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Taxonomic update of the flax family in Mexico

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Abstract

The taxonomy of the family Linaceae has not been updated for over two decades and, particularly in Mexico, there is no work evaluating the taxonomic status of all its species. This study provides an update and integrates each of the taxa in the family Linaceae distributed in Mexico. Specimens of plants of this family collected from across the distribution range in Mexico and deposited in herbaria and digital databases, as well as specialized literature, were reviewed. Twenty-four native and one introduced species belonging to two genera, in addition to two varieties, were recognized for the family; the rate of endemism is more than 50% and all native species are under some threat. Reflecting the previously limited knowledge of the group, many of the specimens that we studied had been misidentified. We provide morphological descriptions, supplemented with photographs, illustrations, morphological descriptions, synonymy, ecological data, assessment of conservation status, and a key to differentiate these species. Results presented here reduce the number of native *Linum* species present in Mexico, modify the distribution range of others, provide data about conservation, as well as new records, and support the presence of the genus *Hesperolinon* in Mexican territory.

Keywords: Conservation, endemism, *Hesperolinon*, Linoideae, *Linum,* Mexican flora

Introduction

The family Linaceae DC. ex Perleb comprises a group of plants of cosmopolitan distribution, located in practically all continents except Antarctica, but with a greater affinity for subtropical and temperate regions of the world (McDill *et al.* 2009, McDill & Simpson 2011). Linaceae comprises two subfamilies, Hugonioideae Mabb. ex Reveal and Linoideae Arn. (Dressler *et al.* 2014), 14 genera, and about 260 species, which display a broad morphological variation attributed mainly to the great diversity of environments where they thrive, as well as to their evolutionary history (McDill *et al.* 2009, McDill & Simpson 2011, Ruiz-Martín *et al.* 2018, Burgos-Hernández & Castillo-Campos 2019).

In Mexico, the family is distributed in arid and moderately humid regions throughout the country (Rzedowski & Calderón de Rzedowski 1992, 1994, Burgos-Hernández & Castillo-Campos 2019). However, the number of species and genera that inhabit Mexican territory is still uncertain. Rzedowski & Calderón de Rzedowski (1992) reported a single genus, *Linum* Linnaeus (1753: 277), with 30 taxa occurring in Mexico. Two years later, these same authors mentioned the presence of 27 species of this genus and recognized another species attributed to *Hesperolinon* (A.Gray) Small (1907l: 84), but did not describe it (Rzedowski & Calderón de Rzedowski 1994). More than two decades later, Villaseñor (2016), in his checklist of the native vascular plants of Mexico, included only the genus *Linum* as a representative of the family in the country, with 25 species, of which 12 endemics. Barrera-Robles *et al.* (2020), based on a review of databases, literature, and herbarium labels, concluded that two genera of the subfamily Linoideae are distributed in Mexico. *Linum*, commonly known as “flax” or “linseed”, with 26 native, of which 13 endemic, and one

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introduced species (*Linum usitatissimum* Linnaeus (1753: 277)), and *Hesperolinon*, commonly called "western flax", represented by a single species, *Hesperolinon micranthum* (A.Gray) Small (1907m: 85), present only in northern Baja California. However, the latter authors did not conduct a taxonomic review of the group.

The contributions that include taxonomic treatments for some of the species distributed in Mexico are found in the works of Rogers (1968, 1969, 1982b, 1984b), as well as those of Nesom (1983) and Arreguín (1985), with their descriptions of new species. Important contributions are also represented by the regional floras of Rzedowski & Calderón de Rzedowski (1992, 1994) for El Bajío and Tehuacán-Cuicatlán, Arreguín (2001) for the Valley of Mexico, and Burgos-Hernández & Castillo-Campos (2019) for the state of Veracruz. However, so far, no taxonomic review is currently available including all species distributed in Mexico, thus maintaining identification errors and synonymies in new collections and databases that have not been curated.

The most obvious issues include the cases of *Linum tenellum* Chamisso & Schlechtendal (1830b: 235) and *Linum scabrellum* Planchon (1848d: 507), since both species tend to be easily confused due to the dense pubescence in their vegetative parts; as a result, these two species are frequently incorrectly identified in herbarium collections (Burgos-Hernandez & Castillo-Campos 2019). Also, difficulties in the taxonomic treatment of *Linum orizabae* Planchon (1848a: 482) and *Linum mexicanum* Kunth (1823: 39) have been reported (Burgos-Hernández & Castillo-Campos 2019, Barrera-Robles *et al.* 2020). *Linum nelsonii* Rose (1906: 117) shows a wide morphological variability that has led to serious identification errors, being particularly misidentified as *Linum schiedeanum* Chamisso & Schlechtendal (1830a: 234) (Rogers 1984b, Rzedowski & Calderón de Rzedowski 1992, Burgos-Hernández & Castillo-Campos 2019). On the other hand, the presence of the genus *Hesperolinon* in Mexico has been challenged; of the 13 species included in this genus, only *H. micranthum* has a distribution range stretching beyond the United States of America down to northwest Mexico (Rogers 1975, Schneider *et al.* 2016, Jepson eflora 2021). In addition, this genus is poorly represented in Mexican herbaria, and there are no works addressing this controversy.

No complete taxonomic treatmet of the entire Linaceae family in Mexico is currently available. The current descriptions of multiple species have not been updated for more than two to four decades and the taxonomic and nomenclatural errors have not been resolved, so the taxonomy of this family remains unclear. Therefore, the present study conducted a comprehensive taxonomic review of the Linaceae family in Mexico to provide clarity on their distribution range and the number of genera and species, as well as to update the available information on each of them. Dichotomous keys are provided, as well as information regarding phenology, ecology, photographs, illustrations, and distribution maps for each species.

Materials and methods

A preliminary list of species of the family Linaceae in Mexico was built based on a review of the taxonomic literature. The list served as a guide for the review of herbarium material of specimens collected in Mexico and deposited in the following herbaria: ANSM, CHAP, CHAPA, CIB, CIIDIR, ENCB, F, GH, HAL, IBUG, IEB, INEGI, K, MICH, MEXU, MO, ND, NY, PH, SLPM, UAMIZ, UC, US, WU, XAL, and YU (Thiers 2022). The protologues, digitized specimens, and databases available for all the species studied were consulted in the digital database of the *Red de Herbarios del Noroeste de México* (Network of Herbaria of Northwest Mexico) (https://herbanwmex.net/portal/), Jepson eflora (http://ucjeps.berkeley.edu), JSTOR Global Plants (www.plants.jstor.org) and Tropicos (www.tropicos.org).

The specimens were corroborated and, in some cases, reidentified from the morphological standpoint aided with a stereomicroscope (STEMI 2000-C, Carl Zeiss, Cd. Mx, Mexico). We used specialized literature, including floristic works (Guzmán-Lucio *et al.* 2013, Villaseñor 2016, Ulloa-Ulloa *et al.* 2017, Barrera-Robles *et al.* 2020), dichotomous keys (Rogers 1963, 1964d, 1968; Burgos-Hernández & Castillo-Campos 2019), monographs (Rogers 1984b, Flora of North America Editorial Committee 2016), regional floras (Rzedowski & Calderón de Rzedowski 1992, 1994, Arreguín 2001, Stafford 2011, Burgos-Hernández & Castillo-Campos 2020) and images from the works mentioned above. The descriptions included in this work include information on phenology, habitat, distribution, elevation, and vegetation types associated with each species. Vegetation types were assigned following the classification by Miranda & Hernández (1963). The names of the species were verified on The International Plant Name Index (https://www.ipni.org/) and The Catalogue of Life 2022 Annual Checklist (Banki *et al.* 2022).

Since most of the species in the family are not listed in any risk category according to the IUCN Red List (IUCN 2021) and the Mexican regulations NOM-059-SEMARNAT-2010 (SEMARNAT 2010), the conservation status of

the species was determined using the occurrence data in the GeoCAT tool (Bachman *et al.* 2011) based on the IUCN Red List categories and criteria (IUCN 2019). In addition, this information was complemented based on the literature, herbarium labels, and background on the distribution areas. Endemisms were determined according to descriptions of specialized studies (Nesom 1983, Rogers 1984b, Arreguín 1985, Alanis-Flores *et al.* 2011, Martínez-de la Cruz *et al.* 2018, Barrera-Robles *et al.* 2020), floristic listings (Villaseñor 2016), distribution data reported in national and foreign digital databases (www.snib.mx, www.gbif.org, www.tropicos.org), and information on herbarium labels.

The distribution maps for each species were produced with the software QGIS v. 3.10.9 (QGIS Development Team 2020), using the collection sites recorded on herbarium material. When the herbarium labels did not include the geographic coordinates of the collection site or these were found to be erroneous, these were corrected or supplemented using the software Google® Earth Pro v. 7.3.2.5776 (Google LLC 2019).

Taxonomy

Linaceae DC. ex Perleb (1818: 107).

Description:—*Herbs* or shrubs, annual or perennial. *Leaves* simple, entire, serrate, or denticulate; alternate, opposite and/or in whorls; sessile or subsessile; venation pinnate; with or without stipules, often provided with stipular glands; glabrous, pubescent, or puberulent. *Inflorescence* axillary or terminal; cyme, panicle, cymose panicle, or raceme, rarely corymb, exceptionally solitary. *Flowers* hermaphrodite, actinomorphic; *sepals* 4–5, imbricate, free or attached at the base, usually persistent, entire or glandular-denticulate; *petals* 4–5, imbricate or convolute, free or united at the base, often deciduous, diverse colors; *stamens* 4–5, rarely 10(–15) or numerous, arranged in a whorl; filaments attached at the base; anthers 2-locular, longitudinal dehiscence, staminodia present or absent; *styles* of equal number as locules, filiform, free, or fused up to near the apex; stigmata 2–5, capitate, subcapitate or filiform; *ovary* superior, (2–)5-locular or apparently (4–)10-locular due to the presence of false septa; ovules 1–2 per locule, anatropous, axillary or apical-axillary placentation. *Fruit* a septicidal capsule, rarely loculicidal, dehiscent at maturity in 4–10 segments; *seeds* compressed, oleaginous.

Key to Linaceae genera in Mexico

1. Petals with reddish venation, presence of basal adaxial appendages; carpels, styles, and stigmata 2 or 3; fruit dehiscent into 4 or 6 segments ..... *Hesperolinon*
- Petals without reddish venation, absence of basal daxial appendages; carpels, styles, and stigmata 5; fruit dehiscent into 5 or 10 segments ..... *Linum*

Hesperolinon (A.Gray) Small, 1907h: 84. Type:—*Hesperolinon californicum* (Benth.) Small, N. Amer. Fl. 25: 86. 1907.

Description:—*Herbs,* annual, thin, glabrous, occasionally pubescent or puberulent; *stems* erect or extended, sometimes slightly decumbent, not branched or branched from the base or from the inflorescence, glabrous or pubescent. *Leaves* entire or with marginal glands; basal leaves arranged in whorls of 4, distal leaves opposite or alternate; sessile or subsessile, with or without stipular glands. *Inflorescence* terminal, in a cymose panicle, sometimes condensed. *Flowers* with 5 *sepals*, imbricate, connate at the base, persistent, entire or with marginal glands, glabrous or villous; *petals* 5, yellow, white to pink, convolute, reddish venation; presence of basal adaxial appendages, more or less conspicuous, that sometimes expand into auricles; *stamens* 5, staminodia absent; *styles* 2–3, free, stigmata capitate or subcapitate; *ovary* superior, 2 or 3-locular, or 4 or 6-locular due to the presence of false septa. *Fruit* a septicidal capsule, ovoid, dehiscent into 4 or 6 segments, glabrous; *seeds* 4 or 6, triangular in cross-section, brown, often with darker spots; testa mucilaginous. The genus comprises one species in Mexico, distributed in a narrow area of the state of Baja California.

Hesperolinon micranthum (A.Gray) Small, (1907i: 85.) (Fig. 1).

Type:—UNITED STATES OF AMERICA. California: Mariposa County, Mt. Bullion, *Bolander 4854* (holotype GH!, isotypes DS, UC!).

Linum micranthum A.Gray (1868: 333).

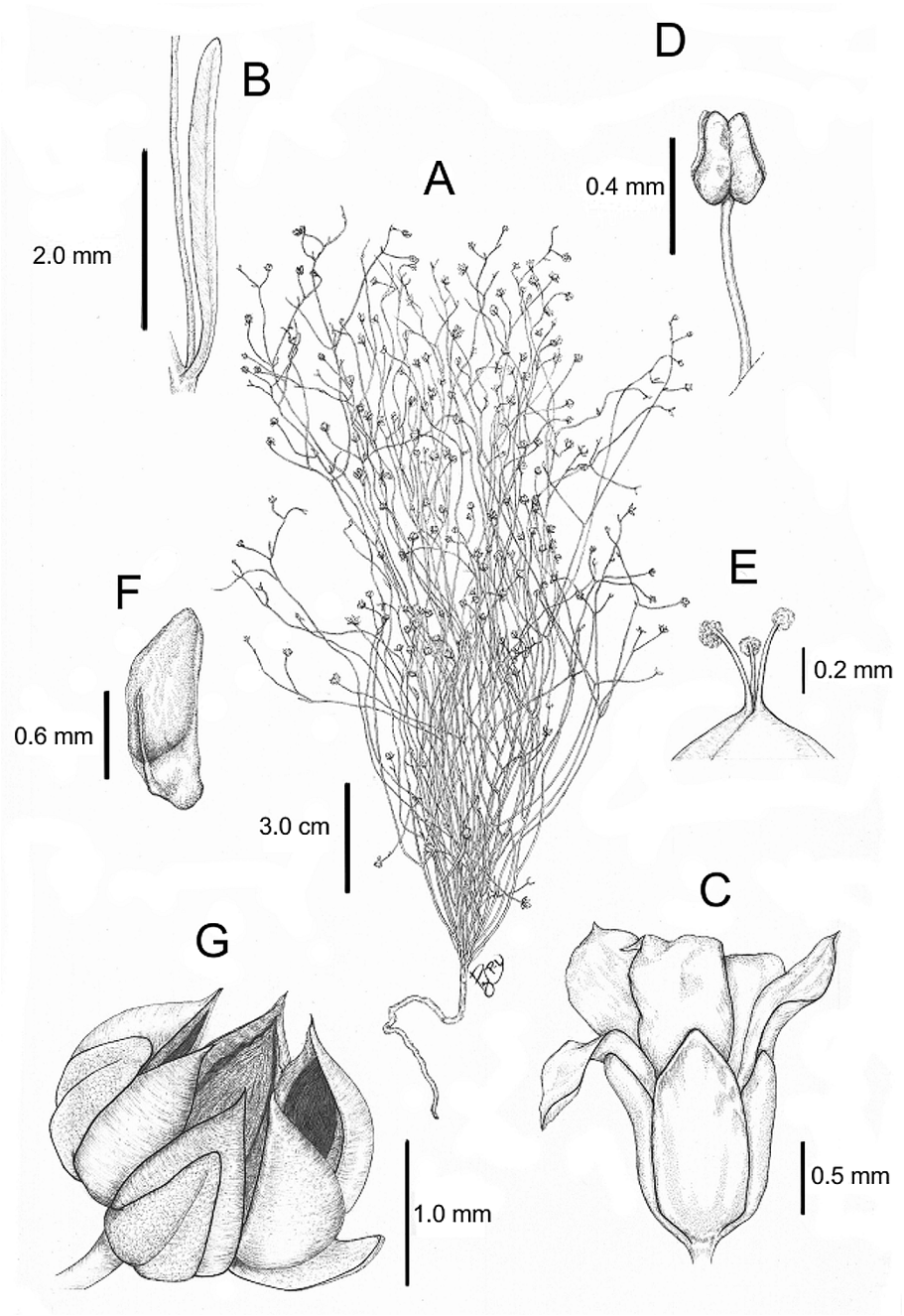

FIGURE 1. *Hesperolinon micranthum*. A. Aspect general of the plant; B. Leaf; C. Flower; D. Filament and anther; E. Styles and stigmata; F. Seed; G. Fruit. Illustrated by Lizbeth Pérez Lucas, based on *I.L. Wiggins 21556*.

Description:—*Herbs*, 5–50 cm in height, glabrous to sparsely puberulent at the base; *stems* slightly decumbent, smooth, branched from the base, glabrous; stipular glands generally present at the base. *Leaves* entire, basal leaves in whorls, distal leaves alternate; linear or closely oblong, (5.5)10.0–20.0(–30.0) × (0.3)1.5–2.5(–3.0) mm; sessile, apex acute to obtuse, glabrous, stipular glands present only in basal leaves. *Inflorescence* in a cymose panicle, pedicels 3.9–14.6(–30.0) mm long, sometimes longer in the fruit; *bracts* 0.9–1.3 mm long, margin entire, apex acute; sepals entire or with minute marginal glands, lanceolate, 1.0–3.0 × 0.6–0.9 mm, apex slightly acuminate, glabrous; *petals* white to light pink, oblanceolate, 1.5–3.5 mm long; *stamens* 1.5–2.5 mm long; anthers purple or dark purple, 0.3–1.0 mm long; *styles* 3, 0.5–1.0(–2.0) mm long, stigmata capitate; *ovary* 3 or 6-locular for the presence of false septa. *Fruit* yellow, 1.3–1.5 × 1.3–1.4 mm, pericarp thin, apex acute, dehiscent into 6 segments; *seeds* 6, 1.1–1.3 × 0.4–0.6 mm.

Distribution:—United States of America; in Mexico, in northern Baja California (Fig. 2a).

Habitat and ecology:—Cypress-juniper forest and chaparral shrubland. Elevation 50–2000 m. Common in serpentine soils in the California biogeographic province.

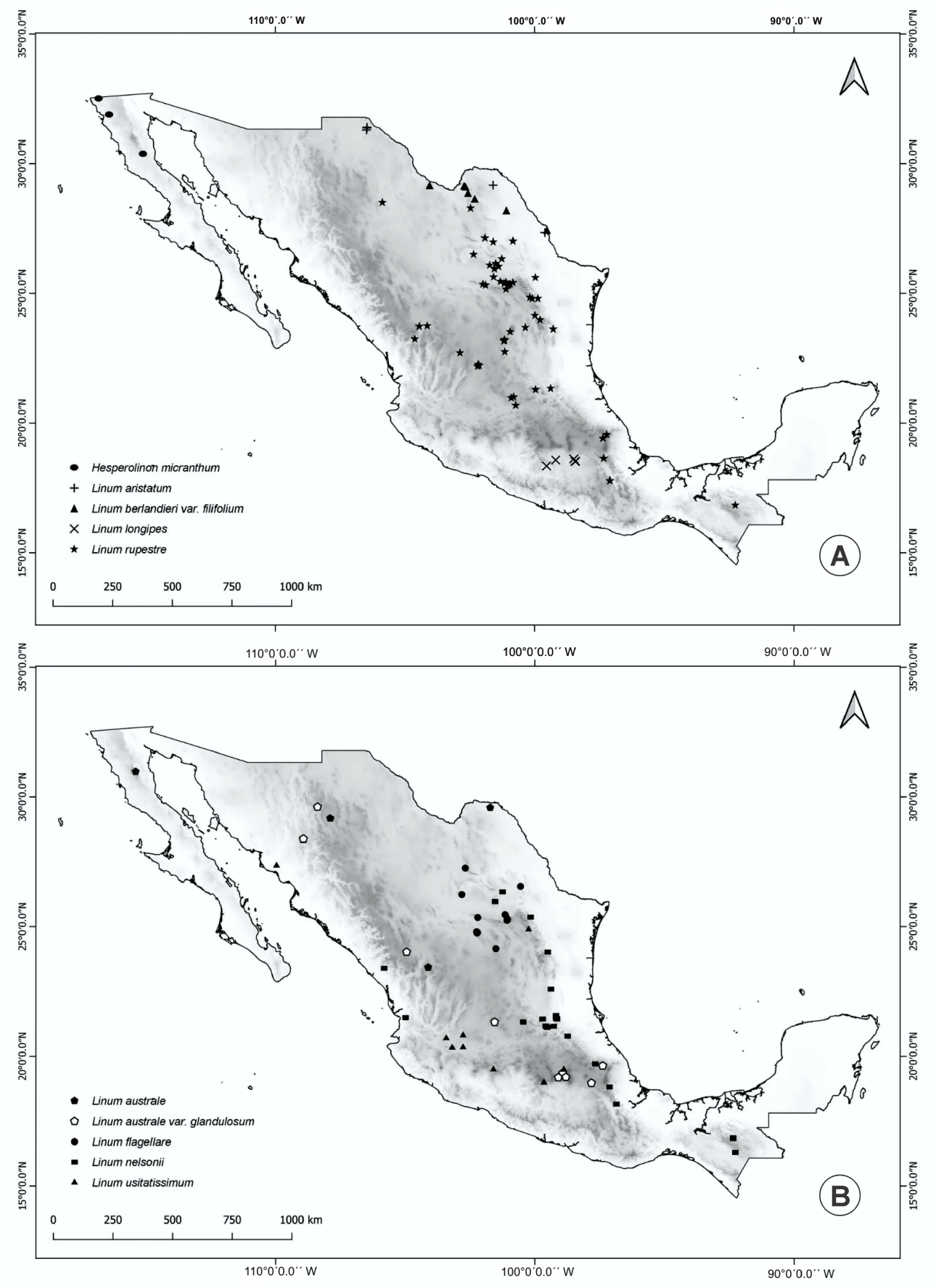

FIGURE 2. Geographic distribution in the Mexican territory of: A. *H. micranthum*, *L. aristatum*, *L. berlandieri* var. *filifolium*, *L. longipes,* and *L. rupestre*; B. *L. australe*, *L. australe* var. *glandulosum*, *L. flagellare*, *L. nelsonii*, and *L. usitatissimum*. Maps by Ma. Isabel Olivares.

Phenology:—Flowering and fruiting in May–October.

Note:—Although the species is not endemic to Mexico, its distribution is restricted to the California biogeographic province (Delgadillo 1998, Morrone 2019). *Hesperolinon micranthum* is the only species in the genus reported (Springer 2009, Schneider *et al.* 2016, Jepson eflora 2019) and corroborated in this study, with a distribution range stretching to Mexico. According to the material reviewed, the species is clearly distinguished from the species in the genus *Linum* distributed in Mexico by the number of carpels, styles, and stigmata, as well as by the dehiscent fruit.

Conservation status:—According to IUCN Red List Categories and Criteria (IUCN 2019), *H. micranthum* is Endangered (EN) (B1 + 2ac(iii)). Its extent of occurrence (EOO) is less than 5,000 km^2 (1,751.668 km^2) and its estimated area of occupancy (AOO) is 12 km^2. This species presents a restricted distribution, only known in Baja California in Mexico. Additionally, its habitat has been subjected to multiple anthropogenic pressures (Morrone 2019), and may face major risks.

S**pecimens examined:**—MEXICO. Baja California: Ensenada, Rancho Caliente, 22 May 1971, *I.L. Wiggins 21556* (ENCB!); Tecate, Cerro Jesús María, 770 m, 30°31’00’’N, 116°49’00’’W, 9 May 1970, *R. Moran 17565* (ENCB!); Tecate, Cerro Matomí, 1300 m, 30°23’00’’N, 115°06’00’’W, 4 May 1973, *R. Moran 20820* (ENCB!).

Linum Linnaeus (1753: 277). Type:—*Linum usitatissimum* L., N. Amer. Fl. 25: 67. 1907.

Description:—*Herbs*, sometimes shrubs, annual or perennial; glabrous, puberulent, or pubescent partially or throughout; *stems* erect or extended, sometimes decumbent, unbranched or branched from the base or from the inflorescence, glabrous or pubescent. *Leaves* entire, dentate or glandular-dentate; alternate, opposite and/or in whorls; sessile or subsessile, with or without stipular glands. *Inflorescence* terminal, in cymose panicles or racemes, rarely in corymbs or solitary. *Flowers* with 5 *sepals*, imbricate, attached at the base, commonly persistent, rarely deciduous; entire, laciniate, ciliate, dentate, or glandular-dentate, glabrous or pilose; *petals* 5; yellow, white, pink, yellowish-orange, orange, or blue, rarely red or crimson-brown; longer than sepals; *stamens* 5, provided with 5 small staminodia or absent; *styles* 5, free, connate at the base or fused up to 1/2 or more of the style length, filiform; stigmata capitate or straight; *ovary* superior, 5-locular or 10-locular for the presence of false septa. *Fruit* with septicidal capsule; ovoid, ellipsoid, or triangular-ovoid; dehiscent into 5 or 10 segments; glabrous or pilose; *seeds* 10, lenticular, flattened, elliptical to broadly elliptical; brown to reddish-brown; testa mucilaginous. The genus comprises 24 native and one introduced species distributed throughout the Mexican territory.

Key to *Linum* species in Mexico

1.	Fruit dehiscent into 5 segments	2
-	Fruit dehiscent into 10 segments	8
2.	Corolla yellow	3
-	Corolla yellow-orange to salmon with a red to wine-red base	5
3.	Root thin; stem puberulent at the base; fruit ovoid	4
-.	Root thick; stem glabrous; fruit ellipsoid	***L. aristatum***
4.	Stipular glands absent, sometimes present only in some parts, then barely conspicuous	***L. australe***
-	Stipular glands present throughout the plant, very conspicuous	***L. australe* var. *glandulosum***
5.	Stems pilose locally or throughout	6
-.	Stems glabrous throughout	7
6.	Plant hirsutulose at the base; sepals glabrous; fruit with translucent thin pericarp	***L. berlandieri* var. *filifolium***
-	Plant densely gray-puberulent to the inflorescence; sepals pubescent; fruit with thick opaque pericarp	***L. puberulum***
7.	Basal leaves alternate; sepals deciduous, 3-nerved; anthers brick-red	***L. elongatum***
-.	Basal leaves opposite; sepals persistent, 1-nerved; anthers brown	***L. vernale***
8.	Corolla blue	9
-	Corolla yellow, yellow-orange, white, or pink	11
9.	Stems erect or ascending	10
-	Stems creeping or prostrate	***L. rzedowskii***
10.	Pedicels villous; anthers white; stigmata capitate	***L. lewisii***
-	Pedicels glabrous; anthers bright-yellow; stigmata linear to claviform	***L. usitatissimum***
11.	Plants densely pubescent throughout	12
-	Plants glabrous or locally pubescent	13
12.	Basal leaves opposite; bracts with stipular glands, conspicuous; petals yellow-orange, pilose at the base	***L. scabrellum***
-	Basal leaves in whorls; upper bracts without stipular glands; petals yellow, glabrous	***L. tenellum***
13.	Stems decumbent	14
-	Stems erect	15
14.	Leaves widely ovate or elliptical, scariose; anthers 0.7–1.2 mm long	***L. cruciata***
-	Leaves narrowly oblanceolate, obovate to narrowly elliptical, rough; anthers 0.5 mm long	***L. lasiocarpum***

15. Annual herbs....16
- Perennial herbs....17
16. Basal leaves in whorls, obovate; 3-nerved sepals; styles fused to near the apex; fruit pale-yellow throughout.... ***L. longipes***
- Basal leaves opposite, elliptical-oblanceolate; 1-nerved sepals; styles free; fruit yellow with purple hues on the upper portion .... ***L. neomexicanum***
17. Root thick....18
- Root thin....20
18. Basal leaves opposite or in whorls; stigmata light brown; fruit yellow with purple hues at the upper portion....19
- Basal leaves alternate; stigmata yellow; fruit yellow throughout.... ***L. flagellare***
19. Styles free or connate at the base.... ***L. orizabae***
- Styles fused to half or close to the apex.... ***L. mexicanum***
20. Fruit glabrous....21
- Fruit pubescent at the apex.... ***L. nelsonii***
21. Fruit yellow with purple hues at the upper portion; petals white or pink.... ***L. pringlei***
- Fruit yellow throughout; petals yellow to greenish-yellow....22
22. Basal leaves alternate or opposite.... ***L. rupestre***
- Basal leaves in whorls....23
23. Leaves with stipular glands at the base; pedicels 0.1–0.2 mm long; bracts 2.0–3.0 mm long; sepals 2.0–5.0 × 1.0–1.5 mm, seeds reddish-brown.... ***L. schiedeanum***
- Leaves without stipular glands at the base; pedicels 3.5–14.7 mm long; bracts 0.6–1.1 mm long; sepals (1.2)1.7–1.8 × 0.5–0.7 mm; seeds light brown.... ***L. modestum***

Linum aristatum Engelmann (1848: 101). (Fig. 3a).

