown bands, glabrous with sparse tiny flattened spherical glands; **stipules** linear, lanceolate to triangular-lanceolate, 2.5–3.5 mm long, glabrous, light-brown, with several minute spherical 0.1–0.2 mm diameter orange to reddish glands at the base of the adaxial side; intra-petiolular glands 1, spherical, color similar to honey, 0.1–0.13 mm diameter, post-petiolular glands absent. **Leaves** imparipinnate, 1.3–9.5 cm long, petiole 2–9 mm long, narrowly channeled on the adaxial side, glabrous; **leaflets** 23–33, 3–11 × 0.8–3.3 mm, the terminal leaflet forming a palmate trefoil, elliptic, oblong-elliptic to elliptic-obovate, flat, glabrate, equally green to dark green in both faces, with tiny circular honey-colored glands. **Inflorescence** terminal, peduncle elongate, up to 11.5 cm long, erect, continuous with the mains stem axes, glabrate, green-brown to brown like the stems, striate, the spikes oblong to ovoid-oblong 3–3.2 cm long, 1.5 cm diameter, dense, the flowers compactly arranged, hiding the rachis. **Interfloral bracts** early deciduous, 6–6.6 × 1.5–1.8 mm, elliptic to elliptic-obovate, basally cuneate, the body abruptly narrow apically and ending in a linear or subulate 3–3.6 mm long awn, mostly white, commonly with green tones in the upper middle part including the awn and the middle vein, scattered or densely pilose abaxially (outwardly), sparse with few trichomes but evidently pilose adaxially (internally), membranous, with few small, oblong to circular, colorless or honey-colored glands; bractlets absent. **Flowers** showy, 1.4 cm long from the base of the calyx, sessile, with the stamens and style exerted, protruding a third or a quarter of its length far beyond the keel-petals. Calyx narrow campanulate to campanulate, 6.2–6.6 × 4.5–4.9 mm, the tube 3.5–3.8 mm long, its orifice slightly asymmetric or oblique, pilose to densely pilose, the trichomes 0.8–1.3 mm long, white, ribbed, the ribs green, including the teeth, white or non-colored on the bottom third, central part of the intercostal spaces with a row of 3–7 translucent, colorless or honey-colored tiny spherical or rarely oblong glands; the teeth 2.7–3 mm long, lanceolate to triangular-lanceolate, densely to spread pilose as the tube, with two glandiform spurs, one on each side at the base of each tooth, light brown to light green. Petals red, color persistent in dried specimens, epistemonous petals joined well below the middle of the staminal (androecial) tube, the wings rising up 2 mm above the base, the keel joined 3.4–3.6 mm above the base; the banner 10–11.2 mm long, ovate-deltate to flabellate, its blade plane, tri-lobated in appearance, the lateral lobes apically rounded, the apical lobe slightly triangular, cordate basally, long unguiculate, the claw 6–6.7 mm long, the blade 4–4.5

mm long, 4.5–4.9 mm wide, yellow in the central part of the blade, but turning white on dried material on both, inner and outer surfaces, and sprinkled with several tiny honey-colored circular glands; the wings 10–10.4 × 2.2–2.6 mm, oblong to elliptic-oblong, apically rounded, the claw 4–4.1 mm long, the blade 6.2–6.5 x 2.2–2.6 mm, not auriculate, with few tiny honey-colored spherical glands basally; the keel 11.9–12.2 mm long, its blades valvately coherent by their outer edges, the claw 6–6.2 mm long, the blade 6–6.2 × 3–3.2 mm, elliptic, slightly oblique dorsally, apically rounded, the blade basally and slightly auriculate, sometimes with a small, oblong or nearly spherical honey-colored gland in the middle part near the back. Stamens 10-merous, 12–12.5 mm long, the filaments free about 2.5–4 mm long, protruding 3–5 mm from the keel petals, the free portion and sometimes part of the staminal column out of the keel petals, the connective honey-colored gland tipped; the anthers 1 × 0.7 mm, purple to brown-purple. Ovary elliptic, 2.5–3 × 1 mm, sparsely pilose, the style 13.6–14.2 mm long, linear, green, basally with few scattered long trichomes, stigma linear, indiscernible from style apex. Pod immature, in lateral view, elliptic to ovate-elliptic, 3.5 × 1 mm, the ventral suture slightly concave, valves thin, hyaline, pilose in the upper half; seed immature 1 x 0.8 mm, light brown.