Type:—MEXICO. Chihuahua: Near Carizal south of El Paso, *Wislizenus 101* (holotype MO!, isotype GH!).

Cathartolinum aristatum Small (1907a: 83).

Mesynium aristatum (Engelm.) W.A.Weber (1984: 3).

Description:—*Herbs*, annual, 10–45 cm in height, glabrous, main root thick; *stems* extended, ascending, rigid, broom-shaped, striate, branched from the base, glabrous. *Leaves* entire, alternate; basal leaves sometimes opposite; linear, (4.8)5.0–20.0 × 0.3–1.1 mm, sessile; apex acute to acuminate, tip whitish to translucent; 1-nerved, membranous, glabrous; stipular glands present at the base, black. *Inflorescence* a cymose panicle, pedicels thin, 6.2–34.0 mm long; *bracts* 5.5–9.0 mm long, apex acuminate, margin glandular-dentate, stipular glands absent; *sepals* deciduous, linear-lanceolate, scariose, 6.4–7.5 mm long, glandular-dentate, apex smoothly attenuated; 3-nerved, central nerve evident; without stipular glands; *petals* yellow to yellow-orange, obovate, 8–12 mm long, glabrous; *stamens* 5–7 mm long, glabrous; anthers elliptical, 0.7–1.1(1.2) mm long, yellow; staminodia absent; *styles* fused to near the apex, 4.5–7.0 mm long; stigmata capitate, yellow. *Fruit* ellipsoid, yellow, clearly longer than wide, 3.5–4.0 × 2.5–3.0 mm, glabrous, pericarp thin, apex obtuse, dehiscent into 5 segments; *seeds* elliptical, dark brown, 2.5–3.0 × 0.8–1.0 mm.

Distribution:—United States of America; in Mexico, in Chihuahua, Coahuila, and Tamaulipas (Fig. 2a).

Habitat and ecology:—Cypress-juniper forest, oak forests, oak-pine forests, thornless or sub-thornless small-leaved shrubland, grasslands, pine forests, vegetation of sandy arid deserts. Elevation (300)1100–3100 m. Dry sandy soils of the Phaeozem, Lithosol, Luvisol, Regosol, Vertisol, and Xerosol types.

Phenology:—Flowering in March–August; fruiting in August–November.

Note:—*Linum aristatum* is easily distinguished from the rest of the species with dehiscence into 5 segments for having pale ellipsoid fruits and thin pericarp, in addition to narrow and smoothly attenuated sepals.

Conservation status:—According to IUCN Red List Categories and Criteria (IUCN 2019), *L. aristatum* is EN (B1 + 2ab(iii)), with an EOO < 5,000 km^2 (52.886 km^2) and AOO < 500 km^2 (12 km^2). The areas where this species occurs in Mexico have been used for tourist-recreational purposes and overgrazing, industrial development, and urban growth have also been reported (Fernández *et al.* 2014).

Specimens examined:—MEXICO. Chihuahua: Along hiway 45, 112 miles N of Gallego, 1250 m, 18 July 1975, *K.L.Wallace et al. 136* (ENCB!); Juárez, 4.8 miles S of Samalayuca, 1275 m, 31°18’00”N, 106°29’00”W, 19 August 1971, *J. Henrickson 5780* (MEXU!); Juárez, 5 km N of Samalayuca, 1250 m, 31°24’30”N, 106°27’36”W, 28 October 1972, *T.L. Wendt et al. 9922* (MEXU!). Coahuila: Gravelly mesas near Díaz, 742 m, 29°10’24.81”N, 101°36’0.97”W, 17 April 1900, *C.G. Pringle 8312* (MEXU!). Tamaulipas: Nuevo Laredo, Sandy upland fourteen miles south of Nuevo Laredo, 141 m, 27°20’25.11”N, 99°36’19.33”W, 24 March 1944, *N.T. Heard & F.A. Barkley 14604* (MEXU!).

Linum australe A.Heller (1898: 627). (Fig. 3b).

Type:—UNITED STATES OF AMERICA. New Mexico: 4 mi E of Santa Fe, *Heller & Heller 3724* (holotype NY!, isotypes F!, GH!, K!, KANU, KSC, MO!, MSC, NEB, US!).

Cathartolinum australe Small (1907b: 81).

Linum aristatum var. *australe* (A.Heller) Kearney & Peebles (1939: 485).

Mesynium australe (A.Heller) W.A.Weber (1984: 3).

FIGURE 3. A. *Linum aristatum*; B. *Linum australe*; C. *Linum berlandieri* var. *filifolium*; D. *Linum cruciata*. Photographs by José Luis Colin.

Description:—*Herbs*, annual, 10–55 cm in height, puberulent in the basal part, glabrous or almost glabrous in the distal part; root thin; *stems* erect, striate, usually branched from the base, glaucous, puberulent. *Leaves* entire, sometimes slightly glandular-dentate, involute, alternate, linear, 4.0–20.0 × 0.5–2.0 mm, sessile, apex acute to acuminate, tip whitish, 1-nerved, coriaceous, glabrous, stipular glands present. *Inflorescence* a cymose panicle, pedicels 2.0–15.0 mm long, striate; *bracts* (3.9)4.0–6.0 mm long; margin scariose, glandular-dentate; sometimes with purple spots, apex acute, stipular glands present or sometimes absent; *sepals* deciduous, linear-lanceolate, 4.0–6.0 × (0.9)1.0–1.5 mm, margin glandular-dentate, occasionally with reddish-purple spots, apex cuspidate-aristate, tip whitish, 1(–3)-nerved, stipular glands present or absent; *petals* light yellow to yellow-orange, oblanceolate or obovate, 6.0–100 mm long, *stamens* 3.0–7.0 mm long; anthers 0.5–1.0(1.1) mm long, yellow; staminodia absent; *styles* fused to near the apex, 2.0–6.0 mm long, stigmata capitate. *Fruit* ovoid, yellow, 3.0–3.2 × 2.4–4.0 mm, glabrous, pericarp thick, apex obtuse, dehiscent into 5 segments; *seeds* elliptical, reddish-brown, 2.0–3.0 × 0.8–1.0 mm.

Distribution:—United States of America; in Mexico, in Baja California, Chihuahua, Coahuila, and Durango (Fig. 2b).

Habitat and ecology:—Oyamel fir forest, oak forests, oak-pine forests, thorny shrublands, and pine forests. Elevation 1500–2700 m. Montane soils, mainly Andosol, Cambisol, Phaeozem, Fluvisol, Lithosol, Regosol, Rendzina, Vertisol, Xerosol, and Yermosol.

Phenology:—Flowering and fruiting in August–September.

Note:—*Linum australe* is the only species within its distribution range that is glabrous beyond the base, with yellow flowers and fused styles almost to the apex. The stems and pedicels strongly striated to sulcate in the distal part are a distinctive character of the species. Its distribution in the northern part overlaps with the distribution of *L. aristatum*; however, they can be differentiated, since the latter presents a much more branched habit, a glabrous stem, and an ellipsoid fruit with thin pericarp.

Conservation status:—According to the criteria established by the IUCN (2019) this species is EN (B2ac(iii)) with an EOO of 512,558.866 km^2 and AOO of 16 km^2, and < 5 localities areknown. It stands out that this species has a wide distribution in the United States of America and that the evaluation presented here only considered Mexican specimens.

Specimens examined:—MEXICO. Baja California: Sierra San Pedro Mártir, canyon at base of Cerro Botella Azul, 2700 m, 19 July 1988, *S. Boyd & A. Liston 2700* (MEXU!). Chihuahua: Road between Babicora and Yepomera, 2500 m, 8 April 1977, *Bennett et al. 821* (CHAPA!). Coahuila: Acuña, 75 km al noroeste de Ciudad Acuña, 565 m, 29°34’56”N, 101°43’31”W, 29 May 2016, *J. A. Encina et al. 5415* (ANSM!). Durango: Súchil, Hacienda El Mortero, 1970 m, 15 September 2001, *N. Almaraz et al. 60* (CIIDIR!).

Linum australe var. ***glandulosum*** C.M.Rogers (1964a: 336). (Fig. 4).

Type:—MEXICO. Durango: Otinapa, *Palmer 465* (holotype US!, isotypes F!, GH, MO!, NY!).

Mesynium australe (C.M. Rogers) W.A.Weber (1984: 3).

Description:—*Herbs* with black stipular glands, very prominent on nodes, base of all leaves, bracts, and sepals.

Distribution:—United States of America; in Mexico, in Chihuahua, Mexico City, Durango, State of Mexico, Guanajuato, Puebla, Sonora, and Veracruz (Fig. 2b).

Habitat and ecology:—Cypress-juniper forest, oak-pine forests, prickly-pear cactus patches, grasslands, oak forests, thornless small-leaved shrubland, and pine forests. Elevation 1500–2650 m. Montane soils, mainly red-ash Acrisol, Andosol, Cambisol, Phaeozem, Lithosol, Luvisol, and Regosol.

Phenology:—Flowering and fruiting in May–September.

Taxonomic note:—The black and prominent stipular glands of *L. australe* var. *glandulosum* on the nodes, leaves, bracts, and sepals make it possible to clearly differentiate this variety of the species.

Conservation status:—Rzedowski & Calderón de Rzedowski (1992) mention that *L. australe* var. *glandulosum* is at risk of extinction. However, according to the criteria established by the IUCN (2019) this variety is Vulnerable (VU) (B2abc(iii)), with an EOO of 164,257.374 km^2 and AOO of 28 km^2, known to < 10 localities. It is worth mentioning that its distribution in areas that harbor large human population nuclei of the country and the constant loss of habitat (CONABIO 2021, Rodríguez-Echeverry & Leiton 2021) could be a cause of threat shortly.

Specimens examined:—MEXICO. Chihuahua: Chuhuichupa, near Chuhuichupa, 2148 m, 29°36’36”N, 108°22’48”W, 1 August 1936, *H. LeSueur 132* (MO!). Mexico City: Milpa Alta, Paraje de Cuauhte, 2650 m, 4 July 1976, *A. Ventura A. 1727* (IEB!). Durango: Durango, 18 miles west of Durango, 24 July 1964, *C.M. Rogers 13183* (MEXU!). State of Mexico: Ixtapaluca, Cerro del Pino, 2300 m, 1 November 1972, *M.L. Arreguín 346* (MEXU!); Tlalmanalco, Tramo Tlalmanalco-Amecameca, 2260 m, 12 September 1976, *J. García P. 199* (CHAPA!). Guanajuato: León, 41 km al NE de León, 2450 m, 14 July 1987, *J. Rzedowski 43752* (IEB!). Puebla: Acatzingo, San Juan Ocozoc, 2110 m, 18°59’00”N, 97°47’00”W, 1 July 1907, *G. Arsené 1921* (MEXU!). Sonora: Yecora, 0.2 km north of Yecora and road to Agua Blanca, 1540 m, 28°22’46”N, 108°55’37”W, 15 July 1997, *A.L. Reina et al. 780* (MEXU!). Veracruz: Perote, Sierra entre Mastaloyan y Frijol Colorado, 2650 m, 19°38’00”N, 97°23’00”W, 25 August 1984, *G. Castillo C. et al. 3288* (XAL!).

Linum berlandieri var. ***filifolium*** (Shinners) C.M.Rogers (1984a: 39). (Fig. 3c).

Type:—UNITED STATES OF AMERICA. Texas: Brewster County, *McVaugh 7798* (holotype SMU, isotypes F, GH!, MICH).

Linum rigidum var. *filifolium* Shinners (1949: 136).

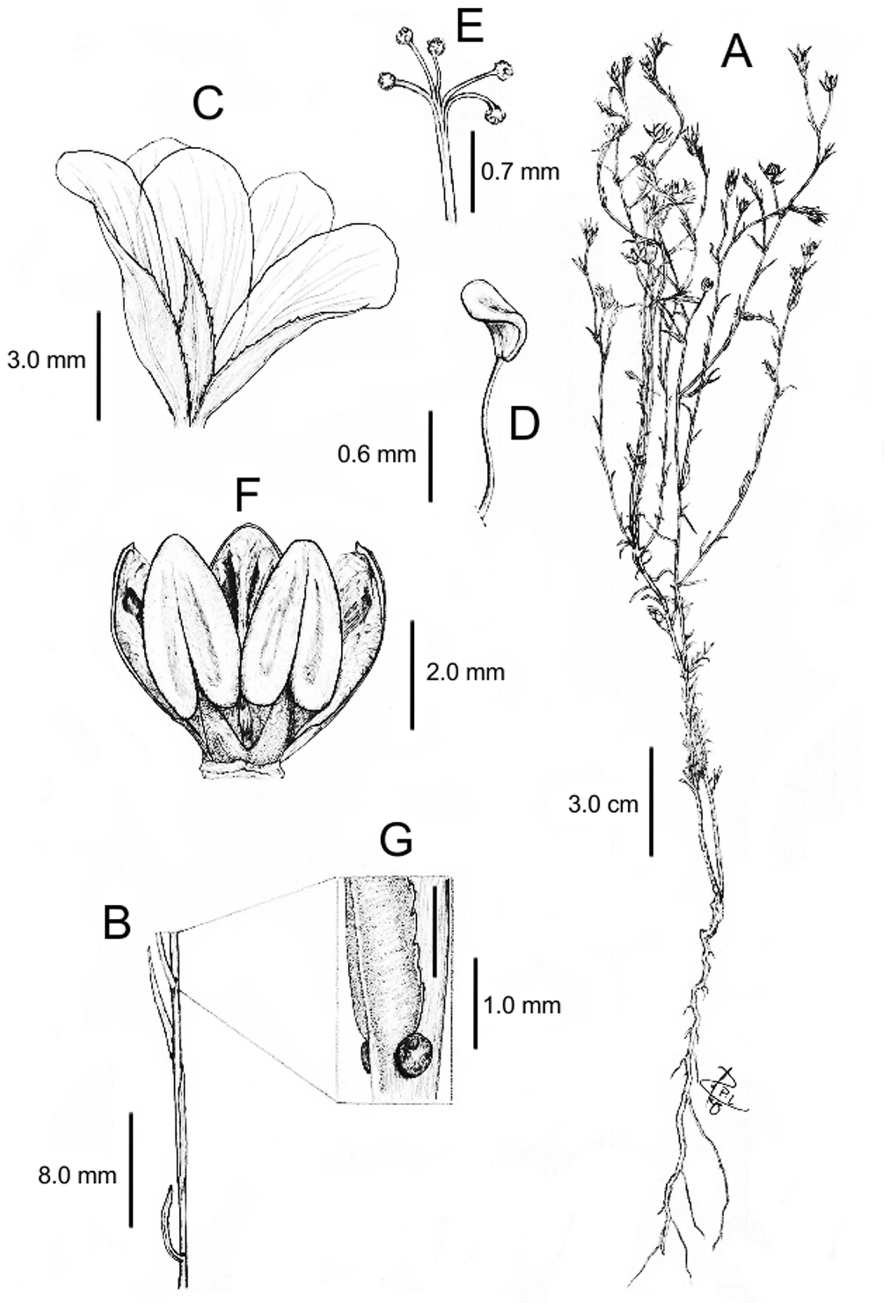

FIGURE 4. *Linum australe* var. *glandulosum*. A. Aspect general of the plant; B. Leaf; C. Flower; D. Filament and anther; E. Styles and stigmata; F. Fruit; G. Detail of stipular glands. Illustrated by Lizbeth Pérez Lucas, based on *A. Ventura A. 1727 & M.L. Arreguín 346*.

Description:—*Herbs*, annual, occasionally perennial, 5–40 cm in height, hirsutulose near the base; root thin; *stems* erect, extended, ascending, striate, branching from the base, essentially glabrous, hirsutulose at the base. *Leaves* entire or distal leaves with few tiny marginal teeth, basal leaves opposite or alternate, distal leaves alternate; linear to linear-lanceolate, (4.5)10.0–25.0 × (0.5)1.0–4.0 mm, the largest near or above the middle part of the stem; sessile, apex acuminate, 3-nerved, scariose, glabrous, stipular glands small present at the base. *Inflorescence* a cymose panicle, dense, pedicels 2.8–4.5 mm long, striate; *bracts* 3.8–6.3 mm long, margin with few minute teeth, apex acuminate, whitish, stipular glands at the base; *sepals* deciduous, lanceolate, (4.9)6.0–12.0 × 1.2–1.5 mm, margin with prominent glandular teeth, sometimes scariose; apex acute or attenuated, usually 3-nerved, glabrous, stipular glands absent; *petals* yellow-orange, reddish to brick-red below the middle portion, widely obovate, 11.0–19.0 mm long, glabrous; *stamens* 4.0–9.0 mm long; anthers 1.0–2.0 mm long, yellow; staminodia absent; *styles* fused to near the apex, 6.0–9.0 mm long, yellow; stigmata capitate, dark brown. *Fruit* widely ovoid to triangular-ovoid, yellow, 3.6–4.7 × 3.0–4.0 mm, pericarp thin, translucent, apex obtuse, dehiscent into 5 segments; *seeds* narrowly ovate, reddish-brown, 2.6–3.4 × 1.0–1.6 mm.

Distribution:—United States of America; in Mexico, in Chihuahua, Coahuila, and Nuevo Leon (Fig. 2a).

Habitat and ecology:—Cypress-juniper forest, crassi-rosette-leaved thorny shrubland, oak forests, yucca forests, thornless or sub-thornless small-leaved shrubland, evergreen thorny tropical forest. Elevation 200–1750 m. Sandy, rocky soils, sometimes calcareous belonging to Kastanozem, Phaeozem, Lithosol, Planosol, Regosol, Rendzina, and Xerosol.

Phenology:—Flowering and fruiting in March–June.

Note:—Only this variety is distributed in Mexico. The presence of bracts with a whitish acuminate apex and the capsular fruit with thin, somewhat translucent pericarp, allows separating *L. berlandieri* var. *filifolium* from *L. berlandieri* var. *berlandieri*.

Conservation status:—According to the criteria established by the IUCN (2019) and its distribution in a few northern states of Mexico, *L. berlandieri* var. *filifolium* is EN (B1 + 2ac(iii)) with an EOO < 20,000 km^2 (11,601.262 km^2) and AOO < 500 km^2 (28 km^2).

Specimens examined:—MEXICO. Chihuahua: Manuel Benavides, Sierra Rica arroyo El Pedregoso, 1743 m, 29°10’12”N, 104°02’58”W, *A. Juárez P. 165* (MEXU!, SLPM!). Coahuila: Villa Acuña, Serranias del Burro Rcho El Bonito, 29°01’30”N, 102°07’30”W, 4 May 1981, *D.H. Riskind 2362* (ANSM!); 2.5 km of Rancho El Jardin on the road toward Mina El Popo, 1600 m, 29°07’00”N, 102°40’00”W, 28 July 1973, *M.C. Johnston et al. 11840* (MEXU!); 5.2 rd miles NW of Rancho El Jardin towars Mina Popo, 1645 m, 29°09’00”N, 102°43’00”W, 2 July 1973, *J. Henrickson & B. Prigge 11460* (MEXU!); 17 miles S of Allende along Hwy 57, 500 m, 28°12’00”N, 101°05’00”W, 3 May 1977, *J. Henrickson & E. Lee 16025* (MEXU!); 22 km ESE of La Cuesta del Plomo on the Múzquiz-Boquillas highway, 1000 m, 28°38’38”N, 102°18’18”W, 7 June 1972, *F. Chiang et al. 7543* (MEXU!); 52 miles SE of Big Bend National Park basin in the S end of the Sierra Maderas del Carmen in Cañon del Alamo, 1450 m, 28°52’00”N, 102°34’00”W, 5 August 1976, *J. Henrickson & B. Prigge 14916* (MEXU!). Nuevo Leon: Hwy. 85, ca. 4 mi. SW of Nuevo Laredo, 14 November 1958, *R.C. Rollins & R.M. Tryon 5802* (MEXU!).

Linum cruciata Planchon (1848b: 499). (Fig. 3d)

Type:—MEXICO. Nayarit: Tepic, *Sinclair s.n.* (holotype K!).

Cathartolinum cruciata Small (1907e: 77).

Linum gracilentum M.E. Jones (1929: 148). Type:—MEXICO. Nayarit: Tepic, *M.E. Jones 22882* (isotypes GH, UC, US!).

Description:—*Herbs*, perennial, 15–50 cm in height, essentially glabrous, root thin; *stems* decumbent toward the base, branched from the base, glabrous in the basal part; pilose in the distal part, near nodes and the inflorescence. *Leaves,* basal ones entire, arranged in whorles of 4; distal ones dentate, alternate, widely ovated or elliptical, 5.4–13.8 × (3.2)3.3–8.3 mm, sessile or subsessile, petiole villous; apex obtuse to subacute, apiculate; 1-nerved, more evident on the abaxial surface; slightly scariose, glabrous, or sparsely pilose, stipular glands present at the base. *Inflorescence* a cymose panicle, with extended branches, pedicels villous, (1.5)3.0–6.0 mm long; *bracts* 1.9–4.3 mm long, margin dentate, with pedunculate glands, apex acute, stipular glands present, black; *sepals* persistent, lanceolate, sometimes quite narrow, (1.8)2.4–3.0 × 0.4–0.8 mm, margin with conspicuous glandular teeth, apex acute to subacuminate, 3-nerved, central nerve evident, glabrous; *petals* light yellow, 4.0–6.0 mm long, glabrous; *stamens* 3.0–4.0 mm long; anthers 0.7–1.2 mm long, light yellow; staminodia minute; *styles* free, 2.5–4.3 mm long; stigmata capitate, yellow. *Fruit* widely ovoid, yellow, (1.1)1.3–1.7 × 1.1–2.0 mm, sparsely pilose above the middle portion, pericarp thin, apex acute, dehiscent into 10 segments, false septa poorly developed; *seeds* widely ovate, brown, 0.8–0.9 × 0.7–0.8 mm.

Distribution:—In Mexico, in Durango, Jalisco, Nayarit, Queretaro, Sinaloa, Sonora, and Tamaulipas (Fig. 5a).

Habitat and ecology:—Deciduous forest, oak forests, oak-pine forests, pine forests, high evergreen tropical forests, low deciduous tropical forest, low thorny deciduous tropical forest, low subdeciduous tropical forest. Elevation 1300–1900 m. Cambisol, Lithosol, Regosol, Vertisol, and Xerosol soil types.

Phenology:—Flowering and fruiting in March–July.

Note:—Endemic to Mexico. It is the only species of the genus within its distribution area that has a combination of characters including leaves in whorls and sepals with conspicuous glandular teeth. In addition, *L. cruciata* presents free styles and short and villous pedicels, which allow differentiating it from *L. longipes*.

Conservation status:—Although *L. cruciata* has an EOO of 315,975.629 km^2, its distribution is not continuous, affecting the extent of occurrence of this species. Based on an AOO of 28 km^2 and the number of localities known (< 10), this species is considered under IUCN criteria (2019) as VU (B2ac(iii)).

Specimens examined:—MEXICO. Durango: Canelas, 1200 m al Norte de Canelas, 5 March 1986, *M. Vizcarra 265* (CHAP!, CHAPA!, CIIDIR!, IBUG!, IEB!, MEXU!, UAMIZ!); Steep side canyons of the RíoTamazula, 1300

m, 20 March 1972, *D.E. Breedlove 24527* (ENCB!). Jalisco: Autlán, Sierra de Manantlán, 1900 m, 19°32’00”N, 104°14’00”W, 23 March 1965, *R. McVaugh 23219* (ENCB!). Nayarit: Tepíc, near Tepíc, 1588 m, 21°29’18.31”N, 104°56’0.16”W, 5 January 1892, *E. Palmer 2013* (US!). Queretaro: Jalpan, a 5 km al SE de Jalpan, 1400 m, 1 May 1982, *P. Tenorio & R. Hernández 316* (MEXU!). Sinaloa: Capadero, Sierra Tacuichamona, 12 february 1940, *H.S. Gentry 5583, 5585* (MEXU!). Sonora: Alamos, Entre San Bernardino y Chinipas, 1250 m, 27°19.3’00”N, 108°44’00”W, 18 March 1992, *G. Ferguson et al. s.n.* (ARIZ!). Tamaulipas: 3 km al Sureste de Puerto Purificación, 2 June 1990, *F. González M. et al. 17402* (MEXU!); 7 km al Sureste de Puerto Purificación, 6 June 1990, *F. González M. et al. 17467* (MEXU!).

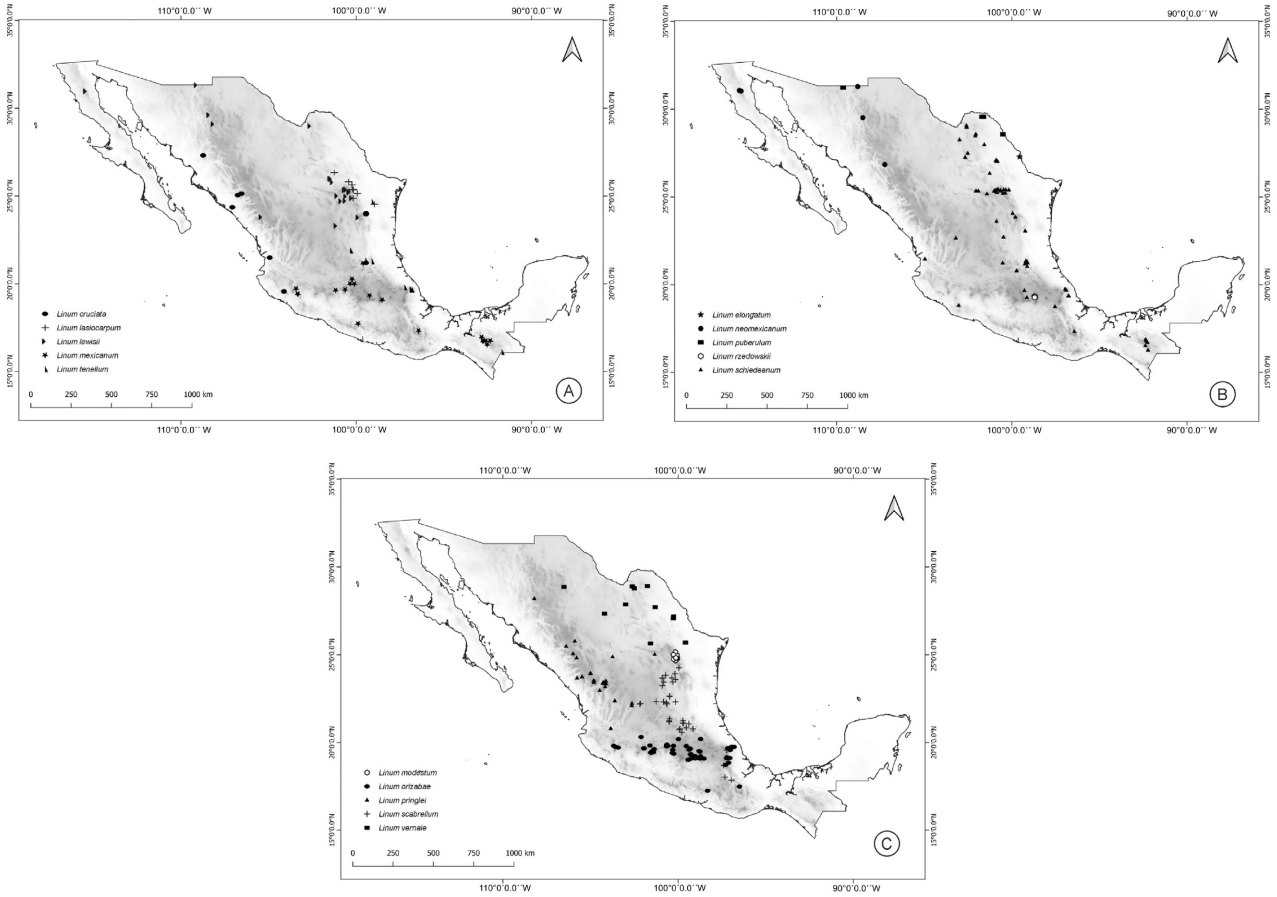

FIGURE 5. Geographic distribution in the Mexican territory of: A. *L. cruciata*, *L. lasiocarpum*, *L. lewisii*, *L. mexicanum*, and *L. tenellum*; B. *L. elongatum*, *L. neomexicanum*, *L. puberulum*, *L. rzedowskii*, and *L. schiedeanum*; C. *L. modestum*, *L. orizabae*, *L. pringlei*, *L. scabrellum*, and *L. vernale*. Maps by Ma. Isabel Olivares.

Linum elongatum (Small) H.J.P.Winkler (1931: 116). (Fig. 6a).

Type:—UNITED STATES OF AMERICA. Texas: Laredo, *Reverchon 3776* (originally cited as *Bush 3776*) (holotype NY!, isotypes MO, US!).

Cathartolinum elongatum Small (1907f: 82).

Description:—*Herbs*, annual, occasionally perennial, 15–30 cm in height, glabrous, root thick; *stems* erect to ascending, striate, branched from the base, branches diffuse, glabrous. *Leaves* entire, sometimes glandular, alternate, linear, 5.0–25.0 × 0.5–1.0(1.5) mm, sessile, apex acute; 1-nerved, nervation more evident in the abaxial surface, scariose; glabrous, stipular glands present, sometimes only at the base of distal leaves. *Inflorescence* a cymose panicle, pedicels 5.2–10.4 mm long; *bracts* 3.2–6.3 mm long, margin dentate, apex acuminate, with stipular glands present at the base; *sepals* deciduous, lanceolate, 6.0–11.0 × 1.4–1.8 mm, margin glandular-dentate, apex attenuate, 3-nerved, stipular glands absent; *petals* yellow-orange to salmon or brownish-red, wine-red base, widely obovate, 14.0–18.0 mm long; *stamens* 5.0–6.0 mm long; anthers 1.5–2.5 mm long, brick-red; staminodia absent; *styles* fused to near the apex, 7.0–9.5 mm long; stigmata capitate, gray to wine-red. *Fruit* ovoid, yellow, 4.0–4.3 × 3.0–3.7 mm, glabrous, pericarp thick, apex obtuse, dehiscent into 5 segments; *seeds* narrowly elliptical, reddish-brown, 2.3–3.0 × 1.2–1.3 mm.

FIGURE 6. A. *Linum elongatum*; B. *Linum flagellare*; C. *Linum lasiocarpum*; D. *Linum lewisii*. Photographs by José Luis Colin.

Distribution:—United States of America; in Mexico, in Tamaulipas (Fig. 5b).

Habitat and ecology:—Thorny shrubland. Elevation 0–300 m. Compact sandy soils, Xerosol type.

Phenology:—Flowering in February–May; fruiting in March–August.

Note:—In its habitat, during the flowering period, the species is easily recognized due to the color of its petals with their distinctive wine-red-colored band near the center, brick-red anthers and wine-red to gray stigmata, which together provide diagnostic characters. The stems of the species are strongly striate.

Conservation status:—*Linum elongatum* is known only from a narrow area of Texas and northern Mexico. One locality is known from Mexico, in the state of Tamaulipas, which may suggest some vulnerability. With only these data, it is not possible to carry out a conservation assessment. Therefore, to explore its probable threat category, it was necessary to integrate the records of GBIF. According to the B criterion (IUCN 2019), this species is Near Threatened (NT). Thus, it presents an EOO close to 20,000 km² (22,940.563 km^2) and AOO < 2000 km² (116 km^2), and although only one locality is known in the country, according to the data found in GBIF it is likely that it is found in ≥ 10, so some degree of uncertainty is added.

Specimens examined:—MEXICO. Tamaulipas: Nuevo Laredo, Along Hwy 2, 5 mi E of junction with Hwy 85, 28 August 1976, *C.M. Rogers 13477* (CIIDIR!).

Linum flagellare H.P.J. Winkler (1931: 116). (Fig. 6b).

Type:—MEXICO. Coahuila: Parras, *Purpus 1122* (holotype NY!, isotypes F, GH!, MO!, UC).

Cathartolinum flagellare Small (1907g: 78).

Linum coahuilense C.M. Rogers (1964b: 279). Type:—MEXICO. Coahuila. 10 mi W of Saltillo, *Correll & Johnston 21403* (LL!).

Description:—*Herbs*, perennial, 25–40 cm in height, glabrous, glaucous, root thick; *stems* erect, more or less branched throughout, glabrous. *Leaves* entire, alternate, basal leaves sometimes opposite, linear to linear-lanceolate, (5.0)11.0–17.0 × (0.5)0.7–1.7 mm, sessile, apex slightly acuminate, 1-nerved, coriaceous, glabrous; stipular glands generally absent, sometimes present only in basal leaves. *Inflorescence* a cymose panicle, more or less diffuse, branches thin, pedicels 2.1–8.3 mm long; *bracts* 2.2–2.7 mm long, margin entire, apex acuminate; *sepals* persistent, narrowly lanceolate, 2.0–5.6 × 0.9–1.3 mm; margin scariose, with sparse glandular teeth, apex extremely acute; 1-nerved, stipular glands absent; *petals* yellow, brownish-red when dried, closely narrow or oblanceolate, 4.0–8.0 mm long, glabrous; *stamens* 2.0–4.0 mm long; anthers 0.6-1.0 mm long, yellow; staminodia minute, sometimes absent; *styles* connate at the base to fused to half their length, 1.4–2.4 mm long; stigmata capitate, yellow. *Fruit* widely ovoid, yellow, 2.4–3.3 × 2.3–2.6 mm, glabrous, pericarp thin, apex pointed, dehiscent into 10 segments, false septa partially developed, septa sparsely ciliate but conspicuous along the margin; *seeds* elliptical, light brown, 1.6–2.0 × 1.0–1.2 mm.

Distribution:—Endemic to Mexico, in Coahuila, Nuevo Leon, and Zacatecas (Fig. 2b).

Habitat and ecology:—Cardonal shrublands, crassi-rosette-leaved thorny shrublands, oak forests, oak-pine forests, yucca shrublands, thornless or sub-thornless small-leaved shrubland, high or medium sub-evergreen tropical forests, low deciduous thorny tropical forest, sandy arid desert vegetation. Elevation 1400–2250 m. Phaeozem, Lithosol, Regosol, and Xerosol soil types.

Phenology:—Flowering in March–September; fruiting in March–October.

Note:—*Linum flagellare* is quite variable in terms of habit, flower size, presence of stipular glands, and style attachment. It is usually confused with *L. rupestre*, which is far more common and with which it shares a similar habit, but from which it can be differentiated by the absence of stipular glands in most leaves, much smaller styles connate at the base or attached to half or almost half its length. In addition, petals exhibit a brownish-red color when dried, a character that persists and is observed in herbarium specimens.

Conservation status:—According to the IUCN (2019) B criterion, *L. flagellare* is VU (B2abc(iii)), with an EOO of 28,947.347 km^2 and AOO of 36 km^2. It is worth mentioning that according to an evaluation carried out by CONABIO (2021), its habitat is constantly threatened by anthropic activities.

Specimens examined:—MEXICO. Coahuila: Parras, Sierra de Parras, 2000 m, 25°21’00”N, 102°12’00”W, 19 September 1993, *G. Nesom et al. 7645* (MEXU!); Saltillo, Suroeste de la Sierra de Zapalinamé, 2013 m, 25°14’32”N, 101°04’13”W, 15 April 2015, *J.A. Encina & J.M. Cárdenas V. 4429* (ANSM!); Saltillo, Slope near Las Barrancas, 3 May 1959, *D.S. Correll & I.M. Johnston 21403* (CHAPA!, MEXU!); Saltillo, Sierra de Zapalinamé, 2245 m, 25°15’26”N, 101°03’19”W, 16 August 2014, *J.A. Encina et al. 3903* (CIIDIR!); 1.5 miles SW of Las Delicias, 1615 m, 26°14’00”N, 102°49’00”W, 15 August 1973, *J. Henrickson 12476* (MEXU!); 3 km al S de El Frayle, 1953 m, 25°00’47”N, 101°20’06”W, 1 October 2016, *M.A. Ayala-Ramos et al. 60* (MEXU!); 30 km WSW of Villa Ocampo, 1600 m, 27°15’00”N, 102°41’00”W, 26 September 1986, *J. Henrickson & L. Woodruff 20376* (MEXU!). Nuevo Leon: Bustamante, Bustamante Canyon, 496 m, 26°32’58.45”N, 100°33’18.68”W, 13 August 1988, *T.F. Patterson 6591* (TEX!). Zacatecas: Concepción del Oro, km 199 de la carretera Zacatecas-Saltillo, 1850 m, 7 May 1977, *J. García P. 316* (CHAPA!); 2.5 miles NNE of Estación Camacho, 1860 m, 24°47’00”N, 102°13’00”W, 25 September 1973, *J. Henrickson 13520* (MEXU!); 5 km by road WSW of Caopas, 1940 m, 24°46’00”N, 102°12’40”W, 28 March 1973, *M.C. Johnston et al. 10453* (MEXU!); 7.5 km by road WSW of Caopas on road to Camacho, 1890 m, 24°45’20”N, 102°13’30”W, 28 March 1973, *M.C. Johnston et al. 10449* (MEXU!).

Linum lasiocarpum Rose (1909: 274). (Fig. 6c).

Type:—MEXICO. Nuevo Leon, near Monterrey, *Pringle 10209* (holotype US!, isotypes CM, F, GH!, MICH, MO, MSC, NY!, UC!).

Description:—*Herbs*, annual, 15–40 cm in height, glabrous, root thin; *stems* slightly decumbent, extending toward the inflorescence, branched from the base, glabrous. *Leaves* entire, basal leaves arranged in whorls of 4, narrowly oblanceolate to obovate; distal leaves opposite and alternate, narrowly elliptical; (4.0)6.0–23.0 × 1.7–6.8 mm, subsessile,

apex obtuse; 1-nerved, nervation more evident in the abaxial surface; occasionally rough hairs near leaf nodes and bases, prominent stipular glands present at the base. *Inflorescence* a cymose panicle, branched, occupying more than half the plant height; pedicels 0.8–2.1 mm long, villous; *bracts* 2.2–4.1 mm long, margin glandular-dentate, apex acute, prominent stipular glands present at the base; *sepals* persistent, lanceolate, 1.7–2.5 × 0.5–1.0 mm, marginal glands conspicuous, sessile, apex acute to acuminate, 3-nerved, stipular glands present; *petals* yellow, narrowly obovate, 3.0–4.0 mm long, glabrous; *stamens* 2.0–3.0 mm long; anthers 0.5 mm long, light yellow; staminodia minute; *styles* free, 2.0 mm in length; stigmata capitate, light yellow. *Fruit* widely ovoid, yellow, 1.2–2.1 × 1.3–2.0 mm, sparsely hirsute at the mid portion, pericarp thin, apex acute, dehiscent into 10 segments, false septa poorly developed, true septa with some marginal hairs; *seeds* ovate**,** light brown, 0.9-1.2 × 0.6-0.7 mm.

Distribution:—Endemic to Mexico, in Coahuila, Nuevo Leon, and Tamaulipas (Fig. 5a).

Habitat and ecology:—Oak forests, oak-pine forests, grasslands. Elevation 600–2100 m. Kastanozem, Phaeozem, Lithosol, Vertisol, and Xerosol soil types.

Phenology:—Flowering and fruiting in March–June.

Note:—Although the prominent stipular glands at the base of leaves and bracts and the villous pedicels clearly separate *L. lasiocarpum* from other northern species such as *L. aristatum*, *L. berlandieri* var. *filifolium*, *L. elongatum*, *L. flagellare*, *L. modestum*, *L. puberulum*, this is not the case with its closest species, *L. nelsonii*. However, the nerves on the leaf under surface, the marginal glands of sepals, and the pointed and hirsute fruits, together allow clearly separating *L. lasiocarpum* from *L. nelsonii*.

Conservation status:—According to the criteria established by the IUCN (2019) *L. lasiocarpum* is EN (B1 + 2ac(iii)), with an EOO < 20,000 km^2 (2,369.840 km^2) and AOO of 28 km^2. The species is restricted to a few states in the Northeast of Mexico.

Specimens examined:—MEXICO. Coahuila: Castaños, Sierra La Gavia, 1351 m, 26°19’60”N, 101°15’00”W, 12 May 1992, *M.H. Mayfield et al. 1321* (TEX!). Nuevo Leon: Galeana, 6 km E of Potosí, 2100 m, 3 July 1984, *Hinton et al. 18725* (CHAPA!); Montemorelos, El Pastor, 845 m, 19 May 1994, *Hinton et al. 24232* (ANSM!, CIIDIR!, IEB!, MEXU!); Monterrey, Northwestern outskirts of Monterrey, 29 March 1973, *C.M. Rogers 13455* (MEXU!); Monterrey, Foothills of the Sierra Madre, 610 m, 15 April 1906, *C.G. Pringle 10209* (MEXU!); Santiago, La Nogalera, 950 m, 16 June 1994, *Hinton et al. 24409* (ANSM!, IEB!); Santiago, Cola de Caballo, 800 m, 25°23’00”N, 100°10’00”W, 20 June 1984, *J.A. Villarreal & M.A Carranza 2778* (ANSM!); Santiago, El Manzano, 1600 m, 19 May 2004, *E. Estrada et al. 16139* (ANSM!). Tamaulipas: San Carlos, Sierra de San Carlos, 1134 m, 24°31’00”N, 98°57’01”W, 17 June/ 1987, *G. Nesom et al. 6053* (TEX!).

Linum lewisii Pursh (1813: 210). (Fig. 6d).

Type:—UNITED STATES OF AMERICA. Missouri: In the valleys of the Rocky Mountains and on the banks, *M. Lewis s.n.* (holotype PH!).

Linum sibiricum var. *lewisii* (Pursh) Lindley (1828: 1163).

Linum perenne var. *lewisii* (Pursh) Eaton & C.Wright (1840: 302).

Linum perenne subsp. *lewisii* (Pursh) Hultén (1947: 1122).

Adenolinum lewisii (Pursh) Á.Löve & D.Löve (1982: 348).

Description:—*Herbs*, perennial, 5–80 cm in height, glabrous or nearly glabrous, root thick; *stems* erect, ascending, striate, branched near the base, glabrous. *Leaves* entire, alternate, linear to linear-lanceolate or linear-oblanceolate, 5.0–30.0 × 0.7–2.0(–4.5) mm, sessile, apex acute, 1-nerved, rough, glabrous, stipular glands absent. *Inflorescence* a cymose panicle, pedicels sparsely villous, 5.0–16.5(–20) mm long; *bracts* 3.2–6.4(8.0) mm long, margin entire, apex acute; *sepals* persistent, elliptical to elliptical-ovate, 2.6–5.0 × 1.8–3.7 mm; margin entire, scariose, whitish; apex acute; 1–3-nerved, stipular glands absent; *petals* blue, obovate, 6.0–15.0(–23.0) mm long; *stamens* 3.0–10.0 mm in length; anthers 1.0–1.7(–2.2) mm long, white; staminodia present, thin; *styles* free, 1.5–6.5(–12.0) mm long; stigmata capitate, light yellow. *Fruit* widely ovate, yellow, 4.6–7.0 × 4.4–6.8 mm, glabrous, pericarp thick, apex acute to apiculate, dehiscent into 10 segments; false septa partially developed, ciliate; *seeds* lanceolate-ovate, dark brown, 2.5–4.5 × 1.5–3.0 mm.

Distribution:—United States of America; in Mexico, in Baja California, Chihuahua, Coahuila, Durango, Nuevo Leon, San Luis Potosi, Sonora, and Tamaulipas (Fig. 5a).

Habitat and ecology:—Oyamel fir forest, cypress-juniper forest, crassi-rosette-leaved thorny shrublands, oak forests, yucca forests, thornless or sub-thornless small-leaved shrubland, grasslands, pine forests, low evergreen thorny tropical forest, deciduous forest, and thorny shrubland. Elevation 1500–3700 m. Cambisol, Kastanozem, Phaeozem, Lithosol, Luvisol, Planosol, Regosol, Rendzina, Vertisol, and Xerosol soil types.

Phenology:—Flowering and fruiting in April–October.

Note:—*Linum lewisii* can be confused with *L. usitatissimum*; however, the sepals shorter than the fruit with scariose whitish margins, a smaller bearing, and the capitate stigmata differentiate *L. lewisii* from the latter.

Conservation status:—Although the AOO of this species is 76 km^2, the EOO (237,518.364 km^2) along with other subcriteria (IUCN 2019), such as a large number of environments where it occurs and the number of known localities inside and outside the country, make it possible to catalog *L. lewisii* as Least Concern (LC).

Specimens examined:—MEXICO. Baja California: San Pedro Martír, Sierra de San Pedro Martír, 2560 m, 30°58'00"N, 115°25'00"W, 19 June 1985, *R.F. Thorne et al. 60925* (MEXU!). Chihuahua: Madera, Colonia Chuhuichupa, 2240 m, 24 June 1990, *A. Benítez 1382* (ANSM!, CHAP!, CIIDIR!, IEB!, UAMIZ!); Madera, Rancho La Ciénega, 2500 m, 31 August 1990, *O. Bravo B. 1391* (CHAP!, CIIDIR!, UAMIZ!). Coahuila: Arteaga, Las Vigas Sierra de Arteaga, 2600 m, 25°20'00"N, 100°39'00"W, *J.A. Villarreal & M.A. Carranza 3784* (ANSM!, CIIDIR!); Arteaga, Sierra de Los Lirios, 3600 m, 3 July 1943, *E. Lyonnet 4003* (CHAP!, IEB!); Cerro San Pedro near N.L., 2200 m, 24°46'00"N, 100°47'30"W, 22 August 1974, *T. Wendt et al. 627* (CHAPA!); Cima de Sierra La Marta, 3600 m, 25 October 1984, *McDonald & Gómez 1247* (XAL!); Cima de Sierra La Viga, 3300 m, 25 October 1984, *McDonald & Gómez 1211* (XAL!); Ramos Arizpe, Cañon del Carmen, 1400 m, 25°59'10"N, 101°28'30"W, 5 August 1975, *M.F. Robert & J. Passini 4498* (ANSM!); Ramos Arizpe, Sierra de La Paila, 2000 m, 25°58'00"N, 100°25'00"W, 31 October 1987, *J.A. Villarreal et al. 4156* (ANSM!); Ramos Arizpe, Cañon Loma Prieta, 1600 m, 25°51'00"N, 101°30'00"W, 23 October 1985, *J.A. Villarreal et al. 3110* (ANSM!); Saltillo, Carretera 54 a 1 km al S de Guadalupe Victoria, 1950 m, 24°59'53"N, 101°04'84"W, 25 September 2013, *F. Meraz et al. 108* (CIIDIR!); Saltillo. Sierra La Viga, 3700 m, 22 August 1986, *McDonald 2087* (XAL!); Sierra Coahuilon, 3500 m, 18 June 1985, *McDonald 1512* (XAL!); Sierra Coahuilon, 2500 m, 22 July 1985, *McDonald 1725* (XAL!); Sierra de la Marta, 3580 m, 16 June 1985, *McDonald 1433* (IBUG!, XAL!); Sierra Maderas del Carmen, 2250 m, 28°59'00"N, 102°36'30"W, 3 August 1974, *T. Wendt & A. Adamcewicz 458* (CHAPA!). Durango: Pueblo Nuevo, El Salto, 2650 m, 23°47'26.2"N, 105°23'48.9"W, 1 September 1934, *F.E. Pennel 18563* (MEXU!). Nuevo Leon: Cerro del Potosí, 3650 m, 21 June 1985, *McDonald 1550* (XAL!); Cumbre de Cerro Potosí, 3600 m, 26 July 1985, *McDonald 1780* (XAL!); Galeana, Cerro del Potosí, 3500 m, 16 May 1981, *L. Arce et al. 1333* (ANSM!); Galeana, Rancho El Compromiso, 1600 m, 3 August 1999, *E. Estrada C. 10553* (ANSM!); Galeana, Rancho Aguililla, 1885 m, 29 June 2000, *Hinton et al. 27593* (ANSM!); Galeana, Cima del Cerro Potosí, 3670 m, 3 August 1988, *A. García 61* (CHAP!, CIIDIR!); Galeana, Rancho Aguililla, 1850 m, 8 August 1990, *Hinton et al. 20476* (CHAPA!); Galeana, Cima del Cerro Potosí, 3500 m, 4 August 1988, *A. García 74* (CIIDIR!). San Luis Potosi: Charcas, Sierra de Monte Grande, 2300 m, 14 September 1989, *J.A. Reyes A. 430* (CHAPA!). Sonora: Agua Prieta, Rancho Puerta Blanca (Cuenca Los Ajos Reserve), 1295 m, 31°18'57"N. 109°05'35"W, 23 March 2007, *A.L. Reina & T.R. Van Devender 275* (MEXU!). Tamaulipas: Peña Nevada, 3600 m, 5 July 1985, *McDonald 1618* (XAL!).

Linum longipes Rose (1906: 117). (Fig. 7a).

Type:—MEXICO. Guerrero: In mountains near Iguala, *Pringle 9261* (holotype US!, isotypes GH!, MICH!, MSC).

Description:—*Herbs*, annual, thin, 22–34 cm in height; glabrous, except for a few short hairs near the nodes and the base of branches; root thin; *stems* erect, simple, unbranched to the middle part, essentially glabrous. *Leaves* entire; basal leaves arranged in whorls of 4, obovate; distal leaves alternate, ovate; (5.3)14.0–18.0 × (2.5)7.5–9.0 mm, petioles 0.1–1.0(2.0) mm long, apex obtuse; 1-nerved, prominent on the abaxial surface; slightly rough, glabrous; stipular glands present at the base, but not well developed. *Inflorescence* a widely open cymose panicle occupying half or more of the plant height, pedicels 7.0–17.0 mm long; *bracts* 2.0-2.8 mm long, margin entire, apex acute-acuminate, stipular glands absent; *sepals* persistent, ovate, 2.0–2.5(2.7) × 0.8–1.2 mm, margin entire or with minute glands, apex acuminate, 3-nerved, stipular glands absent; *petals* yellow, obovate, 4.0 mm long, glabrous; *stamens* 3.0–4.0 mm long; anthers 0.4 mm long, light yellow; staminodia present; *styles* fused to near the apex, 1.7–2.3 mm long; stigmata capitate, yellow. *Fruit* widely ovoid, light yellow, 1.8–1.9 × 1.2–1.9 mm, glabrous, pericarp thin, apex apiculate, dehiscent into 10 segments, false septa incomplete with some marginal hairs; *seeds* elliptical, light brown, whitish cover, 0.4-0.6 × 1.0–1.1 mm.

Distribution:—Endemic to Mexico, in Guerrero, Morelos, and Puebla (Fig. 2a).

Habitat and ecology:—Oak forests, low deciduous tropical forest. Elevation 700–1600 m. Cambisol, Lithosol, and Rendzina soil types.

Phenology:—Flowering and fruiting in October.

FIGURE 7. A. *Linum longipes*; B. *Linum mexicanum*; C. *Linum nelsonii*; D. *Linum neomexicanum*. Photography by José Luis Colin.

Note:—*Linum longipes* shares a similar morphology with *L. cruciata*; however, when reviewing the herbarium material, longer pedicels, glabrous, and fused styles are observed as unequivocal characters of *L. longipes*. Besides, the species shows the unique trait of a few minute hairs near all nodes and at the base of branches.

Conservation status:—*Linum longipes* has an EOO of 416.473 km^2 and an AOO of 16 km^2. In addition to being endemic, the species is known from < 5 localities, thus fulfilling the necessary criteria (IUCN 2019) to be considered as EN (B1 + 2ac(iii)). Therefore, this species is endangered in the wild.

Specimens examined:—MEXICO. Guerrero: Iguala, Mountains near Iguala, 1514 m, 18°22’46.23”N, 99°28’25.71”W, 11 October 1900, *C.G. Pringle 9261* (MEXU!). Morelos: Jojutla, Cerro del Higuerón, 750 m, 14 October 1984, *I. Rivera 25* (MEXU!, UAMIZ!). Puebla: Izúcar de Matamoros, 2 October 1942, *F. Miranda 2222* (MEXU!); Izúcar de Matamoros, Tropical Deciduous Forest at Puerto Las Palmas, 1525 m, 12 October 1986, *D.E. Breedlove & F. Almeda 65221* (MEXU!); Izúcar de Matamoros, Carretera Izúcar-Huajuapan de León, 1300 m, 18°31’33”N, 98°25’05”W, 30 October 1994, *J.L. Panero et al. 5302* (MEXU!).

Linum mexicanum Kunth (1823: 39). (Fig. 7b).

Type:—MEXICO. Guanajuato, Santa Rosa, *Humboldt & Bonpland s.n.* (holotype P-Humb. (photo, F-035185, IEB!)).

Mesynium mexicanum Rafinesque (1837: 33).

Cathartolinum mexicanum Small (1907k: 79).

Description:—*Herbs*, perennial, 50–120 cm in height, glabrous or almost glabrous, often with a voluminous root; *stems* erect, striate, branched to the middle part, sometimes from the base, glabrous. *Leaves* entire, often ciliate, basal leaves opposite or in whorls, distal leaves frequently alternate, often lanceolate or suboblong, varying from linear-lanceolate to oval, 10.0–45.0 × 4.0–20.0 mm, sessile or subsessile, apex acute, 2 prominent lateral nerves near the base, coriaceous, glabrous, occasionally pubescent on the abaxial surface, stipular glands present at the base. *Inflorescence* a cymose panicle, pedicels 2.1–12.6(–15.0) mm long; *bracts* 1.9–4.6 mm long, margin entire, apex acute, stipular glands black at the base; *sepals* persistent, lanceolate to ovate, 2.0–3.5 × 1.2–2.0 mm, margin glandular-dentate, apex acute or cuspidate provided with hairs, 3-nerved, stipular glands absent; *petals* light yellow, obovate, 8.0–12.0 mm long, glabrous; *stamens* 5.0–8.0 mm long; anthers 0.7–1.0 mm long, light brown; staminodia present; *styles* fused up to half or near the apex, 4.0–7.0 mm long; stigmata capitate, light brown. *Fruit* ovoid to conical or subspherical, yellow with purple hues in the upper portion, 1.7–2.3 × 1.6–2.4(–3.0) mm, glabrous, pericarp thick, apex apiculate, dehiscent into 10 acute segments, septa ciliate; *seeds* elliptical to oblong, reddish-brown, 1.5 × 1.0 mm.

Distribution:—Endemic to Mexico, in Chiapas, Mexico City, State of Mexico, Guerrero, Jalisco, Michoacan, Oaxaca, Puebla, and Queretaro (Fig. 5a).

Habitat and ecology:—Oyamel fir forest, deciduous forest, crassi-rosette-leaved thorny shrublands, oak forests, pine-oak forests, thorny shrubland, thornless or sub-thornless small-leaved shrubland, palm-tree forests, pine forests, grasslands, low deciduous tropical forest, low thorny evergreen tropical forest, medium or low evergreen tropical forest. Elevation 2000–2700 m. Acrisol, Andosol, Cambisol, Phaeozem, Lithosol, Luvisol, Ranker, Regosol, Rendzina, Vertisol, and Xerosol soil types.

Phenology:—Flowering in May–September; fruiting in July–November.