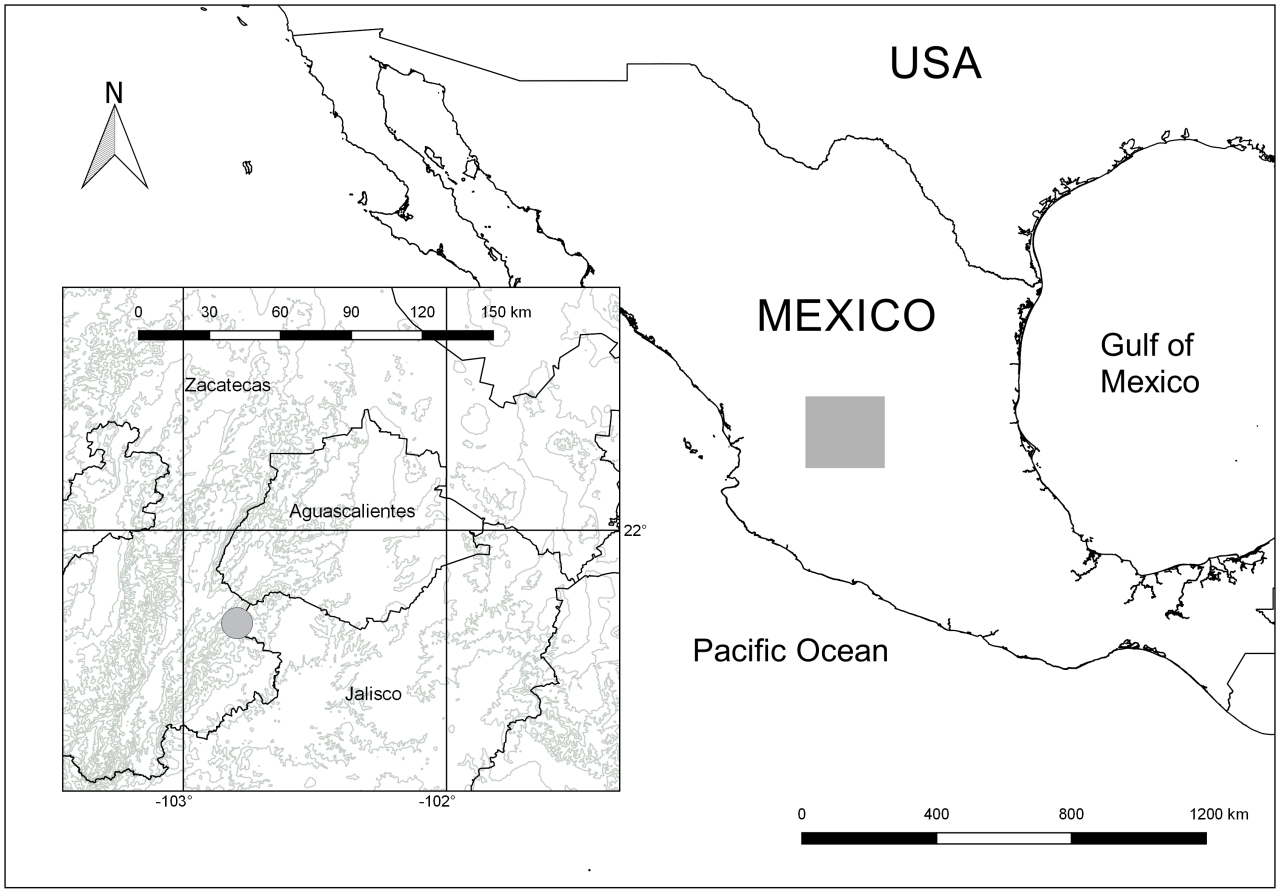

FIGURE 3. Distribution of *Dalea rubriflora* in Zacatecas, Mexico.

Distribution and habitat:—As far as known, there is only one collection of *Dalea rubriflora*. The species was found in an oak forest with elevation of 2590 m in an area locally known as "Sierra del Laurel" (Fig. 3). More collection efforts are needed to know the actual distribution of the species, although it is likely to occur in the neighboring areas of the states of Aguascalientes and Jalisco.

Etymology:—The epithet of the species refers to the characteristic and permanent red color of its flowers (Fig. 2). To our knowledge, this is the only species in the genus *Dalea* whose petals are completely red and keep this color even when the petals are dry. The banner has a yellow spot on its central part, but when the material is dried changes to white, although the rest of the banner remains red on both, inner and outer surfaces.

Phenology:—The specimens were collected in October with flowers and immature fruits. The type collection shows that the basal flowers of the inflorescence are completely developed; the middle flowers are still closed, the petals are developed but not yet open, they remain overlapped one on top of the other and already show their characteristic red color, although the upper flowers are not yet developed. Fruits and seeds may be found in late October or early November.