Note:—*Linum mexicanum* is closely related to *L. orizabae*, with which it shares much of its natural distribution, thus leading to recurrent taxonomic identification issues; *L. mexicanum* can only be differentiated by the presence of fused styles to half or three-quarters of their length.

Conservation status:—According to the criterion B established by the IUCN (2019), *L. mexicanum* can be considered as VU (B2b(iii)), with an AOO of 64 km^2, which is added to the deterioration of its habitat as a consequence of its proximity to large nuclei of human population and an important loss of vegetation cover (Rodríguez-Echeverry & Leiton 2021). Although its EOO is 225,655.320 km^2, its distribution is scattered. It is worth mentioning that Rzedowski & Calderón de Rzedowski (1992) indicated that this species is at risk of extinction.

Specimens examined:—MEXICO. Chiapas: Oxchuc, Terracería hacia 20 de Noviembre, 2050 m, 16°45’20”N, 92°20’58”W, 23 August 1995, *H. Mejía E. & A. Luna G. 679* (XAL!); San Andrés Larrainzar, Cloud Forest near the summit of Chuchil Ton, 2700 m, 3 August 1972, *D.E. Breedlove 26756* (CHAPA!); San Cristóbal de las Casas, Cerro San Cristóbal, 2195 m, 15 October 1965, *D.E. Breedlove & P.H. Raven 13309* (MEXU!); San Cristóbal de las Casas, Arroyo del Rancho Pellizzi, 20 July 1986, *A. Méndez G. 9166* (UAMIZ!); Totolapa, 6-8 km west of Teopisca, 2150 m, 16 August 1972, *D.E. Breedlove 27054* (CHAPA!); Zinacantán, Paraje Navenchauk, 2195 m, 30 July 1981, *D.E. Breedlove 51847* (MEXU!); Zinacantán, Paraje Patosil, 2100 m, 16°45’15”N, 92°44’29”W, 26 September 1994, *A. Chame & M. de J. Gutiérrez 471* (MEXU!). Mexico City: Álvaro Obregón, La Angostura, 2480 m, 19°19’43.4”N, 99°14’11.1”W, 1 September 1941, *E. Lyonnet 3436* (MEXU!). State of Mexico: Temascalcingo, 1.53 km de San José de los Reyes, 2714 m, 19°59’13”N, 100°06’33”W, 27 August 2014, *D. Álvarez et al. 13634* (MEXU!). Guerrrero: General Heliodoro Castillo, Verde Rico, 2.3 km al N, Camino a la Cienega, 2050 m, 17°43’39”N, 99°53’39”W, 5 October 1998, *R. Cruz-Durán 3066* (MEXU!). Jalisco: Ciudad Guzmán, Campamento de Atenquique en camino al cerro de la Media Luna, 2124 m, 18 September 2016, *A. Castro et al. 4167* (IBUG!); Tecalitlán, Rancho El Tigre, 2100 m, 12 August 1979, *F. Gutiérrez L. 20* (IBUG!); Tecalitlán, 17 km al E de Llanitos, 16 August 1990, *J. Villa C. & J. Chávez L. 842* (IEB!, SLPM!). Michoacan: Epitacio Huerta, Cerca de Polvillas, 2600 m, 2 August 1990, *Rzedowski 49726* (XAL!); Hidalgo, Cañada de la Trampa, San Lucas Huarirapeo, 2720 m, 1 October 2004, *X. Madrigal S. 244* (MEXU!); Morelia, Cerro La Máscara, 2300 m, 12 September 1991, *C. Medina G. 2359* (IBUG!, XAL!). Oaxaca: Ixtlán de Juárez, Suroeste del río de la Y, 2100 m, 17°19’5.9”N, 96°26’31.9”W, 24 September 2003, *S. Figueroa B. & F.Y. Guzmán R. 801* (CHAP!, UAMIZ!). Puebla: Cholula, Camino al Cerro El Campanario, 2580 m, 19°04’45”N, 98°31’00”W, 24 August 1987, *T. Ubierna 299* (MEXU!). Queretaro: Pinal de Amoles, 3-4 km al NE de Pinal de

Amoles, 2230 m, 24 September 1991, *E. Carranza G. 3534* (IEB!); Amealco, 2 km de Laguna de Servín, 2650 m, 22 August 1991, *H. Díaz-Barriga et al. 6902* (XAL!).

Linum modestum C.M.Rogers (1964c: 406). (Fig. 8).

Type:—MEXICO. Nuevo Leon: Pablillo, south of Galeana, side of arroyo, 1900–2000 m, *Pennell 16976* (holotype US!, isotype PH!).

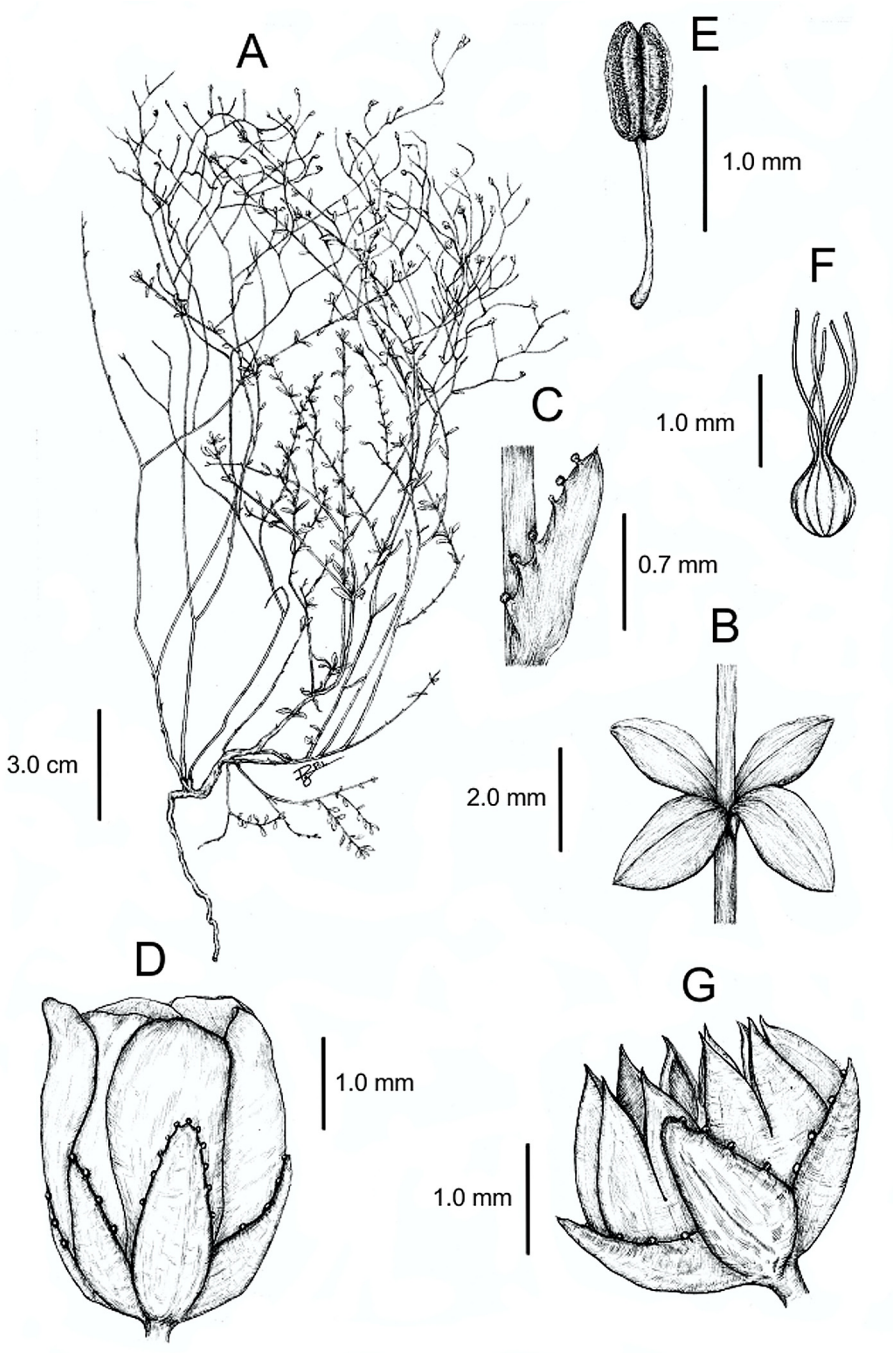

FIGURE 8. *Linum modestum*. A. Aspect general of the plant; B. Basal leaves; C. Distal leaves; D. Flower; E. Filament and anther; F Styles and stigmata; G. Fruit. Illustrated by Lizbeth Pérez Lucas, based on *Henrickson 19265*.

Description:—*Herbs*, perennial, 15–20 cm in height, glabrous, root thin; *stems* erect ascending, dark-purple, striate, branched from the base, glabrous. *Leaves*, basal ones entire, arranged in whorls of 4; distal ones glandular-dentate, alternate; 0.7–4.3 × 0.3–2.3 mm, lanceolate, sessile, apex acute, 1-nerved, glabrous, rough, stipular glands absent. *Inflorescence* a panicle with thin branches, ascending, pedicels 3.5–14.7 mm long; *bracts* 0.6–1.1 mm long, margin glandular-dentate, apex rounded, stipular glands absent; *sepals* persistent, lanceolate to ovate, (1.2)1.7–1.8 × 0.5–0.7 mm, margin glandular-dentate, apex mucronate to subacute, 1-nerved, stipular glands absent; *petals* yellow-green, oblanceolate, 3.0–3.5 mm long, glabrous; *stamens* 2.0 mm long; anthers 0.4–0.6 mm long, light yellow; staminodia

minute or absent; *styles* free, 1.6–1.7 mm long; stigmata capitate, light yellow. *Fruit* widely ovoid, yellow, (0.9)1.5–1.6 × 1.1–1.5(1.7) mm, glabrous, pericarp thin, apex acute, dehiscent into 10 segments; false septa incomplete, true septa sparsely ciliate; *seeds* ovate to elliptical, light brown, 0.8 × 0.5 mm.

Distribution:—Endemic to Mexico, in Nuevo Leon (Fig. 5c).

Habitat and ecology:—Cypress-juniper forest, crassi-rosette-leaved thorny shrublands, pine forests. Elevation 1200–2300 m. Phaeozem, Lithosol, Regosol, Solonchak, and Xerosol soil types.

Phenology:—Flowering in March–September; fruiting in July–November.

Note:—The dark-purple striate stems, branched inflorescence, minute leaves and floral parts, and acute fruit, together with the narrow strip of gypsum soils where it thrives, make it one of the most unique species of the genus *Linum* in Mexico.

Conservation status:—According to IUCN Red List Categories and Criteria (IUCN 2019), *L. modestum* is EN (B1 + 2ab(iii)). Its EOO is 803.899 km^2 and AOO is 40 km^2. In addition, this species is not only an endemic to Mexico, but also presents a type of edaphic endemism (Nesom 1983), so its distribution is restricted to a small area of the state of Nuevo Leon. Moreover, mining operations and human settlements are recorded in its distribution range (Toledo 2005, Salinas-Rodríguez 2015, Gutiérrez-García & Ricker 2019), which may exert pressure on the viability of its populations.

Specimens examined:—MEXICO. Nuevo Leon: Galeana, Santa Rita, 2120 m, 25 June 1981, *Hinton et al. 18196* (ANSM!, CIIDIR!, ENCB!, IEB!); Galeana, Santa Rita, 2010 m, 14 May 1981, *Hinton et al. 18240* (ANSM!, ENCB!); Galeana, SW of Laguna de Labradores, 2267 m, 17 October 2003, *Hinton et al. 28034* (ANSM!); Galeana, Santa Rita, 2160 m, 12 January 1989, *Hinton et al. 19293* (CIIDIR!); Galeana, 700 m al NW del Rancho de Los aguacates, 2250 m, 08 October 1976, *L. Lezama de la R., s.n.* (INEGI!); Galeana, 12.2 road miles E of San Roberto Jct. on road to Galeana, 2150 m, 24°40’00”N, 100°09’00”W, 16 September 1980, *J. Henrickson & P. Bekey 18517* (MEXU!); Galeana, Just S of Cerro Potosí, 2100 m, 24°46’00”N, 100°13’00”W, 10 October 1982, *J. Henrickson & W. Hess 19265* (MEXU!); Galeana, 3.2 mi S of Galeana, 24°47’00”N, 100°03’00”W, 10 October 1985, *B.L. Turner et al. 15553* (XAL!); Rayones, Galeana-Rayones +18 km, 1270 m, 27 February 1990, *Hinton et al. 20155* (CHAP!, CHAPA!); Rayones, Lomas Blancas in San Pedro Carrizales, 1204 m, 12 September 2008, *Hinton et al. 28708* (ANSM!); Rayones, Sierra Pelillos, Puerto Mesa de León, 2100 m, 25°00’00”N, 100°16’00”W, 7 June 1988, *J.A. Villarreal et al. 4359* (ANSM!).

Linum nelsonii Rose (1906: 117) (Fig. 7c).

Type:—MEXICO. Veracruz: municipality of Orizaba, Boca del Monte, *E. W. Nelson 210* (Holotype: US!).

Description:—*Herbs*, perennial, occasionally annual, 17–65 cm in height, glabrous or sparely pubescent, root thin; *stems* erect to decumbent, commonly unbranched up to the inflorescence, essentially glabrous. *Leaves*, basal entire or ciliated, arranged in whorls of 4–6; distal glandular-dentate, alternate or opposite, ovate to obovate; 4.0–18.0(–21.0) × 2.0–12.0 mm, decreasing to the inflorescence, sessile, apex obtuse to rounded or acute in distal leaves; 3–5-nerved, central nerve prominent; smooth, glabrous or with scattered pubescence, stipular glands present at the base. *Inflorescence* a cymose panicle, pedicels 3.0–12.0 mm long, rarely pubescent, whitish hairs; *bracts* 3.5–10.0 mm long, margin denticulate, apex acuminate, stipular glands present at the base; *sepals* persistent, lanceolate to narrowly lanceolate or narrowly ovate, 2.5–4.0 × 1.0–2.0 mm, margin glandular-dentate, apex acute to acuminate; 1–(3)-nerved, central nerve prominent; sparsely pubescent, occasionally with stipular glands present at the base; *petals* yellow-green, oblanceolate to obovate, 3.0–5.0 mm long, glabrous; *stamens* 2.0–4.0 mm long, villous at the base; anthers 0.6–1.0 mm long, light yellow; staminodia small; *styles* free, 1.7–4.0 mm long; stigmata capitate, yellow. *Fruit* widely ovoid, yellow, 1.4–2.0 × 1.5–2.0 mm, pericarp thin, apex acute pubescent, dehiscent into 10 segments, false septa partially developed, septa occasionally with marginal cilia; *seeds* oblong to ovate, reddish-brown, 0.8–1.3 × 0.5–0.7 mm.

Distribution:—In Mexico, in Chiapas, Coahuila, Guanajuato, Hidalgo, Nayarit, Nuevo Leon, Oaxaca, Puebla, Queretaro, San Luis Potosi, Tamaulipas, and Veracruz (Fig. 2b); to Guatemala, Honduras, and Nicaragua.

Habitat and ecology:—Deciduous forest, cypress-juniper forest, oak forests, oak-pine forests, chaparral shrubland, mangrove forest, thorny shrubland, thornless or sub-thornless small-leaved shrubland, pine forests, low deciduous tropical forest, medium or low evergreen tropical forest. Elevation 550–2400 m. Andosol, Acrisol, Cambisol, Phaeozem, Lithosol, Luvisol, Regosol, Rendzina, Vertisol, and Xerosol soil types.

Phenology:—Flowering in February–November; fruiting in April–November.

Note:—According to Rzedowski & Calderón de Rzedowski (1994), the type locality is probably in the state of Puebla. Although *L. nelsonii* is frequently confused with *L. schiedeanum*, *L. nelsonii* can be consistently differentiated from the latter by its pubescent pedicels and stipular glands present at the base of bracts and occasionally in sepals.

Conservation status:—Although according to the criterion B2 established by the IUCN (2019), *L. nelsonii* can be considered as endangered because of presenting an AOO of 80 km^2, its EOO (496,346.970 km^2) exceeds the value necessary for a threatened category. Therefore, this species is LC given its wide distribution and number of known localities inside and outside the country.

Specimens examined:—MEXICO. Chiapas: Comitán, km 17, carretera Comitán, 3 Lagunas, 1781 m, 16°17'39"N, 92°15'59"W, 2 September 2008, *G. López V. 1230* (XAL!); Oxchuc, Tz´unun, a 3 km de la escuela por el lado sur, 2400 m, 13 March 1988, *F. Gómez S. 19* (MEXU!); Oxchuc, 8 km al norte de Oxchuc, 2400 m, 12 May 1988, *F. Gómez S. 164* (MEXU!). Coahuila: Castaños, Sierra La Gavia, 1295 m, 26°10'00"N, 101°18'00"W, 10 August 1995, *M.A. Carranza y J. Encinas 2261* (ANSM!); Castaños, Sierra La Gavia, 1500 m, 26°10'00"N, 101°18'00"W, 25 October 1995, *J.A. Villarreal & M.A. Carranza 8363* (ANSM!); Ramos Arizpe, Sierra de La Paila, 1600 m, 25°58'00"N, 101°32'00"W, 2 November 1988, *J.A. Villarreal et al. 4739* (ANSM!). Guanajuato: San Luis de la Paz, La Ventana, cerca de Mesas de Jesús, 2000 m, 24 March 1990, *E. Ventura & E. López 7837* (XAL!). Hidalgo: Molango, 5-6 km al N de Ismolintla, 1900 m, 20°46'37.23"N, 98°43'59.95"W, 27 April 1981, *R. Hernández et al. 5893* (MEXU!). Nayarit: Tepíc, 5 km de la desviación al Rancho La Noria, 1500 m, 21°29'00"N, 104°59'00"W, *J.I. Calzada et al. 19192* (XAL!). Puebla: Oriental, Zautla, 2000 m, 6 August 1986, *F. Ventura A. 22272* (XAL!). Nuevo Leon: Galeana, Ca. 13 miles SW of Galeana, 2200 m, 24°43'00"N, 100°12'00"W, 10 September 1999, *Henrickson & V. Heuvel 22472B* (ANSM!); Santiago, Cola de Caballo, 9 May 1979, *J.A. Villarreal 2463* (ANSM!). Oaxaca: Eloxotitlán de Flores Magón, Alrededores del Puente de Fierro, 1175 m, 18°09'11.8"N, 96°51'11.7"W, 9 March 2001, *Munn-Estrada et al. 856* (TEX!). Queretaro: Arroyo Seco, 6 km al E de la Florida, 1260 m, 21°25'48"N, 99°42'06"W, 13 April 2007, *S. Zamudio et al. 13698* (IEB!); Jalpan de Serra, 4-5 km al SE de San Juan de los Durán, 1850 m, 24 May 2012, *E. Carranza G. 7670* (ANSM!); Jalpan de Serra, Cañada en la ladera O del Cerro Grande, 2110 m, 21°25'56"N, 99°08'46"W, 29 March 2012, *G. Aguilar-Gutiérrez et al. 854* (IEB!, XAL!); Jalpan de Serra, 4-5 km al sur de La Parada, 1200 m, 18 December 1991, *B. Servín 1481* (IEB!); Jalpan de Serra, 2-3 km al poniente de El Saucito, 900 m, 13 March 1991, *B. Servín 882* (IEB!); Landa, 2 km al S de El Rincón, 900 m, 2 April 1987, *Rzedowski 42916* (XAL!); Pinal de Amoles, 2 km al S de San Pedro Escanela, 1740 m, 22 February 1991, *E. Carranza 3035* (IEB!); Pinal de Amoles, 1.5-2 km al W de San Pedro Escanela, 1780 m, 17 April 1990, *E. Carranza 2438* (IEB!); Pinal de Amoles, Cerca de Huazmazontla, 1300 m, 12 March 1989, *Rzedowski 48399* (XAL!). San Luis Potosi: El Naranjo, Vicinity El Salto above El Naranjo, 446 m, 22°35'11.79"N, 99°23'0.59"W, 1 April 1960, *J.A. Duke 3675* (MEXU!). Sinaloa: Concordia, 4.5 km al SE de La Petaca, 1700 m, 12 February 2000, *R. Vega-Aviña & J.A. Gutiérrez-García 10554* (MEXU!). Tamaulipas: Hidalgo, Into the Sierra 14.9 mi W of Hotel Santa Engracia, 570 m, 24°01'00"N, 99°34'00"W, 17 April 1988, *G. Nesom 6339* (XAL!). Veracruz: Huiloapan, Cerro de San Cristóbal, 1300 m, 18°48'00"N, 97°03'00"W, 22 April 1982, *J.I. Calzada 8592* (XAL!).

Linum neomexicanum Greene (1881: 183). (Fig. 7d).

Type:—UNITED STATES OF AMERICA. New Mexico: Pinos Altos Mountains, *Greene s.n.* (holotype ND!, isotypes GH!, KANU, MO!).

Cathartolinum neomexicanum Small (1907l: 73).

Description:—*Herbs*, annual, 15–60 cm in height, glabrous, sometimes glaucous, root thin; *stems* erect, ascending, branching from the base, glabrous. *Leaves* entire, basal opposite, distal alternate, elliptical-oblanceolate, 8.0–15.0 × 1.0–1.8(–2.5) mm, sessile, apex subacute to acuminate, 1-nerved, rough, glabrous, stipular glands absent. *Inflorescence* a cymose panicle, thin, pedicels almost parallel to the stem, 1.0–4.0(–7.5) mm long; *bracts* 1.5–4.8 mm long, margin entire, apex acute, stipular glands absent; *sepals* persistent, linear-lanceolate to lanceolate, 2.3–4.1(–5.0) × 1.1–1.5 mm, margin glandular-dentate, apex acute to acuminate; 1-nerved, nervation evident; glabrous, stipular glands absent; *petals* yellow, oblanceolate, 4.0–7.0 mm long, glabrous; *stamens* 3.0–5.0 mm long; anthers 0.8–1.3(–1.5) mm long, orange; staminodia absent; *styles* free, 1.5–3.0 mm long; stigmata capitate, yellow. *Fruit* triangular-ovoid to widely ovoid, yellow with purple hues in the upper part, 1.7–2.6(3.5) × (1.9–)2.7–3.5 mm, glabrous, pericarp thick, apex apiculate, dehiscent into 10 segments, false septa partially developed, septa with ciliate margins; *seeds* elliptical-ovate, pale reddish-brown, 2.0–2.5 × 1.1–1.3 mm.

Distribution:—United States of America; in Mexico, in Baja California, Chihuahua, and Sonora (Fig. 5b).

Habitat and ecology:—Cypress-juniper forest, oak-pine forests, pine forests. Elevation 1700–2900 m. Phaeozem, Lithosol, Luvisol, Planosol, Regosol, and Vertisol soil types.

Phenology:—Flowering and fruiting in March–November.

Note:—It is easily distinguished by its thin inflorescence and pedicels parallel to the stem. Within its distribution

range, it is the only species with yellow flowers and free styles. However, when reviewing herbarium specimens, several *L. pringlei* specimens with white flowers were misidentified as *L. neomexicanum*.

Conservation status:—According to the IUCN Red List Categories and Criteria (2019), *L. neomexicanum* is Endangered (B2abc(iii)), as it has an AOO of 20 km^2 and ≤ 5 localities are known in the country. However, considering its EOO (159,584.708 km^2) and its distribution in the United States of America it probably can be considered as LC.

Specimens examined:—MEXICO. Baja California: Sierra San Pedro Mártir, 2475 m, 31°02’00”N, 115°27’00”W, 21 July 1970, *R. Moran 17895* (ENCB!); Sierra San Pedro Mártir, 2000 m, 31°04’00”N, 115°33’00”W, 15 August 1967, *R. Moran & R.F. Thorne 14121* (ENCB!). Chihuahua: Guachochi, Rejogochi cerro oeste de Valle, 10/September/2002, *F. Wyndham 20* (CIIDIR!, MEXU!); Sierra Madre, 29 September 1887, *C.G. Pringle 1201* (MEXU!). Sonora: Agua Prieta, Arroyo Cajón del Diablo, 1772 m, 31°17’19”N, 108°47’49”W, 29 September 2009, *T.R. Van Devender et al. 1693* (MEXU!).

FIGURE 9. A. *Linum orizabae*; B. *Linum pringlei*; C. *Linum puberulum*; D. *Linum rupestre*. Photographs by José Luis Colin.

Linum orizabae Planchon (1848c: 482). (Fig. 9a).

Type:—MEXICO. Veracruz: Orizaba, *H. G. Galeotti 821* (holotype K!).

Linum hypericifolium C.Presl (1831: 2).

Linum lecheoides S.Watson (1882: 332). Type:—MEXICO. San Luis Potosi: in montibus San Miguelito, *J.G. Schaffner 600* (isotypes

GH!, MEXU!, NY).

Cathartolinum lecheoides Small (1907k: 79).

Cathartolinum orizabae Small (1907k: 79).

Cathartolinum hypericifolium Small (1907j: 80).

Description:—*Herbs*, perennial, 20–80(160) cm in height, essentially glabrous, usually with thick root; *stems* erect, ascending, striate, often unbranched to the inflorescence, glabrous or sparingly pilose. *Leaves* entire or slightly dentate, basal leaves opposite or arranged in whorls of 4, distal leaves alternate, linear-lanceolate to oblong-lanceolate, 5.0–45.0 × (1.2–)2.0–9.0 mm, longer and wider toward the mid portion of the stem, sessile or subsessile, apex acute-acuminate; 1-nerved, prominent central nerve on the abaxial surface; membranous, glabrous, stipular glands present at the base. *Inflorescence* a cymose panicle, pedicels 1.5–4(16.4) mm long, occasionally with sparse whitish hairs, *bracts* 1.2–2.5(–4.0) mm long, hairs scattered adaxially, margin entire, apex acuminate, stipular glands present at the base; *sepals* persistent, ovate to obovate, 1.5–2.5(–4.0) × 1.0–2.0 mm; margin entire, rarely with few glandular teeth; apex acute to shortly acuminate, apiculate, occasionally ciliated, slightly scariose; 1-nerved, nerve evident, sparsely pilose along the nerve, frequently glabrous on both sides, stipular glands present; *petals* yellow, obovate or oblanceolate, 3.0–8.0 mm long, glabrous; *stamens* 2.0–4.0 mm long; anthers 0.2–0.5 mm long, yellow; staminodia minute or absent; *styles* free or connate at the base, 0.9–2.0(3.6) mm long; stigmata capitate, yellow. *Fruit* ovoid to conical, yellow with purple hues in the upper part, 1.8–2.2(4.0) × 0.9–2.5(–3.0) mm, glabrous, pericarp thick, apex apiculate, dehiscent into 10 segments, false septa partially developed, septa ciliated; *seeds* compressed, elliptical or oblong, brown, 1.0–1.5 × 0.7–1.0 mm.

Distribution:—Endemic to Mexico, in Mexico City, State of Mexico, Guerrero, Hidalgo, Jalisco, Michoacan, Morelos, Oaxaca, Puebla, Queretaro, and Veracruz (Fig. 5c).

Habitat and ecology:—Oyamel fir forest, deciduous forest, cypress-juniper forest, chaparral shrubland, crassi-rosette-leaved thorny shrubland, cropland, oak forest, oak-pine forest, thornless or sub-thornless small-leaved shrubland, grasslands, pine forests, medium or low evergreen tropical forest. Elevation 1300–3500 m. Soils of volcanic origin of Acrisol, Andosol, Cambisol, Phaeozem, Fluvisol, Lithosol, Luvisol, Ranker, Regosol, Rendzina, Solonchak, Vertisol, and Xerosol types.

Phenology:—Flowering in June–December; fruiting in October–January.

Note:—*Linum orizabae* can be easily confused with *L. mexicanum*, since in part both species are sympatric and share a great morphological similarity. The only character detected that allows differentiating between the two species is the styles free or connate at the base, slightly smaller in *L. orizabae.*

Conservation status:—*Linum orizabae* registers an EOO of 89,115.419 km^2, and although it has an AOO of 280 km^2, a value necessary to be considered endangered, it does not meet the necessary subcriteria. Therefore, this species can be considered as LC (IUCN 2019, 2021). It is important mentioning the affinity of this species to the Trans-Mexican Volcanic Belt.

Specimens examined:—MEXICO. Mexico City: Álvaro Obregón, Santa Rosa, 2700 m, 18 August 1977, *A. Ventura A. 2992* (CHAP!, CHAPA!); Álvaro Obregón, Santa Rosa, 2700 m, 30 April 1977, *A. Ventura A. 2722* (CHAPA!); Álvaro Obregón, Santa Rosa, 2500 m, 1 August 1982, *A. Ventura A. 4000* (CHAPA!); Álvaro Obregón, San Bartolo, 2700 m, 28 July 1979, *A. Ventura A. 3475* (IBUG!, MEXU!, XAL!); Milpa Alta, San Lorenzo, 2650 m, 23 October 1976, *A. Ventura A. 2337* (CHAPA!, XAL!); Milpa Alta, San Pablo, 2750 m, 7 July 1976, *A. Ventura A. 1753* (CHAP!); Milpa Alta, San Lorenzo, 2650 m, 5 October 1976, *A. Ventura A. 2237* (CHAP!, CHAPA!); Milpa Alta, Tenantitla, 2850 m, 31 January 1976, *A. Ventura A. 925* (CHAPA!); Milpa Alta, San Salvador, 2800 m, 11 December 1976, *A. Ventura A. 2468* (CHAPA!); Milpa Alta, San Pablo, 2750 m, 7 July 1976, *A. Ventura A. 1753* (CIIDIR!); Milpa Alta, a 300 m de LR al W del Volcán Ocotecatl, 3320 m, 19°05’07”N, 99°01’25”W, 11 Jul /2004, *J.E. Rivera et al. 3853* (MEXU!); Tlalpan, Topilejo, 2600 m, 25 July 1976, *A. Ventura A. 1891* (CHAPA!, CIIDIR!); Xochimilco, Cerro de Esquehuil, 2800 m, 20 November 1976, *A. Ventura A. 2411* (CHAP!, CHAPA!, XAL!); Xochimilco, Cerro de Esquehuil, 2800 m, 30 June 1976, *A. Ventura A. 1701* (CHAP!, CHAPA!, CIIDIR!); Xochimilco, Cerro de Esquehuil, 2800 m, 16 July 1977, *A. Ventura A. 2990* (CHAPA!). State of Mexico: Amecameca, 1 Km al E de San Antonio, 2250 m, 30 September 1979, *B. Osorio C. 221* (ANSM!); Amecameca, 1 km al E de San Antonio, 2500 m, 27 September1981, *F.J. Díaz P. 42* (CHAP!, CIIDIR!, IBUG!); Chapa de Mota, Cerro de Las Ánimas, 3105 m, 19°47’11.8”N, 99°31’47.9”W, 22 August 2009, *C. Trejo-Díaz 203* (MEXU!); Donato Guerra, Camino a Llano Grande, 2500 m, 19°21’18”N, 100°14’40”W, 26 December 2005, *G. Cornejo T. et al. 1714* (MEXU!); Texcoco, Santa Catarina, 2600 m, 14 July 1982, *E. Ventura V. 386* (CHAP!, CHAPA!, UAMIZ!, XAL!); Texcoco, San Miguel Tlaixpan, 2500 m, 7 May1983, *E. Ventura V. 881* (CHAP!, CIIDIR!); Texcoco, Santa Catarina, 3500 m, 29 March 1983, *E. Ventura A. 656* (INEGI!, XAL!); Tlalmanalco, Arroyo Tlalmanalco, 5 km al ESE de San Rafael, 2790 m, 11 April 1977, *S.D. Koch 7761*

(CHAPA!); Tlalmanalco, 1 km al NE de Sto. Tomás Atzingo, 2450 m, 5 November 1982, *J. García P. 1710* (CHAPA!); Villa Nicolás Romero, Libertad, 2200 m, 10 September 1978, *A. Ventura A. 3313* (CHAPA!, CIIDIR!); Villa Nicolás Romero, 7 km antes de Tlazala de Fabela, 2450 m, 28 August 1984, *J. García et al. 1867* (CHAPA!). Guerrero: Metlatónoc, al S de Yoso Tise´e, 2800 m, 17°15'00"N, 98°19'00"W, 21 September 1988, *A. de Ávila 427* (MEXU!). Hidalgo: Mineral del Chico, El Chico, 2819 m, 20°11'54.99"N, 98°43'9.3"W, 1 September 1930, *E. Lyonnet 146* (MEXU!). Jalisco: San Gabriel, 4.5 km al N de Atequizayán, 2617 m, 27 November 2016, *V. Quintero F. et al. 1449* (CHAPA!, IBUG!); Venustiano Carranza, 15 km al NO de la carretera Cd. Guzmán-Autlán, 2260 m, 23 July 1990, *J. Villa C. et al.* 827 (IBUG!); Zapotlán el grande, Camino al Cerro de la Media Luna, 2136 m, 18 September 2019, *A. Castro et al. 4190* (IBUG!). Michoacan: Cherán, Ladera NE del Cerro San Marcos, 2600 m, 15 August 1987, *M. Pérez R. 211* (CHAP!, IBUG!); Cherán, 3 km al S de Cherán, 2400 m, 13 August 1987, *M. Pérez R. 172* (CIIDIR!, IBUG!); Coeneo, Cerro El Timbe estación de microondas, 2450 m, 11 December 1985, *H. Díaz-Barriga 1848* (CHAP!, XAL!); Hidalgo, Ladera W del Cerro San Andrés, 3030 m, 19°48'25"N, 100°37'37"W, 18 October 2012, *G. Aguilar-Gutiérrez et al. 981* (IEB!); Hidalgo, Ladera S del Cerro San Andrés, 3375 m, 19°47'13"N, 100°35'48"W, 5 November 2010, *G. Aguilar-Gutiérrez & S. Zamudio R. 236* (IEB!); Huiramba, Tupátaro, 2300 m, 28 August 1986, *J.M. Escobedo 1177* (ANSM!); Huiramba, Parte alta del Cerro La Taza, 3190 m, 22 August 1986, *H. Díaz B. & S. Zamudio 2648* (CIIDIR!, IBUG!); Huiramba, Parte alta Cerro Las Nieves, 3350 m, 17 July 1992, *H. Díaz B. & E. García L. 7020* (XAL!); Lagunillas, Cerro El Águila, 2590 m, 19°36'37"N, 101°22'40"W, 12 October 2008, *G. Cornejo T. & G. Ibarra M. 3190* (IEB!); Lagunillas, Cerro El Águila, 2620 m, 16°36'31"N 101°22'18"W, 12 October 2008, *G. Cornejo T. & G. Ibarra M. 3248* (IEB!); La Piedad, Cerro Grande de la Piedad, 2500 m, 30 August 1994, *S. Zamudio et al. 9372* (XAL!); Ocampo, a 1.1 km al SO de Cieneguillas, 2634 m, 19°34'29.4"N, 100°18'43"W, 10 July 2015, *D. Álvarez 15764* (MEXU!); Ocampo, El Salto aprox. 3 km al E de Ocampo, 2240 m, 1 October 1989, *R. Torres C. 13263* (XAL!); Ocuilán, 2 km al N de Santa Mónica, 2370 m, 18°99'16"N, 99°26'08"W, 20 July 1990, *L. Zizumbo A. 17* (INEGI!); Santa Clara del Cobre, Cerro del Burro, 3200 m, 26 May 1988, *E. Pérez-Calix 54* (CIIDIR!, IBUG!, XAL!); Santa Clara del Cobre, San Gregorio, 2650 m, 3 September 1988, *E. Pérez-Calix 195* (CIIDIR!, IBUG!, XAL!); Santa Clara del Cobre, Cerro del Burro, 3000 m, 26 May 1988, *J.M. Escobedo 1414* (IBUG!); Tlalmanalco, 3 km al E de San Rafael, 2700 m, 19 September 1976, *S.E. Cortés 454* (INEGI!); Tlalpujahua, Camino Cerro San Miguel el Alto a Calvario, 2920 m, 21 October 1987, *S. Zamudio R. 5791* (IBUG!, IEB!, XAL!); Zinapécuaro, Presa Pízcuaro, 3050 m, 25 January 1990, *J.M. Jasso 1782* (CHAP!, XAL!); Zinapécuaro, Campamento turístico Los Azufres, 2850 m, 27 July 1986, *S. Zamudio 4200* (CHAP!, CHAPA!, CIIDIR!); Zinapécuaro, Ladera SW del Cerro San Andrés, 3200 m, 28 August 1987, *S. Zamudio R. 5518* (CHAPA!, IEB!); Zinapécuaro, La Cañada a 1 km al E de El Rincón de Jeráhuaro, 2580 m, 15 August 1989, *M.J. Jasso 1381* (CIIDIR!, IBUG!); Zinapécuaro, Presa La Gachupina lado SW, 2910 m, 19 September 1989, *M.J. Jasso 1598* (CIIDIR!, IBUG!); Zinapécuaro, Laguna de Los Azufres, 2870 m, 30 August 1986, *H. Díaz B. & S. Zamudio 2701* (IBUG!); Zitácuaro, Camino al Cerro Cacique, 2230 m, 16 September 1989, *R. Torres & M. Ramírez 13003* (XAL!). Morelos: Huitzilac, Zempoala, 19 September 1938, E. Lyonnet 2485 (XAL!). Oaxaca: Ixtlán de Juárez, Northwest slope of Cerro Humo Chico, 2870 m, 17°29'17.12"N, 96°29'51.5"W, 9 November 1983, *D.E. Breedlove & F. Almeda 59969* (MEXU!). Puebla: Cholula, Camino a Tepetzingo, 19°04'45"N, 98°31'30"W, 2650 m, 4 November 1987, *M. Tlapa A. & G. Ubierna 1275* (XAL!). Queretaro: Amealco, 8 km al NE de San Pablo, 2700 m, 23 October 1989, *Rzedowski 49177* (IEB!). Veracruz: Acajete, Entre Acajete y Puentecillas, 1950 m, 27 June 1985, *M. Chazaro B. & M. Leach 3405* (XAL!); Acajete, Masatepec, 950 m, 14 May 1975, *F. Ventura A. 11336* (XAL!); Acajete, Acajete, 1950 m, 14 May 1979, *F. Ventura A. 16079* (XAL!); Acajete, La Joya, 2050 m, 11 July 1980, *F. Ventura A. 17484* (XAL!); Acultzingo, Cumbres de Acultzingo, 2250 m, 18°43'10"N, 97°17'49"W, 5 November 1985, *J.L. Martínez & R. Acosta P. 916* (XAL!); Calcahualco, A 2 km de Ahuihuixtla, camino a Tres Aguas (Coscomatepec), 1750 m, 19°08'00"N, 97°03'00"W, 25 May 1985, *J.L. Martínez & F. Vázquez 271* (IBUG!); Calcahualco, San Miguel Tlacotiopa, 2600 m, 19°06'00"N, 97°14'00"W, 30 July 1985, *J.L. Martínez & F. Vázquez 527* (IBUG!, XAL!); Calcahualco, El Raicero, 3151 m, 19°06'17"N, 97°13'53"W, 12 August 2009, *D. Jímeno S. 1146* (XAL!); Calcahualco, A 10 km al O de Escola, 2100 m, 19°09'00"N, 97°13'00"W, 26 June 1985, *J.L. Martínez & F. Vázquez 339* (XAL!); Chiconquiaco, entre Chiconquiaco y Planta del Pie, 2100 m, 11 July 1984, *M. Chazaro & L. Robles 3107* (IBUG!, XAL!); Coscomatepec, 8 km SW of Escola, 2500 m, 19°07'00"N, 97°11'00"W, 8 July 1982, *M. Nee & G. Diggs 24859* (XAL!); Las Minas, Vereda de Cruz Blanca Rinconada, 2250 m, *C. Duran E. y P. Burgos 496* (XAL!); Las Minas, Cerro La Tolva, 19°39'00"N, 97°08'00"W, 22 July 1989, *C. Duran E. & M. Bielma 945* (XAL!); Las Minas, Vereda de Cruz Blanca a Las Minas, 19°40'00"N, 97°10'00"W, 17 July 1993, *C. Duran E. & L. Leal 1141* (XAL!); Orizaba, Ladera NW del cerro del "Borrego", 1350 m, 28 January 1984, *J. García P. 1783* (CHAPA!); Rafael Ramírez, Rancho Casa Blanca, carretera a Perote, 2300 m, 19°39'00"N, 97°07'00"W, 27 September 1983, *F. Vázquez B. 1280* (XAL!); Tonayan, Arriba de Monte Real, 2100 m, 1 September 1982, *M. Cházaro & J. Márquez 2612*

(CHAPA!); Tonayan, Arriba de Monte Real rumbo a La Magdalena, 2050 m, 1 June 1981, *M. Cházaro B. 1559* (IBUG!, XAL!).

Linum pringlei S.Watson (1888: 269). (Fig. 9b).

Type:—MEXICO. Chihuahua: shaded slopes, Sierra Madre, *Pringle 1200* (holotype US!, isotypes GH!, MSC, NY!).

Cathartolinum pringlei Small (1907c: 74).

Description:—*Herbs*, perennial, 23–68 cm in height, glabrous, root thin; *stems* erect, branched from near the base, rigid ascending branches, extended, glabrous. *Leaves*, basal entire, opposite; distal discretely dentate, alternate; lanceolate or oblanceolate, 8.0.0–19 × 0.7–3.5 mm, sessile, apex acute or rounded, 2-nerved, membranous, glabrous, stipular glands absent. *Inflorescence* a cymose panicle, pedicels 3.0–14.0 mm long; *bracts* 1.7–3.4 mm long, margin sparsely dentate, apex acute, stipular glands absent; *sepals* persistent, ovate to lanceolate, 3.0–4.5 × 0.8–2.1 mm, margin entire or sparsely dentate above the mid portion to glandular-dentate, apex acute to acuminate, 1-nerved, glabrous, stipular glands absent; *petals* white to pinkish, oblanceolate, 5.0–8.0 mm long, glabrous; *stamens* 2.0–3.0 mm long; anthers 0.6–0.8 mm long, light yellow; staminodia present; *styles* free, 1.1–2.0 mm long; stigmata capitate, white. *Fruit* ovoid-pyriform, yellow with purple hues in the upper part, 2.3–2.7 × 2.3–2.8 mm, glabrous, pericarp thin, apex acuminate, dehiscent into 10 segments, false septa partially developed, septa ciliated along the margins; *seeds* narrow to widely ovate, reddish-brown, 1.5–1.8 × 0.8–1.1 mm.

Distribution:—Endemic to Mexico, in Aguascalientes, Chihuahua, Coahuila, Durango, and Jalisco (Fig. 5c).

Habitat and ecology:—Oyamel fir forest, cypress-juniper forest, oak forests, oak-pine forests, thornless or small-leaved sub-thornless shrubland, palm-tree forests, pine forests. Elevation 1900–2900 m. Cambisol, Kastanozem, Phaeozem, Lithosol, Luvisol, Regosol, Rendzina, Vertisol, and Xerosol soil types.

Phenology:—Flowering in March–September; fruiting in June–October.

Note:—It is easily distinguished from other Mexican flax species by the white to pinkish color of the corolla; however, it is often confused with *L. neomexicanum* based on vegetative traits. The ovoid-pyriform fruits of *L. pringlei* are another character that can be used to identify the species.

Conservation status:—*Linum pringlei* registers an EOO of 229,843.785 km^2, and an AOO of 120 km^2. In addition, the species is known from > 10 localities therefore it is considered as LC. However, the species, besides being endemic, presents a not continuous distribution that affects the estimation of EOO. Furthermore, template forests of the high regions of Mexico as the north-western portion—the area of distribution of the species—are disappearing due to the development of agriculture and livestock (Gutiérrez-Garcia & Ricker 2019, CONABIO 2021), so *L. pringlei* could be threatened in the short term.

Specimens examined:—MEXICO. Aguascalientes: San José de Gracia, 10 km al NW de la Congoja, 2630 m, 22°12’39.2”N, 102°38’5.9”W, 16 October 2013, *Murillo-Pérez 525* (INEGI!); San José de Gracia, 12 km al SW de la Congoja, 2700 m, 16 October 1973, *Rzedowski & McVaugh 778* (MEXU!). Chihuahua: Ocampo, Parque Nacional, Cascada de Basaseachi, 2100 m, 28°11’00”N, 108°12’30”W, 3 October 1986, *R Spellenberg et al. 8674* (CIIDIR!). Coahuila: Saltillo, Ladera caliza 3 km al S de El Frayle, 1953 m, 25°00’47.6”N, 101°20’6.8”W, 1 October 2016, *M.A. Ayala-Ramos et al. 60* (MEXU!). Durango: Cuencamé, Cuencamé de Ceniceros, 12 October 1973, *J. Marroquín 2648* (ANSM!); Durango, Predio Las Bayas, 2710 m, 8 August 1990, *A. García & M. González 569* (CHAPA!, CIIDIR!); Durango, Parque El Tecuán, 4 September 1984, *F. Casillas et al. 38* (CIIDIR!); Durango, Parque El Tecuán, 30 August 1984, *F. Casillas et al. 40* (CHAPA!, IBUG!); Durango, Predio Las Bayas, 2700 m, 23°25’00”N, 104°51’00”W, 8 August 1990, *A. García & M. González 605* (CIIDIR!); Durango, Parque El Tecuán, 30 August 1984, *F. Casillas et al. 40* (CIIDIR!); Durango, Parque El Tecuán, 4 September 1984, *F. Casillas et al. 39* (CIIDIR!); Durango, Parque El Tecuán, 4 September 1984, *F. Casillas et al. 46* (CIIDIR!); El Mezquital, 19 km de Los Charcos, 2400 m, 4 October 1983, *S. González & M. González 2560* (ANSM!, CHAP!, CHAPA!, CIIDIR!, IBUG!, MEXU!); El Mezquital, 22 km al NE de Los Charcos, 2750 m, 1 November 1982, *S. González & J. Rzedowski 2345* (CHAPA!, CIIDIR!); El Mezquital, Rancho de La Mesa, 28 September 1985, *I. Solís 391* (CIIDIR!, IEB!, MEXU!); Otaez, Entre Llano Blanco y San José de la Escalera, 5 October 1990, *A. Benítez 2654* (CHAP!, CIIDIR!, MEXU!); Puente El Cajón San Antonio a 10 km de Altares, 1510 m, 2 October 1990*, O. Bravo B. 1711* (CHAP!, CIIDIR!); Súchil, Trampa Las Iglesias a 2 km de Alemán, 19 September 1986, *F. Acevedo 245* (ANSM!, CHAP!, CIIDIR!); Súchil, Potrero Tinajíta, ejido San Juan de Michis, 23 September 1985, *J. Alvarado 60* (ANSM!, CHAPA!, CIIDIR!, IBUG!, IEB!); Súchil, 4 km al SW de Piedra Herrada, 2400 m, 11 September 1981, *S. González 1948* (ANSM!, CHAPA!, CIIDIR!, ENCB!, IEB!, XAL!); Súchil, Arroyo El Ranchero, 2400 m, 23°22’03”N, 104°18’03”W, 12 August 1990, *S. González & M. González 4751* (CIIDIR!, IBUG!); Súchil, Reserva de la Biosfera de La Michilia, 23°23’99”N, 104°14’99”W, 1 October 1983,

G. Flores 13519 (CIIDIR!); Súchil, Arroyo Las Iglesias, 12 September 1986, *F. Acevedo 234* (CIIDIR!); Súchil, Mesa EL Burro, 2700 m, 23°23'99"N, 104°17'99"W, 18 September 1985, S. *González 3235* (CHAP!, CHAPA!; CIIDIR!, UAMIZ!); Súchil, Arroyo Los Indios, 19 September 1985, *J. Alvarado 36* (CIIDIR!); Tepehuanes, 50 km de Tepehuanes, 2570 m, 12 September 1989, *O. Bravo B. 316* (CHAP!, CIIDIR!); Tepehuanes, 5 km de la Mesa Alta, 2450 m, 6 September 1989, *O. Bravo B. 244* (CHAP!, CIIDIR!); 4 km al NW of Los Angeles along road between Mazatlan and Durango, 2500 m, 28 October 1973, *D.E. Breedlove 35739* (MEXU!). Jalisco: Tequila, Cima del Cerro (Volcán) de Tequila, 2850 m, 8 October 1988, *M. Cházaro B. et al. 5723* (IBUG!, IEB!); Mezquitic, 5 km al NE de El Mortero por el camino a Monte Escobedo, 2300 m, 22°22'00"N, 103°37'00"W, 22 September 2001, *P. Carrillo-Reyes & E.M. Guevara 2677* (IBUG!).

Linum puberulum A.Heller (1896: 627). (Fig. 9c).

Type:—UNITED STATES OF AMERICA. New Mexico: Santa Fe to the Cimarron River, *Fendler 85* (holotype US!, isotypes GH!, K!, MO, NY, PH, UC).

Linum rigidum var. *puberulum* Engelmann (1852b: 25).

Cathartolinum puberulum Small (1907j: 80).

Mesynium puberulum (Engelm.) W.A.Weber (1984: 3).

Description:—*Herbs,* annual or perennial, 5–25 cm in height, densely gray-puberulent to the inflorescence, root thick; *stems* ascending, branched from the base, puberulent. *Leaves,* basal ones entire, occasionally opposite; distal ones sparsely glandular-dentate, alternate; linear, (5.4)7.0–20.0 × 0.6–1.5 mm, sessile, apex acuminate, whitish tip, 1-nerved, scariose, glabrous, stipular glands prominent at the base. *Inflorescence* a cymose panicle, pedicels 3.4(5.0–)–9.5(–10.0) mm long; *bracts* 2.5–7.3 mm long, margin glandular-dentate, apex acuminate, stipular glands prominent at the base; *sepals* persistent, lanceolate, (3.1)4.5–7.0 × 1.1–1.5 mm; margin glandular-dentate, sometimes scariose; apex acute to acuminate, 3-nerved, puberulent at least in the central nerve, stipular glands absent; *petals* yellow-orange to salmon, with reddish to dark-red base; obcordate or widely obovate, 7.0–14.0 mm long; *stamens* 4.0–7.0 mm long; anthers 0.6–1.4 mm long, yellow; staminodia absent; *styles* fused to near the apex, 3.0–7.0 mm long; stigmata capitate, dark brown. *Fruit* ovoid, yellow, 1.7–4.2 × 1.8–4.0 mm, glabrous, pericarp thick, apex obtuse, dehiscent into 5 segments; *seeds* narrowly ovate, reddish-brown, 2.3–3.0 × 0.9–1.3 mm.

Distribution:—United States of America; in Mexico, in Coahuila and Sonora (Fig. 5b).

Habitat and ecology:—Thornless or sub-thornless small-leaved shrubland, sandy arid desert vegetation. Elevation 273–1287 m. Phaeozem, Lithosol, Regosol, and Xerosol soil types.

Phenology:—Flowering and fruiting in April–October.

Note:—This is the only species in the genus in northwest Mexico with puberulent stems, corolla almost hemispherical in shape, and styles attached almost to the apex. It should be noted that some specimens are puberulent only in the basal part; in these cases, the dark brown capitate stigmata help differentiate it from *L. vernale,* which is glabrous and with which it might be confused.

Conservation status:—Although the EOO of *L. puberulum* is 32,537.414 km^2, its distribution in Mexico is not continuous affecting the polygon that encompasses the occurrence of this species. Therefore, based on its AOO (16 km^2) and its localities known (< 5) in the country, the species can be considered as EN (B2ac(iii)). However, this species is widely represented in the United States of America, highlighting that this evaluation corresponds only to Mexico.

Specimens examined:—MEXICO. Coahuila: Acuña, 72 km al noroeste de Ciudad Acuña, 596 m, 29°34'01"N, 101°42'04"W, 23 April 2017, *J.A. Encina et al. 5830* (ANSM!, MEXU!); Acuña, Rancho Los Ángeles, 560 m, 29°34'02"N, 101°37'12"W, 18 April 2017, *J.A. Encina et al. 5750* (MEXU!); Piedras Negras, 13.47 km al sureste de la Ciudad de Piedras Negras, 273 m, 28°31'17"N, 100°29'35"W, 24 April 2016, *J.A. Encina et al 5323* (ANSM!). Sonora: Agua Prieta, Northeast of Sierra Anibácachi, 1287 m, 31°13'59"N, 109°37'53"W, 23 April 2004, *A.L. Reina et al. 300* (MEXU!).

Linum rupestre Engelmann (1850: 232). (Fig. 9d).

Type:—UNITED STATES OF AMERICA. Texas: New Braunfels, *Lindheimer 337* (holotype GH!, isotypes MO!, NY!, PH!, UC, US!, YU!).

Linum rupestre var. *cymosulum* Engelmann (1852a: 26). Type:—MEXICO. Coahuila: Buena Vista, *J. Gregg 63*; 1847 (Holotype: MO!)

Cathartolinum rupestre Small (1907d: 76).

Cathartolinum wrightii Small (1907d: 76). Type:—UNITED STATES OF AMERICA. Texas: from western Texas to El Paso, *C. Wright 71* (holotype NY!, isotypes GH!, UC, US!)

Linum wrightii H.J.P. Winkler (1931: 116).

Description:—*Herbs*, perennial, 25–50(75) cm in height, glabrous, sometimes sparsely pubescent in the basal portion, root thin; *stems* erect, thickened, striate, unbranched up to the level of the inflorescence, essentially glabrous. *Leaves* entire, sometimes slightly dentate; basal leaves alternate or opposite, distal leaves alternate; linear to linear-lanceolate, 4.0–26.0 × (0.3)0.5–2 mm, sessile; apex acute to acuminate, whitish; 1-nerved, coriaceus, glabrous, stipular glands present at the base. *Inflorescence* a cymose panicle, pedicels 2.4–21.0 mm long; *bracts* 2.2–5.5 mm long, margin glandular-dentate; apex acuminate, whitish; stipular glands at the base, conspicuous, black; *sepals* persistent, lanceolate to ovate, (2.4)2.5–5.0 × 0.8–1.2(1.5) mm, generally with a dark wine-red color; margin glandular-dentate, occasionally scariose; apex acuminate to cuspidate, whitish tip, 1-3-nerved, conspicuous nerves, glabrous, stipular glands present at the base; *petals* yellow, oblanceolate or obcordate, 6–11 mm long, pubescent near the base; *stamens* 2.0–8.0 mm long; anthers 0.5–1 mm long, yellow; staminodia present, minute; *styles* free, 3.0–6.5 mm long; stigmata capitate, yellow. *Fruit* widely ovoid, yellow, 1.8–2.4 × (1.0)2.0–3.0 mm, glabrous, pericarp thin, apex acute, dehiscent into 10 segments, false septa partially developed, septa with marginal cilia; *seeds* ovate to widely oblong, reddish-brown, 1.2–1.6 × 1.0 mm.

Distribution:—United States of America; in Mexico, in Aguascalientes, Chiapas, Chihuahua, Coahuila, Durango, Guanajuato, Nuevo Leon, Oaxaca, Puebla, Queretaro, San Luis Potosi, Tamaulipas, Zacatecas, and Veracruz (Fig. 2a).

Habitat and ecology:—Deciduous forest, cypress-juniper forest, cardonal shrublands, chaparral shrubland, crassi-rosette-leaved thorny shrublands, oak forests, oak-pine forests, yucca shrublands, thorny shrubland, thornless or sub-thornless small-leaved shrubland, prickly-pear cacti shrublands, palm-tree forests, grasslands, low deciduous tropical forest, low deciduous thorny tropical forest, sandy arid desert vegetation, zacatonal alpine grasslands. Elevation 1200–3000 m. Limestone Andosol, Cambisol, Kastanozem, Phaeozem, Lithosol, Luvisol, Regosol, Rendzina, Solonchak Vertisol, Xerosol, and Yermosol soil types.