Conservation status:—To date, the new species is known only from one location, so more field surveys are required to define the actual distribution range of *D. rubriflora*. The species is proposed to be placed under the category of Threatened ("Amenazada") under the Official Mexican Standard NOM-059-SEMARNAT-2010 (SEMARNAT 2010). The species considered under this status could be in danger of disappearance, in the short to medium term, if factors that adversely affect their viability continue to operate (e.g., damage or modification of habitat or directly reducing the size of their populations).

Discussion:—At the moment, this is the first time that a species of *Dalea* is registered with flowers that are completely and persistently red from anthesis until dry, with a banner that has a white to yellow macula at the base. When the red is part of the color of the flower of other species of *Dalea*, it is always accompanied by another or other colors and never persists as a single red color; these combinations occur in species of at least three subgenera of *Dalea*, such as subg. *Theodora* Barneby (1977: 150), subg. *Dalea* Barneby (1977: 168), and subg. *Parosela* (Barneby (1977: 284). The keel petals of subg. *Theodora* form a keel that encloses the stamens but are not fused by their edges (valvated); instead, they are attached to each other in an overlapping fashion, one superimposed on the edge of the other. The species that belong to subg. *Dalea* have the keel with separate petals, while the species of subg. *Parosela* have their petals valvately coherent into a conventional keel. This indicates that, independently of the way in which the epistemonous petals are together joined or separated in the corolla, the red color is present but always in combination with other colors not only in these subgenera, but also in other ones with the blades of the epistemonous petals of the keel free as in the species of subg. *Theodora*, such as *D. mollis* Benth (1848: 306) and *D. mollissima* (Rydb.) Munz (1958: 93), where the banner petal is tinged with violet o dull crimson colors. In addition, several species of the subgenus *Dalea* stand out for the latter feature such as *D. pringlei* A. Gray (1882: 201), *D. emarginata* (Torr. & A. Gray) Shinners (1949: 84), *D. exerta* (Rydb.) Gentry (1942: 138), *D. purpurea* Ventenant (1800: 40), *D. reverchonii* (S. Watson) Shinners (1949: 84), *D. lanata* Spreng. (1826: 327). Several species of subg. *Parosela* may show red-violet, vivid magenta, reddish, dull pink-red, magenta-purple, reddish-purple tones in combination with blue, yellow, and white colors such as *D. escobilla* Barneby (1977: 317), *D. mucronata* DC. (1825: 246), *D. formosa* Torr. (1827: 177), *D. zimapanica* Schauer (1847: 746), *D. filiformis* A. Gray (1853: 39), *D. sericea* Lag. (1816: 23), and *D. foliolosa* (Ait.) Barneby (1973: 1). From these species, only *D. pringlei* and *D. exerta* have the androecium protruding beyond the keel petals; however, they have free keel petals, so they are more related to the species of subgen. *Psoropteris* Barneby (1977: 147) and *Theodora* Barneby (1977: 150). Some species with the keel petal valvately coherent by their outer edges and with the androecium partially protruded from the keel petals are *D. nobilis* (Barneby (1977: 313), *D. bicolor* Humb. & Bonpl. ex Willd. (1809: 787), and *D. trochilina* (Brandegee (1892: 220). These species have purple flowers in combination with white color, but never red colored in any of the petals. In addition, the filaments barely exceed the edge of the keel or the anthers are the only ones that protrude from it, although the protruding part never reaches a third of the total length of the stamens. The relevant characteristic of sect. *Rubriflorae* is that encompasses morphological distinctive features that separate it from the other two sections of subg. *Parosela* with exerted androecium, which may represent a case of evolutionary transition from pollination by bees to hummingbirds. The main differences among the three monotypic sections of subg. *Parosela* are shown in the Table 1. In addition, sect. *Rubriflorae* clearly differs from the other two sections by its longer peduncles and by the longer dimensions of its floral parts (i.e., banner, epistemonous petals, staminal column, style, and anthers). It is noteworthy to mention that the red color of the flowers of *D. rubriflora* is a striking feature within the genus, because no other species of *Dalea*, as far as we know, show this feature.

Acknowledgements

Financial support was provided by the Consejo Nacional de Ciencia y Tecnología (Mexico, grant CB-2015-01-25604) and by the Universidad Autónoma de Aguascalientes (grant PIB17-7N). Our gratitude is extended to Albino Luna for the wonderful botanical illustration for the new species.

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