Phenology:—Flowering and fruiting in September–December.

Note:—Its narrow leaves and absence of foliar whorls are traits that allow differentiating *L. rupestre* from its closest related species. The morphology resembles *L. scabrellum,* with which it is usually confused; however*, L. rupestre* is glabrous. It also resembles *L. flagellare* in habit, but the presence of stipular glands in leaves and sepals, as well as the free and much longer styles in *L. rupestre*, allow differentiating it from the latter.

Conservation status:—*Linum rupestre* is one of the most widely distributed *Linum* species in Mexico, with a recorded EOO of 596,195,131 km^2 and AOO of 220 km^2. This, together with its presence in various environments in the country, means that it can be considered as LC.

Specimens examined:—MEXICO. Aguascalientes: Tepezalá, 4 km al E de Tepezalá, 2000 m, 11 September 1980, *M. De la Cerda & G. García 276* (CIIDIR!); Tepezalá, 2 km al E de Tepezalá, 2200 m, 22°13’28”N, 102°08’14”W, 29 May 2009, *G. García 5581* (CIIDIR!); Tepezalá, Arroyo Las Pilas, 2024 m, 22°15’59”N, 102°10’30”W, *J. Martínez-Ramírez 2570* (INEGI!); Tepezalá, 500 m al NE de la cementera Cruz Azul, 2034 m, 22°11’27.66”N, 102°11’53.98”W, 1 February 2013, *J. Martínez R. 2295* (INEGI!); Tepezalá, 4 km al E de Tepezalá, 2247 m, 22°13’13.1”N, 102°08’6.1”W, 19 April 2013, *Araiza-Arvilla 346* (INEGI!). Chiapas: Oxchuc, Tolbil Ja´, 3000 m, 16°49’51”N, 92°15’50”W, 20 June 1988, *F. Goméz-Santiz 244* (XAL!). Chihuahua: Chihuahua, 2.0 mi NE of Aquiles Serdán, Sierra Santa Eulalia, 1530 m, 28°30’00”N, 105°52’0.01”W, 19 July 1977, *E. Lehto 21539* (ASU!). Coahuila: Arteaga, Sierra de Zapalinamé, 1928 m, 25°24’51”N, 100°50’10”W, 15 July 2015, *J.A. Encina & J.M. Cárdenas V. 4913* (ANSM!, MEXU!); Candela, Sierra de Pájaros Azules Campo Santa María, 1800 m, 27°01’00”N, 100°50’00”W, 11 January 1997, *M.A. Carranza et al. 2730* (ANSM!, XAL!); Castaños, Sierra La Gavia Rancho La Gavia, 1295 m, 26°10’00”N, 101°18’30”W, 10 August 1995, *M.A. Carranza & J. Encinas 2263* (CHAP!, CIIDIR!, XAL!); Cuatrociénegas, Rancho Potrero Menchaca, 1300 m, 1 May 1981, *L.E. Rodríguez G. 154* (ANSM!); General Cepeda, Sierra de la Paila, 1750 m, 25°38’00”N, 101°35’00”W, 24 May 1990, *J.A. Villarreal et al. 5640* (ANSM!, CHAPA!); General Cepeda, Sierra de la Paila, parte Oeste, 1560 m, 26°05’00”N, 101°44’00”W, 18 April 1992, *J.A. Villarreal et al. 6349* (ANSM!); General Cepeda, Sierra de la Paila valle de La Nopalera, 1750 m, 25°38’00”N, 101°35’00”W, 27 April 1990, *J.A. Villarreal et al. 5620* (ANSM!); Monclova, On Route 30, west of Monclova, 22 December 1977, *N.A. Harriman 14218* (CHAPA!); North flank of Sierra de los Alamitos, 1400 m, 26°30’00”N, 102°21’00”W, 14 June 1972, *F. Chiang et al. 7772* (MEXU!); Ocampo, Sierra la Encantada, Rcho. Puerto del Aire, 1250 m, 28°17’00”N, 102°28’00”W, 8 September 1990, *M.A. Carranza et al. 743* (ANSM!); Parras, Arroyo seco en el Rancho El Tunal, 2020 m, 25°21’00”N, 101°59’30”W, 16 April 1981, *A.*

Rodríguez & M.A. Carranza 205 (ANSM!); Parras, Rancho El Tunal, 2050 m, 25°20’00”N, 101°55’00”W, 7 October 1983, *A. Rodríguez & M. Carranza 917* (ANSM!, CIIDIR!); Parras, Sierra de Parras en el arroyo seco del Rancho El Tunal, 2050 m, 1 September 1981, *A. Rodríguez & P. Antonio H. 564* (ANSM!); Parras, Arroyo seco en el Rancho El Tunal, 2050 m, 25°21’00”N, 101°59’30”W, 16 April 1981, *A. Rodríguez & M.A. Carranza s.n.* (CIIDIR!); Ramos Arizpe, El Cedral Sierra de la Paila, 1600 m, 26°02’00”N, 101°23’00”W, 16 October 1986, *J.A. Villarreal et al. 3551* (ANSM!); Ramos Arizpe, Sierra de la Paila Ejido el Cedral, 1900 m, 25°57’00”N, 101°33’00”W, 4 October 1989, *J.A. Villarreal et al. 5249* (ANSM!); Ramos Arizpe, Cañada el Diente Sierra de la Paila, 1600 m, 26°09’00”N, 101°30’00”W, 5 October 1988, *J.A. Villarreal & M.A. Carranza 4696* (ANSM!); Ramos Arizpe, Cañada el Diente Sierra de la Paila, 1600 m, 26°09’00”N, 101°30’00”W, 19 September 1989, *J.A. Villarreal & M.A. Carranza 5217* (ANSM!); Ramos Arizpe, El Cedral Sierra de la Paila, 1600 m, 26°02’00”N, 101°23’00”W, 20 August 1987, *J.A. Villarreal & M.A. Carranza 3928* (IBUG!, MEXU!); Saltillo, Entrada Cañón de San Lorenzo, 1974 m, 25°20’22”N, 100°59’10”W, 26 April 2015, *J.A. Encina & J.M. Cárdenas V. 4654* (ANSM!); Saltillo, Ladera baja de la Sierra de Zapalinamé, 2051 m, 25°19’47”N, 101°00’47”W, 25 August 2007, *J.A. Encina et al. 1905* (ANSM!); Saltillo, El Chiflón, aprox. 35 km al NW de Saltillo, 1400 m, 25°27’36”N, 101°19’07”W, 28 July 1998, *M.A. Carranza & J. Valdés R. 2958* (ANSM!); Saltillo, Rancho Los Ángeles, 1900 m, 28 July 1982, *G. Villaseñor et al. 1633* (ANSM!); Saltillo, Estación de Microondas Vega, 1600 m, 25°26’00”N, 101°06’00”W, 5 June 1992, *J.A. Villarreal et al. 6625* (ANSM!); Saltillo, Rancho “Dos arbolitos”, 1800 m, 15 June 1981, *M.A. Carranza et al. s.n.* (ANSM!); Saltillo, Oeste de la Sierra de Zapalinamé, 1951 m, 25°20’7.19”N, 101°01’2.03”W, 19 April 2015, *J.A. Encina et al. 4482* (ANSM!); Saltillo, Camino del Cuatro Sierra de Zapalinamé, 2330 m, 25°21’35”N, 100°56’08”W, 26 July 2003, *J.A. Encina et al. 1139* (ANSM!); Saltillo, S de Saltillo camino a Zacatecas, 1 km al N de La Minita, 2015 m, 25°09’28.6”N, 101°05’52”W, 1 October 2016, *M.A. Ayala-Ramos et al. 57* (MEXU!). Durango: El Mezquital, 5 km al NW de Yonora, 2020 m, 23 May 1987, *M. González & S. Acevedo 2214* (ANSM!, CIIDIR!, IEB!); El Mezquital, 48 km de Durango, 21 April 1981, *Y. Herrera 43* (CIIDIR!); Nombre de Dios, 3 km al W de La Parrilla, 14 November 1983, *S. González et al. 2800* (CHAP!, CHAPA!, CIIDIR!, IBUG!). Guanajuato: Comonfort, 2 k al NE de Empalme Escobedo, 1900 m, 27 June 1987, *Rzedowski 43440* (CIIDIR!, IBUG!, XAL!); San Miguel de Allende, Atotonilco, 1900 m, 8 October 1992, *Rzedowski 51740* (XAL!); San Miguel de Allende, 17 km al NW de San Miguel de Allende, 1900 m, 23 August 1988, *Rzedowski 47143* (XAL!); Xichú, Llano Grande 10 km al Este de Xichú, 1500 m, 14 September 1989, *E. Ventura & E. López 7322* (XAL!). Nuevo Leon: Aramberri, near to San Francisco, 1750 m, 01 June 1997, *Hinton et al. 27060* (ANSM!); Aramberri, km. 5 Carretera La Escondida-Aramberri, 1400 m, 24°06’19”N, 99°53’55”W, 26 August 2005, *P. Carrillo-Reyes & V. Sosa, 4654* (IBUG!); Cadereyta, Ca. 4 km al NE de Cadereyta Jiménez, 20 April 1973, *J. Marroquín 2518* (ANSM!); Dr. Arroyo, Santa Gertrudis, nr., 1780 m, 16 March 1993, *Hinton et al. 22708* (ANSM!); Galeana, Cerro El Potosí, SE of., 2210 m, 23 July 1983, *Hinton et al. 18526* (ANSM!, CHAPA!, CIIDIR!, IBUG!, XAL!); Dr. Arroyo, Matehuala-Dr. Arroyo aprox. 38 km, 17 June 1992, *J.A. Villarreal & M.A. Carranza 6554* (ANSM!); Galeana, El Barrial, 1620 m, 24 September 1979, *Hinton et al. 17662* (IEB!); Zaragoza, Zaragoza, nr., 1365 m, 28 July 1993, *Hinton et al. 23115* (ANSM!); Zaragoza, Sierra El Soldado, 2850 m, 24°48’00”N, 99°52’00”W, 24 August 1989, *J.A. Villarreal et al. 4920* (ANSM!). Oaxaca: Cuicatlán, 16 km al W por la terracería que va rumbo a San Pedro Jocotipac, 1750 m, 19 August 1987, *A. Salinas T. 4323* (IEB!); San Pedro Jocotipac, Loma de En medio 5 km al SE de San Pedro Nodon, 1910 m, 24 October 1991, *P. Tenorio L. & E. Martínez 17903* (MEXU!). Puebla: Chapulco, 2 km antes de llegar a Nicolas Bravo, 2300 m, 28 September 1989, *M. Chazaro B. et al. 6094* (XAL!). Queretaro: Jalpan de Serra, Cerro de los Fresnos, 1500 m, 4 September 1989, *C. Guzmán 107* (IEB!). San Luis Potosi: Catorce, San Antonio, 2146 m, 23°31’34.75”N, 100°56’16.35”W, 13 October 2016, *J. López H. 77* (INEGI!); Charcas, Camino Charcas-Villa de Cos, 2215 m, 23°09’49.6”N, 101°10’54.9”W, 13 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 54* (CHAPA!); Charcas, Sierra de Monte Grande, 2175 m, 14 September 1989, *J.A. Reyes A. 460* (CHAP!, CHAPA!, IBUG!); Charcas, Sierra de Monte Grande, 2175 m, 26 October 1989, *J.A. Reyes A. 923* (CHAPA!, IEB!, SLPM!); Charcas, Sierra de Monte Grande, 2500 m, 13 September 1989, *J.A. Reyes A. 392* (CHAPA!); Charcas, Sierra de Monte Grande, 2175 m, 23 October 1989, *J.A. Reyes A. 875* (CHAPA!); Charcas, Sierra de Monte Grande, 2300 m, 14 September 1989, *J.A. Reyes A. 427* (CHAPA!); Moctezuma, “La Calera” 2.5 km al Oeste del Estanco, 1980 m, 20/August/1976, *M. Bustos Z. s.n.* (CHAPA!). Tamaulipas: Víctoria, ca 17 mi by rd SW of Cd. Víctoria, 1086 m, 23°36’00”N, 99°12’00”W, 31 July 1976, *G.L. Webster & W.S. Armbruster 20567* (TEX!). Veracruz: Totalco, 4 km al SW de Alchichica, 235 m, 19 May 1975, *M. Vázquez-Torres et al. 1968* (CIB!); Perote, Perote, 19°19.3’00”N, 97°13’35.79”W, 2494 m, 19 December 1998, *G. Castillo-Campos 19099* (XAL!). Zacatecas: Jerez, A 2 km al Noreste de la comunidad de Puerta de Chula, 2130 m, 22°42’8.13”N, 102°52’54.81”W, 15 October 2020, *L. Hurtado-Reveles 674* (CHAPA!).

Linum rzedowskii Arreguín (1985: 262). (Fig. 10a).

Type:—MEXICO, State of Mexico: Llano Pinahua, approximately 8 km SW from Rio Frío, municipality of Ixtapaluca, 3200 m, in a clearing in the middle of the pine forest, *J. Rzedowski 37285* (holotype ENCB!).

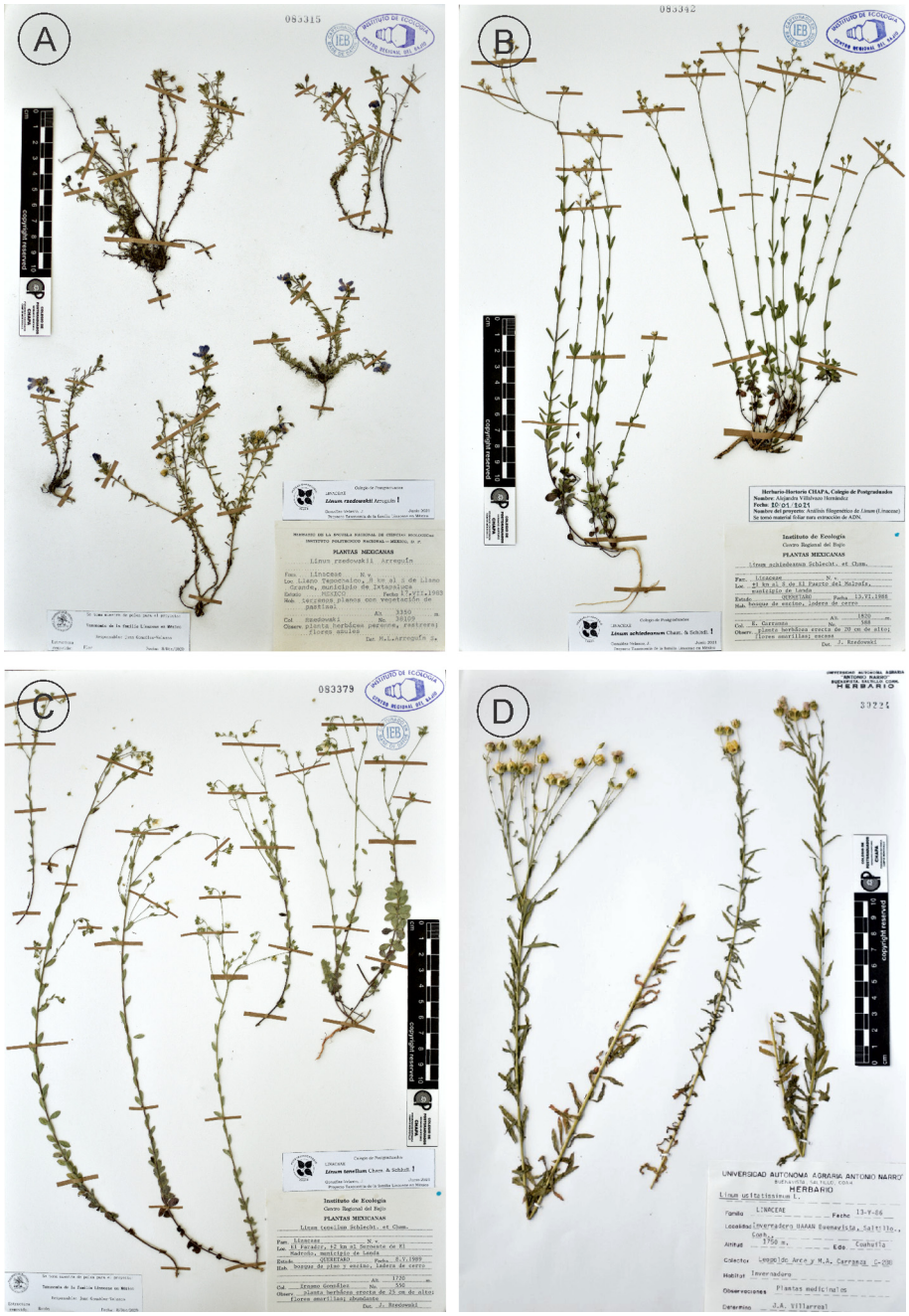

FIGURE 10. A. *Linum rzedowskii*; B. *Linum schiedeanum*; C. *Linum tenellum*; D. *Linum usitatissimum*. Photographs by José Luis Colin.

Description:—*Herbs*, perennial, 15–25 cm in height, glabrous, root thick; *stem* creeping or prostrate, slightly striate, branched from the base, glabrous. *Leaves* entire, alternate, linear-lanceolate, (3.0–)4.6–5.5(–10.0) × (1.0–)1.1–1.3(–2.0) mm, sessile, apex acuminate; 1–3-nerved, central nerve evident; coriaceous, glabrous, stipular glands absent. *Inflorescence* racemose, pedicels (4.5)6.9–10.6 mm long, glabrous; *bracts* 2.1–4.2 mm long, margin entire, apex acute, stipular glands absent; *sepals* persistent, ovate, 3.0–4.0 × 2.0–3.0 mm, shorter than the capsule; margin white, scariose; apex acute; 1-3 nerved, barely evident lateral nerves; glabrous, stipular glands absent; *petals* blue, obovate, 6.0–8.0(11) mm long, glabrous; *stamens* 2.4–4.2 mm long; anthers 0.6–1.0 mm long, yellow; staminodia minute; *styles* free, 1.1–1.9 mm long; stigmata capitate, yellow. *Fruit* ovate, yellow, 5.0–6.0 × 4.0–5.0 mm, glabrous, pericarp thick, apex acute, dehiscent into 10 segments; septa ciliate; *seeds* elliptical, brown, 3.0–4.0 × 1.2–1.5 mm.

Distribution:—Endemic to Mexico, in the State of Mexico (Fig. 5b).

Habitat and ecology:—Grasslands, pine forests, low deciduous tropical forest. Elevation 3000–3500 m. Andosol, Cambisol, Phaeozem, Planosol, Regosol, and Vertisol soil types.

Phenology:—Flowering and fruiting in July–August.

Note:—This blue-flowered species occurs only in a small area of the State of Mexico; its distribution does not overlap that of *L. lewisii*. The creeping habit, the white margins of sepals, and the size of petals support an easy differentiation.

Conservation status:—Although, according to the B1 criterion established by the IUCN, *L. rzedowskii* can be considered Critically Endangered (CN) (EOO = 24 km^2), due to its AOO of 24 km^2 and a number of known localities, together with the degradation of its habitat adjacent to the largest human population nuclei by deforestation and tourism (Pineda-Jaimes *et al.* 2009, CONABIO 2021), this species is considered EN (B1 + 2abc(iii)).

Specimens examined:—MEXICO. State of Mexico: Chalco, Río Frío Estación Forestal Zoquiapan, 3500 m, 16 August 1974, *E. García M. et al. 1256* (CHAPA!); Ixtapaluca, Estación Experimental de Investigación y Enseñanza de Zoquiapan 8 km al S de Río Frío, 3250 m, 04 July 1975, *S.D. Koch 75289* (CHAP!, CHAPA!); Ixtapaluca, Estación Experimental de Investigación y Enseñanza de Zoquiapan 8 km al S de Río Frío, 3000 m, 28 August 1975, *S.D. Koch & J. Magaña M. 75471* (CHAPA!); Ixtapaluca, Estación Experimental de Investigación y Enseñanza de Zoquiapan 8 km al S de Río Frío, 3200 m, 30 October 1975, *S.D. Koch 75704* (CHAPA!); Ixtapaluca, Estación Experimental de Investigación y Enseñanza de Zoquiapan 8 km al S de Río Frío, 3200 m, 3 July 1978, *R. Vega A. 229* (CHAPA!);Ixtapaluca, Llano Pinahua, 3250 m, 12 August 1980, *Rzedowski 36790* (CIIDIR!, IEB!, SLPM!); Ixtapaluca, Llano Grande, 3000 m, 30/August/1983, *E. Ventura V. 1295* (IEB!, XAL!); Ixtapaluca, Llano Tepochaico, 3350 m, 17/July/1983, *Rzedowski 38109* (IEB!, XAL!); Ixtapaluca, Llano Grande, 3100 m, 3 July 1983, *E. Ventura V. 1051* (UAMIZ!).

Linum scabrellum Planchon (1848d: 507). (Fig. 11).

Type:—MEXICO. Hidalgo: Zimapán, *T. Coulter 754* (holotype K!).

Cathartolinum scabrellum Small (1907c: 74).

Linum macradenium Brandegee (1911: 181). Type:—MEXICO, San Luis Potosi, Minas de San Rafael, *Purpus 4923* (holotype UC!, isotype F, GH!, MO!, US).

Description:—*Herbs*, perennial, up to 50 cm in height, pubescent to densely pubescent, root thick; *stems* erect, ascending, striate, branched from the base, sometimes simple, covered with rigid, whitish, conspicuous hairs. *Leaves* entire, occasionally with marginal glands in the upper leaves; basal leaves opposite, distal leaves alternate; linear, linear-lanceolate, inferior leaves occasionally elliptical, 5.0–17.0 × 1.0–3.5 mm, sessile, apex acute to acuminate, 1-nerved, coriaceous, pubescent; black stipular glands present at the base, very conspicuous. *Inflorescence* a cymose panicle, pedicels (5.9)10.0–20.0 mm long; *bracts* 2.5–7.1 mm long, pubescent along the central nerve, margin glandular-dentate, apex acuminate; black stipular glands present at the base, very conspicuous; *sepals* persistent, lanceolate to narrowly ovate, 2.5–5.5(6.0) × 1.0–2.2 mm, margin glandular-dentate; apex acute to acuminate, occasionally with purple hues; 3-nerved, central nerve evident; stipular glands two, black, present at the base, very conspicuous; *petals* yellow-orange, oblanceolate, 4–10 mm long, pilose at the base; *stamens* 4–7 mm long, glabrous or sparsely pilose; anthers 0.4–1.2 mm long, yellow; staminodia minute, sometimes absent; *styles* free, 2.5–6.5 mm long; stigmata capitate, yellow. *Fruit* ovoid to subglobose, yellow, 2.5 × 2.5–4.0 mm, glabrous, pericarp thick, apex acute, dehiscent into 10 segments, false septa partially developed, septa ciliated; *seeds* elliptical to ovate, reddish-brown, 1.5–2.0 × 1.0 mm.

Distribution:—Endemic to Mexico, in Aguascalientes, Guanajuato, Hidalgo, Nuevo Leon, Oaxaca, Puebla, Queretaro, San Luis Potosi, and Veracruz (Fig. 5c).

Habitat and ecology:—Cypress-juniper forest, cardonal shrublands, chaparral shrubland, crassi-rosette-leaved thorny shrublands, oak forest, oak-pine forest, yucca shrublands, thorny shrubland, thornless or sub-thornless small-leaved shrubland, pine forests, grasslands, low deciduous tropical forest, low deciduous thorny tropical forest, sandy arid desert vegetation. Elevation 1400–2950 m. Cambisol, Kastanozem, Phaeozem, Fluvisol, Lithosol, Luvisol, Regosol, Rendzina, Vertisol, and Xerosol soil types.

Phenology:—Flowering in March–December; fruiting in June–December.

Note:—This is the only species in Mexico that is pubescent throughout all its vegetative parts, with no leaves in whorls and with free styles. It is morphologically similar to *L. rupestre,* but the latter is entirely glabrous. It was observed that the specimens of *L. scabrellum* collected in localities further north of its distribution range are slightly less densely pubescent than those from central and southern Mexico; it is possible that Rzedowski and Calderón de Rzedowski (1992) refer to this character when they describe these plants as "*cinereas*" (i.e. whitish-looking).

Conservation status:—*Linum scabrellum* is a species with a wide distribution range and according to the criterion B and subcriteria established by the IUCN (2019), this species can be considered as LC (EOO = 186,173.234 km^2). However, taking into account its AOO of 140 km^2 and the expansion of mining and ranching activities in its distribution area (Salinas-Rodríguez 2015, De Nova *et al.* 2019), the species could see its populations threatened in the short term.

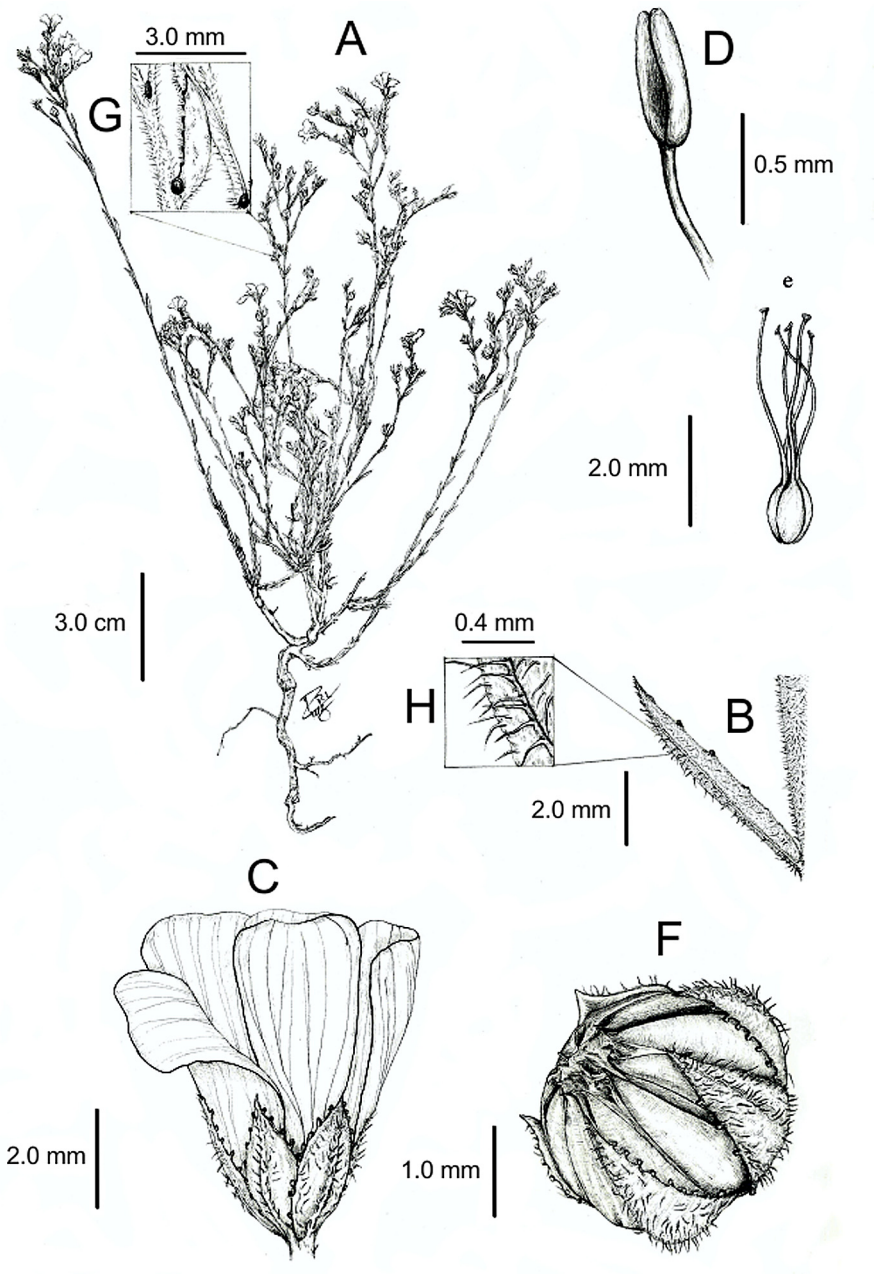

FIGURE 11. *Linum scabrellum*. A. Aspect general of the plant; B. Leaf; C. Flower; D. Filament and anther; E. Styles and stigmata; F. Fruit; G. Detail of stipular glands and bracts; h. Leaf midrib detail. Illustrated by Lizbeth Pérez Lucas, based on *J. González-Velasco & P. Albarrán-González 20001*.

Specimens examined:—MEXICO. Aguascalientes: Tepezalá, Extremo NE de Arroyo Hondo, 2000 m, 22°11’05”N, 102°11’13”W, 1 November 2007, *G. García 5386* (IEB!); Tepezalá, 4 km al E de Tepezalá, 2247 m, 22°13’13.1”N, 102°08’6.1”W, 19 April 2013, *G. García R. 6015* (INEGI!). Guanajuato: Atarjea, Puerto del Gallo, 8 km al Sureste de La Joya, 2100 m, 14 December 1988, *E. Ventura & E. López 6501* (XAL!); San Luis de la Paz, 5 km al S de Pozos, 2100 m, 24 September 1994, *Rzedowski 52586* (ANSM!, XAL!); San Luis de la Paz, cerca de El Pregón, 24 September 1994, *Rzedowski 52569* (IEB!, XAL!); 3 km al W de Pozos, 2300 m, 28 June 1987, *Rzedowski 43481* (XAL!). Hidalgo: Nicolás Flores, El Arenalito, 20°46’04”N, 99°68’56”W, 20 September 1995, *V.H. López B. 134* (CHAP!, XAL!). Nuevo Leon: Aramberri, Cerro Grande, 2180 m, 19 October 1986, *Hinton et al. 19106* (CHAPA!, CIIDIR!, IEB!); Dr.

Arroyo, Carretera Matehuala-Dr. Arroyo aprox. 38 km, 17 June 1992, *J.A. Villarreal & M.A. Carranza 6555* (ANSM!); Dr. Arroyo, Santa Gertrudis, nr., 1780 m,16 March 1993, *Hinton et al. 22707* (ANSM!); Dr. Arroyo, Camino a Agua Nueva, 2000 m, 23 June 1981, *O. Briones 683* (ANSM!, XAL!); Galeana, Santa Gertrudis, 1700 m, 20 July 1993, *Hinton et al. 23043* (IEB!); Mier y Noriega, West of Refugio de Cerros Blancos, 1825 m, 1 October 2001, *Hinton et al. 27692* (ANSM!). Oaxaca: Cuicatlán, 6 km al N de Cuicatlán, 1750 m, 19 August 1987. *A. Salinas T. et al. 4323* (XAL!); 2 km al NE-E de Suchixtlahuaca, 2100 m, 17°43'00"N, 97°21'00"W, 6 June 1985, *F. Chiang et al. 2519* (MEXU!, XAL!). Puebla: Cañada Otate, brecha a Hijaderoaria, 2121 m, 18°01'00"N, 97°20'00"W, 5 November 2001, *P. Tenorio L. & L. Kelly 21561* (MEXU!); Hwy 28, N of Azumbilla (which is N of Tehuacan), 2375 m, 18°41'00"N, 97°24'20"W, 16 July 1991, *Mayfield et al. 876* (MEXU!). Queretaro: Peña Miller, Ejido Maguey Verde, 2242 m, 21°05'21"N, 99°41'45"W, 13 October 2005, *O. Mares A. & M. Sosa M. 497* (ANSM!); Cadereyta, Alrededores de Maconí, 1800 m, 10 November 1988, *Rzedowski 47642* (ANSM!); Ezequiel Montes, Cerro La Caja frente a la Peña de Bernal, 2157 m, 20°44'38.2"N, 99°55'49.3"W, 24 September 2020, *J. González-Velasco & P. Albarrán-González 20001* (CHAPA!); San Joaquín, Cañada La Culebra, 1600 m, 27 August 1978, *S. Zamudio 3221* (CIIDIR!); 5 km al S de Vizarrón, 16 August 1989, *Rzedowski 48673* (CIIDIR!); Cadereyta, Alrededores de Maconí, 1800 m, 10 November 1988, *Rzedowski 47642* (IBUG!); San Joaquín, Cañada La Culebra, 1600 m, 27 August 1978, *S. Zamudio R. 3221* (IBUG!, XAL!); Tequisquiapan, 3 km al W de Las Rosas, 2000 m, 8 September 1990, *Rzedowski 49998* (XAL!); Ezequiel Montes, 7.5 km de Bernal, carretera a Tolimán, 2000 m, 20°46'22"N, 99°54'14"W, 11 October 2008, *E. Carranza & I. Silva 7493* (IEB!); Peñamiller, Camargo, 1700 m, 12 June 1991, *E. Ventura & E. López 9229* (IEB!); Ezequiel Montes, 7.5 km de Bernal, carretera a Tolimán, 2000 m, 20°46'22"N, 99°54'14"W, 11 October 2008, *E. Carranza & I. Silva 7493* (UAMIZ!); Peñamiller, Camargo, 1700 m, 12 June 1991, *E. Ventura & E. López 9229* (XAL). San Luis Potosi: Ahualulco, 9.7 km al W del entronque Ahualulco-Charcas, 2100 m, 10 October 1985, *F. García-Pérez 2025* (ANSM!, INEGI!, SLPM!); Armadillo de los Infante, Sierra de Álvarez, 1800 m, 1 September 2012, *F. García S. 8640* (ANSM!, SLPM!); Armadillo de los Infante, Camino a Tlaxcalilla a 200 m del cruce con la carretera con dirección a la mina, 1711 m, 22°16'0.67"N, 100°40'13.6"W, 10 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 44* (CHAPA!); Charcas, 6 km al E de Miguel Hidalgo, 23°12'00"N, 101°04'00"W, 7 July 1985, *P. Tenorio L. & T.P. Ramamoorthy 9208* (MEXU!); Guadalcazár, Km 9 carretera a Guadalcazár, 1635 m, 22°37'19.3"N, 100°29'26"W, 11 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 49* (CHAPA!); Guadalcázar, 1.6 km al este de la carretera Matehuala-San Luis Potosí, 1609 m, 9 November 2019, *V.W. Steinmann & M.M. Salinas-Rodríguez 8249* (CHAPA!); Guadalcázar, El Cañón Hondo, 12 km al NW de Guadalcázar, 22°36'58"N, 100°29'21"W, 16 November 1996, *R. Torres C. 14852* (IEB!); Guadalcazár, El Cañón Hondo, 12 km al NW de Guadalcazár, 22°36'58"N, 100°29'21"W, 10 October 1996, *R. Torres C. 14698* (IEB!); Real de Catorce, 18 km del entronque Matehuala-San Luis Potosí, 1850 m, 23°50'00"N, 101°05'00"W, 5 June 1990, *J.A. Villarreal et al. 5734* (ANSM!, IBUG!); Real de Catorce, Camino a Real de Catorce sobre la loma que está antes de entrar al pueblo, 2537 m, 23°26'26.5"N, 100°48'59"W, 12 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 52* (CHAPA!); Real de Catorce, Parte alta del cerro Quemado, 2910 m, 23°40'21"N, 100°54'45"W, 25 August 2013, *S. Zamudio R. 16411* (IEB!); Soledad Diez Gutiérrez, 5 km al NE de Laguna Seca, 2000 m, 30 August 1955, *Rzedowski 6293* (SLPM!); Villa Guadalupe, Sierra del Catorce rumbo a los lomeríos, 1833 m, 23°26'26.5"N, 100°48'59.6"W, 12 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 51* (CHAPA!); Villa Juárez, Camino Guaxcamá-Buenavista con dirección a la mina, 1215 m, 22°15'49.6"N, 100°39'38"W, 11 September 2020, *A. Villalvazo-Hernández & J. González-Velasco 45* (CHAPA!). Veracruz: Perote, ladera de cerro, 2400 m, 19°33'47.17"N, 97°13'47.17"W, 19 December 1998, *G. Castillo-Campos 19095* (MEXU!).

Linum schiedeanum Chamisso & Schlechtendal (1830a: 234). (Fig. 10b).

Type:—MEXICO. Veracruz: in sylvaticis prope Jalapam, San Andrés, *C. J. W. Schiede y F. Deppe 517* (*C. J. W. Schiede s.n.*) (holotype WU!, isotypes MO!, HAL!).

Linum coulterianum Planchon (1848a: 498). Type:—MEXICO. Hidalgo: Zimapan, *T. Coulter 758* (holotype K!, isotype GH!).

Linum greggii Engelmann (1852a: 26).

Cathartolinum coulterianum Small (1907d: 76).

Cathartolinum schiedeanum (Schltdl. & Cham.) Small (1907d: 76).

Cathartolinum greggii Small (1907e: 77). Type:—MEXICO. Coahuila: near Saltillo, *Gregg 387* (holotype MO!, isotypes GH!, NY).

Description:—*Herbs*, perennial, 10–70 cm in height, glabrous or almost glabrous, root thick; *stems* erect or extended, striate, unbranched to the inflorescence, glabrous. *Leaves*, basal ones entire, arranged in whorls of 4; distal ones ciliate, rarely opposite; oblanceolate to lanceolate, narrowly elliptical to obovate; 5.0–28.0 × 1.0–8.0 mm, sessile; apex acute, apiculate or mucronate; (1)3-nerved, midnerve conspicuous, occasionally also some lateral nerves; membranous,

glabrous, or rarely with a few hairs near the base; stipular glands present at the base. *Inflorescence* a cymose panicle, pedicels 0.1–2.0 mm long; *bracts* 2.0–3.0 mm long, glabrous, margin glandular-dentate, apex acuminate, stipular glands absent; *sepals* persistent, lanceolate to ovate-lanceolate, 2.0–5.0 × 1.0–1.5 mm; margin widely scariose, glandular-dentate; apex acute to cuspidate; 1–3-nerved, midnerve evident; stipular glands absent; *petals* yellow-green, oblanceolate or narrowly obcordate, 2.0–10.0 × 2.0–6.0 mm, sparsely pilose at the base; *stamens* 2.0–5.0 mm long; anthers 0.3–0.7 mm long, yellow; staminodia minute; *styles* free, 1.5–4.0 mm long; stigmata capitate, yellow. *Fruit* ovoid, light yellow, 1.4–5.0 × 3.0–4.0 mm, glabrous, pericarp thin, apex acute, dehiscent into 10 segments, false septa partially developed, septa with sparse marginal cilia; *seeds* ovate, reddish-brown, 1.0–2.0 × 0.6–1.0 mm.

Distribution:—United States of America; in Mexico, in Chiapas, Mexico City, Coahuila, State of Mexico, Guanajuato, Hidalgo, Michoacan, Nayarit, Nuevo Leon, Oaxaca, Puebla, Queretaro, San Luis Potosi, Tamaulipas, Veracruz, and Zacatecas (Fig. 5b).

Habitat and ecology:—Oyamel fir forest, deciduous forest, cypress-juniper forest, chaparral shrubland, crassi-rosette-leaved thorny shrublands, crop land, oak forests, oak-pine forests, thorny shrubland with lateral thorns, thornless or sub-thornless small-leaved shrublands, palm-tree forests, pine forests, grasslands, high or medium subdeciduous tropical forest, low deciduous forest, zacatonal alpine grasslands. Elevation 450–2950 m. Acrisol, Andosol, Cambisol, Kastanozem, Phaeozem, Fluvisol, Gleysol, Lithosol, Luvisol, Planosol, Regosol, Rendzina, Xerosol, and Vertisol soil types.

Phenology:—Flowering and fruiting in June–February.

Note:—*Linum schiedeanum* can be easily confused with *L. nelsonii,* since the latter varies in pubescence, size, and dimensions of leaves and flowers. However, among the characters that can be cited to differentiate *L. schiedeanum* include leaf width and glabrous pedicels and fruits.

Conservation status:—*Linum schiedeanum* is a species with a wide distribution range and thrives in a great diversity of environments. According to the criterion and subcriteria B established by the IUCN (2019), this species can be considered as LC (EOO = 677,472.147 km^2 and AOO = 264 km^2, > 10 localities known).

Specimens examined:—MEXICO. Chiapas: Amatenango, 5 km al este de la cabecera de Amatenango, 1676 m, 9 March 1988, *J. López P. 339* (CHAPA!); Comitán, Al SW de Comitán atrás fraccionamiento Tenam, 1695 m, 16°15’17”N, 92°13’42”W, 4 September 2008, *F. Hernández N. 2492* (XAL!); Oxchuc, 3 km S Rancho El Cura, 1970 m, 16°42’08”N, 92°15’52”W, *S. Ochoa-Gaona et al. 4163* (CHAPA!); Oxchuc, Barrio Santisima Trinidad, 2050 m, 17 May 1988, *F. Gómez S. 183* (MEXU!); San Juan Cancuc, Cruz ajk te´, 14 February 1992, *J. Brett 824* (XAL!). Mexico City: Xochimilco, Xochitepec, 2250 m, 6 November 1977, *A. Ventura A. 3150* (CIIDIR!, IBUG!). Coahuila: Artega, Puerto San Lorenzo, Cerro La Campana, 2460 m, 2 August 1979, *L. Arce 10432* (ANSM!); Arteaga, Ejido El Puerto, 6 km de Los Lirios, 2520 m, 21 May 1980, *R. López-Aguillón & J.A. Villarreal 664* (ANSM!, CHAP!); Arteaga, Ejido El Puerto, 2520 m, 27 May 1980, *R. López A. & J.A. Villarreal 706* (ANSM!, CIIDIR!); Arteaga, Las Vigas Cañón de Jamé Sierra de Arteaga, 25°20’00”N, 100°39’00”W, 15 September 1988, *J.A. Villarreal & M.A. Carranza 4581* (ANSM!); Arteaga, Las Vigas Cañón de la Carbonera, Sierra de Arteaga, 2600 m, 25°20’00”N, 100°39’00”W, 5 June 1987, *J.A. Villarreal & M.A. Carranza 3758* (ANSM!); Arteaga, La Siberia Sierra de la Marta, 2300 m, 25°12’00”N, 100°30’00”, 27 May 1982, *J.A. Villarreal 1656* (ANSM!); Arteaga, El Morro Sierra de Arteaga, 2900 m, 25°12’00”N, 100°16’00”, 25 September 1991, *J.A. Villarreal & M.A. Carranza 6273* (ANSM!); Arteaga, Puerto San Lorenzo, Cerro La Campana, 2460 m, 2 August 1979, *L. Arce s.n.* (CHAPA!); Arteaga, Sierra de Zapalinamé, 2400 m, 27 June 1990, *Hinton et al. 20411* (IEB!); Candela, Sierra Pájaros Azules Campo Santa María, 1800 m, 27°01’00”N, 100°50’00”W, 28 May 1997, *P. Cruz A. 19* (ANSM!, CHAPA!); Candela, Sierra Pájaros Azules Campo Santa María, 1500 m, 27°02’00”N, 100°54’00”W, 5 December 1997, *M.A. Carranza & D. Sánchez V. 2840* (ANSM!); Castaños, Sierra la Gavia Rancho La Gavia, 1500 m, 26°10’00”N, 101°18’00”W, 25 October 1995, *J.A. Villarreal & M.A. Carranza 8362* (ANSM!); Castaños, Sierra la Gavia Rancho La Gavia, 1295 m, 26°10’00”N, 101°18’00”W, 10 August 1995, *M.A. Carranza & J. Encinas 2262* (ANSM!); General Cepeda, Sierra Pilote de Fierro, 2950 m, 25°10’00”N, 101°25’00”W, 13 August 1993, *M.A. Carranza et al. 1632* (ANSM!, CIIDIR!, MEXU!); Múzquiz, Río Sabinas al noroeste de Múzquiz, 453 m, 27°58’03”N, 101°34’28”W, 3 November 2005, *J.A. Encina & I. Ramírez S. 1574* (ANSM!); Múzquiz, Carretera 53, Múzquiz-Boquillas, entrada al rancho la Babia, 980 m, 28°34’29”N, 102°03’27”W, 16 September 1999, *J.A. Villarreal et al. 8866* (ANSM!); Múzquiz, Cañón Rincón de María en la Sierra de la Babia, 1450 m, 28°27’81.9”N, 102°04’50.7”W, 21 August 1999, *M.A. Carranza et al. 3067* (ANSM!); Ocampo, Sierra Maderas del Carmen, 2270 m, 28°58’00”N, 102°35’00”W, 10 August 2004, *D. Riskind et al. 23794* (ANSM!); Ocampo, Sierra del Pino, ejido Acebuches, 1850 m, 28°15’00”N, 102°59’00”W, 12 October 1991, *M.A. Carranza et al. 901* (ANSM!, CIIDIR!, XAL!); Ocampo, Rancho La Cruz, 2000 m, 27°15’00”N, 102°40’00”W, 11 September 1991, *M.A. Carranza & L. García S. 1176* (ANSM!, CIIDIR!, IBUG!); Ocampo, Sierra Maderas de Carmen, 2050 m, 28°59’00”N, 102°35’00”W,

31 July 1974, *T. Wendt & A. Adamcewicz 443* (CHAPA!); Ocampo, 5 km al SW de Buenavista, 1650 m, 17 September 1981, *J.L. Blando N. 8109145* (INEGI!); Escobedo, Las Vacas, 1600 m, 3 August 1958, *C.A. Ely 195* (XAL!); Parras, Sierra de Parras en el arroyo seco del Rancho El Tunal, 2050 m, 1 September 1981, *A. Rodríguez & P. Antonio H. 398* (ANSM!); Parras, Cañón de Gustrola, 1950 m, 25°20'00"N, 102°03'00"W, 14 October 1983, *A. Rodríguez & M.A. Carranza 1259* (ANSM!, XAL!); Progreso, Rancho "Campo Santa María" de Cementos Mexicanos, 585 m, 27°05'38"N, 100°53'56"W, 4 November 2007, *J.A. Encina & G. Rocha G. 2262* (ANSM!); Saltillo, Camino al Cerro El Penitente, 2710 m, 25°21'03"N, 100°54'47"W, *J.A. Encina et al. 1488* (ANSM!); Saltillo, 300 m al oeste del Ejido Chapultepec, 2220 m snm, 25°14'40"N, 100°50'43"W, 6 July 2016, *J.A. Encina et al. 5548* (ANSM!); Saltillo, Camino del Cuatro, Sierra de Zapalinamé, 1964 m, 25°21'58"N, 100°57'18"W, 19 March 2004, *M.A. Llanas et al. 230* (CIIDIR!); Saltillo, Sierra de Zapalinamé, cañón de San Lorenzo, 2060 m, 25°23'00"N, 101°00'00"W, 03 August 1995, *M.A. Carranza & J. Encinas 2229* (ANSM!, CIIDIR!, MEXU!); Saltillo, Sierra de Zapalinamé 3.15 km al noreste del ejido Cuauhtémoc, 2484 m, 25°17'33.48"N, 100°54'58.11"W, 30 August 2014, *J.A. Encina et al. 4099* (ANSM!); Saltillo, Cañón de Timones al oeste de la Sierra de Zapalinamé, 2064 m, 25°19'47.36"N, 101°00'46.08"W, 26 April 2015, *J.A. Encina & S. Guillermo R. 4554* (ANSM!); Saltillo, Sierra de Zapalinamé Cañón el Coyote, 2262 m, 25°21'28"N, 100°56'51"W, 19 August 2000, *J.A. Encina et al. 575* (ANSM!); Saltillo, Camino del Cuatro Sierra de Zapalinamé, 1968 m, 27°58'03"N, 101°34'28"W, 1 November 2003, *E. Padilla V. 1142* (ANSM!, MEXU!); Saltillo, Sierra de Zapalinamé Cañón de Santa Rosa-los Aguajes, 2400 m, 25°19'38"N, 100°57'46"W, 27 June 2000, *J.A. Encina et al. 712* (ANSM!); Saltillo, Cañón de San Lorenzo, 1800 m, 13 September 1979, *L. Arce & J.A. Villarreal 554* (ANSM!); Villa Acuña, Sierra del Carmen Canyon de Sentenela, 8 July 1936, *F. Lyle W. & C.H. Mueller 583* (ANSM!); State of Mexico: Villa Nicolás Romero, Libertad, 2200 m, 10 September 1978, *A. Ventura A. 3313* (INEGI!). Guanajuato: 3 km al W de Pozos, 2300 m, 28 June 1987, *Rzedowski 43488* (XAL!). Hidalgo: Jacala, km 276 carretera México – Jacala, 1700 m, 30 October 1966, *L.M.V. de Puga 15118* (IBUG!). Michoacan: Coalcomán, al S de Torrecillas, 1950 m, 18°48'25.66"N, 103°02'17.41"W, 21 December 1938, *Hinton et al. 12805* (MEXU!). Nayarit: Xalisco, Cerro Boludo, al W de Xalisco, 1600 m, 20 February 1989, *R.E. González & S. Aguilar 697* (UAMIZ!). Nuevo Leon: Aramberri, Puerto Carretas, 24 June 1981, *O. Briones 714* (ANSM!); Dr. Arroyo, 7 km al S de La Encantada, 2520 m, 23°36'00"N, 99°50'00"W, 18 November 1993, *J.A. Villarreal & M.A. Carranza 7681* (ANSM!); Santiago, Áreas cercanas a Cola de Caballo, 800 m, 25°23'00"N, 100°10'00"W, 10 October 1984, *J.A. Villarreal et al. 2999* (ANSM!, XAL!); Santiago, Sierra Rancho Nuevo, 25°24'00"N, 100°28'00"W, *M.A. Carranza et al. 1797* (ANSM!); Santiago, Laborcitas 15 km al oeste de V. de Santiago, 1400 m, 18 August 1976, *V. Valdez T. 988* (INEGI!); Santiago, Cola de Caballo, 9 May 1979, *J.A. Villareal 17217* (XAL!). Oaxaca: Ixtlán de Juárez, Carretera Ixtlán-Capulalpam km 7.1, 2000 m, 17°19'1.3"N, 96°26'5.59"W, 25 August 2002, *S. Figueroa-Brito & F.Y. Guzmán-Rivera 139* (MEXU!). Puebla: Palmar de Bravo, Cerro Tepoxtla de San Martín Esperilla, 2500 m, 18°44'17.15"N, 97°32'23.49"W, 5 May 1992, *P. Tenorio L. 18283* (MEXU!). Queretaro: Cadereyta, 5 km al S de Vizarrón, 2300 m, 16 August 1989, *Rzedowski 48673* (CIIDIR!); Landa, 7 km al W de Tilaco, 1050 m, 9 June 1986, *R. Fernández N. 3392* (IEB!); Landa, al N del parador Santa Martha, 1750 m, 30 November 1988, *E. Carranza 1224* (IEB!); Landa, 1 km al Puerto de Malpaís, 1820 m, 13 June 1988, *E. Carranza 588* (IEB!); Landa, 1 km al SW de El Lobo, 1600 m, 1 August 1987, *Rzedowski 44023* (XAL!); Landa, 1 km al Sureste de El Pemoche, 1320 m, 2 May 1989, *H. Rubio 626* (XAL!); 7 km por la brecha a Tres Lagunas y Valle de Guadalupe, 2000 m, 2 July 1987, *H. Díaz-Barriga 3819* (IBUG!). San Luis Potosi: Guadalcázar, Matehualilla Sierra La Trinidad, 1920 m, 22°42'7.7"N, 100°28'44.1"W, 16 October 2005, *O. Mares A. & M. Sosa M. 663* (ANSM!); Real de Catorce, Cerro La Cuchilla, 1920 m, 9 October 1979, *J. García P. et al. 1309* (CHAPA!). Tamaulipas: Gómez Farias, Vecinity of "La Perra", 1950 m, 18 June 1982, *G. Diggs & M. Nee 2370* (XAL!). Veracruz: cerro al N del poblado de Jalcomulco, 19°20'40"N, 96°45'00"W, 20 November 1991. *G. Castillo C & P. Moreno 7051* (XAL!); En el cerro, al N del poblado de Jalcomulco, 19°20'10"N, 96°44'50"W, 20 November 1991. *G. Castillo C & P. Moreno 7448* (XAL!); Jalcomulco, 3 km antes de Jalcomulco por la Carr. Tuzamapa-Jalcomulco, 700 m, 19°22'00"N, 96°47'00"W, 15 January 1983, *G. Castillo C. & A.P. Vovides* 2765 (XAL!); Jalcomulco, Cerro del Brujo, 19°19'54"N, 96°45'42"W, 10 January 1992, *G. Castillo C. & P. Zamora C. 8801* (XAL!); Jalcomulco, Cerro del Brujo, 19°19'54"N, 96°45'42"W, 10 January 1992, *G. Castillo C. & P. Zamora C. 8789* (XAL!); Naolinco, Carr. Jalapa-Naolinco, 3 km antes de Naolinco, 1550 m, 29 June 1977*, J.J. Fay & J.I. Calzada 729* (XAL!). Zacatecas: Susticacán, Sierra de los Cardos a 4 km al noroeste de la comunidad de Los Cuervos, 2230 m, 22°38'28.6"N, 103°11'53.6"W, 22 August 2019, *L. Hurtado-Reveles 135* (CHAPA!).

Linum tenellum Chamisso & Schlechtendal (1830b: 235). (Fig. 10c).

Type:—MEXICO. Veracruz: Near Jalapa, *C. J. W. Schiede & F. Deppe 518* (holotype HAL!, syntype HAL!, WU).

Cathartolinum tenellum Small (1907e: 77).

Description:—*Herbs*, annual, occasionally perennial, 8–50 cm in height, densely pubescent; hairs whitish, conspicuous; root thin; *stems* erect to decumbent, striate, commonly unbranched up to the inflorescence, pubescent. *Leaves* glandular-dentate; basal leaves arranged in whorls of 4; distal leaves alternate, rarely opposite; elliptical to obovate toward the base, lanceolate to oblanceolate or oblong toward the distal part; 3.0–13.0 × (1.4)1.5–5.0 mm, gradually decreasing toward the inflorescence; sessile, apex acute to obtuse, 1-nerved; slightly membranous, pubescent; stipular glands present at the base. *Inflorescence* a cymose panicle, sparsely branched; pedicels 2.0–10.0 mm long; *bracts* 2.1–3.4 mm long, pubescent, margin glandular-dentate, apex acute, stipular glands present at the base of the lower bracts; *sepals* persistent, lanceolate to ovate, 1.9–3.0 × (0.8)1.2–1.5 mm, margin glandular-dentate, apex acute, 3-nerved, pubescent or only along veins, stipular glands absent; *petals* yellow, obovate, 2.0–6.0 mm long, glabrous; *stamens* 2.0–3.0 mm long, sparsely pubescent at the base; anthers up to 1 mm long, light yellow; staminodia present, occasionally absent; *styles* free,1.7–2.5 mm long; stigmata capitate, light yellow. *Fruit* ovoid, yellow with purple hues on the upper portion, 1.5–3.0 × 1.2–1.8 mm, sparsely pubescent, apex acute, puberulent or glabrous, dehiscent into 10 segments, false septa incompletely developed, septa without marginal cilia; *seeds* elliptical or ovate, brown, 1.0–1.2 × 0.5–0.7 mm.

Distribution:—Endemic to Mexico, in Chiapas, Queretaro, San Luis Potosi, Tamaulipas, and Veracruz (Fig. 5a).

Habitat and ecology:—Deciduous forest, oak forests, oak-pine forests, grasslands, and high or medium sub-evergreen tropical forest. Elevation 750–2200 m. Andosol, Cambisol, Phaeozem, Lithosol, Luvisol, Regosol, Vertisol, and Xerosol soil types.

Phenology:—Flowering and fruiting in April–December.

Note:—*Linum tenellum* is the only species in the genus that has leaves in whorls and that is densely pubescent throughout, with more stiff and conspicuous hairs, these being characters that support an accurate identification.

Conservation status:—According to the IUCN criteria (IUCN 2019), *L. tenellum* is VU (B1 + 2ac(iii)). This species has an EOO of 6,180,759 km^2 and an AOO of 28 km^2, and is known from < 10 localities. Additionally, the species has a restricted distribution to the Sierra Madre Oriental. Rzedowski & Calderón de Rzedowski (1992) mentioned *L. tenellum* as a species in danger of extinction.

Specimens examined:—MEXICO. Chiapas: La Independencia, Lake shore of Montebello, 1588 m, 16°06’16.81”N, 91°41’23.2”W, 2 May 1945, *A.J. Sharp 45453* (MEXU!). Queretaro: Arroyo Seco, Aprox. 3 km de San Juan Buenaventura, 1460 m, 8 December 1988, *E. Carranza 1236* (IEB!); Landa, 2 km al SO del Madroño, 1720 m, 8 May 1989, *E. González 550* (IEB!, MEXU!). San Luis Potosi: Rioverde, Parque Nacional El Potosí, 2187 m, 1 March 2018, *A.K. Gudiño-Cano et al. 646* (SLPM). Tamaulipas: Piedra Iman, 2 km al ESE de Sn. José, Sierra Sn. Carlos, 790 m, 24°40’30”N, 90°06’00”W, 22 November 1984, *O. Briones 1245* (ANSM!). Veracruz: Atzalan, La Florida, 1700 m, 2 April 1976, *F. Ventura A. 12609* (SLPM!, XAL!); Coacoatzintla, Coacoatzintla, 1200 m, 14 May 1973, *F. Ventura A. 8294* (IEB!, XAL!); Miahuatlán, 5 km al SE de la Colonia Reforma, 1750 m, 19°43’00”N, 56°51’00”W, 24 April 1979, *J.I. Calzada 5331* (XAL!); Tonayan, Desviación de Tonayán, 1600 m, 1 June 1981, *M. Chazaro B. 156* (XAL!).

Linum usitatissimum Linnaeus (1753: 277). (Fig. 10d).

Type:—Habitat hodie inter segetes, Europae australis. *Herb. Clifford 114*, Linum no. 1. (lectotype BM!).

Linum angustifolium Hudson (1778: 134).

Linum humile Miller (1768: 2).

Description:—*Herbs*, annual, 20–100 cm in height, glabrous, root thick; *stems* erect, smooth to simple striate, sometimes sparsely branched from the base, cylindrical, glabrous. *Leaves* entire, alternate, linear to linear-lanceolate, 10.0–40.0 × 0.7–3.0(4.0) mm, sessile, apex acute to acuminate, 1-nerved, scariose, glabrous, stipular glands absent. *Inflorescence* an open cymose panicle, glabrous; pedicels glabrous, 20-35 mm long; *bracts* 10.0–24.0 mm long, glabrous, margin entire, apex acute, stipular glands absent; *sepals* persistent, elliptical to ovate, 5–8 mm long, margin entire, thoroughly ciliated toward the apex or finely ciliate-fimbriate, scariose, apex acuminate, 1-nerved, stipular glands absent; *petals* blue, obovate, 9–15 mm long, glabrous; *stamens* 4.0–5.0(7.0) mm long; anthers (1.0)1.8–2.0 mm long, bright-yellow; staminodia absent; *styles* free or connate at the base, 3.0–6.0 mm long; stigmata linear or claviform, white. *Fruit* widely ovate to subglobose, yellow, 6–10 × 5–10 mm, glabrous, pericarp thick, apex rounded, dehiscent into 10 segments; false septa ciliated; *seeds* lanceolate, brown, 4.0–6.0 × 2.5–3.0 mm.

Distribution:—Native of Europe and Asia (India, Eastern Mediterranean and Near East). Introduced in America, in Canada, United States of America; in Mexico, in Coahuila, State of Mexico, Jalisco, Michoacan, Nuevo Leon, and Sonora (Fig. 2b); to South America; in Asia (far East), South Africa, and Australia.

Habitat and ecology:—Ruderal and cropland. Elevation 1900–3000 m. Limestone Andosol, Cambisol, Phaeozem, Planosol, Regosol, and Vertisol soil types.

Phenology:—Flowering and fruiting throughout the year.

Note:—This blue-flowered species can easily be confused with *L. lewisii*; however, the size of the plant, leaves, and fruits are larger in *L. usitatissimum*. Besides, the linear to claviform styles, as well as its habitat, are key characters for differentiating the species.

Conservation status:—*Linum usitatissimum* is the only species of the family in Mexico that is introduced and naturalized. It is considered a crop, ruderal and weed species (Martínez-Orea *et al.* 2020).

Specimens examined:—MEXICO. Coahuila: Saltillo, Invernadero UAAAN Buenavista, 1750 m, 25°21'25"N, 101°02'04"W, 13 May 1986, *L. Arce 288* (ANSM!). State of Mexico: Texcoco, 2240 m, 19°29'28"N, 98°52'47"W, 14 August 1976, *S.D. Koch 76151* (CHAPA!); Texcoco, Campo Experimental Chapingo, 2250 m, 19°29'00"N, 98°53'00"W, 11 October 1984, *G. Vázquez C. 33* (CHAPA!); Villa Guerrero, Entre el Pueblo y la Autopista, 2267 m, 18°59'20.3"N, 98°38'53.9"W, 6 October 2000, *H. Vibrans 6781* (CHAPA!). Jalisco: Chapala, Carretera Ocotlán-Atequiza, 1500 m, 20°19'38"N 103°11'08"W, 20 May 1968, *L.M.V. de Puga 2727* (IBUG!); Ocotlán, 20°20'45"N, 102°46'12"W, 1 April 1973, *J. Fdo. Amador A. 25* (IBUG!); Tepatitlán, 20°48'26"N, 102°46'07"W, 1 December 1977, *T. Tejeda 135146* (IBUG!); Zapopan, Villa Universitaria al W de Guadalajara, 1550 m, 20°41'47"N, 103°24'47"W, 15 March 1975, *L.M.V. de Puga 17066* (IBUG!). Michoacan: Pátzcuaro, Salida a Uruapan, 2100 m, 19°29'36"N, 101°36'00"W, 20 September 1993, *J.M. Escobedo 2649* (IEB!). Nuevo Leon: Galena, Cerro el Potosí cerca de San José de la Joya, 3200 m, 24°53'12.8"N, 100°14'28.6"W, 24 September 2011, *E. Estrada et al. 20955* (ANSM!). Sonora: Cajeme, Distrito Guaymas, 28°05'26"N, 110°00'47"W, 18 May 1957, *J. Corral 44* (CHAPA!).

Linum vernale Wooton (1898: 452). (Fig. 12).

Type:—UNITED STATES OF AMERICA. New Mexico: Dona Ana Co., Little Mountain, near Las Cruces, *E.O. Wooton s.n* (holotype US!, isotype NY!).

Cathartolinum vernale Small (1907j: 80).

Mesynium vernale (Wooton) W.A.Weber (1984: 3).

Description:—*Herbs*, annual, 10–50 cm in height, glabrous, root thick; *stems* erect to ascending, slightly striate, branched at the base and inflorescences, glabrous. *Leaves* entire, alternate; basal leaves opposite, numerous in the lower part of the stem; linear, 8.0–17.0 × 0.5–1.3 mm, sessile, apex acute, whitish; 1-nerved, nerve most evident on the abaxial surface; scariose, glabrous, stipular glands present at the base. *Inflorescence* an open panicle, pedicels 2.0–12.0 mm long; *bracts* 3.4–6.6 mm long, glabrous, margin glandular-dentate, apex acute, whitish, stipular glands present at the base; *sepals* persistent, lanceolate, 4.0–7.5 × 1.3–1.6 mm, margin glandular-dentate; apex acute-acuminate, whitish; 1-nerved, stipular glands absent; *petals* yellow-orange to salmon, reddish base, widely obovate, 10.0–17.0 mm long, glabrous; *stamens* 4.0–8.0 mm long; anthers 1.0–1.8 mm long, brown; staminodia absent; *styles* fused to near the apex, 4.0–8.0 mm long; stigmata capitate, dark red. *Fruit* ovoid, yellow, 3.0–4.0 × 2.5–3.2 mm, glabrous, pericarp thick, apex acute, dehiscent into 5 segments, false septa incomplete; *seeds* elliptical, reddish-brown, 2.0–2.8 × 0.9–1.3 mm.

Distribution:—United States of America; in Mexico, in Chihuahua, Coahuila, and Nuevo Leon (Fig. 5c).

Habitat and ecology:—Yucca shrublands, thornless or sub-thornless small-leaved shrubland, and pine forests. Elevation 1200–2400 m. Limestone Cambisol, Phaeozem, Lithosol, Solonchak, and Xerosol soil types.

Phenology:—Flowering and fruiting in March–September.

Note:—*Linum vernale* has yellow-orange to salmon corollas, with a reddish base. This coloration facilitates recognizing the species. Besides, *L. vernale* is distinguished from other yellow-flowered species by the attachment of the styles and its dark-red anthers.

Conservation status:—According to the criterion and subcriteria B established by the IUCN (2019), *L. vernale* can be considered LC (EOO = 127,222.723 km^2), and although its AOO is 44 km^2, it is known from > 10 localities. In addition, its distribution range reaches several localities outside the country.

Specimens examined:—MEXICO. Chihuahua: Chihuahua, Parque Cumbres de Majalca, 2075 m, 02 August 1997, *C. Yen & E. Estrada 7699* (ANSM!); Just below the high ridge-crests at the northwestern end of the Sierra del Diablo, 29 July 1941, *R.M. Stewart 1000* (MEXU!). Coahuila: General Cepeda, Sierra de La Paila, 1750 m, 25°38'00"N, 101°35'00"W, 27 April 1990, *J.A. Villarreal et al. 5586* (ANSM!); Lampasos, 1.5 km al NE de La Mesa, 230 m, 20 March 1983, *O. Briones 1021* (ANSM!); Lampasos, 1.5 km al NE de La Mesa, 230 m, 20 March 1983, *O. Briones 1069* (ANSM!); Múzquiz, 5.70 km al sureste de las Esperanzas, 432 m, 27°42'31"N 101°18'20"W, 29

March 2015, *J.A. Encina et al. 5147* (ANSM!); Ocampo, Sierra del Carmen, 1300 m, 28°47’00”N, 102°30’00”W, 27 March 1992, *M.A. Carranza et al. 1337* (ANSM!); Rancho Vista Hermosa, 1458 m, 28°87’38”N, 102°60’29”W, 29 September 1997, *S. Wood et al. 97SW036* (ANSM!); Valley extending northeast from Tanque Armendais to south end of Sierra del Pino, 19 August 1940, *I.M. Johnston & C.H. Muller 370* (MEXU!); Zaragoza, Rancho Los Potros, Sierra El Burro, 1200 m, 28°55’00”N, 101°45’00”W, 14 July 1987, *D. Castillo-Quiroz 536* (ANSM!). Nuevo Leon: Los Ramones, La Presa, camino a la Hda. El Carrizo, 10 May 1979, *J.A. Villarreal 9526* (ANSM!); Los Ramones, La Presa, camino a la Hda. El Carrizo, 10 May 1979, *J.A. Villarreal 9527* (ANSM!).

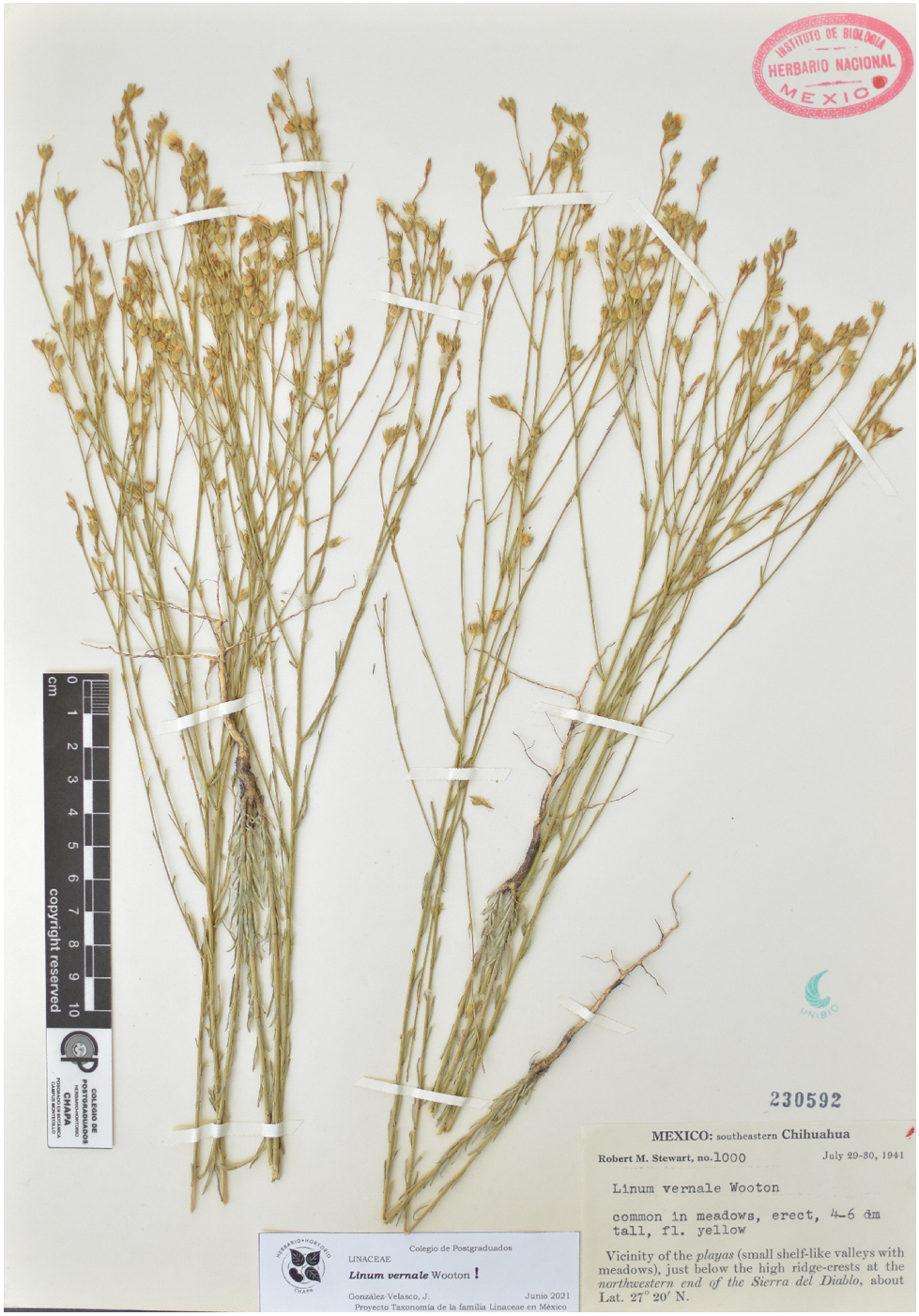

FIGURE 12. *Linum vernale*. Photography by José Luis Colin.

Taxa reported for Mexico and only known from the type material:

Linum gypsogenium G.L.Nesom (1983: 252). Type:—MEXICO. Nuevo Leon: gypsum outcrops, ca. 30 km ENE of Doctor Arroyo, *Nesom 4285b* (holotype US!).

Linum mcvaughii C.M.Rogers (1982a: 205). Type:—MEXICO. Jalisco, Pine and oak forest on a hill slope, between Cuale and Minas de Oro, municipality of Talpa, *R. González T. 466* (holotype MICH!).

Discussion

The diversity of the family Linaceae in Mexico is represented by 24 species and two varieties of the genus *Linum*, with 13 endemic species that account for 52% of the diversity of the family in the country and one species of the genus *Hesperolinon*. Of these, only *L. gypsogenium* and *L. mcvaughii* could not be reviewed, as these species are known only from the type material and descriptions of Rogers (1984b) in the Flora of North America. Considering that this material belongs to collections carried out in Mexican territory and that were observed in digital form, it was decided to count them among the species present in the country. However, they are not included in the dichotomous key, and their description is also not included, as supporting specimens were not available. In addition, in the notes by Rogers (1984b) to the descriptions, this author mentions that *L. gypsogenium* is very similar to *L. scabrellum*, with the only differences being the presence of glands in the apex of hairs and upper leaves being smaller and scarce. In the case of *L. mcvaughii,* this same author mentions that it is very similar to *L. mexicanum*, from which it differs in having inflorescences with more extended branches, smaller and numerous leaves, and longer stamens and styles. Since the 1980s when both species were collected and described, no other specimens of these two species has been collected.

In addition, the presence of *L. guatemalense* Bentham (1844) and *L. lundellii* C.M.Rogers (1979) in Mexican territory is reported in the literature (Rogers 1979, Villaseñor 2016, Barrera-Robles *et al.* 2020). However, no specimen supporting their presence in Mexico was located. According to the Flora of North America (Flora of North America Editorial Committee 2016), the only specimen of *L. lundellii* reported for the country from Nuevo Leon collected in 1934 (*C. H.Mueller & M. Mueller 470* (TEX)) may be misidentified. However, when searching the databases, other collections were found, one from 1944 (*J.T. Painter & F.A. Barkley 14412* (TEX)) from the state of Tamaulipas, and a more recent collection from 2010 (*M.A. Guzmán L.* 255 (TEX)) of Nuevo Leon; both are consistent with the distribution reported by Rogers (1979, 1984b), but could not be reviewed because the respective material was not available. Likewise, Rogers (1968) indicated that *L. guatemalense* is known only from Guatemala and El Salvador. This same author reports that this species is intermediate in many respects with *L. mexicanum* and *L. orizabae*, which suggests that it is likely to be a variety. For the above, neither of these two species could be corroborated and, therefore, considered as species distributed in Mexico.

The taxonomic richness figures reported here contrast with those mentioned by Villaseñor (2016), who indicates the presence of a single genus of Linaceae with 25 species, while Barrera-Robles *et al.* (2020) report two genera, 27 native species, and two varieties. The present work supports the presence of the genus *Hesperolinon* in Mexico and reduces the number of species of *Linum* to 24 native and one introduced species, plus two varieties.

Despite recent phylogenetic studies (McDill *et al.* 2009, Schneider *et al.* 2016) having suggested transferring the species of the genus *Hesperolinon* to *Linum*, our taxonomic review shows, at least at the morphological level, clear differences between the two genera, supported in sufficiently solid characters to maintain them as separate genera. Likewise, the distribution ranges of both genera are well differentiated, with *Hesperolinon* restricted to the California biogeographic province (Delgadillo 1998, Morrone 2006), which contributes to support the separation between both genera. However, caution should be exercised pending further evidence to shed light on this controversy.

The present review uncovered three main issues affecting the taxonomy in the family: the recurring practice of using invalid names, multiple identification errors, and the small number of collections of specimens belonging to the family in recent years. An example worth noting is the case of *Linum pratense* (Norton) Small (1907m: 69), which Villaseñor (2016) listed as a species present in the state of Aguascalientes, but that Barrera-Robles *et al.* (2020) exclude from their listing. In the present revision, no specimens of this species of Aguascalientes were found, but we located five specimens identified as *L. pratense* (*S.D. Koch 75289* (CHAP!, CHAPA!), *S.D. Koch & J. Magaña M. 75471* (CHAPA!), *S.D. Koch 75704* (CHAPA!), *R. Vega A. 229* (CHAPA!)), collected in the municipality of Ixtapaluca, plus one specimen collected in Chalco (*E. Garcia M. 12556* (CHAPA!)), all in the State of Mexico. The analysis of this material revealed that the distribution of these specimens is inconsistent with the distribution reported previously for *L. pratense*, known only from Kansas, Oklahoma, Colorado, Texas, and Arizona (Rogers 1984b, Uno 1984, Crawford & Crawford 2005). In addition, Harris (1968) reports that this species thrives in plains but not in montane regions. We were able to observe that the specimens reviewed under the name *L. pratense* have a decumbent bearing and generally meet the diagnostic characteristics to clearly identify them as *L. rzedowskii*, a species of blue flowers that is microendemic to the Valley of Mexico (Arreguín 2001, Martínez-de la Cruz *et al.* 2018). The material in question was collected between 1974 and 1978, when *L. rzedowskii* had not yet been described (Arreguín 1985), so this is likely the cause of the confusion in the identification of the material.

Another example is *L. scabrellum*, which was recurrently found under the name *Linum macradenium* Brandegee (1911: 181), now a synonym for the species. Also, we found 78% of the specimens of *L. berlandieri* var. *filifolium* identified as *L. rigidum* var. *filifolium*, a current synonym of the variety. It was common to find material identified as *L. cruciata* and *L. cruciatum*. The revision of the taxonomic characters indicates that all these specimens belong to the same species. However, no document supporting the nomenclatural change of the specific epithet from *cruciate* to *cruciatum* was found in the literature; therefore, in coincidence with Rogers (1968, 1984b) and McDill *et al.* (2009), in the present work we consider *Linum cruciata* as the valid name, which was proposed by Planchon in 1848b.

The number of dehiscent segments in the fruit is a relevant character for separating species. However, material with fruits dehiscent into 10 segments were misidentified as species with fruits dehiscent into 5 segments (*O. Briones 683* (ANSM!), *F. Wyndham 20* (CIIDIR!, MEXU!), *S. González 1948* (ANSM!, ENCB!), *C. Trejo-Díaz 203* (MEXU!), *P. Tenorio L. & T.P. Ramamoorthy 9208* (MEXU!), *M. Chazaro B. et al. 6094* (XAL!), *Hinton et al. 17662* (IEB!)). The same happened with the species of 5 segments (*J.A. Encina et al. 5147* (ANSM!), *J.A. Encina et al. 5415* (ANSM!)).

The distribution of taxa is another relevant aspect. Rogers (1968, 1984b) reported *L. aristatum* in the state of Chihuahua, while Villaseñor (2016) also reported it in the states of Coahuila and Sonora. The revised material from *K.L. Wallace et al. 136* (ENCB!), *J. Henrickson 5780* (MEXU!), *T.L. Wendt et al. 9922* (MEXU!), *C.G. Pringle 8312* (MEXU!), supports the presence of the species in Chihuahua and Coahuila, but not in Sonora. In addition, the specimen from *N.T. Heard & F.A. Barkley 14604* (MEXU!) supports its presence also in the state of Tamaulipas, thus expanding its known range of distribution. Similarly, *L. modestum*, a species that Rogers (1968, 1984b) reported as occurring only in a small area of the state of Nuevo Leon, was recently mentioned living also in the states of Coahuila, San Luis Potosi, and Tamaulipas (Villaseñor 2016). However, the present revision supports Rogers (1968, 1984b), as no evidence of the presence of this species outside of Nuevo Leon was found. Moreover, *L. modestum* requires a gypsum-rich habitat for its establishment and subsistence, since it is a case of edaphic endemism (Nesom 1983). The particular habitat requirements of this taxon make it one of the most vulnerable taxa in the family, as open-pit mining operations and a significant increase in human settlements have been reported within its range, which undoubtedly threaten the viability of its populations (Toledo 2005, Salinas-Rodríguez 2015), and that in this work it was classified as Endangered according to the IUCN criteria (2019).

The detailed review of the Linaceae species in Mexico confirms a new record of *L. longipes* for the state of Morelos, supported by the specimen *I. Rivera 25* (MEXU!, UAMIZ!) that was originally identified as *L. mexicanum*. This increases the richness of the Linaceae in that state from five (Barrera-Robles *et al.* 2020) to six species and expands the distribution range of *L. longipes*, which was previously known to comprise the states of Guerrero and Puebla only (Rogers 1968, Villaseñor 2016, Barrera-Robles *et al.* 2020). Besides, for the state of Zacatecas, the richness also increases from two to three species by corroborating *L. schiedeanum* as a new record (Hurtado-Reveles *et al.* 2022), supported by the analysis of the specimen *L. Hurtado-Reveles 135* (CHAPA!). The above is relevant as the lack of an adequate sampling effort in various regions of Mexico may explain the limited or null representation of flax plants in certain states, e.g., Baja California, Colima, and Zacatecas.

Among the taxonomic difficulties in the identification of species, the case of *L. flagellare* and *L. rupestre* stands out; however, the presence of prominent stipular glands at the base of all its leaves in the latter is a key character to differentiate them. Despite this remarkable difference, we found *L. rupestre* material misidentified as *L. flagellare*, and vice versa. For its part, *Linum lewisii* can be confounded with the agricultural species *L. usitatissimum*, although *L. lewisii* can be easily recognized given its distribution range, its unique habitat, its smaller vegetative structures, white anthers, capitate stigmata, and the acute apex of the fruit.

One of the most relevant cases is the difficulty of separating *L. orizabae* and *L. mexicanum*, which had already been reported by Burgos-Hernández & Castillo-Campos (2019, 2020). Both species, endemic to Mexico, share a similar morphology, as well as being sympatric across much of their area of distribution. The only character that can differentiate these two species is the styles, which are free in *L. orizabae* and fused to ½ their length or even to the apex in *L. mexicanum*. This has led to multiple identification errors, as about 13% of the revised material of both species were misidentified. The present review found that the specimens of *L. mexicanum* (*F. Ventura A. 11306, 16079*, *17484* (XAL!), *C. Duran E. & P. Burgos 496* (XAL!), *C. Duran E. & M. Bielma* 945 (XAL!)) reported for the Flora of Veracruz by Burgos-Hernández & Castillo-Campos (2019, 2020) actually correspond to *L. orizabae*. This restricts the distribution range of *L. mexicanum* to the states of Chiapas, Guerrero, Jalisco, Mexico City, Michoacan, Morelos, Oaxaca, Puebla, Queretaro, and State of Mexico, and reduces the species richness of flax in Veracruz. In spite of the present review, both *L. mexicanum* and *L. orizabae* require a comprehensive work including various lines of evidence to add clarity to their areas of distribution and rule out that the variation in style traits is not only a consequence of phenotypic plasticity.

Until the present work, no study has previously evaluated the conservation status of the flax species distributed in Mexico, so except for *L. orizabae*, no species is listed or protected under Mexican (SEMARNAT 2010) or international regulations (IUCN 2021). However, after the evaluation carried out in this study following IUCN criterion B (IUCN 2019), it is possible to say that nine species are Endangered (EN), five are Vulnerable (VU), one is Near Threatened (NT), and nine are of Least Concern (LC). Eleven of the 13 endemic species and two rare species (*L. aristatum*, *L. elongatum*) stand out, whose degree of threat could be exacerbated due to their restricted distribution range, even within Mexican territory, which is reflected in their scarce representation in herbaria. In addition to our evaluation is the anthropic climate change scenario, since the annual winter flowering species that grow in northeastern Mexico, such as *L. elongatum* and *L. lundellii*, and the endemic *L. lasiocarpum* and *L. modestum*, are in this sense more vulnerable (Guzmán-Lucio *et al.* 2013, Gutiérrez-García & Ricker 2019). Something similar occurs with *H. micranthum*, categorized here as EN and which, although not endemic to Mexico, is endemic to the serpentine soils of the California biogeographic province. As reported by Morrone (2019), this province is undergoing a boost in human settlements, tourism, and change in land use, all of which may threaten the permanence, not only of this species, but also of the 12 additional species in the genus.

In conclusion, the present revision reduces the number of species present in Mexico and supports not only the presence of the genus *Hesperolinon* in the country, but also its morphological separation from the genus *Linum*. This work highlights the need to conduct further efforts to collect specimens of Linaceae in Mexico, especially in little explored areas and focusing on species that are poorly represented in herbaria that might be threatened given their restricted distribution range. In this regard, we strongly recommend carrying out more studies focused on assessing the conservation status of the Mexican flax species encompassing other criteria to incorporate them into both national and international regulations.

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